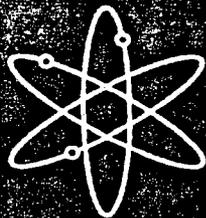




Evaluation of Terminated Nuclear Material Licenses



A Report of Identified Sites and Sealed
Source Licenses



Oak Ridge National Laboratory



U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555-0001



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ABSTRACT

This report presents the results of a six-year project that reviewed material licenses that had been terminated during the period from inception of licensing until approximately late-1994. The material licenses covered in the review project were Part 30, byproduct material licenses; Part 40, source material licenses; and Part 70, special nuclear material licenses. This report describes the methodology developed for the project, summarizes the findings of the license file inventory process, and describes the findings of the reviews or evaluations of the license files. The evaluation identified nuclear material use sites that need review of the licensing material or more direct follow-up of some type. The review process also identified licenses authorized to possess sealed sources for which there was incomplete or missing documentation of the fate of the sources.

CONTENTS

| | |
|--|----------|
| ABSTRACT..... | iii |
| CONTENTS | v |
| FIGURES..... | vii |
| TABLES..... | viii |
| EXECUTIVE SUMMARY | ix |
| ACKNOWLEDGEMENTS..... | xi |
| 1. INTRODUCTION..... | 1 |
| 1.1 THE TERMINATED LICENSE REVIEW PROJECT | 1 |
| 1.1.1 Project Purpose..... | 1 |
| 1.1.2 The Evaluation Process and the Decision System..... | 1 |
| 1.1.3 Summary | 2 |
| 1.2 NUCLEAR MATERIALS LICENSING | 2 |
| 1.2.1 History | 2 |
| 1.2.2 Licensing Documentation..... | 2 |
| 1.2.3 Structure of a Material License | 3 |
| 1.2.3.1 License Application | 3 |
| 1.2.3.2 Amendments | 3 |
| 1.2.3.3 Authorizations..... | 3 |
| 1.2.4 License Content..... | 4 |
| 1.2.4.1 Material Specifications | 4 |
| 1.2.4.2 Licensee and Authorized Users..... | 5 |
| 1.2.4.3 Specification of Uses | 5 |
| 1.2.5 Licensing Practice for Sealed Sources | 5 |
| 1.2.5.1 Sealed Source Licensing..... | 5 |
| 1.2.5.2 Authorizations for Sealed Sources..... | 5 |
| 1.2.5.3 Documentation of Disposition of Sources..... | 6 |
| 1.2.6 Licensing Practice for Loose Materials..... | 6 |
| 1.2.6.1 License Authorizations for Loose Material | 6 |
| 1.2.6.2 Application Information for Loose Material | 6 |
| 1.2.6.3 Waste Generation..... | 6 |
| 1.2.6.4 Onsite Disposal Practices..... | 7 |
| 1.2.7 License Termination and the Site Closure Process | 7 |
| 1.2.7.1 Site Decommissioning..... | 7 |
| 1.2.7.2 Sources of Information | 7 |
| 2. THE EVALUATION SCHEME..... | 9 |
| 2.1 GENERAL OVERVIEW..... | 9 |
| 2.1.1 System Decisions versus User Decisions | 9 |
| 2.1.2 System Structure | 9 |
| 2.2 THE EVALUATION SCHEME | 11 |
| 2.2.1 The Initial Evaluation..... | 11 |
| 2.2.2 The Site Detail Evaluation..... | 13 |
| 2.2.2.1 Materials Scoring Details | 13 |
| 2.3 THE SITE SCORING STRUCTURE | 14 |
| 2.3.1 Accounting for Site Characteristics..... | 14 |
| 2.3.1.1 Dealing with a 'No site' license | 14 |
| 2.3.1.2 Time of Site Closure..... | 15 |
| 2.3.2 System Protocol for Site Closure | 15 |

