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Regulating the Disposal of Low-Level Radioactive Waste

A Guide to The Nuclear Regulatory Commission's 10 CFR Part 61

Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

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Division of Low-Level Waste Management and Decommissioning
Mail Stop 5 E4
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555

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1. THE NRC AND ITS RESPONSIBILITIES

The Nuclear Regulatory Commission (NRC) is responsible for licensing and regulating nuclear facilities and materials and for conducting research in support of the licensing and regulatory process. Authority is derived from the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and other statutes. Activities must be conducted in accordance with the National Environmental Policy Act of 1969, as amended (NEPA). NRC responsibilities include protecting the public health and safety, protecting the environment, and safeguarding nuclear materials in the interest of national security. Agency functions are performed through: standards-setting and rule-making; technical reviews and studies; conduct of public hearings; issuance of licenses; inspection, investigation, and enforcement; and research.

The Commission itself is composed of five members, appointed by the President and confirmed by the Senate. One Commissioner is designated by the President as Chairman.

The Office of Nuclear Material Safety and Safeguards (NMSS) manages and coordinates the NRC's regulation of radioactive waste. Within NMSS, the Division of Low-Level Waste Management and Decommissioning regulates low-level radioactive wastes. Major Division functions include:

- Leading the national effort to regulate and license commercial low-level waste disposal facilities.

- Developing guidance and providing technical assistance to States and compacts to help ensure that the goals of the Low-Level Radioactive Waste Policy Amendments Act of 1985 are met.

NRC's rulemaking for regulating low-level radioactive waste disposal resulted in the addition of a new part to Title 10 of the Code of Federal Regulations -- 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Wastes." 10 CFR Part 61 sets forth the procedures, criteria, and terms and conditions on which the NRC will issue licenses for new disposal sites.

2. LOW-LEVEL RADIOACTIVE WASTES

"Low-level radioactive wastes" is a general term for a wide range of wastes. Industries, hospitals, medical, educational, or research institutions, private or government laboratories, and nuclear fuel cycle facilities (e.g., nuclear power plants and fuel fabrication plants) using radioactive materials generate low-level wastes, as part of their normal operations, just as they generate other types of wastes. Generation of these wastes is a necessary side effect of gaining the societal benefits resulting from these activities. These wastes are generated in many physical and chemical forms and levels of contamination. The generation of wastes is shown conceptually in Figure 1, "Commercial Waste Generation."

A working definition of low-level radioactive wastes is given in the Glossary, p. 22. The spectrum of radioactive wastes produced in the country is shown in Figure 2, "Radioactive Waste." The illustration shows several types of wastes which are not low-level radioactive wastes under NRC statutes. Low-level wastes are generated in four categories:

- below regulatory concern waste;
- generator disposed wastes;
- Class A, Class B, and Class C wastes; and
- greater than Class C wastes.

Less than three million cubic feet of wastes are disposed of annually at the three currently operating commercial sites. It is the disposal of these approximately three million cubic feet of Class A, Class B, and Class C wastes that are the focus of 10 CFR Part 61.

3. MIXED WASTE

"Mixed low-level radioactive wastes" is material that contains both radioactive and hazardous components and meets respectively NRC's definition of low-level radioactive waste in 10 CFR Part 61 and the Environmental Protection Agency's (EPA's) definition of hazardous material in 40 CFR Part 261. Although any type of low-level waste may be "mixed," surveys of waste generators indicate that less than 5 percent of the wastes which would normally be sent to commercial sites would be classified as "mixed."

4. 10 CFR PART 61

4.1 Overview

10 CFR Part 61 was developed during the five-year period from 1978-1982, in response to needs and requests expressed by the public, the Congress, industry, the States, and other Federal agencies for codified regulations specifically for disposal sites. NRC considered extensive public input, including the holding of four regional workshops. NRC issued draft and final environmental impact statements to present the bases for the regulation. The final regulation represented a major agency effort and was published in December 1982.

The lifecycle of a disposal site begins well before wastes are received and continues long after disposal is complete. Part 61 of 10 CFR provides the technical and procedural framework for the entire lifecycle. The graphic, "Lifecycle of a Low-Level Radioactive Waste Disposal Facility" (Figure 3) depicts the lifecycle phases and indicates the corresponding technical and procedural provisions of 10 CFR Part 61. The basic framework of 10 CFR Part 61 applies to any land disposal technology for low-level radioactive wastes. Specifically, the performance objectives and the institutional, financial, and procedural requirements are applicable to all land disposal methods. The specific technical requirements developed for near-surface disposal are generally considered appropriate for most alternative technologies using engineering enhancements. Only mined cavity or similar deep disposal method would require somewhat different technical requirements. The performance objectives are the heart of the rule and allow effective implementation of the systems approach used.

The following discussion summarizes the requirements of 10 CFR Part 61 and is intended to provide a general understanding of the provisions. The reader

should read the regulation itself for precise wording and the exact legal requirements. The discussion covers the following topics:

- the performance objectives;
- technical requirements for the siting, design, operations, environmental monitoring, and closure activities for a near-surface facility;
- classification of wastes;
- technical requirements on waste form;
- institutional requirements;
- financial assurance requirements; and
- administrative and procedural requirements for licensing a facility.

A companion change to 10 CFR Part 20, which established a shipment manifest system, is also discussed.

4.2 Performance Objectives

The four performance objectives in 10 CFR Part 61 were developed expressly for disposal of low-level radioactive wastes. None of the existing provisions of 10 CFR Part 20 relating to acceptable releases to the environment was considered appropriate, since direct control of releases after disposal is more difficult than control of releases from a pipe or stack. Further, the long-term focus is unique to land disposal. In the absence of any applicable EPA general environmental standards, NRC developed the four objectives through rulemaking. NRC's primary goals were to protect the public health and safety and minimize the long-term burden on society. Throughout the lifetime of the disposal facility, there must be reasonable assurance that these objectives will be met. The objectives address protection from releases of radioactivity, inadvertent intrusion, operations, and stability.

4.2.1 Protection of the General Population from Releases of Radioactivity

Release of radioactivity from the site into water, air, soil or through plants or animals must not result in an annual dose, to any member of the public, greater than:

- 25 millirems to the whole body,
- 75 millirems to the thyroid,
- 25 millirems to any other organ.

Reasonable efforts also must be made to keep releases of radioactivity to the general environment as low as reasonably achievable (ALARA).

These release limits apply at the site boundary. The analyses supporting 10 CFR Part 61 demonstrated that these limits could be met by disposal of expected wastes at typical regional sites, using the combination of requirements in the regulation. NRC independently evaluated a range of annual dose limits, from the EPA municipal drinking water value of 4 millirem, to the 500 millirem maximum limit for exposure of members of the public, in NRC's rules in

10 CFR Part 20. The limits adopted are consistent with EPA's limits for the uranium fuel cycle in 40 CFR Part 190. These values represent a fraction of background of radiation (e.g., one-fourth or less).

4.2.2 Protection of Individuals from Inadvertent Intrusion

Design, operation and closure of the facility must ensure protection of any individual who inadvertently enters or occupies the site or who comes in contact with the waste after the institutional control period ends.

Intrusion into disposed waste may be either deliberate or inadvertent. A deliberate intruder would choose to ignore the hazard and commit an illegal act for profit. Such intrusion is considered unlikely and is not addressed by 10 CFR Part 61. Deliberate intrusion was considered unlikely for the following practical reasons. Power tools would be needed to excavate soil covers--the noise would attract attention to the illegal activities. There is insufficient information on the precise location of items of interest in the disposal units. There are not enough unique or valuable materials to warrant the criminal and radiological risks.

The inadvertent intruder would be unaware of the hazards of the disposed wastes and would intrude by accident or without realizing the potential hazard. For example, the inadvertent intruder might construct a house, consume food grown on the land, drink water from a well drilled onsite, or actually disturb the waste itself. Intrusion may or may not occur at a site. Although the performance objective does not contain a specific dose limit, a working limit of 500 millirem to the whole body per year was used in 10 CFR Part 61, to implement this objective. This limit is the generally accepted upper limit for exposures to members of the public. Therefore, 10 CFR Part 61 is designed to restrict doses to future members of the public to the same dose limits that are applied today. Potential doses were calculated using realistic and reasonable assumptions about the intruder and the potential exposure pathways. Even though detectable radioactivity may remain at the site over long periods of time, future inadvertent intruders would not receive doses higher than this working limit.

