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NUCLEAR LEGISLATION IN OECD COUNTRIES

Regulatory and Institutional Framework for Nuclear Activities

United States

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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NUCLEAR ENERGY AGENCY

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

The mission of the NEA is:

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

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

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

UNITED STATES

This chapter was last revised in 1999 and is correct as of that date.

The NEA Secretariat is currently revising this chapter in close consultation with the national authorities and plans to issue a new version in the near future.

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UNITED STATES

[cont'd]

I. GENERAL REGULATORY REGIME

1. Introduction

The centrepiece of nuclear legislation in the United States is the Atomic Energy Act of 1954, a comprehensive statute which replaced the Atomic Energy Act of 1946 [Atomic Energy Act of 1954, as amended, United States Code (USC) 2011 *et seq*.].[1]

In the United States, the Federal Government has assumed most responsibility for regulating nuclear energy. For example, federal legislation and administrative regulations govern facility licensing. Usually, the States can regulate those nuclear activities that the Federal Government has chosen not to address so long as the State regulation does not conflict with federal law. However, in the nuclear field, courts recently have struck down State efforts to regulate high-level radioactive waste disposal and transport of radioactive materials, on the basis that federal regulation is pervasive in the nuclear field. States can adopt more stringent standards for radioactive air pollutants than federal standards governing the same activities. Sometimes, the States agree to assume control over an activity which normally would be regulated by the Federal Government. Pursuant to agreements with the Nuclear Regulatory Commission (NRC), under Section 274 of the Atomic Energy Act of 1954, 31 States, called "Agreement States", regulate materials covered by the agreement, such as by-product, source and special nuclear material for the protection of the public health and safety from radiation hazards. If the NRC finds that to do so is necessary to protect public health and safety, the NRC may terminate or suspend all or part of any such agreement. Further, the NRC retains regulatory

1. In the United States, federal laws generally are cited as "xx USC, Section xxx" which refers to a title and section of the United States Code. The US Code is arranged by subject matter, for example Title 42 contains public health and safety laws, including the Atomic Energy Act of 1954 and the Nuclear Waste Policy Act of 1982. Laws are sometimes also cited as "xx Stat. xxx" which refers to the Statutes at Large, a chronological compilation of all American legislation without regard to subject matter.

   Later in this study, citations to the Code of Federal Regulations (CFR) appear. When an Administrative agency promulgates a regulation, it usually publishes the proposed rule in the Federal Register (Fed. Reg.). After public comment, the final rule is published in the Register. Citations to the Register appear as "xx Fed. Reg. xxx" meaning volume and page number. It is also included in the Code of Federal Regulations, updated yearly. The CFR is arranged into titles which do not correspond numerically to parallel subject areas in the USC. For example, while most nuclear regulations can be found in 10 CFR, they do not appear in Title 42 of the USC which addresses nuclear law. The CFR is arranged into titles, subdivided into chapters, parts and then into subparts and sections.

2. Nuclear reactors owned and operated by the US Department of Energy and the US Department of Defense are not licensed or regulated by the NRC, and are not covered here. In addition, the licensing and regulation of non-power reactors (*e.g.* research reactors), as well as other nuclear facilities such as waste disposal sites, uranium mills, storage centres, burial sites, or other installations are not covered here. See under Mining, Exports, Waste Management and Transport, respectively.

responsibility for: construction and operation of any production or utilisation facility or uranium enrichment facility; export from or import into the United States of by-product, source or special nuclear material, or any production or utilisation facility; and disposal of such other by-product, source, or special nuclear material as the NRC determines should not be disposed of without a licence.

Congress enacted a general framework of legislation governing nuclear energy centred around the Atomic Energy Act of 1954 which marked a transition from the Federal Government's monopoly over production and use of atomic materials to a regime in which private industry would also play a role in their production and use. Military uses of nuclear energy remained however exclusively the domain of the Federal Government. Initially, the Atomic Energy Commission (AEC) constituted an independent agency to oversee the peaceful use of atomic energy. Congress abolished that agency, when it enacted the Energy Reorganization Act of 1974 which created the NRC and transferred to it all the licensing and related regulatory functions previously assigned to the AEC. The remainder of the AEC's functions were transferred to the Energy Research and Development Administration (ERDA). The Department of Energy Organization Act of 1977 abolished ERDA and vested the Department of Energy (DOE) with power over most other aspects of nuclear energy.

2. Mining Regime

Despite some uranium mining activity in the United States, the Atomic Energy Act does not address mining in any detail. [42 USC 2099-2198]. Since the early 1950s, the Atomic Energy Commission and its successors have made estimates of American uranium ore reserves and potential uranium supplies.

The NRC is responsible for licensing extraction of source material, defined as uranium or thorium or any ores containing those materials in such concentration as the NRC may determine by regulation. In 1999, six uranium recovery facilities were licensed to operate. Several other mills were in shut-down or decommissioning status [42 USC 2092, 2014 and 2111] (for details of the licensing process, see Section 3 "Radioactive Substances, Nuclear Fuel and Equipment" *infra*).

The Bureau of Mines in the Department of the Interior (DOI) controls all federal lands with valuable mineral deposits. Commercial operators can lease the land in order to mine uranium or other minerals, but the land is reserved from sale by the Federal Government. The DOE also issues permits specifically for uranium exploration.

The DOE can require detailed reports on mining of source material, but not prior to actual removal from its place in nature. Regulations must not discourage independent prospecting for new deposits. The Atomic Energy Act empowers the DOE to purchase any real property which might contain deposits of source material. The DOE can issue leases or permits to prospect for source material on federal lands and, by virtue of an executive order, can allow prospecting in national parks. In concert with permit requirements, no individual, partnership or corporation can benefit directly from confidential information learned about mineral deposits while participating in the DOE or NRC projects conducted on public land [42 USC 2095-2098].

3. Radioactive Substances, Nuclear Fuel and Equipment

Pursuant to the Atomic Energy Act, the NRC can issue licences to transfer or receive, own or possess, and import or export special nuclear material, source material, or by-product material.

Although the legislation discusses each category separately, the provisions are similar [42 USC 2073, 2092 and 2111].

On 21 July 1995, the NRC issued a final rule on Import and Export of Radioactive Waste. The rule amended NRC regulations governing the Export and Import of Nuclear Equipment and Material to conform to principles of the International Atomic Energy Agency (IAEA) International Code of Practice for the Transboundary Movement of Radioactive Waste. Before the amendments, the rules were predominantly concerned with nuclear proliferation significance. In the light of IAEA safety standards, the amendments step up controls on radioactive waste and require specific licences to export or import "radioactive waste", including mixed waste. The definition of "radioactive waste" effectively excludes certain categories of shipments from the requirements for specific licensing. The rule also distinguishes for different treatment a separate category of "incidental radioactive material" [60 Fed. Reg. 37556 (1995); 10 CFR Part 110]. The NRC will consult with the Department of State and other federal agencies regarding proposed exports of radioactive waste. For all proposed exports and imports, consultation with transit countries will occur to ensure that necessary approvals will be obtained.

a) Special nuclear material

The term "special nuclear material" means plutonium, uranium enriched in the isotopes 233 or 235, and any other material which the NRC determines to be special nuclear material. It also includes any material artificially enriched by any of the foregoing substances, but the term does not include source material. In order to add substances to the list, the NRC must find such material capable of releasing substantial quantities of atomic energy and that the determination that the material is special nuclear material is in the interest of the common defence and security. The President must also give his written assent. Congress has thirty days to disapprove the action [42 USC 2014(a), 2071].

The NRC can issue licences to use special nuclear material for research and development activities [described at 42 USC 2051], in the context of medical therapy [described at 42 USC 2134], or by commercial entities [described at 42 USC 2133] for purposes consistent with the intent of the Act [Section 53(a)-(c); 42 USC 2073(a)-2073(c)]. Originally the AEC (predecessor to the NRC) could distribute special nuclear material by sale, lease with option to buy, or in return for in-kind services. Now, the government generally requires facility operators to buy special nuclear material. The DOE itself establishes a reasonable price scale and may agree to repurchase any unused material.

The NRC can regulate licences by explicitly defining all conditions and limits of ownership, by forbidding assignment of licences, and ensuring that no licensee will be able to construct an atomic weapon. Except when provisions of the Price-Anderson Act apply for indemnification against third-party liability, licensees must hold the government and the NRC harmless for any losses resulting from the use or possession of the material [42 USC 2073(e)]. The DOE must allocate sales of such material on the basis of the project's probable contribution to basic research, to the development of peaceful uses of atomic energy, or to the economic and military strength of the United States [42 USC 2073(f)].

The DOE controls the unlicensed foreign distribution of special nuclear material, while the NRC licences exports. Many of the export regulations reflect the provisions of the Nuclear Non-Proliferation Act (this aspect is dealt with under Section 7 "Non-Proliferation and Exports", *infra*). Subject to certain price limitations, the government can purchase back special nuclear material produced abroad which is generated by the use of special nuclear material, originally leased or sold by the United States, which was not consumed during the course of an agreement for co-operation, or any

uranium remaining after irradiation [42 USC 2074(a)]. There is a statutory exemption from the export licensing requirement for the DOE to supply small amounts of special nuclear material contained in laboratory samples or medical devices to foreign users or when needed in an emergency [42 USC 2074(d)].

A person subject to the Atomic Energy Act may engage in the production of special nuclear material outside the United States only if this activity is pursuant to the Nuclear Non-Proliferation Act and agreements negotiated in accordance with its provisions, or if specifically approved by the Secretary of Energy. Any approval by the Secretary of Energy shall be made only with the concurrence of the Department of State and after consultation with the Department of Commerce, the Department of Defense and the NRC [42 USC 2077].

b) Source material

The term "source material" is defined as uranium, thorium or any other material which the NRC determines to be source material. It also includes ores containing one or more of the foregoing materials in such concentration as the NRC may establish by regulation [42 USC 2014(z)]. If the Commission seeks to enlarge the definition of source material, it must find that the material is essential to the production of special nuclear material and that its designation as source material is in the interest of the common defence and security. The President must agree in writing and Congress has an opportunity to review the determination [42 USC 2091].

A person needs a general or specific licence to transfer, own, export or import, or extract source material except that licences are not required for quantities of source material which, in the opinion of the NRC, are unimportant. Provisions involving foreign and domestic distribution of source material generally parallel those for special nuclear material [42 USC 2092-2094, 10 CFR Part 40]. There are, however, special reporting requirements with respect to ownership, possession, extraction, and refining of source material [42 USC 2095].

c) By-product material

The term "by-product material" means any radioactive material (except special nuclear material) yielded in, or made radioactive by exposure to the radiation incident to the process of producing or utilising special nuclear material. It includes the tailings or wastes produced when source material is milled [42 USC 2014(e)].

Licensing requirements similar to those for possession of special nuclear material or source material apply to by-product material. The Department of Energy is to encourage maximal development of peaceful application for by-product material. To this end, the government can distribute by-product material with or without charge to qualified users, subject to health and defence considerations. Any price schedule inaugurated by the DOE must not discourage private enterprise from competing with government sources. The NRC can exempt certain users from the necessity of a licence, or may decide that, for certain types of by-product material, the strict structure of a licensing scheme is not warranted. The government controls the export of by-product material with a system somewhat similar to that for special nuclear and source material [42 USC 2111 and 2112].

Licences for ownership of by-product material in the form of mill tailings must contain conditions to ensure that the licensee will comply with decontamination or decommissioning requirements. Ownership of by-product material at sites where ores were processed primarily for their

source material content and where such by-product material is deposited reverts to the Federal Government or to the States, if they have exercised an option to acquire it, following termination of the licence (see Section 6 "Radioactive Waste Management", *infra*).

The NRC is responsible for overseeing compliance with decontamination and decommissioning requirements. When land or by-product ownership passes to the United States, the DOE becomes the competent authority to monitor the facilities in conjunction with State agencies [42 USC 2113(b)].

d) State programmes

The NRC administers over 5 000 licences, and 31 States handle an additional 16 500 licences pursuant to agreements with the NRC pursuant to Section 274(b) of the Atomic Energy Act [42 USC 2021]. Under these agreements, the NRC continues to issue licences for construction and operation of production or utilisation facilities; export from or import into the United States of by-product, source or special nuclear material or any production or utilisation facility; disposal of source, by-product or special nuclear material into the ocean or sea; transfer, storage or disposal of radioactive waste resulting from separation in a production facility of special nuclear material from irradiated nuclear reactor fuel (*i.e.* a reprocessing plant); manufacture and distribution of consumer products containing radioactive material (*e.g.* smoke detectors, ceramics, and watches) [10 CFR Part 150, Section 150.15]. In addition, the NRC has retained authority over licensing and regulation of spent nuclear fuel in an independent spent fuel storage installation (ISFSI) and spent nuclear fuel and high-level radioactive waste in a monitored retrievable storage installation (MRS) constructed by the DOE and licensed pursuant to 10 CFR Part 72.

4. Nuclear Installations[2]

a) Initial licensing

The NRC licenses all commercial nuclear power reactors in the United States pursuant to authority conferred by the Atomic Energy Act and the Energy Reorganization Act of 1974. Within the NRC, the Office of Nuclear Material Safety and Safeguards licenses fuel cycle facilities and the Office of Nuclear Reactor Regulation issues reactor licences [42 USC 5801, 5843 and 5844].

The NRC has two different approaches for licensing of nuclear power plants. From the beginning of commercial nuclear power plant licensing under the Atomic Energy Act of 1954, nuclear power plants were licensed in a "two-step" process involving issuance of a construction permit allowing a utility to construct a nuclear power plant, followed by issuance of an operating licence allowing the utility to operate the plant. The NRC's current licensing requirements under this two-step approach are contained in 10 CFR Part 50. In 1989, the Commission adopted a new approach for licensing of nuclear power reactors in 10 CFR Part 52, and that approach was made part of the Atomic Energy Act in 1992 [the Energy Policy Act of 1992 added new Sections 185(b) and 189(a)(1)(B) to the Atomic Energy Act]. Each of these two approaches are briefly described below.

i) "Two-Step" licensing under 10 CFR Part 50

The formal construction permit licensing process begins with filing of a construction permit application containing information addressing safety, environmental impact and physical protection for the proposed design of the plant, as well as antitrust information. If the NRC determines that the application is complete, it accepts the application by formally docketing it and publishing a notice in the Federal Register, and distributing the application to relevant federal, state and local agencies and officials.

The NRC staff undertakes a safety review of the proposed design for the nuclear power plant in accordance with the Standard Review Plan (SRP), a guide containing requirements for each system, component, and structure important for safety. Once the staff finish the Safety Evaluation Report, the Advisory Committee on Reactor Safeguards (ACRS), a statutorily-created committee which advises the Commission with regard to the hazards of existing or proposed reactor facilities and the adequacy of proposed reactor safety standards, completes its review and meets with NRC staff and the applicant. It then submits a letter report to the NRC presenting the results of its independent analysis and recommending whether NRC should issue a construction permit. In accordance with the National Environmental Policy Act of 1969 (NEPA), the NRC conducts an environmental review of the application and prepares an environmental impact statement (EIS) which evaluates the environmental impacts of constructing and operating the proposed plant. A draft EIS is first proposed and published for comment, followed by a final EIS which addresses all comments received. This environment review is parallel to, but separate from consideration of safety aspects of the application. The NRC also conducts a preliminary antitrust review, and refers the application to the US Attorney General's Office for its advice on antitrust. Once the Attorney General provides its advice in a report, the NRC publishes the Attorney General's advice, together with the NRC's final determination on antitrust issues.

