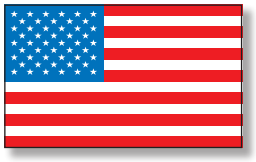
Nuclear Legislation in OECD and NEA Countries

Regulatory and Institutional Framework for Nuclear Activities



United States

OECD
BETTER POLICIES FOR BETTER LIVES

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NUCLEAR ENERGY AGENCY

United States

I. General Regulatory Regime

1. Introduction

In the United States, there are 100 licensed nuclear power plants operating, which generate approximately 20% of the total electricity produced in the United States. Sixty-five of the reactors in operation are pressurised water reactors and 35 are boiling water reactors. The nuclear power plants are mostly privately owned and operated, although some are operated by government-owned entities such as the Tennessee Valley Authority.

There are also 36 "research and test reactors" located primarily at universities. These reactors are used for research, training and testing. The United States also has uranium resources, mainly located in the western part of the country. There are four producing mills and four in situ leach plants. With regard to radioactive waste, low-level waste is stored on-site by the licensees until quantities are large enough for shipments to low-level waste disposal facilities. There are four licensed commercial low-level waste disposal facilities in the country. Finally, spent nuclear fuel and high-level waste are stored on-site until a deep geological repository is built (see under "Radioactive Waste Management").

In the United States, the federal government has assumed most responsibility for regulating nuclear energy. For example, federal legislation and administrative regulations govern nuclear facilities. The centrepiece of nuclear legislation in the United States is the Atomic Energy Act of 1954, 42 USC 2011 et seq.,[1] a comprehensive federal statute that regulates possession and use of radioactive material and facilities that produce or use such material. Although the Atomic Energy Act is central to such regulation, other statutes affect the regulation of radioactive material and facilities, a number of which are mentioned in the discussion that follows this introduction.

The Atomic Energy Act of 1954 marked a transition from the federal government's monopoly over production and use of radioactive materials to a regime in which private industry would also play a role in their production and non-military use. Military uses of nuclear energy remained the domain of the federal government. Under the act, the Atomic Energy Commission (AEC) initially constituted an independent agency to oversee the peaceful uses of atomic energy. Congress abolished the AEC, when it enacted the Energy Reorganization Act of 1974, which created the Nuclear Regulatory

1. In the United States, federal laws are cited by their public law number, by their title or short title, or as "xx USC xxx". "USC" refers to the United States Code, a codification of most federal statutes. In these USC citations, the number before USC is the number of the title of the USC and the number after USC is a section number within that title. The USC 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 (NWPA). Citations to the Code of Federal Regulations (CFR), a compilation of regulations issued by federal agencies, also appear in this chapter. When an administrative agency proposes to issue a regulation, it usually publishes the draft rule in the Federal Register, a daily publication, and invites public comment on the proposed rule. After public comment is considered, the final version of the rule is published in the Federal Register. Citations to the Federal Register appear as "xx Fed. Reg. xxx", signifying the Federal Register volume and page number. After publication, the final rule is incorporated into the CFR. The CFR is arranged into titles but the titles do not correspond numerically to parallel subject areas in the USC.

Commission (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 (DOE) Organization Act, Public Law No. 95-91, abolished the ERDA and vested DOE with power over most other aspects of nuclear energy previously under AEC responsibility. As such, activities conducted by or on behalf of DOE are not subject to regulation by the NRC, except in situations specifically provided for by statute.[2]

The NRC is the federal agency that has the responsibility for regulating the use of radioactive material for civilian purposes and before a person (including an individual, business enterprise, or private institution) can possess or use such material in the United States, that person must obtain a licence to do so from the NRC. Other federal agencies, such as DOE, the Department of Defense (DOD) and the Environmental Protection Agency (EPA) also have jurisdiction over certain matters that relate to the use of radioactive material but there is relatively little dual regulation between these agencies and the NRC.

Generally, individual states may regulate those nuclear activities that are not addressed by the federal government, so long as the state regulation does not conflict with federal law. In some areas that have not been pre-empted by the federal government, there may be regulation by both state and federal law; states can adopt standards that are more stringent than federal standards governing the same activities. Sometimes, states agree to assume control over an activity which normally would be regulated by the federal government. Under section 274 of the Atomic Energy Act, a state may agree to enter into an agreement with the NRC to regulate by-product material and in such a case the NRC thereafter discontinues its regulatory authority over this material. However, the state programme must be compatible with the NRC standards.

2. Mining regime

Despite some uranium mining activity in the United States, the NRC does not regulate uranium mining except for in situ mining. Since the early 1950s, the AEC and its successors have made estimates of American uranium ore reserves and potential uranium supplies. The NRC is responsible for licensing the extraction of source material, defined as uranium, thorium or any ores containing those materials in such concentration as the NRC may determine by regulation.

The Bureau of Mines in the Department of the Interior (DOI) controls all federal lands with valuable mineral deposits.[3] 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. DOE also issues permits specifically for uranium exploration.

2. DOE self-regulates facilities and activities operated by or on its behalf in most arenas addressed in this chapter, including: the use, possession, transfer, import and export (subject to certain exceptions) of special nuclear, source and by-product material; nuclear facilities, including research reactors; radiation protection requirements at its nuclear facilities; radioactive waste management, including storage and disposal facilities; physical protection of nuclear facilities and materials; and transportation of radioactive materials. Specific reference is made where DOE facilities or activities operated by or on its behalf are regulated by the NRC.

3. In some instances, DOE has exercised its Atomic Energy Act authority with respect to mining activities conducted by or on behalf of DOE.

DOE may 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 DOE to purchase any real property that may have the possibility of containing deposits of source material. DOE can issue leases or permits to prospect for source material on federal lands and, if authorised by executive order, can allow prospecting in national parks. No individual, partnership or corporation may benefit directly from confidential information learned about mineral deposits while participating in 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, receive, own, possess, import or export special nuclear material, source material or by-product material. Although the legislation discusses each category separately, the provisions are similar.

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 NRC will consult with the Department of State and other federal agencies regarding proposed exports of radioactive waste. For all proposed exports and imports, the NRC will ask the Department of State to consult with transit countries 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, any other material which the NRC determines to be special nuclear material and any material artificially enriched by any of the foregoing substances. The term does not include source material. In order to add substances to the list, the NRC must determine that such material is capable of releasing substantial quantities of nuclear energy and that the determination of the material as special nuclear material is in the interest of the common defence and security. The President must also give his written assent.

The NRC can issue licences to use special nuclear material for research and development activities, in the context of medical therapy or by commercial entities for purposes consistent with the intent of the Atomic Energy Act. 42 USC 2073(a)-2073(c). Originally, the AEC (predecessor to DOE and the NRC) could distribute special nuclear material by sale, lease with option to buy or in return for in-kind services. Now, these activities (e.g. uranium enrichment activities and sales) are conducted by private sector entities subject to NRC regulation. DOE retains authority under the Atomic Energy Act to regulate the activities conducted by DOE or on DOE's behalf.

The NRC regulates licensees by explicitly defining all conditions and limits of ownership, by forbidding assignment or transfer of licences in violation of the Atomic Energy Act of 1954 and by limiting distribution of the material to terms that will not permit a user to

construct a weapon with the material. Further, except when indemnification and limitation provisions of the Price-Anderson Act apply, licensees must hold the government and the NRC harmless in respect of any damage claims resulting from the use or possession of the material. 42 USC 2073(e).

DOE controls the foreign distribution of special nuclear material conducted by DOE or on DOE's behalf, while the NRC licences exports. Many of the export regulations reflect the provisions of the Nuclear Non-Proliferation Act (see section 7 "Non-proliferation and exports"). Subject to certain price and other limitations, the government can purchase or repurchase, as applicable, special nuclear material produced abroad in a nuclear reactor that is generated by the use of special nuclear material leased or sold by the United States and special nuclear material not consumed in the course of activities conducted in accordance with an agreement for co-operation, or any uranium remaining after irradiation of such material. 42 USC 2074(a). DOE exports are not subject to NRC licensing regulations except to the extent that DOE's activities are subject to the licensing and related regulatory authority of the NRC pursuant to section 111 of the Atomic Energy Act. 42 USC 2141.