4.2.3 Protection of Individuals During Operation

Operations at the land disposal facility must comply with the radiation protection standards of 10 CFR Part 20 -- except for releases of radioactivity from the site which are governed by 10 CFR Part 61.

Every reasonable effort must be made to keep exposures during operation as low as reasonably achievable (ALARA).

This objective is a restatement and affirmation that the occupational exposures should comply with 10 CFR Part 20, so that workers at the sites are protected as they would be at any other nuclear facility. It reminds applicants that potential worker exposures should also be considered in decisions on the site.

4.2.4 Stability of the Disposal Site after Closure

All functions associated with the facility, from siting to closure, should be intended to achieve long-term stability and eliminate the need for ongoing active maintenance after closure.

This performance objective focuses on the long-term aspects of disposal and reflects lessons learned from problems at existing sites. Stability is a cornerstone of the system at work at the sites. Stability of the waste and of the site as a whole is important to prevent subsidence problems which have occurred at closed commercial sites. It is also important so that the access of water to disposed wastes can be minimized and thus reduce migration of radionuclides from the site. Stability also reduces maintenance costs and minimizes the chance of exhausting long-term care funds collected during operations. It reduces the administrative burdens of the long-term care custodian.

4.3 Technical Requirements

In general, regulations may contain two basic types of requirements: performance objectives and prescriptive requirements. Part 61 of 10 CFR contains both. The performance objectives discussed in the preceding section define the overall level of safety and goals to be achieved by land disposal of low-level radioactive wastes. The technical requirements include objectives, but are also prescriptive where deemed necessary and where sufficient technical information was available to support the requirement. The minimum technical requirements for the components of a land disposal system in 10 CFR Part 61 will help ensure that the objectives will be met. Technical requirements are prescribed for the following areas: site suitability, site design, operations and closure, waste classification, waste form, and institutional measures. Requirements for environmental monitoring are also established and will be used to assess the system's performance. Reliance is not placed on any one component of the system; rather, all components interact in achieving the performance objectives. (The technical requirements currently in 10 CFR Part 61 cover only near-surface disposal. Development of near-surface requirements was not an endorsement of that type of disposal technology. It was a pragmatic decision on what technology would be used at the next several sites. See the discussion of alternatives under "Other Issues, p. 17.") The following discussion provides an overview of the more important requirements.

4.3.1 Site Suitability

Part 61 of 10 CFR contains common sense siting requirements which address the natural characteristics of the site (e.g., geohydrology and climate) and other factors. NRC views the siting requirements as minimum requirements for any near-surface disposal method, whether or not engineering enhancements are used. The requirements are primarily directed at aspects to be avoided.

- The site must have characteristics which maximize long-term stability and isolation of waste and ensure that performance objectives are met. (Site characteristics and performance must be evaluated for at least a 500-year period.)

- Sites chosen for low-level radioactive waste disposal must be capable of being characterized, modeled and analyzed and monitored.

- Sites should be avoided where projected population growth, other future developments or known natural resources--such as coal, natural gas and mineral deposits--may negatively affect the ability of the disposal site to meet the performance objectives.

- A prospective site must be well-drained and free of flooding or frequent ponding.

- The disposal site should be located far enough above the water table to prevent groundwater intrusion into the bottom of the disposal unit.

- Sites and areas where tectonic processes--such as faulting, folding, seismic activity, or volcanic activity--and surface geological processes--such as mass wasting, erosion, slumping, landsliding, or weathering--occur frequently and extensively must be avoided.

- Sites must not be located in areas where nearby facilities could adversely impact the site's ability to meet the performance objectives or could significantly mask or interfere with the disposal facility's environmental monitoring program.

4.3.2 Disposal Site Design

The basic design objectives are to minimize water contact with the waste during storage, disposal, and after disposal and to help assure long-term site stability.

- The facility must be designed to provide for long-term isolation of the waste while minimizing the need for active maintenance after the site is closed.

- The design should complement and improve on the site's natural characteristics where reasonable.

- Surface features should be designed to minimize water infiltration into disposal units and minimize erosion.

4.3.3 Environmental Monitoring

Part 61 of 10 CFR requires a comprehensive environmental monitoring program throughout all phases of the facility lifecycle. Site and environmental data must be collected to predict and evaluate disposal site performance.

- Data must include information about the site's ecology, soil chemistry, hydrology, geology, climate, and meteorology. Seasonal characteristics such as climate require pre-operational data for at least a twelve-month period.

- During operation, closure, post-closure, and long-term institutional control, data needed to evaluate both near-term and long-term potential health and environmental impacts must be collected.

- The monitoring systems must be capable of providing early warning of releases of radionuclides before they leave the site boundaries. Provisions for taking corrective or mitigative measures when needed must also be included.

4.3.4 Operations and Site Closure

Basic and general requirements for low-level radioactive waste disposal operations are described as well as requirements for site closure.

- Since much of the Class A wastes are contaminated paper, cloth, and plastics--which may degrade or compress over time--all Class A low-level radioactive waste must be disposed of separately from Class B and Class C wastes, unless the Class A waste meets the stability requirements for the other waste classes. (This prohibition is aimed at maintaining the stability of the portions of the facility which contain higher activity B and C wastes.)

- Waste designated as Class C low-level radioactive waste must be disposed so that the waste containers are no less than five meters below the top of the disposal unit covers. As an alternative to this disposal method, NRC permits the use of intruder barriers such as steel reinforced concrete designed to last--and thus discourage intrusion--for at least 500 years.

- To reduce subsidence or cracking of the caps or barriers covering the waste, all low-level radioactive waste must be placed in the disposal unit in a way that maintains the integrity of the waste package and permits voids to be filled with soil or other materials.

- The boundaries and locations of each disposal unit must be accurately located and mapped by means of a land survey.

- Buffer zones of land adequate for monitoring and possible corrective actions must be maintained between disposed waste and the site boundaries--including beneath the disposed waste.

- Closure and stabilization methods set forth in the approved site closure plan must be carried out as each disposal unit is filled and covered.

- After closure is completed, a post-closure period of maintenance and observation is required to confirm that the closed site is performing as expected. Responsibility for the site cannot be transferred to the custodial agency for long-care until closure is confirmed.

4.3.5 Waste Classification

The 10 CFR Part 61 radioactive waste classification is a systems approach to control the potential dose to man from the disposed waste. The components of the system include the site characteristics, the design and operation of the site, the institutional controls, the waste form, and intruder barriers. The quantity and type of radionuclides permitted in each class are based on combinations of these various components for disposal and on concentrations of radioactive materials that are expected to be in the wastes and that are important for disposal. Three classes are established for routine near-surface disposal: Class A, Class B, and Class C.

Low-level radioactive waste typically contains both short-lived and long-lived radionuclides. Three important time intervals are relied on in setting the waste classification limits. One is the length of time the government will actively control access to the site. (An upper limit of 100 years was used.) The second is the expected life of the waste form. (A 300-year period before failure begins was used.) The third period is the expected lifetime of engineered barriers or assured burial depth, and the time when total failure of the waste form occurs. (A 500-year period was used for this third period.) Concentrations of short-lived radionuclides permitted in the waste are higher than concentrations of long-lived radionuclides, because the short-lived nuclides will significantly decay during the 100 years of assumed institutional controls. Shorter-lived nuclides will also significantly decay during the 300-year design lifetime of stabilized wastes. The limits are further set so that at the end of the 100-year institutional control period, no active site controls or maintenance is needed, and so that at the end of 500 years, no reliance on engineered features or waste form is needed. The limits specified for both short- and long-lived radionuclides will assure that the performance objectives will be met.

Figure 4, "Classes A, B, and C Wastes by Volume and Curies," shows the activity and volumes of commercial low-level wastes disposed of at the three operating sites in 1986. The characteristics of the three classes of waste and the underlying assumptions are summarized in Table 1, "Overview of Classes A, B, and C Waste Characteristics."

4.3.6 Waste Characteristics

All waste(s) Classes A, B, and C are subject to minimum waste form requirements which are designed to protect site workers during handling, including:

- Waste must not be packaged for disposal in cardboard or fiberboard boxes.
- Liquid waste must be solidified or packaged in absorbant material. Not more than 1 percent of the package by volume can be free liquids.
- Wastes that generate toxic fumes or are spontaneously flammable or explosive are prohibited.
- Gaseous materials are subject to concentration and pressure limitations.
- Nonradiological hazards such as infectious properties must be treated to the extent practicable.
- Class B and Class C waste must meet additional waste form requirements to ensure that the waste does not structurally degrade before decay to acceptable concentrations or quantities of radionuclides.
- Waste form or high integrity containers (HICs) used to provide structural stability must maintain gross physical properties and identity for 300 years, under the expected disposal conditions.