A public hearing is required to be held on the construction permit application. An Atomic Safety Licensing Board (ASLB) presides at the hearing and issues an initial decision as to whether a construction permit should be granted. Issues which may be raised by interested parties include safety, environmental, and antitrust issues related to issuance of the construction permit. The initial decision may be appealed to the Commission. Following final NRC action on any appeal, a dissatisfied party can petition for review by the appropriate US Court of Appeals. Otherwise, the Director of the Office of Nuclear Reactor Regulation issues the construction permit.[3]

Two or three years before the scheduled completion of construction, the utility files an application for an operating licence. The purpose of the NRC review at this stage is to determine whether the nuclear power plant has been constructed in accordance with the design approved in the construction permit and the Commission's regulations, and that there is reasonable assurance that the plant can be operated without endangering the public health and safety. While environmental impacts of issuance of the operating licence are required to be evaluated in a supplemental EIS, the review is limited to changes that have occurred since the construction permit EIS. No further consideration of alternative sites is necessary in the supplemental EIS. Finally, as a general matter, an antitrust review

3. The NRC can issue a Limited Work Authorization (LWA) in advance of the final decision on a construction permit if: (1) all environmental and site selection issues for the construction permit have been resolved, and (2) the Atomic Safety and Licensing Board (ASLB) concludes that there is reasonable assurance that the proposed site would be suitable from the standpoint of radiological health and safety for a reactor of the general size and type proposed. The LWA may also authorise installation of the structure foundation, if the ASLB determines there are no unresolved safety issues relating to the installation of the foundation.

is not required at the operating licence stage. A public hearing on the operating licence application is not mandatory, but may be conducted on petition by an interested party or at the NRC's option.

ii) Licensing under 10 CFR Part 52

10 CFR Part 52 was adopted by the NRC to obtain early resolution of safety issues, facilitate standardisation of plant designs, and simplify the "two-step" licensing process, through:

- Early Site Permits which resolve site suitability issues, including suitability of the site for emergency preparedness, and the existence of environmentally-superior sites;
- Design Certification rule making for specific nuclear power plant designs; and
- Combined Construction Permit and Operating Licences, which avoid the need for issuance of a construction permit and a separate operating licence.

Any person authorised to hold a construction permit under 10 CFR Part 50 may apply for an Early Site Permit under 10 CFR Part 52. The application must indicate the number, type, and thermal power level of the nuclear plants which may be placed on the site, and information which will allow the NRC to determine whether the site is suitable for construction and operation of nuclear power plants, in accordance with the relevant siting requirements in 10 CFR Parts 50 and 100, as well as the suitability of the site from environmental and emergency preparedness standpoints. The NRC Staff must prepare an EIS which addresses the applicable requirements of 10 CFR Part 51, including a review to determine whether there are any obviously superior sites. An Early Site Permit may be referenced by any applicant for a construction permit and operating licence under 10 CFR Part 50, or an applicant for a combined licence under Part 52.[4]

Any person may submit an application requesting the NRC to conduct a design certification rule making which approves a nuclear power plant design. The application must contain sufficient information for the NRC to make a final safety conclusion with respect to the adequacy of the design and must describe the inspections, tests, analysis and acceptance criteria (ITAAC) to be used in determining whether a plant referencing the design has been constructed in accordance with the design. The safety of the design is judged in accordance with technically-relevant requirements in 10 CFR Part 50. Once a design certification rule is adopted by the NRC, it may be referenced by any applicant for a construction permit or operating licence under Part 50 or a combined licence under Part 52, and all issues relating to the adequacy of the certified design are treated as resolved in the subsequent proceeding.

Finally, Part 52 authorises the NRC to issue combined construction permits and operating licences (combined licences). The application for a combined licence must include all the administrative and technical information required by 10 CFR Part 50. The application may (but is not required to) reference a design certification. Whether it references a design certification or not, the combined licence application must include the ITAAC for determining whether, once construction is completed, the plant has been constructed in accordance with the combined licence, the NRC's requirements, such that there is reasonable assurance that the facility will operate in accordance with

4. The Early Site Permit also allows the holder to perform the site preparation work that would be authorised under a LWA in 10 CFR Section 50.10(e)(1), if the Environmental Impact Statement for the Early Site Permit has determined that there would be no significant environmental impact stemming from such activities which cannot be redressed.

the combined licence. As with construction permits under 10 CFR Part 50, both an environmental review and antitrust review are conducted, and a mandatory hearing is held prior to issuance of the combined licence where interested parties may raise safety, environmental, and antitrust issues related to issuance of the combined licence. Before the plant may operate, the NRC must find that the acceptance criteria in the ITAAC have been met. The public has an opportunity to request a hearing to determine whether the ITAAC have been met.

b) Operation and inspection, including nuclear safety

Each operating licence contains detailed provisions relating to safety and environmental protection. The licensed facility undergoes periodic inspection during its operating life.

Each reactor site has at least a senior resident inspector and a resident inspector who devote their full attention to it during operation. NRC's regional offices also conduct numerous specialist inspections. There are team inspections run out of either the NRC regional offices or headquarters. The results of the NRC inspection activities are documented in publicly available inspection reports which reflect matters requiring further attention.

On a broader level, reactors are subject to a revised oversight process based on accepted performance indicators with a focus on a more risk-informed and performance-based evaluation and emphasis on a licensee's corrective action programmes.

In response to specific operational occurrences, the NRC may establish an Augmented Inspection Team (AIT) or Incident Investigation Team (IIT), depending on the severity of the occurrence. These teams are composed of experts representing disciplines of particular relevance to the events. They serve to identify issues of specific concern to the facility in question as well as issues of more generic concern to the regulated industry.

In addition to the NRC's direct involvement described above, licensees are required by NRC regulations, as well as by specific licence provisions, to submit certain types of information to the NRC. This may be done on a regular basis or in response to a particular event at the facility. Over the life of a facility, changes to the facility itself or to its operating requirements may be sought by the licensee. Although licensees may make certain changes without NRC approval, those with greater safety significance do require prior NRC approval through a formal amendment process.

In those situations in which the NRC, as a result of its oversight activities, identifies violations of regulatory requirements or other conditions which may significantly affect public health and safety, the NRC has a range of enforcement actions available to it. It may, for example, impose civil penalties, or may order modification, suspension or revocation of licenses.

At the international level, the USA ratified the 1994 Convention on Nuclear Safety on 11 April 1999.

c) Operating licence renewal

The Atomic Energy Act allows a nuclear power plant operating licence to be renewed. The NRC's procedures and requirements for renewal of operating licences are set forth in 10 CFR Part 54. Under current NRC requirements in 10 CFR Part 54, a renewed licence may be issued for a period not exceeding 20 years from the expiration of the current operating licence.

d) Decommissioning

The NRC has the statutory responsibility for protection of public health and safety and the environment related to the possession and use of source, by-product, and special nuclear material under the Atomic Energy Act. One part of NRC's responsibility is to assure safe and timely decommissioning of nuclear facilities which it licenses, and to provide guidance to licensees on how to plan for and prepare their sites for decommissioning. Decommissioning, as currently defined by the NRC, means to remove nuclear facilities safely from service and to reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the licence.

Decommissioning activities do not include the removal and disposal of spent fuel which is considered to be an operational activity or the removal and disposal of non-radioactive structures and materials beyond that necessary to terminate the NRC licence. Disposal of non-radioactive hazardous waste not necessary for NRC licence termination is not covered in the NRC regulations but would be treated by other appropriate agencies having responsibility over these wastes. If nuclear facilities are to be re-used for nuclear purposes, applications for licence renewal or amendment or for a new licence are to be submitted according to the appropriate existing regulation. Re-use of a nuclear facility for other nuclear purposes is not considered decommissioning because the facility remains under licence.[5]

Decommissioning activities are initiated when a licensee decides to terminate licensed activities. Once licensed activities have ceased, licensees are required to decommission their facilities so that their licences can be terminated. At present, this requires that radioactivity in land, groundwater, surface water, buildings, and equipment resulting from the licensed operation be reduced to levels that allow the property to be released for unrestricted use. Licensees must then demonstrate that all facilities have been properly decontaminated and that, except for any residual radiological contamination found to be acceptable to remain at the site, radioactive material has been transferred to authorised recipients. Confirmatory surveys are conducted by NRC, where appropriate, to verify that sites meet NRC radiological criteria for decommissioning.

Several hundred NRC materials licences under 10 CFR Parts 30, 40, and 70 are terminated each year. The majority of these licences involve limited operations, produce little or no radioactive contamination, and do not present complex decommissioning problems or potential risks to public health or the environment from residual contamination.

The NRC has a programme underway to effect timely decommissioning of about two dozen sites, which warrant special NRC oversight either because they have not been decommissioned properly in the past or have been engaged in the decommissioning process for an extended period. The NRC established a Site Decommissioning Management Plan (SDMP) in 1993 for effecting timely decommissioning of these problem facilities. Sites being handled under the SDMP vary in degree of radiological hazard, cleanup complexity and cost.

The decommissioning of commercial nuclear power plants is addressed in 10 CFR Section 50.82, which was adopted in 1996 [61 Fed. Reg. 39278, 21 July 1996].

5. In 1997, the NRC issued regulations which set forth residual radioactive release criteria for licence termination in 10 CFR Part 20 [62 Fed. Reg. 39058; 21 July 1997]. The criteria apply to all facilities licensed by the NRC, with limited exceptions. The regulations allow for restricted use under carefully defined circumstances. The criteria apply to decommissioning of nuclear facilities that operate through their normal lifetime, as well as to those that may be shut down prematurely.

The regulation specifically addresses the timing of termination of the authority to operate. The operator must submit two separate certifications, one when the reactor will shut down permanently and the other when all fuel is permanently removed. Once both certifications have been submitted the reactor can no longer operate and the operator becomes eligible for reductions in fees and other responsibilities. The operator must also submit a Post Shutdown Decommissioning Activities Report (PSDAR) with a schedule of activities through to and including termination. The PSDAR must contain an estimate of costs and a discussion that supports a conclusion that the decommissioning activities are within the parameters of environmental impact statements that were previously considered in the grant of the utility's operating licence, as well as those considered in the generic environmental statement for the 1988 decommissioning Rule.

After submission of the PSDAR, a public meeting will be held in the vicinity of the site. However, after 90 days, in the absence of any NRC objection, the licensee may proceed with intended activities. NRC surveillance of the ongoing decommissioning activities will be facilitated by a new requirement to update the Safety Analysis Report (SAR) every two years. At the conclusion of the decommissioning activities before the licence is terminated, the NRC must approve by licence amendment (with any legal process that entails) the residual radioactivity level that the licensee makes a commitment to meet, and the survey procedures that will demonstrate that the approved level of residual radioactivity has been met for release of the reactor site for unrestricted use.

e) Emergency response

Prior to the accident at the Three Mile Island nuclear plant in March 1979, there were no statutory requirements for offsite preparedness to cope with a nuclear plant emergency. The NRC's regulations, however, required applicants for nuclear power plant construction permits to submit, as part of the application, a description of means of responding to a radiological emergency.

The Three Mile Island accident, though it resulted in no significant offsite radiological exposures, revealed the need for better and more formalised emergency planning. In the NRC Authorization Act for Fiscal Year 1980, [Public Law No. 96-295, 94 Stat. 780], Congress directed the NRC to establish standards for State emergency response plans, and to issue facility operating licences only upon a finding of an adequate State, local, or utility emergency plan. Findings on the adequacy of State and local emergency plans were to be made in consultation with the Federal Emergency Management Agency (FEMA). Although the statutory provision has long since expired, the NRC continues to have in place a system of emergency planning that includes such elements as emergency notification systems (*e.g.* sirens) and periodic emergency exercises and drills.

For full power licensing, the NRC must find that emergency planning provides "reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency" [10 CFR, Section 50.47(a)]. After a required review by FEMA, the NRC and its adjudicatory boards evaluate an offsite emergency plan under 16 planning standards promulgated by the Commission [10 CFR Section 50.47(b)]. "Failure to meet the applicable standards [...] may result in the Commission declining to issue an operating licence," unless an exception applies, for example where "deficiencies in the plan are not significant for the plant in question" [10 CFR Section 50.47(c)(1)].

As regards transport, the Department of Transportation (DOT), the FEMA, and representatives of industry and State governments have developed a model emergency response planning programme for use by shippers and carriers. These agencies, assisted by the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA), have

published a handbook for State and local governments: *Guidance for Developing State, Tribal, and Local Radiological Emergency Planning and Preparedness for Transportation Accidents*, FEMA-REP-5 (1 June 1992). FEMA has issued a revised Emergency Response Plan. The Plan which represents the combined effort of 12 federal agencies, including FEMA, EPA, DOT and the NRC, details the federal response in case of a transportation emergency. The Plan recognises that the primary responsibility for responding to a transportation emergency belongs to State and local governments. The DOT's regulations also include emergency response information for use in the mitigation of accidents involving radioactive material [49 CFR 172.600-172.604]. The NRC has also issued a policy statement on responding to transportation emergencies [49 Fed. Reg. 12335, 29 March 1984].

It should be noted that at the international level, the USA ratified both the 1986 Convention on Early Notification of a Nuclear Accident and the 1986 Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency on 19 September 1988.

5. Radiation Protection

a) Protection of workers

Worker protection requirements apply to all NRC licensees. The regulatory goal is to keep workers informed about the health problems associated with exposures to radiation and methods of minimising exposures, and to encourage workers to bring matters regarding occupational radiation protection to the attention of NRC inspectors. Licensees must post various documents including operating procedures and any notice of violation. Workers are to be instructed in health protection procedures, and appropriate responses to warnings of exposure. Individual workers must receive notification and reports in writing containing information on annual exposure. At the time of termination of a worker's contract, licensees must supply each worker with a written report on exposures received during the workers' period of employment [10 CFR 19.11-19.13].

The NRC inspects facilities to ensure compliance with the NRC radiological health and safety standards. Representatives of workers and the licensee may be provided with the opportunity to accompany the inspectors. If there are fears of non-compliance at a particular facility, a worker or worker's representative can request an unscheduled inspection, but the NRC can decide that an inspection is unwarranted if an informal review reveals no reasonable grounds to believe a violation has occurred. In such case, the appropriate NRC official shall notify the worker or worker's representative in writing of such determination [10 CFR 19.1419.17].

Permissible radiation dosages are subject to an annual limit [10 CFR 20.1201]. Before a licensee may permit a worker to undertake assignments in restricted areas, he must obtain information about the worker's prior occupational exposure.