| | |
|--|-----------|
| 2.3.3 Structure of a Site Detail Evaluation | 15 |
| 2.3.3.1 Categories of the Site Detail Evaluation | 16 |
| 2.3.4 The Total Site Score | 17 |
| 2.4 THE SEALED SOURCE SCORING STRUCTURE | 17 |
| 3. INVENTORY FINDINGS | 19 |
| 3.1 SUMMARY OF FINDINGS | 19 |
| 3.2 DATA UNCERTAINTIES | 19 |
| 3.3 LICENSE FILE INVENTORY | 20 |
| 3.3.1 Region and License Type | 20 |
| 3.3.2 Dates of License Termination | 21 |
| 3.3.3 License Transfers | 23 |
| 3.3.3.1 Types of License Transfers | 23 |
| 3.3.3.2 Superseded Part 30 Licenses | 24 |
| 3.3.3.3 Superseded Part 40 Licenses | 25 |
| 3.3.3.4 Superseded Part 70 Licenses | 26 |
| 3.3.4 License Distribution by State | 26 |
| 3.3.5 Licensee Institutional Category | 28 |
| 4. EVALUATION FINDINGS | 30 |
| 4.1 SUMMARY OF FINDINGS | 30 |
| 4.2 DATA UNCERTAINTIES AND CHARACTERISTICS | 31 |
| 4.3 SITE REVIEW SUMMARY | 32 |
| 4.3.1 Number of Site Licenses | 32 |
| 4.3.2 Material Authorizations | 32 |
| 4.4 DEMOGRAPHIC CHARACTERISTICS OF EVALUATED LICENSES | 32 |
| 4.5 SITE EVALUATION FINDINGS | 36 |
| 4.5.1 Evaluation Scores | 36 |
| 4.5.2 Time Trends | 37 |
| 4.6 BYPRODUCT MATERIAL LICENSE SITE EVALUATIONS | 39 |
| 4.7 SOURCE MATERIAL LICENSE SITE EVALUATIONS | 39 |
| 4.8 SPECIAL NUCLEAR MATERIAL SITE LICENSE EVALUATIONS | 40 |
| 4.8.1 SNM Evaluation Scores | 40 |
| 4.8.2 SNM Evaluations by Region | 40 |
| 4.9 MATERIAL AUTHORIZATIONS | 41 |
| 4.9.1 Loose Material Authorizations | 41 |
| 4.10 SEALED SOURCE EVALUATIONS | 43 |
| 4.10.1 Sealed Source Scoring System Summary | 43 |
| 4.10.2 Characteristics of Identified Sealed Source Licenses | 43 |
| 4.10.3 Termination Dates for Identified Sealed Source Licenses | 44 |
| 4.10.4 Institutional Category of Sealed Source Identifications | 45 |
| 4.11 SEALED SOURCE MATERIAL AUTHORIZATIONS | 46 |
| 5. FINDINGS FOR IDENTIFIED LICENSES | 48 |
| 5.1 SITE LICENSES | 48 |
| 5.2 SEALED SOURCE LICENSES | 49 |
| REFERENCES | 51 |
| Appendix . Data and Detailed Results | 52 |
| A.1 DATA DESCRIPTIONS | 52 |
| A.1.1 Inventory Data | 52 |
| A.1.2 Evaluation Data | 53 |
| A.2 NRC REGIONS AND PROGRAM CODES | 54 |

FIGURES

| | |
|---|----|
| Figure 2.1 The General Evaluation Process..... | 10 |
| Figure 2.2 Material Scoring Scheme..... | 11 |
| Figure 2.3 Structure of a Site Detail Operation | 16 |
| Figure 2.4 Specifics of a Sealed Source Evaluation | 18 |
| Figure 3.1 Number of Terminated Licenses, By Time Period..... | 21 |
| Figure 3.2 Number of Part 30 Terminations by Time Period..... | 22 |
| Figure 3.4 Number of Part 70 Terminations, by Time Period | 23 |
| Figure 3.5 Federal Superceding Licenses for Part 30 Terminations..... | 25 |
| Figure 3.6 Federal Superceding Licenses for Part 40 Terminations..... | 25 |
| Figure 3.7 Federal Superceding Licenses for Part 70 Terminations..... | 26 |
| Figure 3.8 Number of Licenses By State | 27 |
| Figure 4.1 Number of Site Licenses by NRC Region | 33 |
| Figure 4.3 Distribution of All Nonzero Site Scores | 37 |
| Figure 4.4 Distribution of Total Site Score for Identified Site Licenses | 37 |
| Figure 4.5 Time Trends in Site Score Values..... | 38 |
| Figure 4.6 Proportion of Evaluations Identified for Site Review | 38 |
| Figure 4.7 Sites Identified by Time Period | 39 |
| Figure 4.8 Frequency Distribution of Site Scores for Part 30 Licenses..... | 39 |
| Figure 4.9 Distribution of Total Site Scores for Identified Source Material Licenses..... | 40 |
| Figure 4.10 Distribution of Site Scores for Identified SNM Site Licenses | 40 |
| Figure 4.11 Rate of Identification for Sealed Source Followup, by Time Period of Termination..... | 44 |
| Figure 4.12 Termination Dates for Identified Sealed Source Licenses | 45 |
| Figure A.1 Schematic of Inventory Data | 52 |
| Figure A.2 Evaluation Data Organization Scheme | 53 |
| Figure A.3 Map of NRC Regions | 54 |