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 NRC 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 general or specific licence is required to transfer, own, export, 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. However, the NRC is authorised to issue special reporting requirements with respect to ownership, possession, extraction, refining and shipment of source material. 42 USC 2095.

c) By-product material

For many years, the term "by-product material" has been defined to mean 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 and the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. 42 USC 2014(e)(1) and (2). However, the definition of by-product material was

expanded by the Energy Policy Act of 2005 to include (1) certain discrete sources of radium-226, (2) certain discrete sources of naturally occurring radioactive material, other than source material and (3) certain accelerator-produced radioactive material. 42 USC 2014(e)(3) and (4).

Licensing requirements similar to those for possession of special nuclear material or source material apply to by-product material. The government may distribute by-product material, with or without charge, to qualified users, subject to health and defence considerations. Any price schedule or distribution of by-product material 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 material ownership passes to the United States, DOE becomes the competent authority to monitor the facilities in conjunction with state agencies. 42 USC 2113(b).

d) Agreement State programmes

Approximately 17 400 materials licences are administered by the 37 states that participate in the NRC Agreement State Programme. An NRC Agreement State is one that has signed an agreement with the NRC under section 274(b) of the Atomic Energy Act, 42 USC 2021(b), authorising the state to regulate materials within that state. Under such an agreement, the NRC relinquishes its regulatory authority over the material covered by the agreement and the state obtains the authority to regulate the material. However, the NRC may not relinquish its authority for regulating the construction and operation of production or utilisation facilities or any uranium enrichment facility; the export from or import into the United States of by-product, source or special nuclear material, or of any production or utilisation facility; the disposal of source, by-product or special nuclear waste material into the ocean or sea; federal facilities; or the disposal of other by-product, source, or special nuclear material as the NRC determines by regulation or order should not be disposed of without an NRC licence because of the hazards or potential hazards thereof. In the latter regard, the NRC has retained regulatory authority over, among other things 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) licensed pursuant to 10 CFR Part 72.

4. Nuclear installations[4]

a) Initial licensing

The NRC licences all commercial nuclear power reactors in the United States pursuant to authority conferred by the Atomic Energy Act of 1954 and the Energy Reorganization Act of 1974. Within the NRC, the Office of Nuclear Material Safety and Safeguards licences fuel cycle facilities and the Office of Nuclear Reactor Regulation issues reactor licences. 42 USC 5801, 5843 and 5844. In addition, authority has also been delegated to the Director of the Office of New Reactors to issue licences and amendments, certifications, permits and limited work authorisations under 10 CFR Part 52.

The NRC has two different approaches for licensing 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.[5] Each of these two approaches is briefly described below.

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

The formal construction permit licensing process begins with the 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, 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 staff guide containing acceptance criteria for each system, component and structure important for safety. Once the staff finishes 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 the NRC staff and the applicant. It then submits a letter report to the NRC presenting the results of its independent analysis and recommending whether the NRC should issue a construction permit. In accordance with the National Environmental Policy Act of 1969 (NEPA), 42 USC 4321 et seq., 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

4. Nuclear facilities owned and operated by DOE are not subject to licensing by the NRC, except for those facilities specifically enumerated in the Energy Reorganization Act of 1974. 42 USC 5842. An explicit exclusion from NRC licensing of utilisation facilities of the Department of Defense is contained in 42 USC 2140.

5. The Energy Policy Act of 1992 added new sections 185(b) and 189(a)(1)(B) to the Atomic Energy Act.

and published for comment, followed by a final EIS which addresses all comments received. This environmental review is parallel to but separate from consideration of safety aspects of the application. 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 and environmental issues related to issuance of the construction permit. The initial decision may be appealed to the NRC. Following final NRC action on any appeal, a dissatisfied party can petition for review by the appropriate US Court of Appeals. Otherwise, a construction permit is issued.[6]

Before the scheduled completion of construction, the construction permit holder 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 EIS regarding the construction permit. No further consideration of alternative sites is necessary in the supplemental EIS. 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 and environmental 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.
- Combined Licences, which avoid the need for issuance of a construction permit and a separate operating licence.

Any person that may apply for a construction permit under 10 CFR Part 50 or a combined licence under 10 CFR Part 52 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

6. 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 related to the construction permit have been resolved, (2) the Director of the Office of New Reactors determines that the applicable standards and requirements of the Act and the Commission's regulations applicable to the activities to be conducted under the LWA have been met and issuance of the LWA will provide reasonable assurance of adequate protection to public health and safety and will not be inimical to the common defense and security and (3) the ASLB determines that there are no unresolved safety issues relating to the activities to be conducted under the LWA that would constitute good cause for withholding the authorisation.

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 under 10 CFR Part 50 or an applicant for a combined licence under Part 52.[7] As an Early Site Permit is a partial construction permit, the NRC holds a mandatory hearing to determine whether, taking into consideration the site criteria of 10 CFR Part 100, a reactor or reactors having characteristics that fall within the parameters for the site can be constructed without undue risk to the health and safety of the public and whether environmental issues have received adequate consideration in accordance with the requirements of 10 CFR Part 51. The Commission must treat as resolved, in any proceeding on an application for a construction permit or combined licence that references an Early Site Permit, those matters that had already been resolved in the proceeding on the application for the Early Site Permit.

Any person may submit an application requesting the NRC to conduct a design certification rulemaking, 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 10 CFR Part 50 or a combined licence under 10 CFR Part 52 and all issues relating to the adequacy of the certified design are treated as resolved in the subsequent proceeding.

Finally, 10 CFR 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. 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 and NRC's requirements, so that there is reasonable assurance that the facility will operate in accordance with the combined licence. The application may reference an Early Site Permit, in which case the application must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the Early Site Permit and to resolve any other significant environmental issue not considered in any previous proceeding regarding the site or design. As with construction permits subject to 10 CFR Part 50, an environmental review is conducted and a mandatory hearing is held prior to issuance of the combined licence where interested parties may raise safety and environmental issues related to its issuance. If the application references an Early Site Permit, interested

7. The Early Site Permit also allows the holder to perform the site preparation work that would be authorised under a LWA authorised under 10 CFR 50.10(e), if the applicant proposes, in the Early Site Permit application, a plan to redress the site in the event that the activities are performed and the Early Site Permit expires before it is referenced in an application for a Construction Permit or Combined Licence and the EIS for the Early Site Permit has determined that there would be no significant environmental impact stemming from such activities that cannot be redressed.

parties also have the opportunity to seek a determination on whether the reactor falls within one or more of the site parameters included in the permit, or the site is in compliance with the terms of the permit. Before the plant may operate, the NRC must find that the acceptance criteria in the ITAAC have been met and the public has an opportunity to request a hearing to determine this issue.

b) Operation and inspection, including nuclear safety

Each operating licence and combined 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. The NRC regional offices also conduct numerous special inspections. There are team inspections that are handled by 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 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 licences.

At the international level, the United States ratified the 1994 Convention on Nuclear Safety in April 1999. The latest National Report for the Convention on Nuclear Safety (NUREG 1650) is available at the NRC's website.[8]

8. See NRC (2013), "The United States of America National Report for the Convention on Nuclear Safety (NUREG-1650)," available at: www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1650/.

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, a renewed licence may be issued in increments not exceeding 20 years after the expiration of the current operating licence. 10 CFR 54.31. The initial operating license is not to exceed 40 years.

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 licences. In addition to specifying decommissioning requirements in regulations, the NRC provides 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 or for use under restricted conditions 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 must be submitted in accordance with NRC regulations.

Decommissioning activities are initiated when (1) a licensee decides to stop conducting licensed activities, (2) the licence expires without timely renewal, or (3) the licence is revoked by the NRC. Once licensed activities have ceased, licensees are required to decommission their facilities so that their licences can be terminated. 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 remaining residual radiological contamination that is at acceptably low levels, radioactive material has been transferred to authorised recipients. Confirmatory surveys are conducted by the NRC, where appropriate, to verify that sites meet NRC radiological criteria for decommissioning.

A significant number of 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.

NRC's procedural requirements applicable to nuclear power reactor licensees' licence termination and related decommissioning of commercial nuclear power reactors (and non-power reactor licensees) are set forth in 10 CFR 50.82. The regulation specifically addresses the timing of termination of the authority to operate.

e) *Emergency response*

Prior to the accident at the Three Mile Island nuclear plant in March 1979, there were no statutory requirements for off-site 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 off-site 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, 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. A finding on the adequacy of state and local emergency plans requires consultation with the Federal Emergency Management Agency (FEMA). The NRC regulations now require power reactor licensees to maintain emergency plans that include 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." The NRC's finding must be based on a prior review required to be undertaken by FEMA. For full power licensing, the on-site and off-site emergency response plans for nuclear power reactors must meet 16 planning standards promulgated by the NRC. "Failure to meet the applicable standards ... may result in the Commission declining to issue an operating license," except that a licence may be issued where a specifically listed condition applies; for example, where "deficiencies in the plan are not significant for the plant in question" 10 CFR 50.47.