Each licensee must take various preventive measures such as radiation protection equipment, surveys of hazards, personnel monitoring, and display of signs, labels, and signals [10 CFR Part 20, Subpart F-J]. Each licensee must train employees in precautionary techniques [10 CFR 19.12].

Licensees must also comply with applicable requirements of the Occupational Health and Safety Act, administered by the Occupational Safety and Health Administration within the Department of Labor, as well as applicable State health and safety laws.

b) Protection of the public

The NRC has established basic standards applicable to all its licensees to protect against hazards arising from licensed activities [10 CFR Part 20]. These pivotal regulations establish permissible dose levels for radiation exposure, such as occupational dose limits [Subpart C], dose limits for individual members of the public [Subpart D], precautionary procedures [Subpart J], and waste disposal [Subpart K]. The focus of Part 20 is occupational dose and emission levels resulting from licensed activities. It neither controls nor monitors radiation exposure from background sources. In 1991, the NRC issued revised standards to reflect scientific information, changes in the basic philosophy of radiation protection and to conform with recommendations of international radiation protection organisations [56 Fed. Reg. 23360, 21 May 1991].

All phases of nuclear facility construction and operation as well as the regulation of nuclear materials are subject to public health, safety and environmental constraints [42 USC 2011 *et seq.*]. Executive Order No. 12898 directs all federal agencies to develop strategies for considering "environmental justice" in their programmes, policies and activities. "Environmental justice" is described in the Executive Order as "identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programmes, policies, and activities on minority populations and low-income populations". The NRC has implemented procedures to consider environmental justice when preparing documents pursuant to the National Environmental Policy Act of 1969 [42 USC 4321-4370(c)]. Licensees must also comply with other applicable environmental laws, including the Federal Water Pollution Control Act of 1972 [42 USC 1251-1387] and the Clean Air Act of 1974 [42 USC 7401-7671(q)]. Under the latter statute and the Comprehensive Environmental Response, Compensation, and Liability Act (commonly referred to as CERCLA or "Superfund") [42 USC 9601 *et seq.*], radioactive emissions are by definition classified as "hazardous pollutants". The Department of Transportation (DOT) and the Environmental Protection Agency (EPA) either develop standards or assist in their development.

In addition to meeting existing regulatory criteria, an applicant for a NRC operating licence, in a final safety analysis report, must predict emission levels during various postulated accident situations. During each licence review, NRC completes an assessment of facility biological impact pursuant to the Endangered Species Act. The NRC also reviews the socio-economic impacts of siting decisions.

An Executive Order requires the Executive Branch to submit to the NRC a concise environmental review for the Commission to consider in its review of appropriations for the export of power reactors or waste facilities [Executive Order 12114, Section 4.1, 1979].

The Radiation Control for Health and Safety Act of 1968 amends the Public Health Services Act. This statute authorises the Federal Government to promulgate standards to control emission from electronic products. Regulation extends to ionising or non-ionising electromagnetic radiation as well as particle, sonic, infrasonic and ultrasonic radiation [82 Stat. 1179, Section 357].

The regulations promulgated under the 1968 Act are performance standards. They apply, in some instances, to warnings, labels, and instructions. Manufacturers must notify the government, distributor and consumer of any danger with reasonable promptness, disclosing as much information as possible about adverse effects without compromising trade secrets [21 CFR Parts 1000 and 1002].

The NRC licenses hospitals and physicians to use radioactive materials in diagnosis and treatment. NRC reviews facilities, personnel, programme controls, and equipment described in each application to ensure safety of the public, including patients, and workers. In the United States, however, most authority to regulate non-radiological health and safety matters rests with individual

States. Indeed, a majority of States are so-called "Agreement States" and regulate radiological health and safety in programmes that are compatible with the NRC's requirements.

6. Radioactive Waste Management

Three agencies share responsibility for the United States' radioactive waste management policy. The NRC must formulate and implement regulations ensuring storage and disposal methods that are safe for long-term waste management. The DOE has the lead responsibility for developing technologies and programmes for handling, treatment, storage, transport and disposal of commercial spent nuclear fuel, high level waste, and all defence-generated waste. The Environmental Protection Agency (EPA) must establish the maximum allowable release of radionuclides to the biosphere, as part of its authority under the Atomic Energy Act of 1954 to develop generally applicable environmental radiation protection standards [42 USC 2011-22961]. The EPA radiation protection standards, entitled "Radiation Protection Programs" [40 CFR Subchapter F (190 Series)], are generally implemented by the DOE for activities within its jurisdiction and by the NRC for its commercial licensees. In some areas, where the EPA has not yet promulgated regulations, the DOE and NRC rely on their own orders or regulations.

a) High-level waste

The Nuclear Waste Policy Act of 1982 was signed into law on 7 January 1983, and was extensively amended on 22 December 1987. Most recently, the Nuclear Waste Policy Act was amended on 24 October 1992 by enactment of the Energy Policy Act of 1992 [42 USC 10141]. The Nuclear Waste Policy Act established the Federal Government's responsibility and policy for disposing of high-level radioactive waste and spent nuclear fuel. The Act authorises the Secretary of Energy to conduct site characterisation activities at Yucca Mountain, Nevada, to determine its suitability as a repository. Any such repository would be subject to licensing by the NRC. In general, the Department's activities and facilities are not subject to such licensing.

The Act also established a Nuclear Waste Fund composed of payments made by the generators and owners to ensure that the costs of carrying out activities relating to disposal are borne by the generators and owners. Nearly all commercial spent nuclear fuel to be disposed of is owned by utilities that operate nuclear power plants and those ratepayers ultimately pay for disposal. The relevant fees are described in the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste [10 CFR Part 961] which was executed between the utilities and the Department. A methodology was also developed, through rule making, to allocate the costs for disposal of federal defence-related waste in a repository. In 1993, Congress established a Defense Nuclear Waste Disposal Fund and makes annual appropriations for the Federal Government's share of disposal costs associated with high-level radioactive wastes from the weapons complex.

Pursuant to the Atomic Energy Act and the Nuclear Waste Policy Act, the NRC issued in 1981 a final rule entitled Disposal of High-Level Radioactive Wastes in Geologic Repositories [10 CFR Part 60], which prescribes rules governing the licensing of a geologic repository site, constructed or operated pursuant to the Nuclear Waste Policy Act. The rule contains siting, design, and performance criteria, as well as criteria for monitoring and testing. The rule adopts a multi-barrier approach, by providing design criteria for the waste package as well as for the geologic repository operations area.

The EPA issued environmental radiation protection standards in 1985 [40 CFR Part 191], which were remanded by a federal court in 1987 [Natural Resources Defense Counsel v. EPA, 824 F.2d 1258 (1st Cir. 1987)]. The court required that the EPA address, *inter alia*, the different time frames for protection of individuals (1 000 years) and total or "cumulative" population dose (10 000 years) as well as ground-water protection issues. As noted earlier, Congress enacted the Energy Policy Act in 1992, which required a study by the National Academy of Sciences (NAS) to address:

- the reasonableness of a health-based standard based on individual dose;
- the ability of post-closure oversight to prevent an unreasonable risk of breaching the repository's barriers or increasing the exposure of the public to radiation beyond allowable limits; and
- the capability to make scientifically supportable predictions of the probability of human intrusion for 10 000 years.

The NAS study, issued in August 1995, addresses new public health and safety standards for the Yucca Mountain site to be issued by the EPA, based upon and consistent with the NAS study. The standards must prescribe the maximum annual effective dose equivalent to individual members of the public from releases to the accessible environment from radioactive materials stored or disposed of in the repository. EPA published standards on 27 August 1999 [40 CFR Part 197], and the NRC must modify its technical criteria to be consistent with the EPA standards. The NRC published proposed technical criteria on 22 February 1999 [10 CFR Part 63]. The NRC's criteria must assume, to the extent consistent with the NAS study, that engineered barriers and the DOE post-closure oversight of the site shall be sufficient to:

- prevent any activity at the site that poses an unreasonable risk or breaches the repository's engineered or geological barriers; and
- prevent any increase in the exposure of individual members of the public to radiation beyond allowable limits.

The Energy Policy Act also directs the DOE to continue to oversee the repository site to prevent any activity that poses an unreasonable risk of breaching the engineered or geologic barriers, or increasing the exposure of individual members of the public to radiation beyond allowable limits.

In 1997, Congress required that the DOE prepare and submit to the Congress and the President in 1998 a "Viability Assessment" describing the following:

- the preliminary design concept for the critical elements for the repository and waste package;
- a total system performance assessment, based on the design concept and the scientific data and analysis available by 1998, that describes the probable behaviour of a repository in the Yucca Mountain geologic setting;
- a plan and cost estimate for the remaining work required to complete and submit a licence application to the NRC; and

- an estimate of the costs to construct and operate a repository in accordance with the design concept.

The "Viability Assessment", published by the DOE in December 1998, provided Congress, the President and the public with information on the technical and economic feasibility of a repository at Yucca Mountain and clarified the critical issues to be addressed before the Secretary of Energy decides whether to recommend Yucca Mountain for a repository.

An environmental impact statement, which accompanies any site recommendation and licence application, was published for public comment in July 1999 and is scheduled to be finalised in 2000. A decision by the Secretary on whether to recommend Yucca Mountain is scheduled for 2001, after issuance of a final environmental impact statement. If a decision is made to recommend the Yucca Mountain site, a licence application would be submitted in 2002. Emplacement would commence in 2010 and would be completed in 2033, according to present schedules.

Waste Isolation Pilot Plant (WIPP)

In 1980, Congress authorised construction of the Waste Isolation Pilot Plant (WIPP) as a research and development facility to demonstrate safe and permanent disposal of transuranic radioactive waste resulting from the defence activities of the United States. In 1991, the DOE completed construction of WIPP in a mine constructed 655 metres below ground surface in an ancient salt dome on approximately 10 240 acres 26 miles east of Carlsbad, New Mexico. In 1992, Congress passed the Waste Isolation Pilot Plant Land Withdrawal Act (WIPP Act) [Public Law No. 102-579] which details how the DOE should proceed with developing the facility. The WIPP Act prohibits, for example, disposal of high-level radioactive waste or spent nuclear fuel at WIPP as the facility can only serve for disposal of transuranic or "TRU" waste resulting from defence activities, such as manufacture of nuclear weapons. The Act establishes the EPA as the regulator of many of the DOE's activities at WIPP. Thus, the EPA is responsible under the WIPP Act for both issuing disposal regulations [Subparts B and C of 40 CFR Part 191] and determining whether the DOE is in compliance with those regulations. Under Section 8 of the WIPP Act, the EPA must certify that the DOE has complied with the EPA radioactive waste disposal standards before WIPP can function as a disposal facility.

Much of the waste destined for disposal at WIPP is in the form of "transuranic mixed waste" or "TRU-mixed" waste, a combination of radioactive components and hazardous waste components, the majority of which is currently stored at 23 DOE sites in 16 States. The EPA regulates hazardous wastes in the United States pursuant to the 1988 Resource Conservation and Recovery Act (RCRA) [42 USC 6901 *et seq.*]. States are authorised by RCRA to develop and implement their own hazardous waste programmes in lieu of the federal programme administered by the EPA. In general, a State programme must, subject to EPA approval, be "equivalent" to and "consistent" with the federal programme and other authorised State programmes and provide for adequate enforcement.

On 18 May 1998, the EPA issued its certification that WIPP will comply with its radioactive waste disposal regulations [40 CFR Part 191] which constituted its final approval under the WIPP Act for emplacement of TRU waste to commence. However, the State of New Mexico has sought to enjoin the shipment of mixed-TRU waste to WIPP on the ground that the DOE does not have a RCRA permit to operate a facility for mixed TRU waste and that the DOE does not have "interim status" under RCRA which could allow it to dispose of TRU-mixed waste without an actual RCRA permit. On 16 November 1998, the DOE provided to the State of New Mexico results of confirmatory samplings of TRU waste at Los Alamos National Laboratory showing that the TRU waste under consideration

contained hazardous contaminants which were "either below regulatory limits or below detection limits". The DOE maintains that this TRU waste can be shipped to the WIPP facility prior to obtaining a RCRA Part B permit since the TRU waste in question does not require a hazardous waste permit. In 1999, WIPP began receiving shipments of TRU waste.

West Valley Demonstration Project

In order to demonstrate the solidification of liquid high-level wastes, Congress passed the West Valley Demonstration Project Act, authorising a high-level waste project in West Valley, New York [42 USC 2021(a)]. This project, at the first commercial fuel-reprocessing site, will demonstrate solidification of waste by vitrification or other technology. The DOE has primary responsibility for the project, with NRC monitoring activities.

b) Low-level waste

The Low-Level Radioactive Waste Policy Amendments Act [42 USC 2021(b) *et seq.*] originally enacted in 1980 and substantially amended in 1985, establishes the policy for disposal of commercial low-level radioactive wastes, providing that such waste can be most safely and efficiently managed by States and State compacts on a regional basis. It declares that each State is responsible for disposal of low-level radioactive waste generated within its borders, with the exception of low-level radioactive waste owned or generated by the DOE, the United States Navy, or the Federal Government as a result of any research, development, testing or production of any atomic weapon. The Act further invites States to form compacts as necessary for the establishment and operation of regional disposal facilities.

The Act provided that States with an existing regional disposal facility (there were three: in Barnwell, South Carolina; Richland, Washington; and Beatty, Nevada) would make capacity available to other States or compact regions for a seven-year period through 1992, thus providing a transition period for States or compact regions without disposal sites to construct facilities. However, those three "sited compact regions" would not be required to provide disposal capacity for waste in excess of certain volume limitations established under the Act, and could, under certain conditions and with Congressional consent, restrict use of regional disposal facilities to waste generated within the compact region beginning in 1993. During the transition period, disposal of waste generated outside of a sited compact region could be subject to escalating surcharges. Further, the Act provided for milestones to be met by each unsited compact or State towards siting disposal facilities. Failure to meet milestones would result in added surcharges on waste disposal and eventual loss of access to the three available disposal facilities. An escrow account was also established composed of a percentage of the surcharge fee to be repaid to States or compact regions meeting the milestones.

To date, Congress has consented to 10 regional compacts, comprising 44 States, via the Omnibus Low-Level Radioactive Waste Interstate Compact Consent Act (1986), the Appalachian States Low-Level Radioactive Waste Compact Consent Act (1987), the Southwestern Low-Level Radioactive Waste Compact Consent Act (1988), and the Texas Low-Level Radioactive Waste Disposal Compact (1998). The so-called Texas Compact is a disposal compact between the States of Maine, Vermont and Texas. On 22 October 1998, the Texas Natural Resource Conservation Commission voted unanimously to deny the licence application of the Texas Low-Level Radioactive Waste Disposal Authority to construct a disposal facility in Hudspeth County, Texas. The Texas legislature abolished the Authority on 30 May 1999. The Texas legislature will meet again in 2001.