TABLES

| | |
|--|----|
| Table 2.1. System Information about Materials | 14 |
| Table 3.1 Distribution of Identified License Inventory Records by NRC Administrative Region..... | 20 |
| Table 3.2 Number of Material Licenses Superseded or Transferred to an Agreement State..... | 24 |
| Table 3.3 Number of Licensees, by Institutional Category..... | 28 |
| Table 4.1 Nature of Materials Authorizations for Materials Licenses..... | 32 |
| Table 4.2 Number of Evaluations by NRC Region..... | 33 |
| Table 4.3 Licenses Identified for Site Review by Institutional Category and NRC Region..... | 34 |
| Table 4.4 Evaluation Results by State of Principal Operation..... | 35 |
| Table 4.5 SNM License Evaluations, by Region and Score Category..... | 41 |
| Table 4.6 Most Commonly Authorized Loose Materials | 41 |
| Table 4.7 Institutional Category for Identified Sealed Source Licenses | 46 |
| Table 4.8 Commonly Authorized Materials in Sealed Source Authorizations..... | 47 |
| Table 5.1 Materials Frequently Authorized on Site Score Licenses..... | 48 |
| Table 5.2 Materials Frequently Authorized under Identified Sealed Source Licenses..... | 50 |
| Table A.1 NRC Material License Program Codes..... | 54 |

EXECUTIVE SUMMARY

The Terminated License Review Project (TLR) evaluated nuclear material licenses terminated by the United States Nuclear Regulatory Commission (NRC) and its predecessor agencies since inception of material regulation in the late 1940's. The objectives of the review process were

- (1) to identify sites with potential for meaningful residual contamination, based on the information contained in the license documentation
- (2) to identify sealed sources with incomplete or no accounting that could represent a present public hazard

Material license categories reviewed were Part 30, byproduct material licenses; Part 40, Source material licenses; and Part 70, special nuclear material (SNM) licenses. Oak Ridge National Laboratory (ORNL) conducted the initial review and evaluation of terminated licenses to identify candidates for further review by NRC or the responsible Agreement State. NRC personnel carried out the next level of review, with specific license review conducted by Region offices. This document presents information from the evaluations of license documentation carried out by ORNL.

All ORNL reviews were performed using the available documentation in the physical license files. A license file can contain a wide variety of licensing documentation, including: the license and amendments; the licensee's application; administrative material from NRC's oversight of the license; NRC and licensee correspondence; notes or other material describing the licensee's operation, the site(s) of use under the license, materials authorization, handling and final disposition; information about waste and disposal sites; and decommissioning and site closeout documentation.

License documentation review began in early 1991 and continued through 1997. During the review period, a total of 31,482 material licenses were reviewed at ORNL for sealed source disposition and for criteria that should trigger further site review. Of those licenses, 24,949 (79 percent) of the evaluations were for Part 30 licenses, 5,118 (16 percent) of the evaluations were for Part 40 licenses, and 1,415 (5 percent) of the evaluations were for Part 70 (SNM) licenses.

A total of 675 licenses were identified for further site review of one or more sites used under the license. Of those 675 licenses, 219 (32 percent) were byproduct material licenses, 343 (51 percent) were Source material licenses and 113 (17 percent) were SNM licenses. Fewer than one percent of Part 30 (Byproduct material) licenses were identified for site review. Part 40 (Source material) licenses and Part 70 (SNM) licenses had approximately a seven percent and eight percent likelihood, respectively, of being flagged for further site review.

A total of 564 licenses were identified for further review of the fate of one or more sealed sources authorized under the license. Of these, 382 licenses (68 percent) were byproduct material licenses, 37 (6 percent) were Source material licenses, and 145 (26 percent) were SNM licenses.

Between 25 and 30 percent of Part 40 and Part 70 licenses that were terminated were superseded by another license. Presently, between 16 and 18 percent of Part 30 terminated licenses are superseded by another federal license.

The six states with the largest number of terminated licenses are Pennsylvania (3,472), New Jersey (2,349), Massachusetts (2,348), Illinois (1,992), California (1,963), and Ohio (1,960). These six states together accounted for over 37 percent of all terminated licenses.