For an emergency with potential radiological consequences, the NRC operates under the United States' National Response Framework (NRF) and its associated Nuclear/Radiological Incident Annex (NRIA). The NRF and NRIA describe the role of co-ordinating agencies, co-operating agencies and other federal agencies that may be involved in a co-ordinated response to a radiological emergency. The NRC's Office of Nuclear Security and Incident Response's Division of Preparedness and Response ensures that the NRC is prepared to respond as the co-ordinating agency to significant reactor, fuel cycle facility and nuclear materials events involving the NRC and the NRC Agreement State licensees, to support federal responses to other significant radiological events for which the NRC is not the co-ordinating agency and to investigate safety-significant events. In response to a licensee event that could threaten public health and safety, the NRC promptly sends to the event a Site Team from one of its four regional offices. Until the Site Team is in place, the NRC response is led from the Headquarters Operations Center (HOC), where a team of specialists evaluates the status of the licensee's critical safety functions and the protective actions recommended by the licensee and implemented by the state and local authorities. All communications with the media, state and federal officials, the Congress and the White House, are co-ordinated from the HOC. The HOC provides logistical and technical support to the NRC Site Team once it is in place to lead the NRC response.

With regard to transport, the NRC has independent regulatory authority over safety in the transportation of radioactive material, establishes design standards for the cases used to transport licensed spent fuel and reviews and certifies cask designs prior to their use. It also conducts inspections to ensure that spent fuel packages and shipments are in

accordance with NRC and Department of Transportation (DOT) safety regulations. Memoranda of understanding and more informal consultations allow the agencies to work together in areas where their jurisdiction overlaps. States also have an important role to play in the area. In fact, in many situations the primary responsibility for responding to a transportation emergency belongs to state and local governments. The Energy Policy Act of 2005 also contains provisions relating to transportation.[9]

At the international level, the US 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. Radiological protection[10]

a) Protection of workers

Occupational worker protection requirements apply to all NRC licensees. The regulatory goal is to keep workers informed about 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 request of an occupational worker who is terminating employment that involved exposure to radiation or radioactive materials, during the current calendar quarter or the current year, an NRC licensee shall provide that worker with a written report regarding the radiation dose received by that worker from operations of the licensee during the current year or fraction thereof. If the most recent individual monitoring results are not available at that time, a written estimate of the dose must be provided together with a clear indication that this is an estimate. 10 CFR 19.11-19.13.

The NRC inspects facilities to ensure compliance with the NRC radiological health and safety regulations. Representatives of workers and the licensee may be provided with the opportunity to accompany the inspectors. A worker or worker's representative can request an inspection if that worker or representative believes that a violation of the Atomic Energy Act (AEA), an NRC regulation, or a licence condition exists or has occurred. If the NRC determines that an inspection is unwarranted because there are no reasonable grounds to believe that a violation exists or has occurred, the appropriate NRC official shall notify the worker or worker's representative in writing of such determination. 10 CFR 19.14-19.17.

Permissible occupational radiation dosages are subject to an annual limit. 10 CFR 20.1201(a). Each licensee must take various preventive measures such as the provision of radiation protection equipment, surveys of hazards, personnel monitoring

9. In this connection, see sections 651(d) and 656 of Public Law No. 109-58, 119 Stat. 802, 813, which respectively address radiation source protection and secure transfer of nuclear materials.

10. For its nuclear facilities and activities, DOE promulgated regulations that govern worker safety and health, 10 CFR Part 835, occupational health and safety, 10 CFR Part 851, and protection of the public and the environment through DOE order requirements [DOE Order 5400.5].

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 non-radiological safety 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 non-radiological safety requirements of 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 and public dose and emission levels resulting from licensed activities. It neither controls nor monitors radiation exposure from background sources.

All phases of nuclear facility construction and operation, as well as the regulation of nuclear materials are subject to public health, safety and security constraints. AEA, 42 USC 2011 et seq. Licensees must also comply with various federal environmental laws, including: the Endangered Species Act, 16 USC 1531-1544; 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.

The NRC licences the use of radioactive materials by physicians and hospitals and issues regulations to ensure the safety of the public, including patients and workers. However, a majority of states (usually referred to as "Agreement States") have entered into agreements with the Commission for the state to regulate radiological health and safety with respect to one or more categories of radioactive material listed in section 274(b) of the Atomic Energy Act of 1954. 42 USC 2021(b). Agreement States' programmes must be 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 that storage and disposal methods are safe for long-term waste management.[11] DOE has the lead responsibility for disposal of commercial spent nuclear fuel and high-level waste and for developing technologies and programmes for handling, treatment, storage, transport and disposal of all DOE-generated or owned waste. EPA must establish standards for protection of the environment from radionuclides released to the biosphere, as part of its authority under the Atomic Energy Act of 1954, as amended, to develop generally applicable environmental radiation protection standards. EPA radiation protection

11. NRC regulations on disposal of radioactive waste are found at 10 CFR Parts 60, 61 and 63.

standards, entitled "Radiation Protection Programs", 40 CFR Subchapter F, Part 190, are generally implemented by DOE for activities within its jurisdiction and by the NRC for its commercial licensees.

At the international level, the United States ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management in April 2003.

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. The Nuclear Waste Policy Act was further 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 underground in a deep geologic repository. The act authorises the Secretary of Energy to construct one geologic repository, the Environmental Protection Agency to establish applicable public health and safety standards and the NRC to establish regulations for and licence the construction, operation and decommissioning of the repository. Further, the packages used to transport the high-level radioactive waste and spent nuclear fuel would have to be certified by the NRC for such purposes.

The act also established a Nuclear Waste Fund composed of payments made by the generators and owners to pay for the disposal program. All commercial generators were required to enter into a contract with DOE. The provisions of the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste are set forth in 10 CFR Part 961. A methodology was developed, through rulemaking, to allocate the costs for disposal of federal defence-related waste in a repository. In 1993, Congress established a Defense Nuclear Waste Disposal Fund.

In February 2002, the Secretary of Energy recommended the Yucca Mountain site to the President for development as a repository. That recommendation was adopted by the President and approved by the Congress. The Yucca Mountain-specific public health and safety radiation protection standards promulgated by EPA are codified at 40 CFR Part 197 and the Yucca Mountain-specific licensing regulations promulgated by the NRC are codified at 10 CFR Part 63. In 2008, DOE submitted a licence application to the NRC for construction authorisation. In 2009, Yucca was determined to not be a workable option and work on the project was terminated. The NRC's administrative hearing process on the licence application has been suspended since 2010. In 2013, the US Court of Appeals for the District of Columbia Circuit issued a writ of mandamus ordering NRC to proceed with its review of the licence application to the extent its limited funds permitted. In November 2013, in response to the writ of mandamus, the NRC Commission issued an Order ordering the NRC staff to, among other things, complete the Safety Evaluation Review for the licence application.

DOE remains committed to fulfilling its obligation to dispose of spent nuclear fuel and high-level radioactive waste. In 2012, the Administration issued its Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste. The Strategy is a framework for moving towards a sustainable program to deploy an integrated system capable of transporting, storing and disposing of used nuclear fuel and high-level radioactive waste from civilian nuclear power generation, defence, national security and other activities.

i) 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 ("TRU") waste resulting from the defence activities of the United States. In 1991, DOE completed construction of WIPP in a mine constructed 655 metres below ground surface in an ancient salt dome approximately 26 miles east of Carlsbad, New Mexico. In 1992, Congress enacted the Waste Isolation Pilot Plant Land Withdrawal Act (WIPP Act), Public Law No. 102-579, which detailed how DOE should proceed with developing the facility and established the EPA as regulator of DOE's activities at WIPP.