The NRC regulations divide low-level waste management into an operational and post-operational phase (*i.e.* pre-closure and post-closure of the site). The rules aim to protect individuals against inadvertent exposure, protect the public from general releases into the environment, and maintain stability of the disposal site, and prevent inadvertent intrusion. The regulations include classification of waste, procedural criteria for licensing and technical criteria for sites [10 CFR Part 61]. The NRC has licensed disposal of special nuclear material at two commercial burial sites, and is assisting in the closing of another site.

The Energy Policy Act of 1992 [Public Law No. 102-496, 42 USC 2023] added a new section to the Atomic Energy Act which provides for State authority to regulate radiation below the level of regulatory concern of the NRC. Section 276(a) provides that no provision of that Act, or the Low-Level Radioactive Waste Policy Act, may be construed to prohibit or otherwise restrict the authority of any State to regulate, on the basis of radiological hazard, the disposal or offsite incineration of low-level radioactive waste, if the NRC exempts such waste from regulation.

c) Disposal at sea

Congress adopted a policy regulating disposal at sea of all material which could adversely affect human health, welfare, the marine environment, or the economic potential of the ocean waters by passing the Marine Protection Research and Sanctuaries Act of 1972. The Act applies to United States registered vessels or aircraft, or foreign craft dumping materials in territorial waters. The Act specifically identifies radioactive waste as a controlled substance, regardless of whether it is generated by a civilian or military source: no one can dump high-level waste. In specific instances, the EPA may allow dumping of low-level waste if disposal would not unreasonably endanger human health or the marine environment or its economic potential. In reviewing applications, the EPA considers the volume and concentration of the material to be dumped, the projected disposal site, disposal method, and the persistence of any permanent adverse effects [33 USC, Section 1414].

On 6 January 1983, Congress enacted a two-year moratorium on ocean disposal of low-level radioactive waste except for small amounts to be disposed of for research or demonstration purposes [33 USC 41414(i)]. It should be noted that the United States ratified the 1972 London Convention on the Prevention of Marine Pollution by the Dumping of Wastes and Other Matter on 6 May 1974. The United States, in November 1993, as a Party to this Convention, adopted a resolution which effectively prohibited all sea dumping of radioactive waste.

d) Uranium mill tailings

In passing the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), Congress found that mill tailings at active and inactive uranium milling operations may pose a significant health hazard, especially through potential radon diffusion into the environment. Under Title I of UMTRCA, on co-operation with interested States, Indian tribes, and site users, Congress provided for assessment and remedial action at inactive sites and, where appropriate, for reprocessing tailings to extract any remaining uranium or unstable materials. In addition, Title II of UMTRCA establishes a programme to regulate mill tailings during uranium or thorium ore processing at active mill operations and after termination of such operations in order to stabilise and control such tailings in a safe and environmentally sound manner, and to minimise or eliminate radiation health hazards to the public [42 USC 7901 *et seq.*].

The DOE is directed to designate inactive uranium processing sites for remedial action, and to complete any remedial action at such locations where States have contributed a percentage of cleanup costs [42 USC 7912].

Relying on the advice of the EPA, the DOE is directed to develop remedial action priorities at each site. When appropriate, the DOE can require States to purchase real property for disposal sites. If a property owner voluntarily undertook remedial action prior to the date of enactment of the above-mentioned Act, it may ask for reimbursement. When necessary, the DOE can purchase lands for potential disposal sites, and in some cases can utilise land owned by the Department of the Interior [42 USC 7916].

The DOE, after promulgation of health and safety standards by EPA, can solicit proposals from private parties who want to reprocess mill tailings. Then the DOE must decide whether or not such mill tailings should be reprocessed and whether recovery of residual minerals at each site is practical, depending upon source material concentration remaining in the residue. A person allowed to recover any mineral must remit a share of the resulting profit to the DOE in order to repay the DOE for any remedial actions in rehabilitating the units. The DOE has undertaken remedial actions at inactive uranium mill processing sites [42 USC 7918].

e) Formerly Utilized Sites Remedial Action Program (FUSRAP)

The DOE has been involved in a Formerly Utilized Sites Remedial Action Program (FUSRAP) since 1974. This is a major environmental effort to clean up sites contaminated from past activities under the Manhattan Project since World War II involving uranium ore and other radioactive materials. The DOE has examined almost 400 sites, reviewing old records and performing radiological surveys. Remedial action has been underway since 1979. By 1992, 33 sites in 13 States had been identified as requiring remedial action. On 30 September 1997, Congress ordered the DOE to transfer FUSRAP to the Army Corps of Engineers.

7. Non-Proliferation and Exports

The United States ratified the 1968 Treaty on the Non-Proliferation of Nuclear Weapons on 5 March 1970.

Rules governing nuclear export controls are contained in the Atomic Energy Act, as amended by the Nuclear Non-Proliferation Act of 1978 [42 USC 2074, 2077, 2094, 2139, 2139(a), 2141, 2153-2153(f), 2155, 2155(a), 2157-2160(a)]. Exports of production or utilisation facilities and special nuclear material (except some plutonium 238 and other special nuclear material exempted by the Commission) must take place pursuant to an agreement for co-operation. Such agreements are negotiated by the Department of State, with the technical assistance and concurrence of the DOE. They are also reviewed by the members of the NRC. The Atomic Energy Act provides that an agreement for peaceful nuclear co-operation must be approved by the Secretary of Energy and the Secretary of State and, upon their recommendation, by the President, who must make certain statutory determinations and authorise execution of the agreement. The Atomic Energy Act mandates that numerous specified provisions be contained in these agreements. An agreement for peaceful nuclear co-operation does not commit the United States to any specific exports or other co-operative activities, but rather establishes a framework of conditions and controls to govern subsequent commercial transactions, if any.

Any agreement for nuclear co-operation between the United States and another nation must contain assurances that the co-operating country will undertake safeguards to protect special nuclear material purchased or produced under the agreement, so long as the material is in its possession or under its jurisdiction regardless of the duration of the agreement [42 USC 2153, 2156].

The NRC cannot issue export licences or exemptions unless it makes certain findings and until it is notified by the Secretary of State that in the judgement of the executive branch, the proposed action will not be inimical to the common defence and security. The Secretaries of Energy, Commerce, and Defense, the Director of the Arms Control and Disarmament Agency and the Nuclear Regulatory Commission co-operate to complete this executive branch judgement. Whenever there are several applications involving one nation, the Commission may render a single opinion as regards compliance with the statutory criteria if there are no materially changed circumstances from the terms of the preceding contract. Such a decision is not subject to judicial review. With Congressional approval, the President can overrule an NRC decision not to permit export.

International Atomic Energy Agency (IAEA) safeguards govern all-important nuclear exports. Some minor components are not covered. Foreign governments cannot transfer United States origin special nuclear materials to other nations unless the United States approves the action. Prior approval must be obtained from the United States for any reprocessing of nuclear material originating in the United States [42 USC 2156-2158]. Source or special nuclear material exported from the United States may not be enriched after export except as authorised specifically in an agreement for co-operation. No major critical components of any enrichment, reprocessing or heavy water production facility may be exported except as specifically authorised in an agreement for co-operation [42 USC 2153(a), 2164].

a) Exports of source material, special nuclear material, production or utilisation facilities and sensitive nuclear technology

The Atomic Energy Act of 1954 specifies the criteria that the NRC must determine have been satisfied before it can issue an export licence. The criteria that are applied to exports of source material, special nuclear material, production or utilisation facilities and any sensitive nuclear technology to non-nuclear weapon States are:

- IAEA safeguards will be applied to the materials or facilities exported and to any special nuclear material used in or produced through the use of such materials;
- no material, facilities, or sensitive nuclear technology exported will be used for a nuclear explosive device or for research on or development of such a device;
- adequate physical security measures will be maintained with respect to the exported facilities or material and any special nuclear material used in or produced through the use of the facility or material;
- no materials, facilities, or sensitive technology to be exported and no special nuclear material produced through the use of such material will be retransferred to the jurisdiction of any other nation or group of nations without the prior consent of the United States;
- no material to be exported and no special nuclear material produced through the use of such material may be reprocessed, and no irradiated fuel elements containing such

material removed from a reactor, shall be altered in form or content without the prior approval of the United States;

- no sensitive technology may be exported unless the foregoing five conditions will be applied to any nuclear material or equipment which is produced or constructed through the use of the sensitive technology exported;

- the recipient nation must have full-scope safeguards; and

- the export must not be inimical to the common defence and security of the United States.

All of the criteria specified above except for the first and the seventh are applied to exports to nuclear-weapon states.

In 1992, the Atomic Energy Act of 1954 was amended to include criteria, in addition to those summarised above, which would apply to exports of highly enriched uranium. Specifically, the NRC is precluded from issuing licences for the export of highly enriched uranium to be used as fuel or a target in a nuclear research or test reactor unless it determines:

- there is no alternative fuel (fuel enriched to less than 20% ^{235}U) or target of lesser enrichment that can be used in the reactor;

- the proposed recipient of that fuel has provided assurances that whenever an alternative fuel or target can be used, it will use that alternative; and

- the US Government is actively developing an alternative fuel or target that can be used in the reactor.

Before taking action on most applications, the NRC receives the Executive Branch's views, which the Department of State provides to the NRC, after consulting with the Departments of Defense, Energy, and Commerce and the Arms Control and Disarmament Agency.

b) Exports of components

The NRC is also responsible for the licensing of components for production or utilisation facilities which are not defined as production or utilisation facilities, but are especially designed or prepared for use in such a facility or are especially relevant from the standpoint of export control because of their significance for nuclear explosive purposes. NRC regulations specify the components which must be licensed by the NRC. Other components for production and utilisation facilities, including dual use and balance of plant items, are licensed by the Department of Commerce under the terms of the Export Administration Act.

Before issuing a licence authorising the export of a component to a non-nuclear weapon state, the NRC must determine:

- IAEA safeguards will be applied;

- the component will not be used in or for research and development of a nuclear explosive device;

- the component will not be retransferred without the prior consent of the United States; and

- the export would not be inimical to the common defence and security of the United States.

All of these criteria, except for the first one, are applied to exports to nuclear weapons states.

c) Exports of by-product material

The NRC also licenses the exports of by-product material. Before issuing an export licence the NRC must determine that the export would not be inimical to the common defence and security of the United States. The NRC's regulations generally authorise the export of some by-product materials; others require a specific licence from the NRC.

d) Conduct resulting in the termination of exports or economic assistance

The Atomic Energy Act also provides that certain actions (taking place after 10 March 1978) such as detonation of a nuclear explosive device, termination or abrogation of IAEA safeguards, or material violation of an IAEA safeguards agreement, will result in the termination of exports of nuclear equipment, materials, or sensitive technology to nations which have engaged in such conduct.

The Foreign Assistance Act precludes economic assistance to countries which deliver nuclear enrichment equipment or technology to other countries or receive such equipment, unless equipment is subject to IAEA safeguards and will be placed under multilateral auspices and management when available.

e) Subsequent arrangements

Under the Atomic Energy Act, subsequent arrangements, such as approval for retransfers or reprocessing, or arrangements for the storage or disposition of irradiated fuel elements must be approved by the DOE, with the concurrence of the Department of State, and in consultation with the NRC and the Department of Defense [42 USC 2160].

f) Technology exports

The Atomic Energy Act provides that exports of nuclear technology relating to the production of special nuclear material must be approved by the DOE. The DOE has promulgated regulations found in 10 CFR Part 810 which indicate which activities have been generically authorised and which require a specific authorisation. When an activity requires specific authorisation, the DOE must find that the activity for which the export will be utilised will not be inimical to the interest of the United States.

g) Information and restricted data

A major component of the national domestic safeguards system is the control and declassification of restricted data. The term "Restricted Data" means all data concerning :

- design, manufacture or utilisation of atomic weapons;
- the production of special nuclear material;
- the use of special nuclear material in the production of energy.

The DOE reviews restricted data and declassifies as much as possible in order to enlarge public understanding and disseminate technical information. [42 USC 2014, 2161, 2162 and 2163]. The Department of Defense participates in this process and the Central Intelligence Agency (CIA) participates when the information to be reviewed for declassification involves the atomic energy programmes of other nations. The energy agencies can divulge restricted data to other nations when authorised by an international agreement, but cannot reveal information about design and fabrication of nuclear weapons. In co-operation with regional defence organisations, the United States may share certain types of weapons information [42 USC 2164].

The Office of Personnel Management can supervise security checks on licensees or persons holding government contracts. There are elaborate criteria for determining employee access to restricted data, and appellate procedures under the aegis of a Personnel Security Board. When necessary, the President can involve the Federal Bureau of Investigation (FBI) in security checks [42 USC 2165].

Through rule making, including appropriate notice and comment procedures, the NRC can preclude unauthorised public disclosure of information about the licensee security measures and material accounting procedures if disclosure would endanger public health or the common defence by increasing the likelihood of theft, diversion or sabotage [42 USC 2167].

8. Physical Protection

The NRC has regulations to deter, prevent and respond to the unauthorised possession or use of special nuclear material, and to the sabotage of nuclear facilities. In general, safeguards for fuel facilities emphasise protection against theft or diversion of special nuclear material, while those for power reactors stress protection against radiological sabotage.

Only a few of the licensed fuel cycle facilities must meet the stringent requirements for physical protection required of facilities having Category I quantities of materials, *i.e.* over 5 kg of highly enriched uranium, or more than 2 kg of plutonium. Regulations stipulate special training for guards and provide for communication with central alarm facilities. Frequent emergency testing maintains system efficiency. In the case of radiological sabotage, plant operators must establish special communications with local law officials. Security guards have authority to use deadly force if they reasonably believe it necessary for their own self-defence or the defence of others [10 CFR 73.26(e)(3)].

Most other fuel cycle facilities (those that do not have Category I quantities of materials) are subject to rules on licensee fixed site and in-transit requirements for physical protection of special nuclear material. These rules control access to plants by mandating various detection systems. Entry

controls and constant surveillance ensure security. Only authorised material placement and movement occur. Isolation zones permit security personnel to seal off potential threats.

Another aspect of NRC regulations concerning physical protection is found in 10 CFR Parts 70 and 74 relating to accounting and inventory control to detect losses of nuclear material. Those regulations concern material control and accounting at fixed sites and documenting transfer of special nuclear material and source material at enrichment facilities.

Furthermore, the President is authorised to suspend nuclear co-operation with any nation or group of nations which has not ratified the 1979 Convention on the Physical Protection of Nuclear Material. The United States ratified the latter Convention on 13 December 1982.

9. Transport

The Department of Transport (DOT) and the NRC share federal responsibility for safety in the transport of radioactive material. The DOT regulates the transportation of radioactive material under the Transportation Safety Act of 1974, which incorporates the Hazardous Material Transportation Uniform Safety Act. The NRC's regulatory authority is based upon the Atomic Energy Act of 1954, and the Nuclear Waste Policy Act of 1982.

To avoid duplication, the two agencies have delineated their roles in a Memorandum of Understanding (MOU) (44 Fed. Reg. 38690). Under the MOU, the NRC is responsible for developing safety standards for shipping packages used for the domestic transport of large quantities of radioactive material (*i.e.* Type B packages) or fissile material. The DOT is responsible for developing domestic safety standards for smaller quantity shipping packages (*i.e.* Type A packages), developing and implementing safety requirements for carriage, and for implementing package safety requirements for import and export shipments. The DOT, as the designated US competent authority, also represents the US at the IAEA in developing international package safety standards. Under the MOU, the NRC advises the DOT on technical matters involving IAEA package standards.