Table 1 Overview of Classes A, B, and C Waste Characteristics

CHARACTERISTIC	CLASS A WASTE	CLASS B WASTE	CLASS C WASTE
Concentration	low concentrations of radionuclides	higher concentrations of radionuclides	highest concentration of radionuclides
Waste Form	must meet minimum waste form requirements	must meet minimum waste form requirements	must meet minimum waste form requirements
	does not require stabilization (but may be stabilized)	requires stabilization for 300 years	requires stabilization for 300 years
Examples	typically contaminated protective clothing, paper, laboratory trash	typically resins and filters from nuclear power plants	typically nuclear reactor components, sealed sources, high activity industrial waste
Intruder Protection	after 100 years, decays to acceptable levels to an intruder	after 100 years, decays to acceptable levels to an intruder, provided waste is recognizable	after 500 years, decays to acceptable levels to an intruder
	requires no additional measures to protect intruder	requires stabilization to protect intruder	requires stabilization and deeper disposal (or barriers) to protect intruder
Segregation	unstable Class A must be segregated from Classes B and C	need not be segregated from Class C	need not be segregated from Class B

- Liquid in wastes must be limited to 1 per cent by volume for HICs, or 0.5 percent by volume for solidified wastes.

- Void spaces must be reduced to the extent practicable.

4.3.7 Institutional Requirements

Part 61 of 10 CFR has two basic institutional requirements: (1) government ownership of the land before disposal of wastes and (2) a governmental institutional control period. Given the uncertainty of predicting how long governmental agencies will maintain control over disposal sites after they have been closed, and in consideration of the societal burden of such long-term control, 10 CFR Part 61 requires that governmental controls not be relied on for more than 100 years.

- After closure of a site disposing of Classes A, B, and C wastes, the license must be transferred from the site operator to the State or Federal land owner, who must have a program to restrict assess to the site throughout a 100-year institutional control period.

- At a minimum, environmental monitoring, periodic surveillance, and minor custodial care must be provided during the institutional control period.

- The land owner is responsible for administering the funds to cover the costs of institutional control activities.

- The site as a system must be capable of meeting the performance objectives after the 100-year period by relying only on passive controls such as markers and land records. The passive control period is assumed to last for 500 years.

- The State or Federal agency which is in control of the site may wish to continue a presence after the 100 years during the passive control period, and there is nothing in 10 CFR Part 61 which precludes this option.

4.4 Financial Assurances

4.4.1 Applicant Qualification and Assurances

- Applicants for a low-level radioactive waste disposal facility license must demonstrate that they have the necessary funds to cover the estimated costs of conducting all licensed activities over the operating life of a planned facility--including the costs of construction and operation.

4.4.2 Funding for Disposal Site Closure and Stabilization

- Prospective disposal site operators must show that sufficient funds will be available to carry out appropriate site closure and stabilization to assure that additional State or Federal funding for these activities is unnecessary. The assurances must be based on NRC-approved cost estimates for each category.

- Liability of the site operator remains in effect until:

  - the site is closed and stabilized;
  - the program has been completed and approved by NRC; and
  - the license has been transferred to the site owner.

- Regardless of the type of assurance provided, the site operator's surety mechanism must be reviewed annually by NRC to be sure that adequate funds are available for the completion of the NRC-approved plan to close the site. The amount of the surety should be adjusted, taking into account possible changes in costs of closure and stabilization based on inflation, increased land disturbances, changes in engineering plans, and completed closure and stabilization projects.

4.4.3 Financial Assurances for Institutional Control

- Before a license is issued, the applicant must provide to the NRC for its approval a binding agreement--such as a lease--between the applicant and the site owner that ensures adequate funds will be available to cover the costs of monitoring and any required maintenance during the institutional control period. (NRC will check periodically to be sure that changes in inflation, technology, and disposal facility operation are reflected in the arrangement.)

- Any subsequent changes in the arrangement relevant to institutional control must be approved by the Commission.

4.5 Other Provisions

Part 61 of 10 CFR includes a number of other requirements designed to address procedural and implementation matters. Subpart A of 10 CFR Part 61 addresses matters such as scope and applicability to existing sites and includes a concepts section and a definitions section. The concepts section is a useful reference for the reader to clarify how many of the provisions fit together. Definitions and many of the concepts are covered in the "Glossary of Terms" of this document. Implementation aspects such as recordkeeping and filing reports are explicitly covered in 10 CFR Part 61. Subpart B of 10 CFR Part 61 addresses licensing procedures, and Subpart F addresses participation by State governments and Indian Tribes.

4.5.1 Licensing Procedures

Part 61 of 10 CFR includes licensing procedures that were developed expressly to facilitate licensing of low-level radioactive waste sites. It specifies requirements at each of the critical steps in the lifecycle of the site, including issuing the initial license, major amendments, operating license renewal, site closure, license transfer to the custodial governmental agency, and license termination. (See NUREG-1274.)*

*See the References section.

- A license application to dispose of low-level radioactive wastes must contain substantial information on a wide range of topics, including the proposed operator. It must include a comprehensive description of the natural features of the site; the planned construction, operation, and closure of the site; and expected wastes to be accepted for disposal. (See NUREG-1199.)*

- NRC will review each license application to determine whether the information, technical analyses, and proposed plans provide reasonable assurance that the requirements of 10 CFR Part 61 will be met. All subsequent licensing actions will involve similar NRC findings. (See NUREG-1200.)*

- Proposed and final site closure plans are required.

- If the site operator prematurely stops accepting wastes, he remains responsible for the site and disposed wastes until closure is completed and the governmental agency assumes the responsibility for institutional control.

4.5.2 Participation by State Governments and Indian Tribes

Under 10 CFR Part 61, States and Indian Tribes which may be affected by a planned low-level radioactive waste disposal site may submit a proposal for participating in the review of the license application. The proposal must contain:

- a list of issues which the State or Tribe wishes to review,

- a proposed schedule,

- the process that the State or Tribe would follow to encourage local governments and citizens to participate in the review, and

- the expected impact of the facility on the State or Tribe.

After review of the proposal, NRC may approve all or part of the proposal to participate.

4.5.3 Other NRC Regulations

A number of NRC regulations other than 10 CFR Part 61 apply to the transport and disposal of low-level radioactive wastes.

10 CFR Part 2 "Rules of Practice for Domestic Licensing Proceedings" contains agency legal and procedural requirements for licensing, enforcement, and hearings.

10 CFR Part 19 "Notices, Instructions, and Reports to Workers; Inspections" provides for informed radiation workers.

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*See the References section.

10 CFR Part 20 "Standards for Protection against Radiation" is the basic regulation for protection of workers and the general public from harmful radiation exposures, including those from waste disposal.

10 CFR Part 21 "Reporting of Defects and Noncompliance" adds to quality assurance confidence for vendor products.

10 CFR Part 51 "Environmental Protection Regulations for Domestic Licensing and Related Functions" addresses NRC's compliance with NEPA and the regulations of the Council on Environmental Quality.

10 CFR Part 71 "Packaging and Transportation of Radioactive Material" addresses NRC and U.S. Department of Transportation (DOT) requirements for transportation.

10 CFR Part 150 "Exemptions and Continued Regulatory Authority in Agreement States and in Offshore Waters under Section 274" governs the Agreement State program.

10 CFR Part 170 "Fees for Facilities and Materials Licenses and Other Regulatory Services under the Atomic Energy Act of 1954, as Amended" covers fee requirements for NRC licensees and applicants.

4.5.4 Manifests and Generator Responsibilities

Part 61 of 10 CFR addresses the disposal site and its operation. The waste generators and waste management firms play a key role in achieving safe disposal. It is important to get the wastes safely to the disposal sites and in the right form for disposal. Accurate information on the wastes is important in both handling and disposal. To meet this need, a manifest system was developed in parallel with 10 CFR Part 61 and added to the waste disposal section of 10 CFR Part 20.

- The shipper must prepare a manifest for each shipment. The manifest is used to track the shipment from the waste generator to emplacement at the site. If all or part of a shipment is missing, the shipper must investigate and resolve the matter and report the results to NRC.

- The waste generator must comply with the waste classification and waste form requirements in 10 CFR Part 61.

- The waste generator must have a quality control program to back up the waste form and classification certifications made to the disposal site operator.