Detailed material information was not always necessary in order to eliminate the license from further consideration. Still, 65 percent of the evaluations did include detailed information on material authorizations. For those 20,560 licenses that did have recorded detailed information for materials, 11,557 (56 percent) authorized at least 1 sealed source, and 10,435 (51 percent) had at least 1 material authorized as loose material.

Two other final products resulting from the review process include

- a relational database that represents a complete inventory of all archived information regarding material licenses. This inventory can be searched by license number, licensee name, and physical file location, as well as other characteristics.
- a computer decision system that allows a user to conduct a structured evaluation process for each material license, assessing both site contamination potential and the need for sealed source follow-up. For licenses with unsealed material, the decision system arrives at a final overall "site score" that is a judgment regarding both the magnitude and potential severity of possible site contamination. For sealed sources, the system assigns both individual scores to unaccounted sealed sources based on current hazard and arrives at a Total Sealed Source Score for the license, calculated as the sum of the individual sealed source scores.

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Betty Kline, with the assistance of others, carried out a very large portion of the six-year day-to-day data abstraction and license review effort that is represented by this report. Her dedication to excellence, her commitment to carrying out her job in the most efficient and thorough manner, and her steady and calm demeanor did a great deal to make this work possible. We would like to acknowledge the help and participation of Cathy Lewis, Gina McDuffee, Patricia Brimer, and others who contributed to the effort of license review.

1. INTRODUCTION

1.1 The Terminated License Review Project

1.1.1 Project Purpose

The United States Nuclear Regulatory Commission decided in 1990 to undertake review¹ of terminated material licenses to assure that facilities were properly decontaminated and pose no threat to public health and safety. The original scope included licenses terminated between the years 1965 and 1985. Archived document files for terminated licenses that spanned licenses in that time span were identified for project use².

Although the initial objective of the project was *site* review, a decision was made by NRC to include a review of the final sealed source accounting in the review process. Thus, each license evaluation potentially included two separate evaluation phases, a *site review* and a *sealed sources review*. Consequently, the first step in the review process (after the information inventory process was completed) was a determination of the nature of the materials authorized, and, if possible, those actually possessed, during the entire period of the license. If sealed materials were possessed, a sealed source review was carried out. If unsealed materials were possessed, a 'site evaluation' was carried out.

The site evaluation might more accurately be called a 'loose materials evaluation', since specific information about the site or sites of use was not present and evaluation of the current condition of the use site(s) was indirect. The scoring system developed for the evaluation process arrives at a numeric value called a 'Summary Site Score' or a 'Total Site Score.' This overall score reflects the system's best overall estimate of the combined likelihood and potential importance of present residual contamination for all the site(s) of use under the license. In this context, importance is based on level of potential public health impact, at least at a conceptual level.

Construction and completion of this task was complicated by several issues. Material licensing has been conducted in some fashion since the late 1940's. During the nearly fifty-year span of material licensing, very large numbers of highly diverse material licenses have been issued and terminated by multiple federal regulatory agencies, using different laws and regulations. The total number of material licenses ever issued is almost certainly well over 50,000, including active material licenses. Procedures, including those for license issuance, license review, documentation, and the closeout and decommissioning process, have evolved and changed drastically over time. Until completion of the current project, no computer data base existed for historical records and licensing information.

1.1.2 The Evaluation Process and the Decision System

Oak Ridge National Laboratory undertook the actual project effort in early 1991. The initial shipment of licensing material included close to 1000 boxes for over 20,000 licenses. Although a specific estimate is not available, the average license file for that time period probably contained somewhere between 100 and 150 pages of material. Section 2 will outline and describe the nature of licenses and the content of license files.

In order to achieve consistent review of this large volume of material, it was first necessary to develop a standardized, computerized process for examining, recording and screening the licensing material. A review process, along with software to support that process, was developed in the initial project stages. The evaluation process, the software, and the project databases and database management have all been modified considerably during the period of the project. These modifications were made both to improve the evaluation process structure, reflecting the continual growth in the body of knowledge about licensing and the characteristics of material licenses, and in order to make improvements and refinements in the decision system and its underlying numeric scoring system that actually carries out the evaluation process. This report will sometimes separate results into separate sections based on time period of the evaluation, because of distinctions in how the evaluation process was carried out during different project phases.

¹ The terms 'review' and 'evaluate' are often used in this document synonymously.

² Because licensing material is not archived by termination year, these time periods are approximate.