In May 1998, EPA issued its certification that WIPP will comply with its radioactive waste disposal regulations at 40 CFR Part 191. In 1999, WIPP began receiving shipments of TRU waste. The WIPP Act requires that EPA "re-certify" the facility every five years following initial receipt until the end of the decommissioning phase. In March 2006, EPA re-certified that WIPP continues to comply with waste disposal regulations at 40 CFR Part 191, subparts B and C and WIPP Compliance Criteria at 40 CFR Part 194. In addition, in October 2006, EPA issued a revised permit specifying the conditions under which remote-handled TRU waste may be disposed at WIPP. In January 2007, DOE made its first shipment of remote-handled TRU waste to WIPP. In 2010, the EPA re-certified WIPP to operate for another five-year period. The new re-certification is expected in 2014.

ii) West Valley Demonstration Project

The West Valley Demonstration Project Act of 1980 (WVDP) requires that the Secretary of Energy carry out a high-level radioactive waste (HLW) demonstration project at the Western New York Service Center in West Valley, New York to demonstrate solidification techniques that can be used for preparing HLW for disposal. 42 USC 2021(a). The Center includes a former nuclear fuel reprocessing facility that operated from 1966 to 1972 and was licensed until 1981 when a private company that had operated the site left. Under the demonstration project, DOE is authorised to solidify and package HLW at the site, dispose of low-level waste and TRU waste produced by the demonstration project and decontaminate and decommission facilities in accordance with NRC requirements. After DOE's responsibilities are completed, the premises will be returned to New York State. In 2002, DOE completed solidification of the liquid HLW at the site and the NRC issued its final policy statement on decommissioning criteria for the WVDP. In 2005, the Waste Management Record of Decision was signed, which allowed stored low-level waste (LLW) and mixed low-level waste (MLLW) to be disposed of off-site. In 2009, the Decommissioning Record of Decision was signed making short-term clean-up decisions and deferring most long-term decisions, such as excavation of buried waste, for at least 10 years.

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. Thus, the act invites states to form compacts as necessary for the establishment and operation of regional disposal facilities. It declares that each state is responsible for the disposal of low-level radioactive waste generated within its borders, with the exception of

low-level radioactive waste owned or generated by DOE, the United States Navy, or the federal government as a result of any research, development, testing or production of any nuclear weapon. It also mandates that the federal government is responsible for the disposal of greater-than-class C low-level radioactive waste resulting from NRC-licensed activities.

The act provided that states with an existing regional disposal facility (there were at that time 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, the Congress has consented to 10 regional compacts, which currently comprise 42 states. Eight states, Washington, DC and Puerto Rico are currently unaffiliated with any compact. However, currently there are four active licensed commercial disposal sites for low-level radioactive waste: Barnwell in South Carolina; US Ecology in Richland, Washington; EnergySolutions in Clive, Utah; and Waste Control Specialists in Andrews, Texas.

The NRC regulations divide low-level waste management into 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, 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 Energy Policy Act of 1992, Public Law No. 102-496; 42 USC 2023, added a new section to the Atomic Energy Act that provides for the 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 off-site incineration of low-level radioactive waste, if the NRC exempts such waste from regulation.

c) Disposal at sea

The 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. It 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, 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, 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 1414.

On 6 January 1983, the 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. In November 1993, the United States 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), 42 USC 7901 et seq., the Congress found that mill tailings at active and inactive uranium milling sites might pose a significant health hazard, especially through potential radon diffusion into the environment. At many of these sites, the public was allowed to use mill tailings, the sandy nature of which made it an excellent material for use in mortar. When the mill tailings mortar was used in the construction of building foundations, it resulted in radon levels in homes and other structures that posed an inhalation risk to occupants. Under Title I of UMTRCA, on co-operation with interested states, Indian tribes and site users, the Congress provided for assessment and remedial action at inactive uranium milling sites and at nearby properties that became contaminated by uranium mill tailings from the milling sites and, where appropriate, for reprocessing tailings to extract any remaining uranium or unstable materials. In addition, Title II of UMTRCA authorises the NRC 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. Under either Title I or Title II, upon termination of site clean-up by DOE (Title I) or upon termination of site clean-up by the licensee and the termination of the licence by the NRC or by a State (Title II), title to the uranium mill tailings disposal sites will ultimately transfer to the United States. DOE's Office of Legacy Management will assume responsibility for long-term custody.

DOE was directed to designate inactive uranium milling sites for remedial action and to complete any remedial action at such locations where states have contributed a percentage of clean-up costs. 42 USC 7912.

Relying on the advice of the EPA, DOE was directed to develop remedial action priorities at each site. When appropriate, DOE could have required 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, DOE can purchase land for a potential disposal site, and in some cases, can utilise public federal land managed by the Department of the Interior. 42 USC 7916.

DOE, after promulgation of health and safety standards by EPA, was authorised to solicit proposals from private parties who wanted to reprocess mill tailings. Then DOE needed to decide whether or not such mill tailings should be reprocessed and whether recovery of residual minerals at each site was practical, depending upon source material concentration remaining in the residue. A person allowed to recover any mineral had to remit a share of the resulting profit to DOE in order to repay DOE for any remedial

actions in rehabilitating the units. There has been no reprocessing of mill tailings or recovery of residual minerals under this provision.

DOE has completed surface remedial actions at 22 inactive uranium milling sites and over 5 000 nearby vicinity properties. 42 USC 7918. DOE's Office of Legacy Management, which was established in 2004, is responsible for ensuring that DOE implements its post-closure responsibilities. As of 2014, DOE is responsible for providing long-term surveillance and maintenance services at approximately 28 (Title I and Title II) uranium mill tailing disposal sites.

e) *Formerly Utilized Sites Remedial Action Program (FUSRAP)*

DOE has been involved in the Formerly Utilized Sites Remedial Action Program (FUSRAP) since 1974. This is a major environmental effort to clean-up radioactively contaminated sites contaminated from past activities of the Manhattan Project, as well as the US Atomic Energy Commission. DOE has examined more than 600 sites, reviewing old records and performing radiological surveys. Remedial action has been underway since 1979. By 1997, 46 sites in 14 states had been identified as eligible for the program and requiring remedial action. Between 1979 and 1997, DOE performed remedial actions at these sites.

In 1997 the management of FUSRAP was transferred from DOE to the Army Corps of Engineers. Between 1997 and 2014, seven additional sites have been added to the program both by congressional action and by Corps designation. To be designated, sites must pass a rigorous evaluation, including identification of key contaminants to determine the source of the contamination. The Army Corps of Engineers conducts its actions consistent with the Comprehensive Environmental Response, Compensation, and Liability Act and the National Oil and Hazardous Substance Pollution Contingency Plan, in consultation with affected communities and regulators. Stakeholders include the landowners, EPA, the NRC, DOE, state regulators, contractors, taxpayers and community residents where FUSRAP sites are located. The Army Corps of Engineers meets regularly with DOE to evaluate potential new sites and transition those completed back to DOE for long-term stewardship.

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 (commonly referred to as a "123 Agreement"). Such agreements are negotiated by the Department of State, with the technical assistance and concurrence of 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 agreement must be submitted to and lie before the Congress for a requisite number of days mandated by statute and may thereafter enter into force for the United States only if the Congress does not disapprove

it. 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 Under Secretary of State for Arms Control and International Security and the NRC 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 to 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. In the absence of congressional disapproval, the President can overrule an NRC decision not to permit export.

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.[12] 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.

12. DOE exports are not subject to NRC licensing regulations except to the extent that its activities are subject to the licensing and related regulatory authority of the NRC pursuant to section 111 of the Atomic Energy Act. 42 USC 2141.

- 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.
- 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 also 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 1992 amendment precluded the NRC 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% 235U) 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.
- The US government is actively developing an alternative fuel or target that can be used in the reactor.