5. HISTORY AND BACKGROUND

5.1 The Low-Level Radioactive Waste Policy Act of 1980 (P.L. 96-573)

In 1979, two of the three operating facilities--in Hanford, Washington and Beatty, Nevada--were temporarily closed and the third site--at Barnwell, South Carolina--reduced the annual volume of waste that it would accept by 50 percent. These actions by the host States were due primarily to a series of transportation and packaging incidents. These three States with operating sites made it

clear that they would not continue to accept all the nation's low-level radioactive wastes. Initially, the U.S. Congress considered a Federally oriented solution to the problem of assuring adequate low-level waste disposal capacity.

Eventually, however, in response to policy recommendations from State-supported organizations, including the National Governors' Association and the National Conference of State Legislatures, the Low-Level Radioactive Waste Policy Act of 1980 was enacted.

The 1980 Act made each State responsible for providing disposal capacity for low-level radioactive wastes generated within its border. It:

- encouraged States to form regional compacts to collectively meet their obligations to provide for disposal capacity, and
- allowed those compacts ratified by Congress to exclude waste generated outside their borders, beginning on January 1, 1986.

5.2 The Low-Level Radioactive Waste Policy Amendments Act of 1985 (P.L. 99-240)

By late 1984, it was evident that regions without waste sites were not progressing rapidly enough to have new facilities operating by the deadline of 1986. A change in the law appeared necessary in order to allow time for the construction of the additional disposal sites foreseen in the 1980 Act.

After extensive negotiations between representatives of the three States with operating disposal sites and the forty-seven unsited States, a consensus was reached which ~~led to the passage of~~ enabled Congress to pass the Low-Level Radioactive Waste Policy Amendments Act of 1985.

The Agreement. The sited States of Washington, Nevada and South Carolina agreed to continue to make their sites available to the entire country for an additional seven years--but only if the unsited States and regions showed specific progress toward developing new disposal capacity.

The final date when sited States could exclude waste from outside their regional borders was extended to January 1993. In exchange, the unsited States and regions ~~were~~ required to meet a series of specific dates--or milestones (regarding disposal site development)--if the generators of those States are to avoid economic penalties and possible loss of access to operating disposal sites.

The Amendments Act also:

- specifies precisely which categories of low-level radioactive waste are a State responsibility;
- establishes volume ceilings for individual nuclear reactors and for operating disposal sites;
- makes the Federal government responsible for disposing of commercial low-level radioactive waste exceeding Class C concentration limits.

In addition, the Amendments Act requires NRC to establish procedures for:

- licensing disposal technologies other than shallow land burial;
- reviewing petitions to allow certain wastes to be classified as below regulatory concern; and
- licensing new sites in a timely fashion.

5.3 Congressional Approval of Compacts

When Congress approved the Low-Level Radioactive Waste Policy Amendments Act in December 1985, it also approved seven pending regional compacts. Subsequent low-level radioactive waste compacts must also be ratified by Congress.

5.4 Other Governmental Agencies in Low-Level Radioactive Waste Management

A number of other Federal and State agencies play important roles in developing and implementing standards and regulations governing commercial low-level waste management.

5.4.1 EPA

EPA has the authority to develop general environmental protection standards and Federal radiation protection guidelines for releases of radioactivity to the general environment and for exposures of workers and members of the public. NRC and Agreement States implement EPA's general environmental standards through regulations and licensing actions. When EPA standards for low-level radioactive waste management are issued, NRC will have to amend 10 CFR Part 61 if it does not comply with the EPA standards, and may have to amend other regulations, also, depending on the content of the final EPA standards for low-level wastes. EPA hopes to issue proposed standards in 1988. Currently, only EPA's Clean Air Act standards in 40 CFR Part 61 would apply to waste disposal site releases.

5.4.2 U.S. Department of Energy (DOE)

DOE, as provided in the 1985 Low-Level Radioactive Waste Policy Amendments Act, provides technical assistance and information to States and regional compacts on:

- alternative low-level radioactive waste disposal technology designs,
- volume reduction options,
- transportation practices for shipment of low-level radioactive waste,
- health and safety considerations for managing low-level radioactive waste, and
- computerized data bases to monitor the management of low-level radioactive waste.

DOE must submit an annual progress report to Congress on the status of regional and State efforts to site and license low-level radioactive waste facilities.

DOE has acknowledged that it is the Federal agency responsible for disposal of low-level radioactive wastes which contain radionuclides in concentrations exceeding Class C limits in 10 CFR Part 61.

5.4.3 DOT

DOT develops and enforces regulations addressing vehicles, drivers, and packages for transport of all hazardous materials, including radioactive materials. NRC also regulates these activities for radioactive materials. Through a Memorandum of Understanding, NRC and DOT have delineated their responsibilities. NRC regulates packaging for wastes containing relatively high amounts of materials to assure safety and safeguards in transport. DOT addresses all other aspects of transport.

5.5 States

5.5.1 NRC'S Agreement State Program

Under Section 274 of the Atomic Energy Act, NRC can relinquish to the States portions of its regulatory authority. States may assume authority for licensing and regulating byproduct materials (fission and activation products), mill tailings, source material (the raw materials of nuclear energy), and small quantities of special nuclear material (fissile materials). An agreement between the Governor of the State and the Commission allows States to assume this authority--hence the term "Agreement State." As of the beginning of 1988, twenty-nine States have entered into agreements with NRC and now regulate over 65 percent of the 20,000 licensees using byproduct, source, and small quantities of special nuclear material in the United States. In 1981, the Commission determined that limited agreements for regulation of low-level radioactive waste disposal sites alone were acceptable.

Each Agreement provides that the State will use its best efforts to maintain continuing compatibility with the NRC's regulatory programs. States which plan to license new disposal sites must adopt most of the nonprocedural parts of 10 CFR Part 61 to maintain compatibility. All Agreement States must adopt the manifest system in 10 CFR Part 20 to cover waste generators in the State. NRC maintains a continuing relationship with each Agreement State to assure continued compatibility; however, States are independent regulatory authorities under the Agreements. In making licensing decisions, States may take local conditions into account as long as the program remains compatible and adequate to protect the public health and safety.

5.5.2 Other State Roles

- States may be authorized by certain Federal agencies to implement Federal laws and regulations which may affect low-level radioactive waste management. For example, under EPA programs, States are generally responsible for implementing and enforcing the requirements associated with the Clean Air and Clean Water Acts. Over forty States have been authorized by EPA to administer at least parts of

the Resource Conservation and Recovery Act (RCRA) requirements governing hazardous wastes. (However, these authorizations do not involve EPA relinquishing authority as NRC does for Agreement States.)

- Consistent with compact responsibilities, State legislatures have established agencies responsible for the siting, development, and operation of low-level waste sites.

- States may also negotiate or impose requirements at the sites as landowners of the sites, or long-term custodians.

- As of October 1987, seven regional compacts had been approved by various State legislatures and Congress. These regional compacts, directed by Commissioners appointed by the governors of each of the compact's member States, are responsible for activities such as developing compact plans, selecting host States, and controlling import and export of wastes in their regions. The compact Commissions have no licensing authority over low-level radioactive waste management.

5.6 Local Governments

The role of local governments in low-level radioactive waste management is not addressed in Federal low-level radioactive waste laws or regulations. Host State legislation on facility siting may provide a role for local governments which can range from the creation of a local oversight committee to community choice of technology and a site operator.

6. OTHER ISSUES

6.1 Alternative Technologies

Part 61 of 10 CFR establishes the basic framework for licensing any land disposal of low-level radioactive wastes. However, the specific technical requirements and focus were on near-surface disposal. Part 61 of 10 CFR was developed in anticipation that the next sites would use this technology. The term "near-surface" was used to emphasize that the conventional practices of the 50's and 60's was not intended. No endorsement of a technology was intended, and reserve sections were included for later use, if needed for technologies other than near-surface disposal.

- Conceptual methods of near-surface disposal considered as alternatives to 10 CFR Part 61 enhanced shallow land burial include below-ground vaults, above-ground vaults, earth mounded concrete bunkers, shafts, and modular concrete canisters; other land disposal options include deeper disposal at intermediate or deep mine depths.

- NRC does not plan to add technical requirements for alternative methods to 10 CFR Part 61, because 10 CFR Part 61 may be used to license near-surface methods that use engineered barriers or structures without change. However, guidance for licensing alternative methods is being developed, and NRC is focusing on guidance development for methods that use engineering materials with earth cover (e.g., below-ground vaults).

- NRC published NUREG-1241, "Technical Position Statement on Licensing of Alternative Methods of Disposal for Low-Level Radioactive Waste," to provide technical guidance and policies for applying 10 CFR Part 61 to alternatives.