The shipment of radioactive material is subject to DOT's regulations in 49 CFR Parts 171 to 180. These regulations include requirements for packaging, labelling and marking of packages, placarding of vehicles, carrier performance and training, emergency response information, routing and shipping papers. A final rule of 30 August 1995 [60 Fed. Reg. 188, September 1995, pp. 50292-50336] amended the Hazardous Materials regulations to harmonise them with those of the IAEA. The amendments require the offerors and carriers to maintain written radiation protection programmes, provide revisions to the definition and packaging for low specific activity radioactive materials, and require use of the International System of Units for the measurement of activity in a package of radioactive material. However, the basic standards for packaging radioactive materials remain unchanged. The DOT's regulations also include individual "modal" requirements for air (Federal Aviation Administration), rail (Federal Railroad Administration), highway (Federal Highway Administration) and vessel (US Coast Guard).

The DOT's regulations limit the amount of material which may be transported at any one time. Special tables incorporated into the regulations dictate the minimum distance which may exist between packages and people, animals, or other radioactive parcels if the packages are stored in a warehouse, depot, or rail car. Special decontamination requirements apply when rolling stock is used to transport radioactive materials [49 CFR 174.700].

When a shipper plans to transport radioactive material by road, special precautions in the DOT regulations govern storage and loading of packages and the gross weight to be carried. In addition, the NRC imposes special handling and surveillance requirements similar to those outlined for rail transport. There are also DOT spatial limitations on shipment placement within vehicles and special reporting requirements in case of an accident [49 CFR 177.834, 177.842, 177.843].

The Coast Guard assisted by the National Cargo Bureau, Inc., inspects cargo stowed for shipment on inland waterways or the high seas. If a foreign ship does not enter internal waters of the United States, it may transit the territorial sea without meeting American packaging requirements as long as the shipment is in compliance with the International Maritime Dangerous Goods Code of the International Maritime Organisation (IMO).

In addition to DOT regulations, NRC licensees are subject to the requirements in 10 CFR Parts 71 and 73. First, Part 71 covers package standards for Type B and fissile material packages, quality assurance requirements for package users and manufacturers, and notification requirements for certain waste shipments. Second, Part 73 includes safeguards requirements to protect special nuclear material from theft or sabotage. For example, for shipments of irradiated reactor fuel and strategic special nuclear fuel, the NRC can require approved route plans (for safeguards purposes), armed escorts, vehicle immobilisation, communication equipment, surveillance, and periodic reporting under Part 73. Part 73 also requires that shippers provide prior notification to State governors of spent fuel shipments.

An amendment to the Energy Reorganisation Act of 1974 [Public Law No. 79-94] forbids the NRC to license any air shipment of plutonium except for medical use, except in certified safe containers. Two packages, certified in 1978 and 1981, are available for use, and are able to withstand the crash of a high speed jet aircraft as well as crushing, puncturing, slashing, fire, and deep underwater immersion [42 USC 5841].

In 1987, Congress enacted two additional restrictions. First, Congress forbade the transportation of spent fuel or high level radioactive waste by the DOE except in packages that have been certified by the NRC for such purpose [42 USC 10175]. Second, Congress prohibited the transportation of plutonium by air through the air space of the United States from one foreign nation to another foreign nation unless the NRC certifies to the Congress that the container can withstand without rupture, a drop test from the maximum cruising altitude of the aircraft, and that the package can withstand the stresses produced during a worst case aircraft accident. The packages certified under Public Law No. 79-94 are exempted from this restriction.

10. Nuclear Third Party Liability

The federal legislation on nuclear indemnity and limitation of liability in the US, the Price-Anderson Act, forms part of the Atomic Energy Act of 1954, as amended. Originally enacted in 1957 for a ten-year term, the Price-Anderson Act was amended several times; its duration was extended to 1 August 1977 in 1965, to 1 August 1987 in 1975 and currently by the Price-Anderson Amendments Act of 1988, to 1 August 2002. The Price-Anderson Act governs liability and compensation in the event of a nuclear incident arising from the activities of NRC licensees and DOE contractors. While permitting individual States to largely retain their jurisdiction over matters relating to civil liability, the Price-Anderson Act sets forth requirements governing maximum available insurance, liability limits and channelling of compensation claims in order to achieve the goal of fair and adequate compensation of nuclear damage. The system originally provided stability and security to an infant nuclear power industry at a time when a lack of nuclear risk experience made it difficult

for insurers to calculate costs. It also made it possible for the US Government to secure private contractors for its nuclear research needs.

The Price-Anderson Act is administered by the NRC with respect to all nuclear power plants which are subject to NRC licensing, and by the DOE with respect to the nuclear activities undertaken on its behalf by its contractors.

Given that liability is generally determined by the tort law of the State where the nuclear incident occurs, the Price-Anderson Act does not purport to channel such liability to the operator as is the case under some other legal systems; rather it ensures that anyone who is held liable will be indemnified. The Act defines "public liability" as any legal liability resulting from a nuclear incident or precautionary evacuation, except employees' claims for workers compensation, claims arising out of an act of war or claims for loss of or damage to onsite property.

The Price-Anderson Act defines a "nuclear incident" as "any occurrence, including an extraordinary nuclear occurrence, within the United States causing, within or outside the United States, bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of source, special nuclear or by-product material."

The 1966 amendments introduced the notion of an "extraordinary nuclear occurrence" with a view to strengthening the protection of the public by eliminating the legal defences that would normally be available under State tort law systems. An extraordinary nuclear occurrence is essentially an event causing a significant release of nuclear material offsite or a significant increase in radiation levels offsite and in respect of which the Federal Government (either NRC or DOE) determines that there has, or will be, substantial damage to persons or property. Any determination by the NRC or the Secretary of Energy in this respect is final and conclusive. The elimination of the specified defences effectively results in strict liability. It is also to be noted that in the event of an extraordinary nuclear occurrence, the Price-Anderson Act would prevent the operation of any State statute of limitations which would have the effect of barring claims filed more than three years from the date on which the claimant first knew, or should reasonably have known, of his injury or damage and the cause thereof [42 USC 2209(n)(1)].

In addition to nuclear incidents, precautionary evacuations have also been covered by the Act since the 1988 amendments. A precautionary evacuation may be ordered by the responsible governmental entity, even if there has been no nuclear release from a nuclear installation, if the event has posed an "imminent danger of bodily injury or property damage". Evacuated persons are entitled to recover the costs they incur as a result of the evacuation.

As to liability amounts, the limitation of liability for nuclear power plants was originally set in 1957 at United States dollars (USD) 560 million, with first USD 60 million coming from the nuclear insurance pool and USD 500 million coming from the US Government through indemnification agreements. Over the years, the insurance portion gradually increased and the government's funding responsibility gradually decreased, to the point where the US Government's indemnification obligation was phased out and replaced by a system of retrospective assessments, called standard deferred premiums, which are paid by the operators of the power plants. The combined effect of this new two-tiered system of compensation is that the current limit of liability has now increased to USD 9.7 billion [42 USC 2209(b)].

Under the first tier, plant licensees must maintain financial security in an amount equal to the maximum liability insurance available from private sources, currently USD 200 million. Two private

nuclear insurance pools hold premium reserves under an Industry Credit Rating Plan to assure the availability of funds in the event of a nuclear incident. Under this Plan, a portion of the annual premiums is set aside as a reserve either for payment of losses or for eventual refund to policyholders.

Under the second tier, retrospective premiums are payable by all plant operators to cover liability for damage exceeding the first tier. In the event of an incident, each operator would be charged a prorated share of the excess damage up to a statutory maximum of USD 83.9 million per reactor per incident. Given the number of currently operating reactors, this maximum approximates USD 9.4 billion. The limit of liability will increase as the number of operating power reactors increases by USD 83.9 million per reactor. This premium is adjusted for inflation every five years. An additional 5% may be added to cover legal defence costs. NRC collects the premium and guarantees payment to victims whose claims have been accepted or adjudicated. The NRC's revised regulations for financial protection and indemnity agreements appear at 10 CFR Part 140.

Mandatory coverage exists only for nuclear power plants with a rated capacity of 100 MWe or more and for certain research and test reactors. The NRC has the power to extend this coverage to other nuclear installations, but has not as yet done so. Thus, for example, fuel fabrication plants and reprocessing facilities are not covered by the mandatory provisions and must rely on private insurance and defences under State law.

As regards DOE contractor activities, there is mandatory coverage for DOE contractors and any other person who may be liable for public liability resulting from a nuclear incident or precautionary evacuation arising out of or in connection with any contractual activity on behalf of DOE [42 USC 2210]. The DOE indemnification covers such persons up to the statutory limit for a nuclear incident at a commercial power plant in the United States (USD 9.7 billion). With respect to a nuclear incident outside the United States, the indemnity is limited to USD 100 million and only covers contractual activity on behalf of DOE that involves material owned by the US Government.

With regard to jurisdiction over damage claims arising from a nuclear incident, it is the United States District Court in the district where the nuclear incident takes place, which shall hear such claims without regard to the citizenship of any party or the amount in controversy. Where the nuclear incident takes place outside the United States, jurisdiction lies with the United States District Court for Columbia.

Unless the Price-Anderson Act is again renewed before its expiration date of 1 August 2002, coverage will not be available for any nuclear power plant that commences operation after that date. Such expiration will not, however, jeopardise coverage for existing facilities which remains in effect until they are decommissioned. Both the NRC and the DOE filed reports with Congress recommending that the Act be continued without significant changes.

II. INSTITUTIONAL FRAMEWORK

Many governmental organisations, both federal and state, contribute to United States nuclear regulation, power production, and research. Some private organisations are active in this area as well.

This introduction section will provide an overview to explain the interrelationships among these bodies.

The Federal Government assumes primary responsibility for regulating nuclear energy; moreover, federal grants and contracts fund a major portion of academic and private research and development. Until 1974, the Atomic Energy Commission (AEC) served as the umbrella agency charged with responsibility for all civilian and military projects involving atomic energy. In that year, the AEC was abolished and two successor agencies took over its mission.

The Nuclear Regulatory Commission (NRC) assumed the regulatory role and the Energy Research and Development Administration (ERDA) inherited the promotional activities. Later the ERDA was incorporated into the Department of Energy (DOE). The NRC is an independent agency, with commissioners appointed by the President.

Various advisory bodies assist federal agencies. Under the Federal Advisory Committee Act, most advisory bodies must be fairly balanced in terms of points of view represented and the functions to be performed; the meetings are normally open to the public. Usually these committees consist of experts who advise on technical matters or policy issues. In some instances, special working groups composed of representatives from many government agencies work together as planning groups, serving in an advisory capacity.

State governments also regulate aspects of nuclear energy. States take major responsibility for emergency planning. State and local government agencies ranging from law enforcement to public health and environmental agencies participate in nuclear energy policy (see Part I of this study *supra*). Pursuant to 42 USC 2021, the NRC is authorised to relinquish a portion of its jurisdiction over nuclear materials to the States. This is done by having the NRC and the governor of an interested State enter into an agreement providing the State with authority to regulate the materials covered by the agreement to protect public health and safety from radiation hazards. Such an agreement may cover source materials, by-product materials, and small quantities (generally, quantities not sufficient to form a critical mass) of special nuclear materials, though the primary focus of the State programmes is usually by-product material. There are currently 30 Agreement States.

Colleges and universities play a major role in nuclear research and development. These institutions receive grants and contracts from federal agencies to finance research. A few actually assume total responsibility for operating government-owned laboratories.

Many public and semi-public bodies recommend policy alternatives. There are numerous societies of scientists and engineers which also set up working groups to study nuclear policy, and publish journals and informative reports.

Environmentalist and consumer groups can present oral and written testimony at Congressional hearings to consider proposed legislation and at public meetings held by the NRC for the purpose of receiving input on issues before the agency. They often intervene in the licensing process, and initiate litigation.

Finally, private industry plays an important role in the energy field. Public utilities lobby for legislative proposals. The major nuclear entities have established the Nuclear Energy Institute (NEI) which represents the industry before the Congress, the NRC, and other relevant bodies. The private sector has set up research groups such as the Electric Power Research Institute (EPRI) which conduct research on a non-profit basis. Some corporations operate government-owned laboratories under contract.

1. Regulatory and Supervisory Authorities

As mentioned previously, the NRC and the DOE share most authority over nuclear affairs. A list of other federal agencies having oversight functions are arranged by the cabinet-level department to which they belong; for instance, the United States Geological Survey (USGS) is a part of the Department of the Interior.

a) Nuclear Regulatory Commission (NRC)

i) Legal Status

In 1974, Congress passed the Energy Reorganisation Act creating the Nuclear Regulatory Commission (NRC) to assume the licensing function of the former Atomic Energy Commission (AEC). This independent regulatory body enjoys its own legal personality. While the NRC is responsible to the President, it exercises considerable independence in regulatory matters [42 USC 5801 and 5841].

ii) Responsibilities

The NRC is responsible for licensing and regulating nuclear materials and facilities, and for conducting research in support of the licensing and regulatory process as mandated by the Atomic Energy Act and other applicable statutes. Its responsibilities include protecting the environment, safeguarding materials and plants in the interest of national security, and assuring conformity with antitrust laws. The NRC acts through standards setting and rule making, technical reviews and studies, issuance of licences, permits and authorisations, inspection and investigation, evaluations of operating experience, and undertaking of confirmatory research.

The NRC issues licences for transfer, delivery, acquisition, ownership, possession, or import of special nuclear material, source material, and by-product material. It licenses medical and academic facilities as well as commercial power reactors. Licensing extends to both construction and operation of facilities and includes licensing of operating personnel (see Part I of this study).

The NRC maintains an active inspection and enforcement programme. It investigates violations and initiates enforcement proceedings. The NRC can seek judicial remedies such as injunctions, and can assess fines and penalties.

The NRC enters into co-operative agreements with States to help them assume the responsibility for regulating certain aspects of nuclear energy, such as medical applications and transport. The co-operating State assumes responsibility for narrowly circumscribed facets of the regulatory function, normally assigned to the NRC [42 USC 2021 and 2152].

Under the Price-Anderson Act, the NRC enters into indemnification agreements with nuclear reactor licensees for liability arising out of a nuclear incident. It investigates the causes of major incidents and reports to Congress.

iii) Structure

The Energy Reorganization Act of 1974 established the NRC as an independent regulatory agency with five commissioners, of whom no more than three may be members of the same political party. The President, with the advice and consent of the Senate, appoints the commissioners, who must be United States citizens. Each commissioner serves for five years and, during that time, may not engage in any other business or vocation. The President may remove a commissioner only for neglect of duty, inefficiency, or malfeasance in office. Each commissioner enjoys full access to all data relating to NRC duties, and each has equal authority and responsibility in decision-making. In order for the NRC to act, a majority of members present must concur; however, a quorum requires the presence of three commissioners [42 USC 5841].