The Energy Policy Act of 2005, Public Law No. 109-58, amended the Atomic Energy Act of 1954 to permit exports of highly enriched uranium to specific countries (Canada, Belgium, France, Germany and the Netherlands) for medical isotope production in reactors that are either utilising an alternative nuclear reactor fuel or have agreed to convert to an alternative nuclear reactor fuel when such fuel can be used in the reactor. 42 USC 2160d.

b) Exports of components

The NRC is also responsible for the licensing of components for the 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 that:

- 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.
- 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 also applied to exports to nuclear weapons states.

c) Exports of by-product material

The NRC also licences 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) Exports and imports of radiation sources

The Energy Policy Act of 2005, Public Law No. 109-58, added a new section 170H on radiation source protection to the Atomic Energy Act. 42 USC 2210h. The new section prohibits the export and import, sale or other transfer of ownership of IAEA Code of Conduct category 1 and category 2 radiation sources, unless certain conditions are met. The conditions include, as the NRC considers appropriate:

1) For exports, a Commission determination that (A) a notification of the export has been provided to the recipient country before shipment, (B) the foreign recipient is authorised to possess the radiation source under the laws of the country of the recipient, and (C) the recipient country can ensure that the radiation source will be managed in a safe and secure manner.
2) For imports, a Commission determination that (A) the recipient is authorised by law to receive the radiation source, and (B) the shipment will be made in accordance with applicable federal or state law.
3) For sale or other transfer, a Commission determination that (A) the licensee has verified that the proposed recipient is authorised under law to receive the radiation source and (B) that the Commission has required that the transfer will be made in accordance with applicable federal or state law. [The NRC's implementing regulations can be found at 10 CFR 110.42(e)].

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

The Atomic Energy Act 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, nuclear materials or sensitive nuclear technology to nations that have engaged in such conduct. As amended by the Energy Policy Act of 2005, Public Law No. 109-58, the Atomic Energy Act also prohibits the export (with certain exceptions) of nuclear equipment, nuclear materials or sensitive nuclear technology to countries identified by the Department of State as engaged in state-sponsored terrorism. 42 USC 2158.

The Foreign Assistance Act precludes economic assistance to countries that 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.

f) Subsequent arrangements

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

g) Technology exports

The Atomic Energy Act provides that exports of nuclear technology relating to the production of special nuclear material must be approved by DOE. 42 USC 2099. 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, DOE must find that the activity for which the export will be utilised will not be inimical to the interest of the United States.

h) 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:

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

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's 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. Nuclear security

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, regulations governing fuel cycle facilities have emphasised protection against theft or diversion of formula quantities (i.e. greater than 5 kg) of strategic special nuclear material and protection against radiological sabotage, while those for power reactors have stressed protection against radiological sabotage. Licensed facilities possessing formula quantities of strategic special nuclear materials must meet stringent physical protection requirements and some other NRC-licensed fuel cycle facilities are also affected by the requirements.

In addition, security regulations stipulate requirements related to access authorisation to certain facilities, as well as training and qualifications for security guards. Frequent testing by licensees of equipment and personnel maintains system efficiency, while periodic NRC security evaluations, including force-on-force testing, provide assurance of the effectiveness of licensee security plans. Plant operators must also establish special communications with local law officials.

The NRC requires power reactor licensees to utilise armed security officers as part of their protective strategies. The Energy Policy Act of 2005 added a new section to the Atomic Energy Act relating to possession and use of firearms by NRC licensees' security personnel. 42 USC 2201a. This has led to further consideration of this topic and development of new NRC regulations relating to the subject.

Another aspect of NRC regulations concerns physical protection, including assertion of control to detect losses of nuclear material through accounting and inventory control processes. This subject area is also affected by provisions contained in the Energy Policy Act of 2005 and that too resulted in further consideration of this area.

9. Transport

The DOT and the NRC share the primary federal responsibility for regulating the safety of the transport of radioactive materials in commerce. In addition, DOE has broad authority under the Atomic Energy Act of 1954 to regulate all aspects of activities involving radioactive materials that are undertaken by DOE or on its behalf, including the transportation of radioactive materials.[13] The DOT regulates the transportation of radioactive material under the Federal Hazardous Material Transportation Law in 49 USC 5101-5128. The NRC's regulatory authority is based upon the Atomic Energy Act

13. DOE exercises this authority for certain DOE shipments, such as shipments undertaken by government employees or shipments involving national security or other special circumstances.

of 1954, the Nuclear Waste Policy Act of 1982 and relevant provisions of the Energy Policy Act of 2005.

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.

Transportation of radioactive materials in commerce to, from or within the United States is subject to DOT's regulations in 49 CFR Parts 171 to 180, which include requirements for packaging, labelling and marking of packages, placarding of vehicles, carrier performance and training, emergency response information and carrier operations including stowage and segregation of packages. A final rule issued in 1995, 60 Fed. Reg. 50292, amended DOT's Hazardous Materials Regulations to harmonise them with those of the IAEA. In addition, other individual "modal" requirements apply to transportation of radioactive materials by air (Federal Aviation Administration), rail (Federal Railroad Administration), highway (Federal Motor Carrier Safety Highway Administration) and vessel (US Coast Guard).

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 Organization (IMO).

Separately, NRC licensees are subject to the NRC packaging standards for Type B and fissile material packages, quality assurance requirements for package users and manufacturers and notification requirements for certain waste shipments. Other NRC regulations address 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. The NRC's regulations also require that shippers provide prior notification of shipments of certain radioactive material, including spent fuel shipments, to state governors.

An amendment to the Energy Reorganization Act of 1974, Public Law No. 79-94, forbids the NRC to licence any air shipment of plutonium, except for medical use in certified safe containers. Two packages, certified in 1978 and 1981, are available for use in air transport for up to 2 kg of plutonium metal 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, in amendments to the Nuclear Waste Policy Act (NWPA) Congress forbade the transportation of spent fuel or high-level radioactive waste by DOE to the high-level waste geologic repository, 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 United States, the Price-Anderson Act, is part of the Atomic Energy Act of 1954. Originally enacted in 1957 for a 10-year term, the Price-Anderson Act has been amended numerous times and its duration repeatedly extended. The most recent extension was enacted under the Energy Policy Act of 2005 and was notable for the length of the extension – 20 years, until 31 December 2025. The Price-Anderson Act governs liability and compensation for harm to the person or property of members of the public in the event of a nuclear incident arising from the activities of NRC licensees and DOE contractors. Although the act provides for state law to govern civil nuclear liability matters, unless the state law is inconsistent with federal provisions, 42 USC 2014hh., jurisdiction over matters relating to liability is available in the United States District Court for the district in which the accident occurred. 42 USC 2210n(2). The Price-Anderson Act sets forth requirements governing insurance to be purchased by licensees (commercial reactor licensees must buy the maximum amount available) and provides for 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 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 all legal liability to the operator, as is the case under some other legal systems. Rather, the act provides that a single limitation on public liability applies to a nuclear incident and ensures an insurance scheme or other payment up to that limit for those held legally liable. 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 on-site property.

The Price-Anderson Act, 42 USC 2014q., 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 Price-Anderson Act was amended in 1966 to introduce the concept of an "extraordinary nuclear occurrence" in order to strengthen protection of the public by eliminating, in appropriate circumstances, certain legal defences that would normally be

available under state tort laws. An extraordinary nuclear occurrence is essentially an event causing off-site a significant release of nuclear material or a significant increase in radiation levels and in respect of which the federal government (either NRC or DOE) determines that there has been, 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. An extraordinary nuclear occurrence determination can also preclude the use against a claimant of any issue or defence based on state statute of limitations if the claim was brought within three years from the date on which the claimant first knew, or should reasonably have known, of his injury or damage and the cause. 42 USC 2210(n)(1).

Amendments enacted in 1988 introduced "precautionary evacuation" as an additional category for which coverage is available, even if no "nuclear incident" actually occurred. A precautionary evacuation may be ordered by the responsible governmental entity without any 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. 42 USC 2014gg.

As to liability amounts, the limitation of liability for nuclear power plants was originally set in 1957 at USD 560 million, with the 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 two tiered system of compensation is that the current limit of liability is approximately USD 12 billion. 42 USC 2210(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 375 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 121.255 million per reactor per incident. Given the number of currently operating reactors, this maximum approximates USD 12 billion. The limit of liability will increase or decrease as the number of operating power reactors increases or decreases. This premium is adjusted by NRC for inflation every five years. An additional 5% may be added to cover legal defence costs. The 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 for all facilities licensed by the NRC under sections 103 and 104 of the Atomic Energy Act, unless Congress specifically provides otherwise. This includes all nuclear power reactors, including research, educational and test reactors and potentially includes commercial reprocessing facilities. In 1990, Congress enacted a new section 193 of the Atomic Energy Act which specifically bars Price-Anderson coverage for the licensee of any uranium enrichment facility built after that date. Only nuclear power

reactors with a rated capacity of 100 MWe or more are included in the mandatory retrospective premium pooling system. The research, educational and test reactors are covered by any insurance that they are required to purchase and by federal indemnification of USD 500 million, if needed. The NRC has the authority to extend this coverage to other nuclear installations, such as fuel fabrication facilities. Licensees without Price-Anderson coverage rely on private insurance and are not required to relinquish available defences under state law. The NRC has the authority to extend Price-Anderson coverage, in its discretion, to materials licensees under sections 53 and 63 of the Atomic Energy Act if it determines that it is warranted.