6.2 Storage

Generators usually store their low-level radioactive wastes for one of two reasons: (1) to allow the short-lived radionuclides to decay to innocuous levels so that the wastes can be disposed of only according to their nonradiological properties (termed "hold-for-decay" disposal); and (2) to provide short-term contingency protection in case of limited access to disposal sites. Storage is not addressed by 10 CFR Part 61. Storage is regulated as an operational matter subject to the same requirements to protect public health and safety and the environment as other operations. Short-term storage is approved under the operating regulations such as 10 CFR Part 50 for nuclear reactors, or 10 CFR Part 30 for industrial licensees, and long-term storage is approved under 10 CFR Parts 30, 40, and 70.

- The "hold-for-decay" practice is common among medical and academic institutions which typically generate small volumes of wastes containing discrete radionuclides having very short half-lives (e.g., days). Hold-for-decay of wastes that contain long-lived radionuclides such as most reactor wastes is not considered practical due to factors such as: larger volumes; wide variety in physical and chemical form and radionuclide content; the long storage times needed for decay; and the dollar and exposure costs of dealing with surveys and sorting.

- In Generic Letters to licensees 81-38 dated November 10, 1981 and 85-14 dated August 1, 1985, NRC stated its policy that licensees should continue to ship wastes for disposal at existing sites to the maximum extent practicable. NRC recognized the potential need for interim contingency measures and provided guidance for approving storage. However, NRC expressed concerns about storage, including: storage becoming de facto disposal; distraction of reactor management from the safe operation or construction of the reactor if wastes not generated by the facility were accepted; impacts on State efforts to develop disposal capacity; and the potential for package and waste disintegration.

- NRC views long-term storage of wastes for more than five years as a significant safety and environmental matter and requires specific application and approval so that factors such as impacts on operations and effluent releases, effects of accidents or fires, financial assurances, and arrangements for final disposal can be evaluated.

- Storage must allow for wastes to be readily retrieved. Waste retrievability as a design option at disposal sites is neither required nor prohibited by 10 CFR Part 61. Retrievability should not compromise the ability to meet the performance objectives.

7. QUESTIONS AND ANSWERS

Why doesn't NRC prohibit the release of all radioactivity from low-level radioactive waste disposal facilities?

There is no way to guarantee that any disposal facility, for any waste, will not release some amount of radioactivity. The NRC designed the 10 CFR Part 61 regulations to limit the releases of radioactivity from the site to levels which present an acceptable risk to the general public.

Why didn't NRC require that the disposal facility remain under constant care, until there was no chance of any exposure to an inadvertent intruder?

No structure or site can be guaranteed to contain low-level radioactive waste in perpetuity. Given the fact that facilities deteriorate and human institutions may not maintain complete control, NRC chose to rely on the more realistic requirements of 100 years of institutional care, coupled with specific site characteristics, waste packaging, design of the facility, and limits on the amounts and concentrations of radioactivity accepted at the site, to protect public health and safety.

Won't future low-level radioactive waste disposal sites fail as some past sites have?

Three commercial low-level radioactive waste disposal facilities -- at Maxey Flats, Kentucky; Sheffield, Illinois; and West Valley, New York -- have been closed prematurely for a variety of reasons. The existing sites have experienced subsidence and slumping of trench covers, as wastes and trench covers have consolidated, and as voids in the waste packages and in the soil backfill between packages have filled. Water has accumulated in the trenches (i.e., the "bathtub" effect), and offsite movement of radioactivity by varying pathways has occurred. The lack of stability and water accumulation resulted in large uncertain maintenance costs that were not anticipated in planning for the long-term care of the sites by the States.

Part 61 of 10 CFR is directed at preventing past problems experienced at the sites. The rule requires technical, institutional, and financial planning for long-term care throughout the lifecycle of the site, beginning with site selection and design.

Does 10 CFR Part 61 apply to the sites currently operating in Washington, Nevada, and South Carolina?

No. Existing NRC disposal site licensees were exempted from 10 CFR Part 61, with the expectation that the provisions would be imposed, to the extent practicable, through license conditions. Part 61 of 10 CFR as a NRC regulation does not legally apply to Agreement State licensees. (Agreement States must adopt state regulations for them to apply. Since NRC exempted existing licensees, Washington, Nevada and South Carolina were not required to adopt regulations for the existing sites.) The three operating sites are located in Agreement States, and NRC licenses only the disposal of special nuclear material at two of the three. The exemption for existing licensees applied to the two NRC licenses. However, the

waste classification and waste form requirements were implemented for receipt and disposal of wastes at the sites, through State and NRC license conditions, as the waste requirements became effective on NRC licensed waste generators. NRC and the States are working together to implement the remaining requirements of 10 CFR Part 61 in the State and NRC licenses.

How is 10 CFR Part 61 enforced?

Before operation of a new site, NRC will review the information submitted by the applicant and grant a license only if the proposed activities will be in compliance with the regulation. The license granted will contain specific conditions designed to ensure that the regulation will continue to be met at the site. NRC will inspect the site before the initial receipt of wastes, and periodically during operations, to determine continued compliance with the regulation and implementing licensing conditions. For existing sites, NRC inspects for compliance with license conditions which impose 10 CFR Part 61 provisions, on a site-specific basis. If violations are discovered, NRC has a range of options available to correct the situation. For example, NRC may negotiate, issue violation notices, issue orders, impose civil penalties, refer the situation to the Department of Justice for criminal action, or revoke the license to operate.

NRC also inspects the waste generator's activities and quality control program to ensure that the NRC licensed generators are meeting the waste form and classification requirements. These requirements have been in effect on NRC licensees since December 1983.

What methods are used to stabilize Class B and Class C wastes to achieve a 300-year design life?

Part 61 of 10 CFR allows the use of processing, containers, structures, or the waste form itself to provide stability. This offers a waste generator flexibility for managing various waste streams in a cost-effective manner. The most prevalent ways of meeting the stability requirements are by solidification of liquid wastes using cement, vinyl ester styrene, or asphalt media, or by use of HICs.

Does 10 CFR Part 61 permit transuranic elements to be disposed of in a near-surface low-level radioactive waste disposal facility?

Yes. All three classes of waste may contain transuranic elements. NRC's classification system contains exposure-based concentrations for specific radionuclides such as transuranics, and is not based on their arbitrary presence or absence. If waste material contains more than 100 nanocuries of long-lived transuranic elements per gram, it is considered unsuitable for routine disposal. The 100 nanocurie limit is the upper limit for Class C wastes and wastes exceeding this limit are now a Federal disposal responsibility.

Why doesn't NRC require that Class A wastes be stabilized?

Stability of all wastes is the most desirable option when cost effectiveness, impacts on small operations, and practicality are not considered. However, medical research, university research, and small-scale industrial

research would be significantly affected by such a requirement. Analyses demonstrated that if relatively innocuous unstable Class A waste is sufficiently segregated from the higher activity waste established as Class B and Class C, stabilization is not required to meet the performance objectives. Part 61 of 10 CFR encourages waste treatment, and NRC policy urges volume reduction; these activities tend to reduce the unstable properties of Class A waste.

Since detectable radioactivity remains at a low-level waste disposal site long after 500 years (e.g., some radionuclides have half-lives of 100,000 years or more), why is a design life of 500 years established for intruder protection measures?

Pathway analyses demonstrated that sufficient decay of the short-lived isotopes would occur in 500 years to enable the performance objectives to be met without further reliance on the protection measures. In view of the difficulty in projecting performance of engineered features and materials, it is prudent not to rely on barriers indefinitely. Maximum concentration limits are set for all wastes, so that remaining activity will be at a level that does not pose an unacceptable hazard to an inadvertent intruder or to the public health and safety.

Is an environmental impact statement (EIS) required to obtain a license for a low-level waste disposal site?

Yes. Part 51 of 10 CFR requires that an EIS be prepared by NRC for licenses granted under 10 CFR Part 61. However, Agreement State requirements vary regarding the need for the preparation of a document equivalent to an EIS. The NEPA applies only to Federal actions.

Are formal hearings required in the licensing process for a new site?

No. Formal hearings are not required. However, they may be requested under 10 CFR Part 2 and granted if requesters raise issues of merit. Informal and informational hearings may also be held upon request or upon NRC initiative. The State and compact siting processes, the scoping process for NRC's EIS, and comment on the draft EIS and draft licensing documents provide other opportunities for identification and resolution of public issues.