The President appoints one of the five commissioners as chairperson who acts as the principal executive officer and the official spokesman of the Commission. The chairperson is responsible for preparing policy planning and guidance for Commission consideration, and for conducting the administrative, organisational, budgetary and certain personnel functions of the NRC [42 USC 5841 and 5801].

Executive Director for Operations (EDO)

The position of the Executive Director for Operations (EDO) is established by statute. As the head of the NRC staff, the EDO reports to the chairperson and is subject to the chairperson's supervision and direction, as provided in Reorganization Plan No. 1 of 1980. The EDO is the chief operational and administrative officer of the Commission, and is authorised and directed to discharge such licensing, regulatory, and administrative functions of the NRC and to take actions as are necessary for day-to-day operations of the Commission. The EDO supervises and co-ordinates policy development and operational activities of the NRC's three major programme offices (Nuclear Reactor Regulation, Nuclear Material Safety and Safeguards, and Nuclear Regulatory Research) as well as the Incident Response Operations function, NRC regional offices, and such other offices as those of Enforcement, Administration, State Programs, Human Resources, Investigations, and Small Business and Civil Rights.

Office of the Chief Financial Officer (CFO)

The Office of the Chief Financial Officer (CFO) is responsible for the NRC's Planning and Budgeting, and Performance Management Process and for all of the NRC's financial management activities. The CFO must report directly to the head of the Commission. The CFO establishes planning, budgeting, and financial management policy for the Commission and provides advice to the chairperson and the Commission on these matters. The CFO develops and maintains an integrated Commission accounting and financial management system; establishes policy and directs oversight of Commission financial management personnel, activities, and operations; prepares and transmits an annual report which includes the Commission's audited financial statement to the chairperson and the Director, Office of Management and Budget; monitors the financial execution of NRC's budget in relation to actual expenditures, controls the use of Commission funds to ensure that they are expended in accordance with applicable laws and standards, and prepares and submits to the chairperson timely cost and performance reports; and reviews, on a periodic basis, fees and other charges imposed by the NRC for services provided and makes recommendations for revising those charges as appropriate. The CFO provides an Commission-wide management control programme for financial and programme managers to comply with the Federal Managers' Financial Integrity Act of 1982, and is responsible for

implementing the Chief Financial Officers Act and the Government Performance and Results Act at the NRC. The CFO represents the NRC on the Federal CFO Counsel.

Office of the Chief Information Officer (OCIO)

The Office of the Chief Information Officer (OCIO) must report directly to the head of the Commission. The Chief Information Officer is responsible for ensuring the proper management of information resources. More specifically, the OCIO plans, directs, and oversees the delivery of centralised information technology (IT) infrastructure, applications, and information management (IM) services, and the development and implementation of IT and IM plans and policies to support the mission of the Commission. The Office advances the achievement of NRC's mission by assisting management in recognising where IT can add value while transforming or supporting Commission operations. The OCIO also provides principal advice and assistance to the chairperson, the commissioners, and other Commission executives to ensure that Commission IT and IM resources are selected and managed in a manner that maximises their value, manages risks, and is consistent with federal laws and regulations. The CIO represents the NRC on the Federal CIO Council.

Supporting the Executive Director for Operations, and reporting to him through the Deputy Executive Director for Management Services, are the Offices of Administration, Human Resources, and Small Business and Civil Rights:

Executive Council

In 1997, the Commission established an Executive Council consisting of the EDO, CFO and CIO to provide Commission wide administrative management and planning of NRC operations. The Council ensures that the Commission planning, budgeting, financial and human resource management, information technology and programmatic decisions, are fully integrated.

Office of Congressional Affairs (OCA)

The Office of Congressional Affairs (OCA), which reports directly to the chairperson, serves as the primary contact point for all NRC communications with Congress. OCA provides advice and assistance to the chairperson, Commission, and NRC staff on all NRC relations with Congress and views of Congress toward NRC policies, plans, and activities; maintains liaison with congressional committees and members of Congress on matters of interest to the NRC; serves as primary contact point for all NRC communications with Congress, reviewing and concurring in all outgoing correspondence to members of Congress; co-ordinates NRC internal activities with Congress; plans and develops NRC's legislative programme; and monitors legislative proposals, bills, and hearings.

Office of Public Affairs (OPA)

The Office of Public Affairs (OPA), reports directly to the chairperson. OPA develops policies, programmes, and procedures for the chairperson's approval for informing the public of NRC activities. OPA also prepares, clears, and disseminates information to the public and the news media concerning NRC policies, programmes, and activities; keeps NRC management informed on media coverage of activities of interest to the Commission; plans, directs, and co-ordinates the activities of

public information staffs located at regional offices; conducts a co-operative programme with schools; and carries out assigned activities in the area of consumer affairs.

Office of the General Counsel (OGC)

The Office of the General Counsel (OGC) reports directly to the Commission. OGC staff directs matters of law and legal policy, providing opinions, advice, and assistance to the Commission with respect to all of its activities; reviews draft Commission opinions on public petitions seeking direct Commission action and rule-making proceedings; monitors adjudicatory proceedings, and reviews draft Commission adjudicatory decisions; provides interpretation of laws, regulations, and other sources of authority, and the legal form and content of proposed official actions; represents and advises staff offices in all programmatic activities and administrative litigation in connection with licensing and enforcement; prepares or concurs in all contractual documents, interagency agreements, delegations of authority, regulations, orders, licenses, and other legal documents, and prepares legal interpretations thereof; represents the NRC in administrative proceedings related to such matters as personnel, procurement, and EEO; reviews and directs intellectual property work; represents and protects the interest of the NRC in legal matters, in court proceedings, and in relation to other government agencies, administrative bodies, committees of Congress, foreign governments, and members of the public; provides legal advice to the Commission (including staff), and represents the Commission in courts of appeals proceedings to review Commission orders and rules; and, in co-operation with the Department of Justice, represents the Commission in court proceedings affecting the Commission's programmes in the federal district courts and the Supreme Court.

Office of the Secretary of the Commission (SECY)

The Office of the Secretary of the Commission (SECY), which reports directly to the Commission, provides general management services to support the Commission and to implement Commission decisions. SECY also advises and assists the Commission and staff on the planning, scheduling, and conduct of Commission business; and maintains the official adjudicatory dockets of the Commission. It also directs and administers the NRC history programme, and integrates automated data processing and office automation initiatives into the Commission's administrative systems. Additionally, SECY manages the Commission Decision Tracking System. Finally it is responsible for the implementation of the Federal Advisory Committee Act and maintains liaison with certain boards and advisory committees.

Office of International Programs (IP)

The Office of International Programs (IP), which reports directly to the Commission, provides assistance and recommendations to the chairperson, the Commission, and NRC staff on international issues. IP staff provides overall co-ordination for NRC's international activities, including nuclear exports and imports, international safeguards, international physical security, non-proliferation matters, and international co-operation and assistance in nuclear safety and radiation protection; plans, develops, and implements programmes, in concert with other NRC offices, to carry out policies established in these areas; plans, develops, and manages international nuclear safety information exchange programmes, and co-ordinates international research agreements. IP obtains, evaluates, and uses pertinent information from other NRC and US Government offices in carrying out assigned responsibilities; manages NRC's foreign intelligence responsibilities; and establishes and maintains working relationships with individual countries and international nuclear organisations, as well as

other involved US Government agencies. The Office also assures that all international activities carried out by the Commission are well co-ordinated internally and government-wide and are consistent with the NRC and US policies.

Office of Commission Appellate Adjudication (OCAA)

The Office of Commission Appellate Adjudication (OCAA), which reports directly to the Commission, is responsible for monitoring cases pending before presiding officers; providing the NRC with an analysis of any adjudicatory matter requiring a Commission decision (*e.g.* petitions for review of initial licensing board decisions, certified questions, interlocutory referrals, stay requests), including available options; drafting any necessary decisions pursuant to the Commission's guidance after presentation of options; and in significant cases consulting with the Office of the General Counsel in identifying options to be presented to the Commission and in drafting the final decision to be presented to the Commission.

Advisory Committees

The Commission currently has several advisory committees chartered under the Federal Advisory Committee Act. This Act imposes certain constraints on advisory committees, primarily that they give advance notice of their meetings, and, unless certain exemptions apply, hold them open to the public.

These Committes include, *inter alia*:

- the *Advisory Committee on Reactor Safeguards (ACRS)*: the ACRS, consisting of 10 members with expertise in scientific and engineering disciplines, is NRC's only statutory advisory committee. It provides advice on potential hazards of proposed or existing reactor facilities, the adequacy of proposed safety standards and such other matters as the Commission may request. The statute requires that the ACRS review certain types of applications such as those for construction permits or operating licenses for power reactors or test reactors.

- the *Advisory Committee on Nuclear Waste (ACNW)*: the ACNW, consisting of four members with expertise in scientific and engineering disciplines, renders advice on nuclear waste management issues as directed by the Commission on the basis of periodic reviews of ACNW proposals.

Office of Nuclear Reactor Regulation (NRR)

The Office of Nuclear Reactor Regulation (NRR), which reports directly to the EDO, is one of the NRC's three major statutory programme offices. NRR employs approximately 20% of the Commission's personnel. NRR staff is responsible for ensuring the public health and safety through licensing and inspection activities at all nuclear power reactor facilities in the United States. NRR is responsible for the oversight of all aspects of licensing and inspection of manufacturing, production, and utilisation facilities (except for facilities reprocessing fuel and performing isotopic fuel enrichment), and receipt, possession, and ownership of source, by-product, and special nuclear material used or produced at facilities licensed under 10 CFR Part 50. NRR staff develops policy and inspection guidance for programmes assigned to the regional offices and assesses the effectiveness and

uniformity of the region's implementation of those programmes. It identifies and takes action in co-ordination with the regional offices regarding conditions and licensee performance at such facilities that may adversely affect public health and safety, the environment, or the safeguarding of nuclear facilities and assesses and recommends or takes action in response to incidents or accidents. NRR staff is responsible for licensing issues and regulatory policy concerning reactor operators, including the initial licensing examination and requalification examinations; emergency preparedness, including participation in emergency drills with federal, state, and local agencies; radiation protection; security and safeguards at such facilities, including fitness for duty; and the inspection of nuclear component supplier facilities. NRR responsibilities include the technical review, certification, and licensing of advanced nuclear reactor facilities and the renewal of current power reactor operating licenses.

Office of Nuclear Material Safety and Safeguards (NMSS)

The Office of Nuclear Material Safety and Safeguards (NMSS), which reports directly to the EDO, is one of the NRC's three major statutory programme offices. It employs approximately 12% of the Commission's personnel. NMSS is responsible for ensuring the public health and safety through licensing, inspection, and environmental reviews for all activities regulated by the NRC, except operating power and all non-power reactors, and for the safeguards technical review of all licensing activities, including export/import of special nuclear material, excluding reactors. The Office develops and implements NRC policy for the regulation of activities involving the use and handling of radioactive materials, such as: uranium recovery activities; fuel fabrication and development; medical, industrial, academic, and commercial uses of radioactive materials; safeguards activities; transportation of nuclear materials, including certification of transport containers, and reactor spent fuel storage; safe management and disposal of low-level and high-level radioactive waste; and management of related decommissioning. Its safeguards responsibilities include developing overall Commission policy, monitoring and assessing the threat to the environment including liaison with intelligence agencies as appropriate, and those licensing and review activities appropriate to deter and protect against threats of radiological sabotage and threats of theft or diversion of special nuclear material at fuel facilities and during transport. The NMSS identifies and takes action to control safety and safeguards issues for activities under its responsibility, including consulting and co-ordinating with international, federal, state, and local agencies, as appropriate.

Office of Nuclear Regulatory Research (RES)

The Office of Nuclear Regulatory Research (RES), which reports directly to the EDO, is one of the NRC's three major statutory programme offices. It employs approximately 7% of the Commission's personnel. RES recommends and implements programmes of nuclear regulatory research. It independently proposes regulatory outcomes in the form of improvements to NRC's regulatory programmes/processes to achieve enhanced safety, efficiency or effectiveness based on the results of this research. It co-ordinates research activities with the programme offices, as appropriate, and co-ordinates the development of consensus and voluntary standards for Commission use. Based on research results and experience gained, the Office resolves safety issues for nuclear power plants and other facilities regulated by the NRC including those issues designated as Generic Safety Issues. It assesses the effectiveness of selected NRC programmes, including the regulations and guidance, with regard to risk reduction potential, burden reduction potential, and the degree to which margins exist in design and operations of licensed facilities, and conducts research to reduce uncertainties in areas of potentially high risk or safety significance. The Office leads the Commission initiative for co-operative research with the DOE, the nuclear industry, universities and international partners; and co-ordinates research activities outside the Commission, including appointment of staff to committees

and conferences. It maintains technical capability to develop information for resolution of nuclear safety issues and provides technical support and consultation to the programme offices in the specialised disciplines involved. It also provides independent analysis of operational data and assessment of operational experience through the review, analysis and evaluation of the safety performance of facilities licensed by the NRC. The Office collects, analyses, and disseminates operational data; assesses trends in performance from this data; evaluates operating experience to provide insights into and improve the understanding of, the risk significance of events; and produces periodic performance indicator, and Accident Sequence Precursor Reports. RES also manages the NRC power reactor backfit programme, including the Committee to Review Generic Requirements (CRGR), to assure that new regulatory requirements (unless needed to assure adequate protection of the public health and safety) are justifiable on a cost-benefit basis.

Advisory Committee on the Medical Uses of Isotopes (ACMUI)

The ACMUI, which reports directly to the EDO, consists of 12 members: qualified physicians and scientists and other representatives of the medical community, including a patients' representative. The ACMUI considers medical questions referred to it by the NRC staff (primarily the Office of Nuclear Material Safety and Safeguards) and gives expert opinions on the medical uses of radioisotopes. It also advises the NRC staff, as required, on matters of policy.

Incident Response Operations

Incident Response Operations, which reports directly to the EDO, develops and directs the NRC programme for investigation of operational incidents. It develops and directs the NRC programme for response to incidents, and is the Commission incident response interface with the FEMA and other federal agencies. It also exercises oversight of the regional response programmes; manages the NRC Operations Center; and receives, screens, and promptly communicates to the cognisant offices operational event information reported to the Operations Center.

Office of State Programs (OSP)

The Office of State Programs (OSP) reports to the EDO through the Deputy Executive Director for Materials, Research and State Programs. It is responsible for establishing and maintaining effective communications and working relationships between the NRC, states, local governments, other federal agencies and Indian tribe organisations. It serves as primary contact for policy matters between the NRC and these external groups; keeps the NRC apprised of these groups' activities as they may affect the NRC; and conveys to NRC management these groups' views toward NRC policies, plans, and activities. It administers the Agreement States Program providing training and technical assistance and reviewing the adequacy and compatibility of the States' radiation control programmes, which now have responsibility for some two-thirds of all materials licensees in this country. State Programs assists the States in such high priority areas as the development of programmes for the disposal of low-level waste and the control of uranium milling sites. State liaison officers appointed by State governors, and NRC Regional State Liaison Officers, attached to each of NRC's regional offices, serve as primary contact points between the Agreement States and the NRC.