The Energy Policy Act of 2005 authorised a special Price-Anderson financial accommodation for potential licensees of a grouping of modular reactors where each single reactor exceeds the 100 Mwe that would trigger an obligation to the retrospective premium pool but in which no facility exceeds 300 Mwe and the total for the group does not exceed 1 300 Mwe. Such a grouping would be treated as a single reactor solely for determining its obligations under the Price-Anderson Act. 42 USC 2210b.(5)(A).

With regard to 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. DOE indemnification covers such persons up to USD 10 billion, the new statutory limit provided by the Energy Policy Act of 2005. This limit is adjusted by DOE for inflation every five years. 42 USC 2210d.(2)(B). The act also increased the indemnity limit and the liability limit for a nuclear incident outside the United States to up to USD 500 million. 42 USC 2210e. This only covers contractual activity on behalf of DOE that involves material owned by the US government. There is no adjustment for inflation for a nuclear incident outside the United States.

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 the District of Columbia. 42 USC 2210n.(2).

On 19 December 2007, legislation implementing the Convention on Supplementary Compensation for Nuclear Damage (CSC) was signed by the President into law. Congress had passed the bill as part of the 2007 Energy Independence and Security Act, Public Law No. 110-140, H.R. 6. The Energy Independence and Security Act is an omnibus energy policy law that consists mainly of provisions designed to increase energy efficiency and the availability of renewable energy. Section 934 of the act implements the CSC that was adopted in 1997. As of July 2014, the CSC has been signed by the United States and 17 other countries and ratified by five countries, including the United States but has not yet entered into force. The United States deposited its instrument of ratification on 21 May 2008. The CSC will come into force when one more country with a combined nuclear capacity of 400 gigawatts (thermal) of nuclear power or two countries with substantial nuclear programs ratify. Each party to the CSC is required to establish a compensation system for nuclear damage that consists of two tiers. Under the first tier, the party shall ensure the availability of minimum 300 million Special Drawing Rights. In the United States, this obligation will be fulfilled by the existing Price-Anderson Act. 42 USC 2210. Under the second tier, all parties shall make available public funds according to a formula set out in the convention. These funds will be drawn

on to compensate nuclear damage in the event that the first tier is exhausted. Section 934 requires the US contribution to the second tier to be paid by suppliers of nuclear equipment and services under a formula to be developed by the Department of Energy.

Section 934 directs DOE to promulgate regulations to implement a retrospective risk pooling program whereby United States nuclear suppliers will be responsible to pay (reimburse) the United States for its contribution to the second tier. In 2010, DOE published a Notice of Inquiry entitled "Convention on Supplementary Compensation for Nuclear Damage Contingent Cost Allocation," requesting public comment on its development of these regulations. 75 Fed. Reg. 43945 (27 July 2010). A draft notice of proposed rulemaking, the next step in the regulatory process, is being prepared by DOE.

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 regulatory responsibilities of the AEC were assumed by the Nuclear Regulatory Commission (NRC). The NRC is an independent federal agency whose five commissioners are appointed by the President. The AEC's promotional activities were inherited by the Energy Research and Development Administration (ERDA) which was later incorporated into the Department of Energy (DOE). In addition to its promotional responsibilities, DOE, along with the Department of Defense, is also responsible for the military applications of nuclear materials and facilities.

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 chapter supra). Pursuant to 42 USC 2021, the NRC is authorised to relinquish a portion of its jurisdiction over certain nuclear materials and activities 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 37 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. A number of universities also operate NRC-licensed, low-power research reactors.

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 NRC. They often intervene in the licensing process, provide input on proposed regulations 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 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 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.

a) Nuclear Regulatory Commission (NRC) [14]

i) Legal status

In 1974, Congress passed the Energy Reorganization 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. Although 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 primary responsibilities include ensuring that the use of nuclear materials and facilities is consistent with the protection of the public health and safety, the common defence and security of the United States and protecting the environment. 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 licences 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 chapter, supra).

The NRC maintains an active inspection and enforcement programme. It investigates violations and initiates enforcement proceedings. The NRC can seek judicial remedies,

14. More information on the NRC's organisational structure can be found at the agency's website: www.nrc.gov.

such as injunctions and can assess fines and penalties. The violation of some NRC regulations can also result in criminal prosecution.

The NRC enters into co-operative agreements with states to help them assume the responsibility for regulating certain aspects of nuclear energy, such as the licensing of certain nuclear materials, 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's term lasts five years,[15] with the terms staggered such that one (and only one) commissioner term expires each year. Upon a term's expiration, a commissioner may be reappointed by the President for another five-year term with the advice and consent of the Senate. While serving, a commissioner may not engage in any other outside 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 information relating to commission responsibilities 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 chairman who acts as the principal executive officer and the official spokesman of the commission. The chairman 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.

In addition, pursuant to the Reorganization Plan No. 1 of 1980, the chairman is authorised to take certain additional powers in the event of an emergency. Notably, in an emergency involving a particular licensed facility or materials licensed or regulated by the commission, the chairman assumes all functions of the commission, including the functions of declaring, responding, issuing orders, determining specific policies, advising the civil authorities and the public, directing and co-ordinating actions relative to such an emergency incident. The chairman may delegate this emergency authority to other commissioners or to the staff. The Reorganization Plan and the Consolidated Appropriations Act of 2014, section 402, also require the chairman to inform the Commission and Congress regarding the assumption and termination of this emergency authority, as well as any steps taken in response to the emergency.

15. In the event a commissioner's appointment occurs after the term the commissioner will be serving has already commenced (for example, due to a delay in the appointment process, or due to another commissioner leaving the agency and creating a vacancy during the middle of a term), the new appointment would remain effective only until the end of the ongoing five-year term. Thus, in practice, some commissioner appointments may be for less than five years.

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 chairman and is subject to the chairman's supervision and direction, as provided in Reorganization Plan No. 1 of 1980. The EDO is the chief operational and administrative officer of the NRC 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 statutory programme offices, as well as the incident response operations function, the NRC regional offices and such other offices as those of new reactors, enforcement, administration, federal and state materials and environmental management programmes, human resources, investigations, nuclear security and incident response 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 chairman of the Commission. The CFO establishes planning, budgeting and financial management policy for the Commission and provides advice to the chairman 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 chairman and the Director, Office of Management and Budget.
- Monitors the financial execution of the 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 chairman timely cost and performance reports.
- 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.

Office of the General Counsel (OGC)

The Office of the General Counsel (OGC) reports directly to the Commission. OGC directs matters of law and legal policy, providing opinions, advice and assistance to the Commission with respect to all of its activities. Among its responsibilities, it:

- Reviews draft Commission opinions on public petitions seeking direct Commission action and rulemaking proceedings.
- 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, licences 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.
- In co-operation with the Department of Justice, represents the Commission in court proceedings affecting the Commission's programmes in the federal district courts, the federal courts of appeals 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 and rulemaking 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.

Office of International Programs (OIP)

The Office of International Programs (OIP), which reports directly to the Commission, provides assistance and recommendations to the chairman, the Commission and NRC staff on international issues. The OIP staff provides overall co-ordination for the 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 radiological 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. The OIP obtains, evaluates and uses pertinent information from other NRC and US government offices in carrying out assigned 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.

Advisory committees

The Commission currently has several advisory committees chartered under the Federal Advisory Committee Act, 5 USC Appendix. 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 committees include, inter alia:

- The Advisory Committee on Reactor Safeguards (ACRS), which consists of a maximum of 15 members with expertise in scientific and engineering disciplines, is the 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 licences for power reactors or test reactors.
- The Advisory Committee on the Medical Uses of Isotopes (ACMUI), which reports to the Director, Division of Materials Safety and State Agreements, Office of Federal and State Materials and Environmental Management Programs. It advises the NRC on policy and technical issues that arise in the regulation of the medical uses of radioactive material in diagnosis and therapy. The ACMUI membership includes health care professionals from various disciplines who comment on changes to NRC regulations and guidance, evaluate certain non-routine uses of radioactive material, provide technical assistance in licensing, inspection and enforcement cases and bring key issues to the attention of the Commission for appropriate action.