Why doesn't 10 CFR Part 61 take into account active maintenance past the closing of the site?

Custodial care involving minor maintenance activities such as minor repairs of unstable Class A areas or repairs to fences will take place as needed during the period of licensed institutional control. The long-term care fund established can and will provide monies for these limited activities. Part 61 of 10 CFR assumes that this licensed period involving minor maintenance and access controls will not last for longer than 100 years. The post-closure observation and maintenance period required before transfer of the site for custodial care will provide additional assurances that only minor maintenance will be required. The combination of siting, site design and operation, site closure, and waste form requirements in 10 CFR Part 61 are aimed at eliminating the need for active

maintenance (e.g., pumping and treating water that has been in contact with the wastes) after the site closes. Predicting the costs for significant remedial maintenance activities in perpetuity and assuring the availability and use of funds to perform such maintenance is difficult. Part 61 of 10 CFR limits this uncertainty and minimizes the expected long-term costs and societal burden.

Are there any other versions of 10 CFR Part 61?

10 CFR Part 61 is the Federal regulation which applies to the licensing of commercial low-level wastes sites in non-Agreement States. Agreement States licensing such sites must have compatible regulations in place. To assist States in issuing their regulations, the Conference of Radiation Control Program Directors prepares suggested State regulations based on Federal regulations. NRC reviews these suggested State regulations and each State's proposed and final regulations for compatibility. State regulations frequently differ in procedural aspects from NRC's regulations, and other variations may exist. However, the key features of 10 CFR Part 61, such as the performance objectives and minimum technical requirements, are expected to be essentially identical. However, for areas not addressed or areas where alternatives are an integral part (e.g., for waste form), State regulations or license conditions may be more stringent, provided overall compatibility is maintained.

Who is responsible for and regulates Defense low-level radioactive wastes?

Defense wastes are generally wastes that are generated or owned by DOE and generated by research and development and other atomic weapons program activities. They are the Federal government's responsibility under Section 3 of the Low-Level Radioactive Waste Policy Amendments Act and are normally disposed of at DOE disposal sites. NRC has no regulatory authority over the disposal of these wastes, and 10 CFR Part 61 does not apply. EPA regulates the wastes as hazardous, if they qualify as mixed wastes.

8. GLOSSARY OF TERMS

"Above-ground vaults" are engineered disposal units on a foundation near the ground surface. At least part of the structure or building would be above the final postclosure surface grade.

"Active maintenance" means any significant remedial activity needed during the period of institutional control. It includes ongoing activities such as the pumping and treatment of water from disposal units, or one-time measures such as replacement of a disposal unit cover.

"Agreement State" means any State with which the NRC or the Atomic Energy Commission has entered into an effective agreement under Subsection 274b of the Atomic Energy Act.

"Alternative technologies" are disposal technologies for land disposal of low-level radioactive waste other than enhanced shallow land burial (called near-surface disposal in 10 CFR Part 61). Alternate technologies generally employ engineered structures and barriers. Technologies considered to be

within the framework of 10 CFR Part 61 include below-ground vaults, above-ground vaults, earth-mounded bunkers, shaft disposal, and mined cavity disposal.

"ALARA" is an acronym for "as low as reasonably achievable" and means making every reasonable effort to maintain exposures and releases below established limits, as is practicable, consistent with the particular use. ALARA decisions should take into account the state of the technology, the costs in relationship to public health and safety benefits to be gained, and other societal benefits of the use of atomic energy.

"Background radiation" is radiation that occurs in the natural environment and includes cosmic rays and naturally radioactive elements in soil. Background varies depending on local conditions. In the United States, levels vary from 100 to 200 millirems per year, excluding exposures to radon.

"Below-ground vaults" are engineered disposal units that are built to remain below the final surface grade at the site.

"Below regulatory concern" (BRC) wastes are wastes with radioactive content so low that unregulated release or disposal does not pose an unacceptable risk to public health or safety.

"Buffer zone" is a portion of the disposal site that is controlled and lies under the disposal units and between the disposal units and the boundary of the site.

"Byproduct material" has two legal definitions: (1) any radioactive material (except special nuclear material) resulting from production or use of special nuclear material, and (2) uranium or thorium mill tailings and associated wastes.

"Code of Federal Regulations" (CFR) is a codification of the rules which have been published by the executive departments and agencies of the Federal government. The CFR is divided into titles, representing broad subject areas, and chapters and parts. For example, 10 CFR Part 61 is codified under Title 10 "Energy," Chapter I, "Nuclear Regulatory Commission," and Part 61, "Licensing requirements for land disposal of radioactive waste."

A "compact" means an agreement entered into by two or more States under the Low-Level Radioactive Waste Policy Amendments Act of 1985. Compacts must be ratified by state legislatures and signed by the governors of the member States and then approved by Congress.

A "curie" is a unit to measure the rate of radioactive decay. It is roughly equivalent to the radioactivity in one gram of radium-226 and is defined as 37 billion disintegrations per second. A nanocurie is one billionth of a curie.

"Disposal" is defined in the Low-Level Radioactive Waste Policy Amendments Act to mean the permanent isolation of low-level radioactive waste pursuant to the requirements established by NRC or the licensing Agreement State.

"Disposal unit" means a discrete portion of the disposal site into which waste is placed for disposal.

"Disposal site" means that portion of a land disposal facility which is used for disposal of wastes. It consists of disposal units and a buffer zone.

"Earth-mounded bunkers" are disposal technologies which may include both above-ground and below-ground construction and which include earthen covers.

"Greater than Class C wastes" are wastes containing concentrations of radionuclides which exceed the Class C limits established in 10 CFR Part 61.

"Half-life" is the unit of time it takes a radioactive material to lose half of its radioactivity through decay.

"Inadvertent intruder" means a person who might occupy the disposal site after closure and engage in normal activities, such as agriculture, building a house, or other pursuits in which the person might be unknowingly exposed to radiation from the waste.

"Institutional control period" means the period of time following closure of the site during which the State or Federal land owner must control access to the site; conduct environmental monitoring; and conduct other custodial activities such as repair of fencing, repair or replacement of monitoring equipment, revegetation, minor repairs to soil covers or the disposal units, and general upkeep such as mowing grass.

"Low-level radioactive waste" is defined in the Low-Level Radioactive Waste Policy Amendments Act to mean radioactive material subject to NRC regulation that is not high-level waste, spent fuel, or mill tailings and which NRC classifies as low-level radioactive wastes. NRC regulates source, byproduct, and special nuclear materials.

"Manifest" means the document prepared by the generator or shipper of waste, which contains information about the waste, including the volume and radioactive content, as well as its origin and destination.

"Mined cavity" includes cavities developed in the removal of natural resources and does not mean a high-level waste repository.

"NARM" derives from Naturally-occurring or Accelerator-produced Radioactive Material. The major isotope of concern is radium. NARM is a State responsibility and is not regulated by NRC.

A "near-surface disposal facility" means a land disposal facility in which radioactive waste is disposed of in or within the upper 30 meters of the earth's surface.

"Radionuclide" is a species of atom that emits radiation.

"Rem" is a unit of radiation dose which is used to measure the biological effectiveness of the dose. A millirem is equal to 1/1000 of a rem.

"Shaft" disposal refers to a disposal technology in which wastes would be disposed of in shafts or boreholes augered, bored, or sunk by conventional construction means.

"Shallow land burial" generally means the land disposal of wastes, as practiced before the late 1970's, in shallow earth trenches with clay or soil covers.

"Source material" means uranium or thorium or any other material which the NRC determines to be source material, and ores containing these materials.

"Special nuclear material" is plutonium, uranium-233, uranium enriched in the isotopes 233 or 235, and any other material that NRC determines to be special nuclear material, other than source material.

"Storage" means retention of waste, before disposal, in a manner that allows for surveillance, control, and subsequent retrieval for transport and disposal.

"Transuranic element" (TRU) is an element having an atomic number higher than 92. EPA and DOE use the term "transuranic waste" to mean wastes containing more that 100 nanocuries of alpha-emitting transuranic isotopes per gram.

9. REFERENCES

"10 CFR 61" (text, final rule), Federal Register, Vol. 47, No. 248, December 27, 1982, pages 57446-57477.

"Final Environmental Impact Statement on 10 CFR Part 61." U.S. NRC, November 1982, (NUREG-0945, Vols. 1-3), available from the National Technical Information Service (NTIS), U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161 or the U.S. Government Printing Office (GPO) by calling (202)275-2060 or by writing to the U.S. Government Printing Office, P.O. Box 37082, Washington DC 20031-7082.