Office of Enforcement (OE)

The Office of Enforcement (OE) is subject to oversight by the Deputy Executive Director for Reactor Programs. The NRC's enforcement programme has been developed to support the NRC's overall safety mission in protecting the public and the environment. Consistent with that purpose, enforcement action should be used as a deterrent to emphasise the importance of compliance with regulatory requirements, and to encourage prompt identification and prompt, comprehensive correction of violations. Violations are identified through inspections and investigations. All violations are subject to civil enforcement action and may also be subject to criminal prosecution. The Commission uses three primary enforcement sanctions: Notices of Violation, civil penalties, and orders. A Notice of Violation identifies a requirement and how it was violated, and formalises a violation. A civil penalty is a monetary fine issued under authority of Section 234 of the Atomic Energy Act. Civil penalties may be assessed up to USD 110 000 per violation per day. Notices of Violation and civil penalties are issued based on violations. Orders may be issued for violations, or in the absence of a violation, because of a public health and safety issue.

Office of Investigations (OI)

The Office of Investigations (OI) was created in 1982 as a commission-level office independent of the EDO and the NRC staff. In 1989, pursuant to a congressional directive, the Commission placed OI under the EDO in order to emphasise that the office's primary role is to support the regulatory activities of the NRC, especially the Office of Enforcement. The Director of OI reports directly to the Deputy EDO for Reactor Programs. OI has a field office in each region.

OI develops policy, procedures, and quality control standards for investigations of licensees, applicants, their contractors or vendors, including the investigations of all allegations of wrongdoing by other than NRC employees and contractors. OI plans, co-ordinates, directs, and executes administrative affairs of the Office, including the development and maintenance of a management information system. The Office maintains current awareness of inquiries and formal investigations; keeps Commission principals currently informed of matters under investigation as they affect public health and safety matters; and co-ordinates liaison with other agencies and organisations to ensure the timely exchange of information of mutual interest.

Office of Human Resources

The Office of Human Resources provides overall leadership and management of Commission-wide human resources (HR) policy programmes. It develops and implements both short- and long-range human resources strategic plans consistent with Commission-wide programmatic goals and objectives; and assists and advises NRC management in the planning and implementation of HR goals consistent with Commission policies and mission. The Office plans and implements NRC human resources policies, programmes, and services providing organisation and position management analysis; recruitment and employment services; labour and employee relations services, and workforce information and analysis. It plans and implements Commission-wide training and development policies and programmes designed to establish, maintain, and enhance the skills employees need to perform their current jobs effectively and to meet the future skill needs of the Commission. It oversees the NRC occupational safety and health programmes including the workers' compensation and employee assistance programmes; and provides advice and support for the planning, development, implementation, oversight, and evaluation of HR information systems.

Most recently the Technical Training Center in Chattanooga, Tennessee was consolidated into the Office Of Human Resources to integrate technical and non-technical training within one organisational unit and to develop a consolidated and prioritised Commission training budget and planning process. The Technical Training Center programme includes training in the area of reactor technology, probabilistic risk assessment, radiation protection, fuel cycle, and regulatory skills to provide the necessary technical and regulatory foundation to support staff activities and decisions. Training is provided for inspectors, license reviewers, operations centre duty officers, licensing project managers, technical reviewers, reactor technology instructors, and other NRC staff. Technical training for the NRC is highly dependent on the full-scope simulators, classroom information technology systems, and office technology systems that constitute the infrastructure at the Center.

Office of Small Business and Civil Rights (SBCR)

The Office of Small Business and Civil Rights (SBCR) is responsible for the development, implementation and management of three major programmes – Affirmative Action, which includes affirmative employment initiatives and a managing diversity process; Civil Rights; and the Small Business Procurement Preference Program. The mission of SBCR is to facilitate equal employment opportunity for all NRC employees and applicants through an on-going affirmative employment process; to provide for prompt, fair and impartial processing of EEO complaints and to eliminate or modify procedures or practices that give rise to valid complaints; and to ensure that small, minority, and women-owned businesses have full and fair opportunity to participate in NRC procurement activity.

Office of Administration (ADM)

The Office of Administration (ADM) provides centralised services in the areas of contracts and property management, facilities and security, and administrative services including rule-making and Commission directives support, transportation, parking, translations, audio-visual services, food services, mail distribution, furniture, supplies, and safety equipment. The Director, ADM, administers the NRC security and classification programmes.

Regional Offices

NRC's four regional offices are located in the Philadelphia (Region I), Atlanta (Region II), Chicago (Region III), and Dallas (Region IV) areas (a field office, located near San Francisco, was consolidated with Region IV in October 1998). Approximately 30% of the Commission's personnel are stationed in the Regions. Each regional office is headed by a regional administrator, appointed by the Executive Director for Operations, who is responsible for executing established NRC policies and assigned programmes relating to inspection, enforcement, licensing, State agreements reviews, State liaison, and emergency response within the region's boundaries.

For regionalised programmes, the regional offices perform an implementation function for the sponsoring headquarters programme office, from which they take direction. Included among the responsibilities of Regional Offices are the inspection and evaluation of engineering, construction, and operational activities of power reactors; implementation of nuclear material safety, licensing and inspection, emergency preparedness, and safeguards licensing functions assigned to the region; co-ordination of the NRC's Incident Response Program for activities within the region; issuance of notices of violation and proposed civil penalties (subject to further approval of headquarters,

depending on severity); review of Agreement State regulatory programmes; and provision of technical assistance to Agreement States in carrying out their regulatory programmes.

Office of the Inspector General (OIG)

A 1988 Amendment to the Inspector General Act of 1978, a statute designed to promote integrity and efficiency in government programmes, provided for the appointment of NRC's first Inspector General. NRC is the only independent regulatory commission with an IG appointed by the President and confirmed by the Senate. Under the statute the IG reports directly to the NRC Chairperson.

The OIG provides policy direction for and conducts, supervises, and co-ordinates audits and investigations relating to all NRC programmes and operations; reviews existing and proposed legislation and regulations and makes recommendations concerning their impact on the economy and efficiency of NRC programmes and operations and on the prevention and detection of fraud and abuse in such programmes and operations; recommends policies for, and conducts, supervises, or co-ordinates other activities for the purpose of promoting economy and efficiency in the administration of, or preventing and detecting fraud and abuse in, NRC programmes and operations; recommends policies for and conducts, supervises, or co-ordinates relationships between the NRC and federal, state and local agencies, and non-governmental entities relating to the promotion of economy and efficiency in the administration of, or prevention and detection of fraud and abuse in, NRC programmes and operations or identification and prosecution of participants in fraud or abuse; keeps the Chairperson and Congress fully and currently informed concerning fraud and other serious problems, abuses, and deficiencies relating to the administration of NRC programmes and operations; recommends corrective actions and reports on the progress made in implementing corrective actions; complies with GAO standards for audits of federal establishments, organisations, programmes, activities, and functions; and expeditiously refers criminal matters to the Department of Justice.

iv) Financing

Under the Omnibus Budget Reconciliation Act of 1990, those regulated by the NRC are required to pay fees which collectively total approximately 100% of the NRC budget. The NRC collects fees for review of licence applications, construction permits, operating licences, licence amendments, and renewals; assesses fees for inspections; and also imposes an annual fee on its licensees. Although the NRC collects substantially all of its budget through its fee recovery programme, the NRC remits the fees to the federal Treasury. The moneys, therefore, are not available for Commission disbursement until Congress has appropriated the funds [42 USC 2214].

b) Department of Energy (DOE)

i) Legal status

With enactment in 1977 of the Department of Energy Organization Act [42 USC 7101 *et seq.*], the United States Congress combined the energy management functions of the Federal Government into a single cabinet-level Executive Branch agency charged with co-ordinating federal energy policy and programmes. This agency, the Department of Energy (DOE), is the successor to the Energy Research and Development Administration and heir to the research, development, and demonstration

functions of the former Atomic Energy Commission. In this capacity, it is charged with and carries out non-defence nuclear missions pursuant to broad legislative authorities that include the Atomic Energy Act of 1954, as amended [42 USC 2011 *et seq.*], the Nuclear Waste Policy Act of 1982, as amended [42 USC 10101 *et seq.*], the National Competitiveness Technology Transfer Act of 1989 [15 USC 3701 *et seq.*], and the Energy Policy Act of 1992 [42 USC 10141 note, 42 USC 2297 *et seq.*, 42 USC 2061].

(ii) Responsibilities

The DOE conducts and supports an extensive array of activities related to the nuclear fission and fusion fuel cycles, including research, development, and demonstration; training and education, and technology transfer in the following areas:

- production, processing, and utilisation technologies, including support for advanced fission reactor development and development and demonstration of fusion energy as a potential commercial power source;
- environmental impacts and aspects of biomedical, physical and safety science related to nuclear power production;
- research in fundamental nuclear physics, the results of which feed into applied technology;
- management of high-level radioactive waste and spent nuclear fuel and support for the national low-level radioactive waste programme;
- international efforts to ensure nuclear safety, prevent nuclear proliferation, and assure stable energy supplies in crisis situations;
- safe transportation of radioactive materials;
- production for, and application of nuclear power systems in support of other federal agency missions, including the space missions of the Department of Defense and the National Aeronautics and Space Administration (NASA).

To assist it in discharging its responsibilities, the DOE also monitors, accumulates and disseminates to other federal agencies and to the public information from domestic and world energy markets; negotiates bilateral and multilateral energy agreements in consultation with the NRC, the Department of State and other agencies; and ensures that countries purchasing US nuclear fuel conform to IAEA safeguards.

In international nuclear transactions, the DOE administers US nuclear export policy in conjunction with the NRC and the Departments of State and Commerce, as provided for in the Nuclear Non-Proliferation Act of 1978 and the Atomic Energy Act of 1954. It also approves contracts for the sale of special nuclear materials and enrichment services to foreign nations; participates in reviews of export licences for equipment, reactors, and nuclear materials, and approves re-transfers of US origin nuclear material by foreign governments.

iii) Structure

Line Operations

The DOE is headed by the Secretary of Energy, who articulates national energy goals, plans for strategic programme implementation to meet the nation's short and long-term energy needs, and advises the President on energy issues and in the formulation of major national energy policies.

The Deputy Secretary acts on behalf of the Secretary in the Secretary's absence and, together with the Under Secretary, is responsible to the Secretary for DOE programmes that involve:

- overseeing and supporting the development of applied nuclear energy resources and technologies and constructing and operating the DOE's civilian research and test reactors;
- discharging the Secretary's responsibilities for the disposal and storage of high-level radioactive waste and spent nuclear material, including supporting related research, development, and demonstration activities and managing the Nuclear Waste Fund [see subsection (iv) "Financing", *infra*];
- managing the DOE basic research and development programmes and non-proliferation and security activities;
- managing the DOE's technical information resources and science education initiatives, the latter of which includes university reactor fuel assistance and other reactor research and training programmes in the universities, the private sector, and at the national laboratories; and
- planning for the use and overseeing the management of the DOE Laboratory Complex, in which many of the research and development programmes are conducted or facilitated and much of the civilian technology transfer takes place.

Below the level of these officials, the Assistant Secretaries and the Director of Energy Research are assigned specific responsibilities from among those enumerated in the DOE Organization Act. Assignments that relate to one or more aspects of the nuclear fuel cycle include:

- resource applications;
- environmental responsibilities;
- international and policy matters;
- national security;
- intergovernmental policies and relations;
- nuclear waste management; and
- public and congressional relations.

In addition to Secretariat assignments, the Director of Energy Research is, by law, advisor to the Secretary on the DOE research programmes and the operations and health of the multi-purpose laboratories. As such, the Director plays a major role in institutional planning for the Laboratory Complex.

The Office of Civilian Radioactive Waste Management was established by the Nuclear Waste Policy Act. The Director of the Office is responsible for carrying out the functions of the Secretary of Energy under the Act and is appointed by the President, by and with the consent of the Senate.

The Field Establishment

The DOE Operations Offices oversee and administer the contracts under which DOE installations, including the Laboratory Complex described below, are operated and, on a daily basis, perform a number of services related to or in support of DOE grants, co-operative agreements, and research and development agreements involving transfers of technology to the private sector. Through their managers, these Offices co-ordinate on and inform the DOE Headquarters of these field activities, as appropriate. The Operations Offices are located in Albuquerque, New Mexico; Chicago, Illinois; Idaho Falls, Idaho; Las Vegas, Nevada; Oakland, California; Oak Ridge, Tennessee; Aiken, South Carolina, and Richland, Washington.

The DOE carries out many of its missions through the use of its Laboratory Complex. Featuring many unique and state-of-the-art facilities, a number of the individual laboratories, including all of the multi-programme laboratories, have research and development capabilities in subject-matter that relates to one or more elements of the nuclear fission or nuclear fusion fuel cycle.

The laboratories within the complex, with few exceptions, are operated for the DOE by private-sector Management and Operating (M&O) Contractors, a regime that was initiated during the Manhattan Project[6] and carried over to the AEC through the Atomic Energy Acts of 1946 and 1954. Their facilities are available to non-DOE researchers, engineers, and technicians through "work-for-others" and user-facility arrangements on the basis of non-interference with DOE programmes. The DOE policy requires full cost recovery for work-for-others and for proprietary user facility access; non-reimbursable, non-proprietary user access is granted for meritorious, peer-reviewed proposals. In addition, consortia of non-DOE parties working with one or more of the laboratories under Cooperative Research and Development Agreements (CRADAs) are provided access to laboratory facilities.

Within the Laboratory Complex, the Idaho National Engineering Laboratory, Idaho Falls, Idaho, concentrates on nuclear reactor research and development, nuclear safety research, and radioactive waste technology development, and the Argonne National Laboratory, Chicago, Illinois and Idaho Falls, Idaho, devotes substantial resources to the design and testing of advances in fission-reactor technology.

The other DOE multi-programme laboratories are: Brookhaven National Laboratory, Upton, New York; Lawrence Berkeley Laboratory, Berkeley, California; Lawrence Livermore National Laboratory, Livermore, California; Los Alamos National Laboratory, Albuquerque, New Mexico; Oak Ridge National Laboratory, Oak Ridge, Tennessee; Pacific Northwest Laboratory, Richland, Washington, and Sandia National Laboratories, Albuquerque, New Mexico and Livermore, California.

6. This project was initiated by President Roosevelt in 1943 to develop a nuclear weapons programme.

Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission is an independent agency established within the DOE by the DOE Organization Act. It is responsible for overseeing domestic interstate operations of electric utilities, with the goal of ensuring that adequate energy supplies are available at reasonable prices, while allowing producers sufficient latitude to operate in the free marketplace. The Commission deals with nuclear energy to the extent that its decisions influence the determination of an overall energy mix.