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 and the largest office at the NRC. The NRR is responsible for ensuring the public health and safety through licensing and inspection activities at all nuclear power reactor facilities in the United States. The NRR is further 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. The 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. The NRR staff is responsible for licensing issues and regulatory policy concerning reactor operators, including the initial licensing examination and re-qualification examinations; and the inspection of nuclear component supplier facilities. The NRR responsibilities include the technical review, certification and licensing of advanced nuclear reactor facilities and the renewal of current power reactor operating licences.

Office of New Reactors (NRO)

The Office of New Reactors (NRO), which reports directly to the EDO, is responsible for accomplishing key components of the NRC's nuclear reactor safety mission for new reactor facilities licensed in accordance with 10 CFR Part 52. As such, the NRO is responsible for regulatory activities in the primary programme areas of siting, licensing

and oversight for new commercial nuclear power reactors, to protect the public health, safety and the environment and to promote the common defence and security.

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. The NMSS is responsible for regulating activities, which provide for the safe and secure production of nuclear fuel used in commercial nuclear reactors; the safe storage, transportation and disposal of high-level radioactive waste and spent nuclear fuel; and the transportation of radioactive materials regulated under the Atomic Energy Act. The NMSS ensures safety and security by implementing a regulatory programme involving activities including licensing, inspection, assessment of licensee performance, events analysis, enforcement and identification and resolution of generic issues. The NMSS develops and implements NRC policy for the regulation of these activities involving uranium recovery, conversion, and enrichment activities; fuel fabrication and development; transportation of nuclear materials, including certification of transport containers and reactor spent fuel storage; and safe management and disposal of spent fuel and high-level radioactive waste. NMSS has lead responsibility within the NRC for domestic and international safeguards policy and regulation for fuel cycle facilities, including material control and accountability (MC&A). The Office is also responsible for regulation and licensing of recycling technologies intended to reduce the amount of waste to be disposed through geologic disposal and to reduce proliferation concerns. The NMSS creates and maintains the regulatory infrastructure to support the NRC's role in licensing a reprocessing facility and a related fuel fabrication facility and vitrification and/or waste storage facility. It lays the groundwork for and prepares the NRC to perform a potential regulatory role for new, expanded and modified commercial fuel cycle facilities, which may include recycling, transmutation and actinide burning.

On 5 October 2014, the NRC's Office of Federal and State Materials and Environmental Management Programs (FSME) merged into NMSS. All of FSME's former responsibilities and duties are now performed by NMSS. NMSS, therefore, now has the overall authority to implement the NRC's responsibilities to regulate nuclear material. NMSS performs this role in close partnership with other NRC offices, federal agencies, Agreement States non-Agreement States native American tribal governments and the public. NMSS develops and implements rules and guidance for the safe and secure use of source, by-product and special nuclear material in industrial, medical, academic and commercial activities and at decommissioning, uranium recovery, low-level waste and incidental waste sites. NMSS also develops policies and procedures for assessing the performance of licensing and inspection functions of NRC's regions and Agreement States through the Integrated Materials Performance Evaluation Program. It is through this programme that the NRC exercises its oversight responsibility under section 274 of the Atomic Energy Act, as amended, to ensure that the Agreement States maintain adequate and compatible radiation protection programmes.

Office of Nuclear Regulatory Research (RES)

The Office of Nuclear Regulatory Research (RES), which reports directly to the EDO, is the third of the NRC's three statutory programme offices. The RES recommends and implements programmes of nuclear regulatory research. It independently proposes regulatory outcomes in the form of improvements to NRC's regulatory programmes and 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 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.

Office of Nuclear Security and Incident Response (NSIR)

The Commission established the Office of Nuclear Security and Incident Response (NSIR) in April 2002 as part of its evaluation of NRC's programmes for safeguards and security in the aftermath of the terrorist attacks of 11 September 2001. The NSIR reports directly to the EDO and it combines a number of the safeguards and security functions previously conducted in NRR, NMSS and the Office of Administration. It has the responsibility for NRC's incident response centre and capabilities and is charged with developing overall policy and providing management direction for evaluation and assessment of technical issues involving security at nuclear facilities, monitoring and assessing the threat environment and maintaining the safeguards and security interface with other federal, state and local agencies, as appropriate. The Office also administers programmes for protection of classified and sensitive unclassified information, the information security programme and the licensee personnel security programme.

Regional offices

The NRC's four regional offices are located in the Philadelphia (Region I), Atlanta (Region II), Chicago (Region III) and Dallas (Region IV) areas. 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)

The 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 the NRC's first Inspector General (IG). Under the statute the IG reports directly to the chairman.

The OIG, inter alia, 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 the NRC programmes and operations.

iv) Financing

Under the Omnibus Budget Reconciliation Act of 1990, the NRC must recover approximately 90% of its budget authority by assessing fees to its licensees. The NRC collects fees for the review of licence applications, construction permits, operating licences, licence amendments and renewals, assesses fees for inspections, and it also imposes an annual fee on its licensees. Although the NRC collects 90% of its entire budget through its fee recovery programme, it 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)[16]

i) Legal status

In 1977, with the enactment 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 carries out non-defence nuclear missions pursuant to broad authorities that include: the Atomic Energy Act of 1954, as amended, 42 USC 2011 et seq.; the Energy Reorganization Act of 1974, 42 USC 5801, et seq.; the Department of Energy Organization Act of 1977, 42 USC 7101, 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.; the Energy Policy Act of 1992, 42 USC 10141 note, 42 USC 2297 et seq., 42 USC 2061; and the Energy Policy Act of 2005, 42 USC 2011, et seq. DOE, along with the Department of Defense, is also responsible for the military applications of nuclear materials and facilities.

16. See DOE website available at: www.energy.gov.

ii) Responsibilities

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, as well as 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; and
- production for and application of nuclear power systems in support of other federal agency missions, including the missions of the Department of Defense and the National Aeronautics and Space Administration (NASA).

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

In international nuclear transactions, DOE administers US nuclear export policy in conjunction with the NRC and the Departments of State, Commerce and Defense, 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

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.

DOE programmes involve:

- Overseeing and supporting the development of applied nuclear energy resources and technologies and constructing and operating 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 fuel, including supporting related research, development, and demonstration activities and managing the Nuclear Waste Fund (see subsection (iv) "Financing", infra).
- Managing DOE basic research and development programmes and non-proliferation and security activities.
- Managing 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.
- 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 Deputy Secretary, there are three Under Secretaries. The Under Secretary for Management and Performance has primary responsibility for managing the Offices of: Management and Administration; Chief of Human Capital; Chief Information Officer; Economic Impact and Diversity; Hearings and Appeals; Environmental Management; and Legacy Management.

The Under Secretary for Science and Energy has primary responsibility for managing the Offices of: Science, Fossil Energy; Energy Efficiency and Renewable Energy; Nuclear Energy; Electricity Delivery and Energy Reliability; Indian Energy; and Technology Transfer Coordinator. The Under Secretary for Nuclear Security has primary responsibility for national security matters and is also the Administrator of the National Nuclear Security Administration (NNSA). The NNSA was established by Congress in the National Defense Authorization Act of 2000 and is a semi-autonomous agency within DOE responsible for enhancing national security through the military application of nuclear energy; maintaining and enhancing the safety, security, reliability and performance of the US nuclear weapons stockpile; reducing global danger from weapons of mass destruction; providing the US Navy with safe, militarily effective nuclear propulsion plants and ensuring their safe and reliable operation; promoting international nuclear safety and non-proliferation; and supporting US leadership in science and technology. 50 USC 2401. Included among DOE's activities is responding to nuclear and radiological emergencies in the US and abroad.

Below the level of the Under Secretaries, there are Assistant Secretaries who are assigned specific responsibilities from among those enumerated at section 203(a) of the DOE Organization Act, including:

- energy resource applications;
- energy research and development functions, including the fuel cycle for nuclear energy resources;
- environmental responsibilities;
- international programmes and policy;
- public and congressional relations; and
- intergovernmental policies relating to national energy policies.

The field establishments

DOE carries out many of its missions through the use of its field offices, including national laboratories. 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 across the entire spectrum of energy-related subject matter, including elements of the nuclear fission or nuclear fusion fuel cycle.