"Draft Enviornmental Impact Statement on 10 CFR Part 61." U.S. NRC, September 1981, (NUREG-0945, Vols. 1-4), available from GPO or NTIS. Note that both the draft and final statements should be consulted for background and completeness.

"The Nuclear Waste Primer; A Handbook for Citizens." The League of Women Voters Education Fund 1985. Nick Lyons Books, distributed by Schoken Books, 62 Cooper Square, New York, New York 10003.

"The Low-Level Radioactive Waste Handbook; A User's Guide to the Low-Level Radioactive Waste Policy Amendments Act of 1985." National Governors' Association Center for Policy Research, November 1986, NGA, 444 North Capital Street, Washington DC 20001.

"Licensing of Alternative Methods of Disposal of Low-Level Radioactive Waste," U.S. NRC, December 1986, (NUREG-1241), available from GPO or NTIS.

"The Role of the State in the Regulation of Low-Level Radioactive Waste," U.S. NRC, March 1983, (NUREG-0962), available from GPO or NTIS.

"Review Process for Low-Level Radioactive Waste Disposal License Application under Low-Level Radioactive Waste Policy Amendments Act," U.S. NRC, August 1987, (NUREG-1274), available from GPO or NTIS.

"Plans and Schedules for Implementation of U.S. Nuclear Regulatory Commission Responsibilities under the Low-Level Radioactive Waste Policy Amendments Act of 1985 (P.L. 99-240)," U.S. NRC, August 1987, (NUREG-1213, Rev. 1) available from GPO or NTIS. Note that this document contains a comprehensive list of NRC low-level waste publications in Appendix E and copies of the Act and key NRC Federal Register notices.

"Standard Format and Content of a license application for a Low-Level Radioactive Waste Disposal Facility," U.S. NRC, January 1987 (NUREG-1199), available from GPO or NTIS.

"Standard Review Plan for the review of a license application for a Low-Level Radioactive Waste Disposal Facility," U.S. NRC, January 1987 (NUREG-1200), available from GPO or NTIS.

10. NRC CONTACTS FOR FURTHER INFORMATION

Division of Low-Level Waste Management and Decommissioning
NMSS
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(301)492-3342

Public Affairs
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(301)492-7715

State, Local and Indian Tribes Programs
GPA
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(301)492-0326

State Liaison Officer
Region I
631 Park Avenue
King of Prussia, PA 19406
(215)337-1246

State & Government Affairs Staff Director
Region II
101 Marietta Street NW, Suite 2900
Atlanta, GA 30323
(404)331-5597

State and Government Affairs Director
Region III
799 Roosevelt Road
Glen Ellyn, IL 60137
(312)790-5666

State Liaison Officer
Region IV
Parkway Central Plaza Building
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011
(817)860-8267

State Liaison Officer
Region V
1450 Maria Lane, Suite 210
Walnut Creek, CA 94596
(415)943-3714