Nuclear Waste Technical Review Board

The Nuclear Waste Policy Act established an independent Nuclear Waste Technical Review Board within the Executive Branch. The Board is charged by law with evaluating the technical and scientific validity of activities taken by the Secretary of Energy pursuant to the Nuclear Waste Policy Amendments Act of 1987, including site characterisation activities for the geologic high level radioactive waste repository and activities relating to the packaging and transportation of high-level radioactive waste and spent nuclear fuel. Statutory investigative powers are available to it in carrying out its responsibilities. It reports its findings, conclusions, and recommendations not less than twice per year to Congress and to the Secretary.

United States Uranium Enrichment Corporation (USEC)

The Energy Policy Act of 1992 (EPACT) (Public Law No. 102-486) amended the Atomic Energy Act of 1954 and created the United States Uranium Enrichment Corporation (USEC) as a wholly owned government corporation to operate the DOE's uranium enrichment programme and enrichment plants [42 USC 2297(b)]. The EPACT required that the USEC operate as a business enterprise, acquiring uranium for enrichment, low-enriched uranium for resale, highly-enriched uranium for conversion into low-enriched uranium, and selling enriched uranium and related services to the DOE, domestic and foreign persons [42 USC 2297(b)-2]. The USEC was directed to lease the DOE's uranium enrichment operations at the Portsmouth and Paducah Gaseous Diffusion Plants. These plants, now managed by the USEC, are regulated by the NRC. The USEC began operations on 1 July 1993 and its privatisation was completed in 1998.

iv) Financing

The DOE receives the primary funding for its nuclear programmes from the United States Treasury through the Congressional appropriations process. As previously indicated, the Laboratory Complex generates revenues from the performance of reimbursable work-for-others and for proprietary use of facilities on a full-cost recovery basis. These revenues, to the extent they are not applied, under M&O contract provisions, to the upkeep and maintenance of the facilities, are however offset against DOE appropriations.

c) Department of Labor

This cabinet-level Department has overall responsibility for worker safety. The Department of Labor also has jurisdiction in the first instance over any complaint by a nuclear industry employee that he or she has been discriminated against or discharged for "whistleblower" activities. Whistleblower

activities include notifying the NRC or the employer about statutory or regulatory violations, testifying before Congress or in another governmental proceeding regarding nuclear matters; and refusing to engage in unlawful practices if the employee has identified the alleged illegality to the employer [42 USC 5851].

In addition, the Occupational Health and Safety Administration (OSHA), an organisation within the Department of Labor, develops and promotes occupational health and safety standards, conducts inspections, and issues penalties. The Mine Safety and Health Administration develops mine safety and health standards, proposes penalties for violations of the standards, investigates accidents and co-operates with States in developing mine safety and health programmes.

d) Department of Transportation (DOT)

This cabinet-level Department works with the NRC to regulate the safety of transporting radioactive materials. Within the Department of Transportation (DOT), the Research and Special Programmes Administration has issued regulations which govern all modes of transport of hazardous materials, including radioactive materials and radioactive wastes.

e) Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) assumes overall responsibility for United States environmental quality. The EPA issues standards and guidance to limit human exposure to radiation. The EPA works with the public, industry, the States and other government agencies to inform people about radiation's risks and to promote actions that reduce human exposure. The EPA measures environmental levels of radiation and assesses radiation's effects on people and the environment. The EPA is also empowered to establish standards for disposal of radioactive wastes.

Within the Agency, the Office of Radiation Programs, managed by the Office of the Assistant Administrator for Air, Noise, and Radiation, has the specific authority to establish generally applicable environmental standards for releases of radiation into the environment and to promulgate rules limiting emission of hazardous pollutants into the atmosphere. It provides technical assistance to State radiation protection agencies, setting up a surveillance and inspection system for measuring radiation levels in the environment. The NRC is responsible for promulgating rules that implement EPA standards in NRC-licensed facilities.

2. Advisory Bodies

Each federal agency may have a number of advisory committees which assist it in developing policies, priorities, or research plans. As an example the following listing is arranged according to the federal agency to which the panel is responsible.

a) DOE Advisory Committees

The DOE uses the expert consideration, counsel, and recommendations of advisory bodies that address, wholly or as a part of their activities, programmes or issues associated with the nuclear fission and nuclear fusion fuel cycles.

Nuclear Energy Research Advisory Committee

The Nuclear Energy Research Advisory Committee was established on 1 October 1998 to advise the Secretary of Energy through the Director of the Office of Nuclear Energy, Science and Technology on: 1) periodic reviews and recommendations concerning the Nuclear Energy Research and Development Program within the Office of Nuclear Energy, Science and Technology; 2) long-range plans, priorities and strategies to address more effectively scientific aspects of nuclear energy research and development; 3) appropriate levels of funding to develop those plans, priorities, and strategies and maintaining appropriate balance between the different elements of the programme; 4) national policy and scientific aspects of nuclear energy research issues of concern to the Department of Energy as requested by the Secretary or the Director of the Office of Nuclear Energy, Science and Technology.

Advisory Committee on Human Radiation Experiments

This Advisory Committee established by the President in 1994 to investigate human radiation experiments carried out or sponsored by the United States Government during the period 1944 through 1974 has completed its work and issued a final report in October 1995. The Committee examined eight different categories of experiments: 1) with plutonium and other atomic bomb materials; 2) the Atomic Energy Commission's programme of radioisotope distribution; 3) nontherapeutic research on children; 4) total body irradiation; 5) research on prisoners; 6) human experimentation in connection with nuclear weapons testing; 7) intentional environmental releases of radiation; 8) research involving uranium miners and residents of the Marshall Islands.

Basic Energy Sciences Advisory Committee

The Basic Energy Sciences Advisory Committee was established on 16 October 1986 to advise the Secretary of Energy, through the Director of Energy Research, on elements of the Department's Basic Energy Sciences Program. This Programme includes a broad range of basic research into materials and chemical science, engineering and geosciences, applied mathematical sciences, energy biosciences, and advanced energy projects. In materials sciences, for example, research addresses the limitations that frequently restrict the performance of current energy systems and the development of future energy systems that will use advanced structural materials and testing techniques for improved operations.

Biological and Environmental Research Advisory Committee (BERAC)

The Biological and Environmental Research Advisory Committee (BERAC) was established on 22 November 1983 to conduct periodic reviews of elements of the DOE Biological and Environmental Research Program and provide advice on long-range plans, priorities and strategies to address more effectively the scientific aspects of energy-related biological and environmental issues of DOE policies and programmes.

High Energy Physics Advisory Panel/Nuclear Science Advisory Committee

The High Energy Physics Advisory Panel was established on 13 January 1967 to advise the DOE on the national high energy physics research programme. This programme includes studies of

the basic underlying structure of matter and energy and of the fundamental forces. The Nuclear Science Advisory Committee, a joint DOE/National Science Foundation advisory panel, provides advice concerning basic nuclear research programmes that concentrate on how the fundamental particles and forces combine to form atomic nuclei. In carrying out their advisory responsibilities, these Committees assess the adequacy of current facilities, the institutional balance of support needed for optimised scientific productivity, and the training of scientists. The programmes within their cognisance include those which have provided the bedrock for much of today's technological society, including nuclear power.

The Secretary of Energy Advisory Board

The Secretary of Energy Advisory Board, established on 2 January 1990 to succeed the Energy Research Advisory Board, provides expert guidance to the Secretary on DOE's research and development, and energy programmes, activities, and operations. The Secretary may charge this Board with the study of any aspects of any programs or operations within the DOE's cognisance, including those involving research and development in nuclear power (fission and fusion), future directions and operations of the Laboratory Complex, and high-level waste and spent nuclear fuel management and disposal.

National Electric and Magnetic Fields Advisory Committee

The National Electric and Magnetic Fields Advisory Committee was established on 14 January 1993 pursuant to the Energy Policy Act of 1992 to advise the Secretary of Energy and the Director of the National Institute of Environmental Health Sciences, under the US Department of Health and Human Services, on the design and implementation of a programme that will concentrate on the possible human health effects of electric and magnetic fields, and on issues of concern to State regulatory and health agencies, electric utilities, electric equipment manufacturers, labour unions, and the public with regard to the measurement assessment and management of these fields.

b) Advisory Committees to the Department of Health and Human Services

Two Groups, the Medical Radiation Advisory Committee (Radiation Study Section), and the Radiopharmaceutical Drugs Advisory Committee, help develop regulations and set research priorities for the Food and Drug Administration of the Public Health Service.

3. Public and Semi-Public Agencies

The following federal agencies sometimes exert regulatory authority over some aspects of nuclear energy; however, the major thrust of their activities is research oriented or advisory in nature. For example, while the Department of Commerce regulates the export of technology, it also develops measurement standardisation schemes. The Department of Defense overlaps into the civilian sector. Agencies are listed alphabetically by cabinet-level department, followed by independent federal agencies, and, finally, a few semi-public groups.

A. Cabinet-Level Departments

a) Department of Agriculture

This cabinet-level department advises the DOE and the NRC about potential impact of nuclear facility siting in rural areas and on lands controlled by the Forest Service. Within the Department, the Science and Education Administration funds research in the life sciences and studies and promotes the use of radioisotopes in agriculture.

b) Department of Commerce

This Department licenses exports of certain components for nuclear plants. Within the Department, the National Institute of Standards and Technology develops improvements in radiation measurement and instrument calibration. The National Oceanic and Atmospheric Administration researches the occurrence of radionuclides in estuaries. It studies the effect of radioactive materials on marine organisms and seeks application of radioactive tracers to fisheries problems.

c) Department of Defense (DOD)

Within the Department of Defense (DOD), several agencies study medical applications of nuclear technology, such as the Armed Forces Radiobiology Research Institute which develops biomedical applications of isotopes and examines long-term effects of radiation exposure, and the Uniformed Services University of the Health Sciences which does research on nuclear safety and dosimetry.

d) Department of Health and Human Services (DHHS)

Under the auspices of the Department of Health and Human Services (DHHS), the Public Health Service sponsors health research.

The Office of Radiological Health operates programmes to reduce exposure to hazards of ionising as well as non-ionising radiation. It prepares standards for safe exposure limits, and develops methods for controlling exposure, especially to radiation emitted by electronic products.

The National Cancer Institute of Health, Radiation Oncology Branch undertakes clinical and laboratory research for direct medical management of cancer patients, concentrating on simulating cellular kinetics in the laboratory in order to better sequence radiotherapy.

The Food and Drug Administration (FDA), an organisation within the DHHS, regulates to assure the safety of new devices and drugs, whether or not they contain by-product material, as they are placed in service. The FDA regulates the manufacture and distribution of radiopharmaceuticals, biologics and medical devices for safety and efficacy; the NRC regulates radiation safety associated with the actual use of these products. The FDA authority is exercised at the investigational, pre-market review, and manufacturing site level, and in its post-market surveillance, which includes user facilities when serious problems are reported.

e) Department of the Interior

Three separate agencies within this cabinet-level department assist in developing nuclear resources. The United States Geological Survey (USGS) conducts field and laboratory investigations supporting the DOE waste disposal efforts, and collaborates with the DOE on earth science technology. It conducts research on processes related to nuclear waste disposal and characterisation of potential disposal sites. It consults with the NRC on earth science matters related to regulation of waste repositories and the licensing of nuclear facilities. Finally, the USGS is implementing a nuclear hydrology programme to study the movement of radioactive material in groundwater.

The Denver Federal Center makes field and laboratory studies of radioactive minerals and radiogenic isotopes related to geochronology. It is also conducting research to trace the movement of water, and is comparing geohydrologic environments for radioactive waste disposal.

The Bureau of Land Management, as custodian of federal lands, reviews proposals involving federally controlled land (*e.g.* waste disposal).

f) Department of State (DOS)

The DOE and the NRC negotiate international accords in concert with the Department of State (DOS). The DOS negotiates agreements for co-operation and evaluates political, military and legal ramifications of export agreements. Pursuant to the Nuclear Non-Proliferation Act of 1978, the DOS plays an active role, screening agreements and contracts for compliance with United States nuclear law and policy.

Within the State Department, the Bureau of Oceans and International Environmental and Scientific Affairs is responsible for formulation and implementation of policies and proposals concerning nuclear non-proliferation, nuclear exports, and other aspects of nuclear policy in relation to other nations and international organisations. The Bureau assists the DOE in negotiating contracts for technology transfers.

B. Other Federal Agencies and Offices

a) Federal Emergency Management Agency (FEMA)

This Agency (FEMA) assumes lead responsibility for all offsite nuclear emergency planning and response. With the DOE and the NRC, it co-ordinates federal, state and local efforts to develop and evaluate radiological emergency response plans and warning systems, with particular emphasis on the adequacy of state and local plans.

b) National Aeronautics and Space Administration (NASA)

This Agency (NASA), concerned with civilian and military aspects of space exploration, operates the Lewis Research Center. The Center conducts projects in life sciences, nuclear medicine, and radiobiology. It has also studied the impact of radiation damage emanating from nuclear activities in space.

c) Tennessee Valley Authority (TVA)

This federal Agency (TVA) conducts a co-ordinated resource conservation, development, and land use programme in the Tennessee River Valley Region. It also produces and markets various types of power, including nuclear. The TVA investigates options for waste disposal and nuclear safeguards.

d) White House Offices

Two offices attached directly to the White House help decide priorities.

The Office of Management and Budget (OMB) develops the Administration's budget proposals each year. With authority to review individual federal agency requests subject to congressional approval, the OMB can influence which aspects of nuclear energy receive emphasis.

The Office of Science and Technology Policy co-ordinates research developments undertaken by various agencies, especially interdisciplinary approaches to waste disposal.

C. Semi-Public Agencies

a) American National Standards Institute (ANSI)

This organisation (ANSI) acts as a clearing-house to co-ordinate standards development. It consists of several management boards, one of which is the Nuclear Standard Board. Both NRC and DOE participate in that Board as voting members. The Board reviews standards developed by other organisations, such as the American Society of Mechanical Engineers and the American Society for Testing and Materials. The Institute deals with, among others, utilisation or measurement of ionising radiation, nuclear energy, fissionable materials, and chemical processing of nuclear materials. The ANSI represents the United States in the International Standards Organisation (ISO) and the International Electrotechnical Commission.

b) National Academy of Sciences (NAS)

The National Academy of Sciences (NAS) is an umbrella group which conducts research in all areas of science and engineering, including the physical and social sciences. It publishes a report on the Biological Effects of Ionising Radiation, and has set up a standing board dealing with radioactive waste management.

c) National Council on Radiation Protection and Measurement

This group studies nuclear physics, nuclear medicine and waste disposal as they relate to radiation protection. The Council formulates recommendations on radiation protection and measurement by compiling available scientific information from many disciplines. The Scientific Committee of the Council drafts recommendations which are in turn adopted by the Council. The recommendations cover consumer protection, occupational health, environmental protection, and nuclear waste disposal.

d) National Nuclear Data Center

The Center, a part of Brookhaven National Laboratory, co-operates with the OECD, the IAEA and focuses on continuing relationships with the former Soviet Union States in publishing the Computer Index of Nuclear Data (CINDA). The Center assists in computer data retrievals and evaluates a broad range of technical multidisciplinary data.