The field offices, with few exceptions, are operated for DOE by private sector Management and Operating (M&O) contractors, a regime that was initiated during the Manhattan Project 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. 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.

The laboratories within the complex include: 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 National Laboratory, Richland, Washington; and Sandia National Laboratories, Albuquerque, New Mexico.

Advisory committees

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. These committees are governed by the Federal Advisory Committee Act of 1972. 5 USC Appendix 2.

Federal Energy Regulatory Commission[17]

The Federal Energy Regulatory Commission (FERC) is an independent agency established within DOE by the DOE Organization Act, headed by a five-member Commission. FERC 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. FERC deals with nuclear energy to the limited extent that, where applicable, it reviews rates for the recovery of costs of constructing, operating and decommissioning nuclear power plants.

FERC focuses on reliability, integrity, security, and operation of the Bulk Power System (i.e. electric power grid) for the United States. Both FERC and the NRC have jurisdiction over cyber security at commercial nuclear power plants in the United States. In an effort to avoid potential problems resulting from this dual jurisdiction, FERC and the NRC have entered into a Memorandum of Understanding setting forth how both agencies will

17. See the Federal Energy Regulatory Commission website, available at: www.FERC.gov.

exercise their regulatory authority over cyber security at commercial nuclear power plants in the United States.

Nuclear Waste Technical Review Board[18]

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.

iv) Financing

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.

c) Department of Labor (DOL)[19]

The Department of Labor (DOL) has overall responsibility for worker welfare and safety. Although the NRC has authority under the Atomic Energy Act to take action against its licensees for discriminating against employees who raise concerns within the NRC's jurisdiction – so-called "nuclear whistleblower" cases – DOL also has the authority to provide a personal remedy to the employee. 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. Similar whistleblower provisions involving DOL remedies apply to DOE contractor employees. DOE also has authority to provide a personal remedy to employees of its contractors or subcontractors for engaging in lawful whistleblower activities. Regulations implementing DOE's whistleblower programme are at 10 CFR Part 708.

d) Department of Transportation (DOT)[20]

The Department of Transportation (DOT) works with the NRC to regulate the safe transport of radioactive materials. Within DOT, the Pipeline and Hazardous Materials Safety Administration has issued regulations which govern all modes of transportation of hazardous materials, including radioactive materials and radioactive wastes.

18. See the Nuclear Waste Technical Review Board website, available at: www.nwtrb.gov.

19. See the DOL website, available at: www.dol.gov.

20. See the DOT website, available at: www.dot.gov.

e) *Environmental Protection Agency (EPA)*[21]

The Environmental Protection Agency (EPA) assumes overall responsibility for the United States environmental quality. EPA issues standards and guidance to limit human exposure to radiation. 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. EPA measures environmental levels of radiation and assesses radiation's effects on people and the environment. EPA is also empowered to establish standards for disposal of radioactive wastes.

Within EPA, the Office of Radiation and Indoor Air 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 radiological 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. 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*

i) *Department of Agriculture*[22]

This cabinet-level department advises DOE and the NRC about potential impacts of nuclear facility siting in rural areas and on lands (over 178 million acres) controlled by the Forest Service.

ii) *Department of Commerce*[23]

The Department of Commerce licences 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.

21. See the EPA website, available at: www.epa.gov.
22. See the Department of Agriculture website, available at: www.usda.gov/wps/portal/usdahome.
23. See the Department of Commerce website, available at: www.trade.gov/index.asp.

iii) Department of Defense (DOD)[24]

Within the Department of Defense (DOD), several agencies study medical applications of nuclear technology, such as the Armed Forces Radiobiology Research Institute which conducts research in the field of radiobiology, development of medical countermeasures to ionising radiation and development of state-of-the-art radiation injury assessment technologies, while providing operational medical guidance on treatment of radiation injuries to the services; and the Uniformed Services University of the Health Sciences which, through its Department of Radiology and Radiological Sciences and Department of Radiation Biology, conducts research in a variety of areas of radiology, including MRI, trauma, gastrointestinal radiology, cardiac imaging, neuroradiology and within the narrower area of nuclear technology, research on dosimetry, including Electron Paramagnetic Resonance (EPR) and dose reconstruction, as well as other radiological sciences.

iv) Department of Health and Human Services (DHHS)[25]

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

The National Institutes of Health's National Cancer Institute, 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 radiological safety associated with the actual use of these products.

The Center for Devices and Radiological Health, within the FDA, is responsible for ensuring the safety and effectiveness of medical devices and eliminating unnecessary human exposure to man-made radiation from medical, occupational and consumer products. Radiation-emitting products regulated by the FDA include microwave ovens, video display terminals and medical ultrasound and x-ray machines.

v) Department of the Interior[26]

Within the Department of the Interior, the United States Geological Survey (USGS) conducts field and laboratory investigations supporting DOE's waste disposal efforts and collaborates with DOE on earth science technology. It conducts research on processes related to nuclear waste disposal and characterisation of potential disposal sites.

24. See the DOD website, available at: www.defenselink.mil.

25. See the DHHS website, available at: www.hhs.gov.

26. See the Department of the Interior website, available at: www.doi.gov.

vi) Department of State (DOS)[27]

DOE and the NRC negotiate certain international accords in concert with the Department of State (DOS). The DOS also negotiates agreements for peaceful co-operation. 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 Department of State, the Bureau of International Security and Nonproliferation (ISN) 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.

b) Other federal agencies and offices

i) Federal Emergency Management Agency (FEMA)[28]

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

ii) National Aeronautics and Space Administration (NASA)[29]

This agency, concerned with civilian and military aspects of space exploration, uses radioisotope power systems (furnished by DOE) in connection with its interplanetary space missions to provide power and to heat scientific instruments in the spacecrafts. NASA operates the Glenn Research Center in Ohio. 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. Also, for example, NASA launched the Nuclear Spectroscopic Telescopic Array Mission (NuSTAR) in 2012 to study black holes, map supernova explosions and study active galaxies.

iii) Tennessee Valley Authority (TVA)[30]

The Tennessee Valley Authority (TVA) is a wholly-owned corporate agency and instrumentality of the United States. This federal agency 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 power and is licensed by the NRC to operate commercial nuclear power plants.

iv) White House offices

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

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27. See the Department of State website, available at: www.state.gov.
28. See the FEMA website, available at: www.fema.gov.
29. See the NASA website, available at: www.nasa.gov.
30. See the TVA website, available at: http://tva.gov.

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 (OSTP) was established by Congress to advise the President and others within the Executive Office of the President on the effects of science and technology on domestic and international affairs. It also co-ordinates research developments undertaken by various agencies, especially interdisciplinary approaches to waste disposal.

c) Semi-public agencies

i) American National Standards Institute (ANSI)[31]

The American National Standards Institute (ANSI) acts as a clearing-house to co-ordinate standards development with accredited standards developing organisations. For example, the Nuclear Energy Standards Coordination Collaborative (NESCC) is a joint initiative established under DOE and NRC sponsorship in co-ordination with the National Institute of Standards and Technology and ANSI. It was established in 2009 as a forum where nuclear stakeholders can work together to respond to industry needs for new and revised standards. ANSI represents the United States in the International Organization for Standardization (ISO) and the International Electrotechnical Commission.

ii) National Academy of Sciences (NAS)[32]

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.

iii) National Council on Radiation Protection and Measurement (NCRP)[33]

In accordance with its charter, Public Law No. 88-376, the National Council on Radiation Protection and Measurement's (NCRP) mission is to formulate and widely disseminate information and recommendations on radiological protection and measurements which represent the consensus of scientific thinking. The NCRP studies nuclear physics, nuclear medicine and waste disposal as they relate to radiation protection.

iv) National Nuclear Data Center[34]

The Center, a part of Brookhaven National Laboratory, co-operates with the Organisation for Economic Co-operation and Development (OECD), the IAEA and focuses on continuing relationships with the former Soviet Union States in publishing the Computer Index of

31. See the ANSI website, available at: www.ansi.org.
32. See the NAS website, available at: http://nasonline.org.
33. See the NCRP website, available at: www.ncrponline.org.
34. See the National Nuclear Data Center website, available at: www.nndc.bnl.gov.

Nuclear Data (CINDA). The Center assists in computer data retrievals and evaluates a broad range of technical multidisciplinary data.