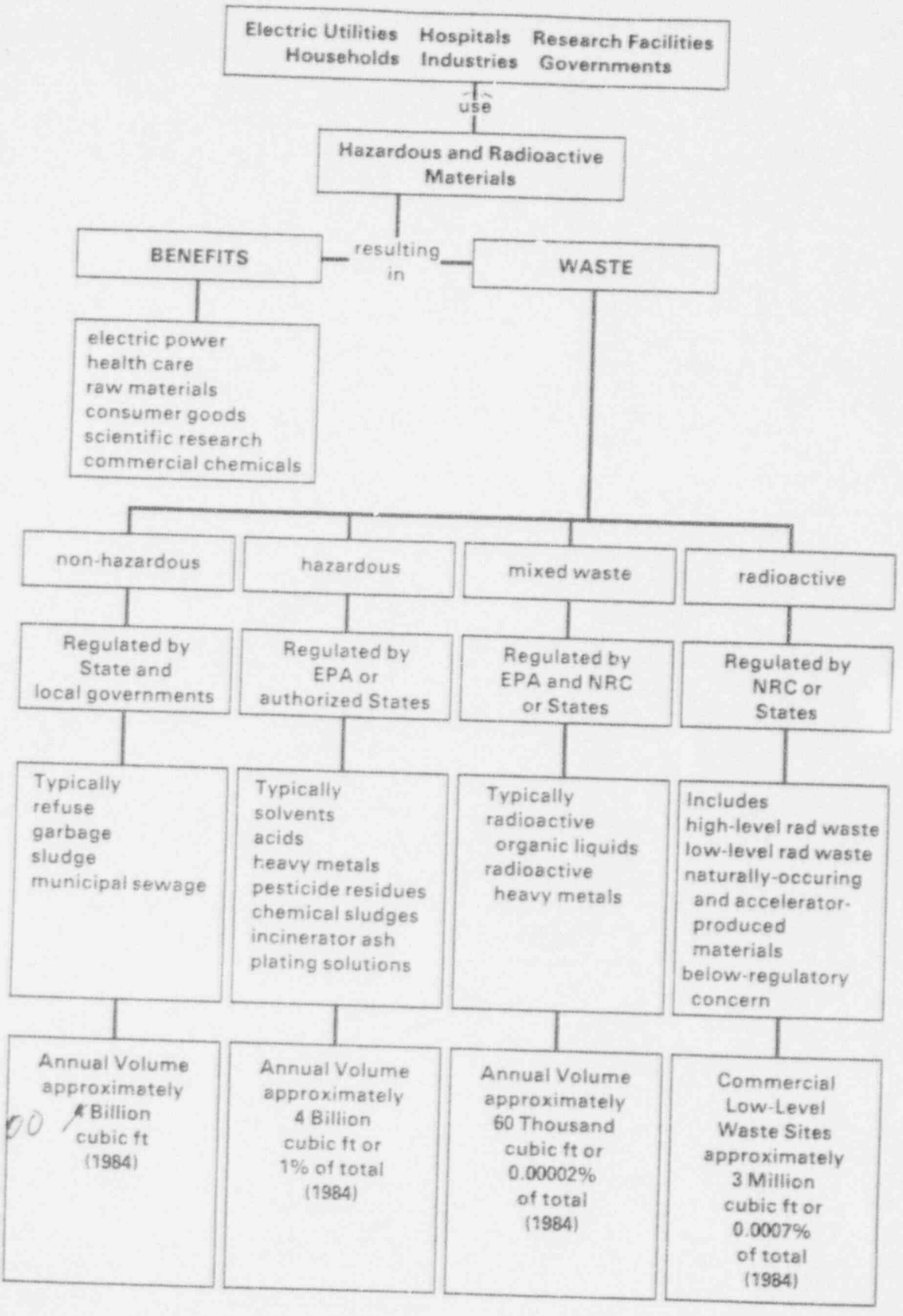

Figure 1. Commercial Waste Generation

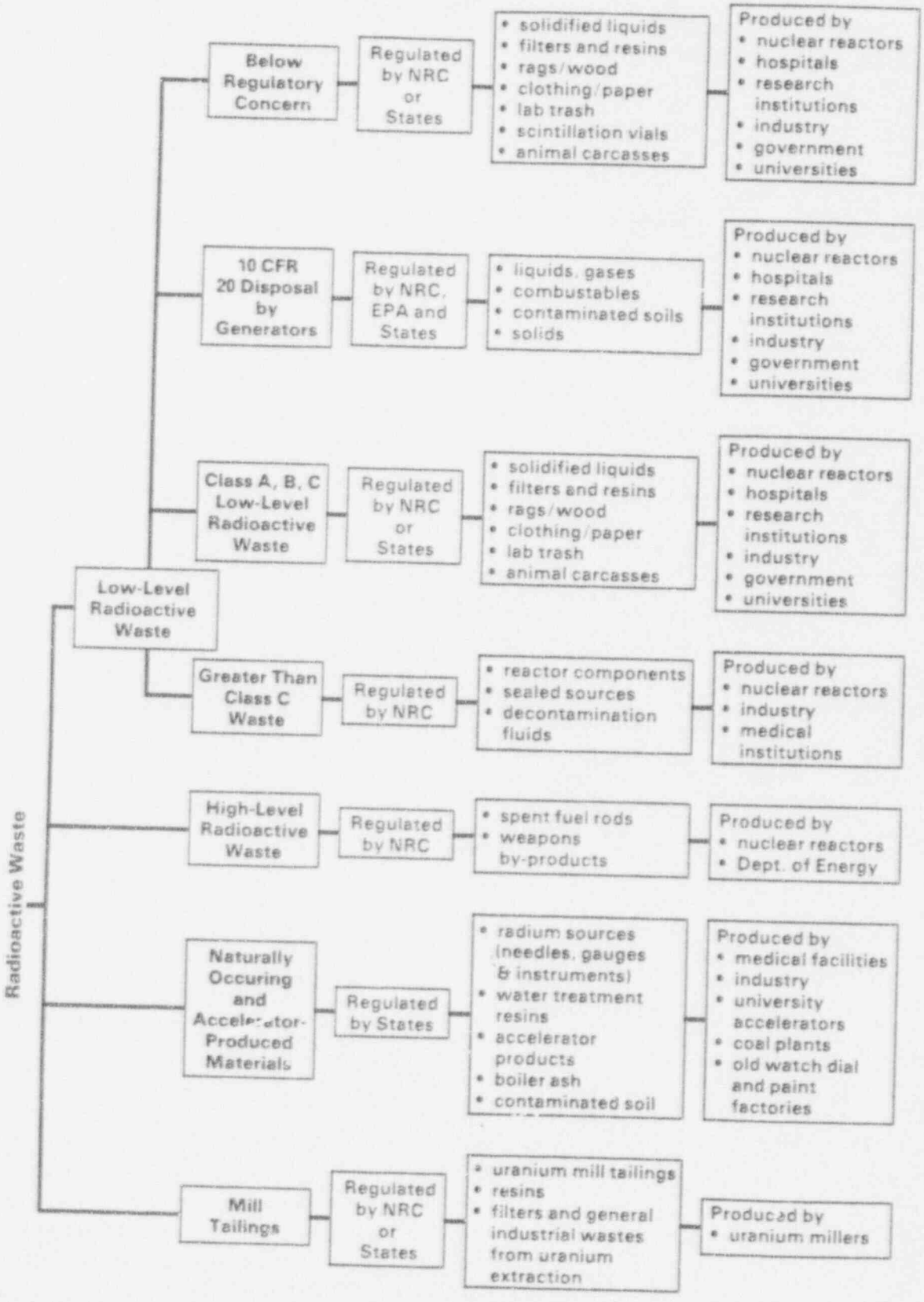

Figure 2. Radioactive Waste

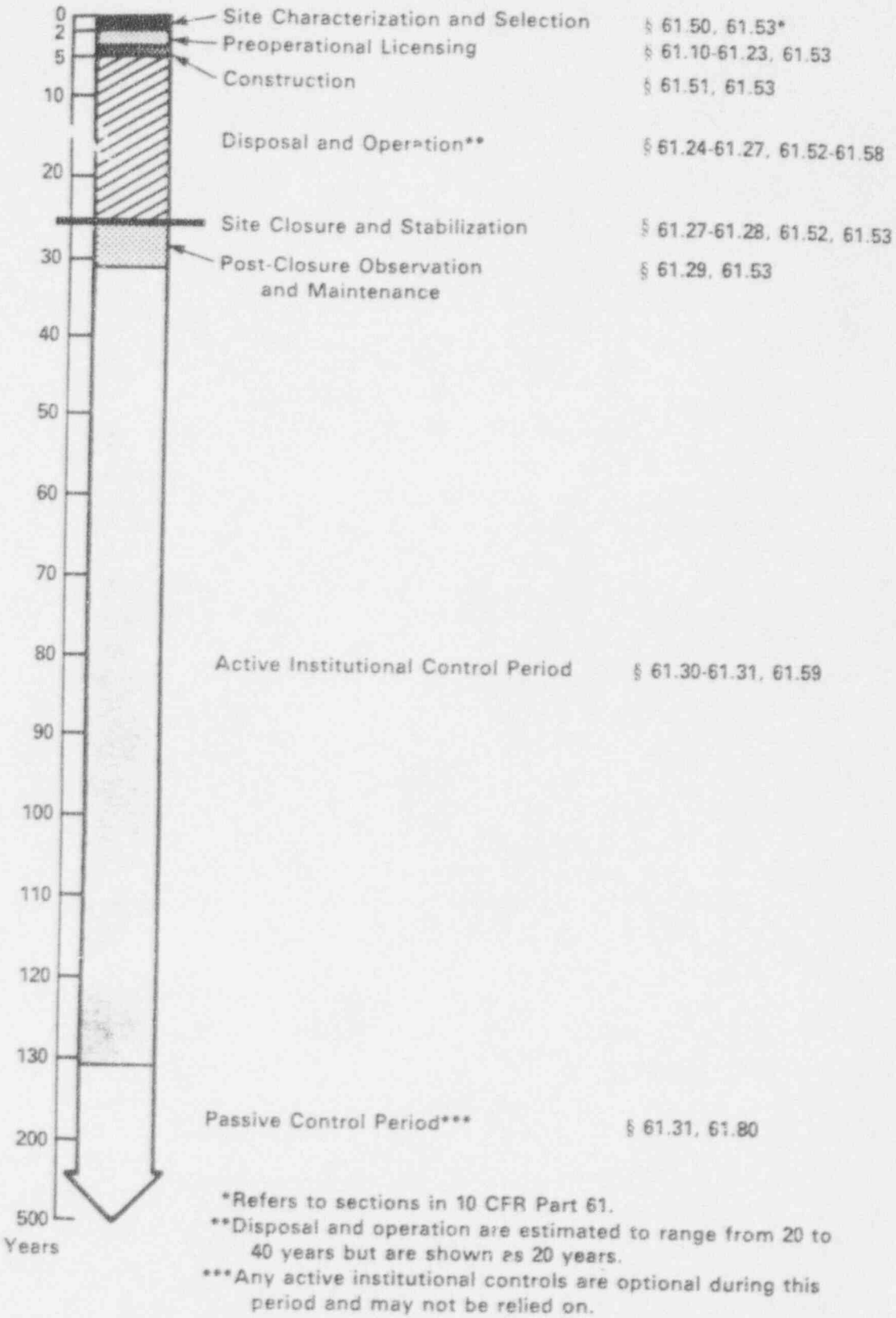

Figure 3. Lifecycle of a Low-Level Radioactive Waste Disposal Facility

Calendar Year 1986

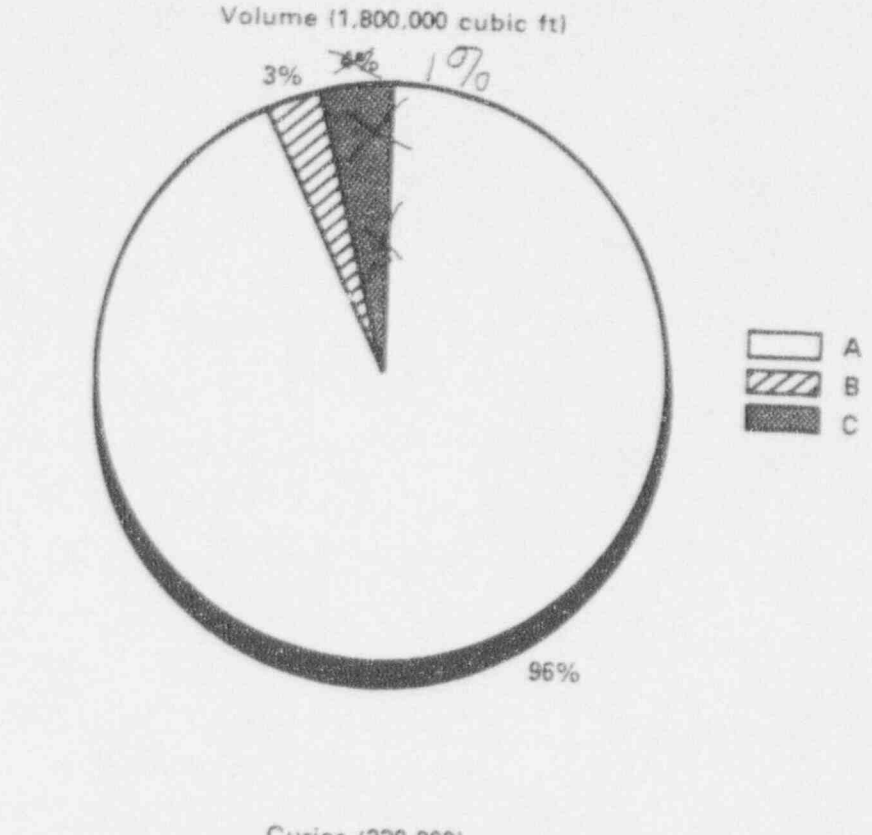

Figure 4.
Class A,B, and C Wastes by Volume and Curies