1.1.3 Summary

Upon completion of the evaluation phase of the project in late 1997, an evaluation of the available documentation for 31,482 terminated material licenses was completed. Each of those evaluations was based on a computerized inventory process that summarized the information contained in the available documentation for the license. Over 37,000 separate license files were inventoried. Computerized entry of information was carried out for 60,677 folders (37,518 license file inventory records, and 23,159 supplemental files). Each evaluation potentially includes: 1) an accounting for sealed sources (if they were authorized); 2) an evaluation that assesses both the likelihood and potential severity of residual site contamination (if materials were authorized in unsealed form).

1.2 Nuclear Materials Licensing

1.2.1 History

The federal regulation of the use of radioactive material began in the late 1940's, under the auspices of the United States Atomic Energy Commission (AEC). At that time, individuals or institutions wishing to use radioactive materials were issued an authorization by the AEC to receive and use the materials. In 1954, the authorization process was replaced by a licensing process with the passage of The Atomic Energy Act of 1954, which established and defined the regulatory and licensing authority of the AEC. Users were then required to be licensed by the AEC to possess and/or use nuclear materials, as defined by the AEC in Title 10 of the Code of Federal Regulations (CFR). Material licenses were placed into three basic categories: byproduct material licenses (10 CFR Part 30); source material licenses (10 CFR Part 40); and special nuclear material (SNM) licenses (10 CFR Part 70). Materials were also licensed for possession and use at production and utilization facilities under 10 CFR Part 50. A material license was then required for possession and/or use of any specific nuclear material above 'exempt quantities', as specified in the Code of Federal Regulations or defined by the AEC.

In 1975, the NRC was established by Congress as an independent agency through the passage of the Energy Reorganization Act of 1974, as amended. All current and historical files regarding material licenses were transferred to the NRC, along with regulatory authority and licensing responsibility for material licenses. Except for those in Agreement States, the NRC currently issues and administers all material licenses in the three categories. An Agreement State is one that has signed an agreement with the NRC under 10 CFR Part 150, allowing the State to regulate the use of radioactive material within that State. States can regulate only byproduct materials, source materials, and SNM in quantities less than a critical mass.

Historically, most materials licensing was done in AEC and then NRC Headquarters. In 1983 the NRC Regions took over licensing for materials, with the exception of fuel cycle and waste disposal facilities.

1.2.2 Licensing Documentation

All licensing documentation is contained in file folders maintained by the AEC prior to 1975 and the NRC after 1975. The 'license file' typically consists of one to four (or more) physical folders containing copies of the license, application materials, inspection reports, and other correspondence. For licensees with large operations, multiple authorized materials, or multiple sites, the license information may be contained in as many as four or five separate folders. Supplemental materials are sometimes placed in separate folders and labeled as such (e.g., 'Correspondence' or 'Inspection' or 'General file'). The licensing information is primarily maintained by the NRC Region Office where the licensee is located. Historically, copies of the file information were also maintained at NRC Headquarters. Physical files for terminated licenses are periodically placed in archival boxes that are combined into a group referred to as a Job. A Job consists of a variable number of boxes of licensing material. Unneeded material for active licenses can be retired as well, so that not all material in a given job may pertain to terminated licenses. Each box is identified by a Job number and a Box number, with a Job having a variable number of boxes. The boxes are stored at the NRC Archival facility near Washington D.C. A single job number often consists entirely of files from a specific NRC Region or from Headquarters.

The folders making up a license file may be kept together, retired at the same time, and contained in the same Job. However, it appears that in the past licensing folders containing material judged to be no longer needed for an active

license were retired and placed in jobs for archival periodically throughout the license period³. For this reason, it was not uncommon for TLR personnel to find license folders for a given license number in widely separated jobs, sometimes several years apart in the evaluation or review period. Additionally, supplemental material for a license, such as inspection folders, might be contained in different jobs than the license folders.

Both these factors produced a requirement for a process that included the ability to re-evaluate licenses when additional information was found. Also, many evaluations were done, at least initially, with incomplete information.

1.2.3 Structure of a Material License

Nuclear material licensing covers a huge range of materials whose potential hazards range from almost nothing to extremely high. Uses for nuclear materials are equally diverse. Consequently, a very wide scope of factors must be taken into account in nuclear material licensing law, regulation, and practice. The factors that needed to be considered and taken into account in the construction of the license evaluation method were equally broad.

1.2.3.1 License Application

The federal material licensing process begins when an application for use of radioactive materials is filed with the NRC by the prospective licensee. Each application is assigned a docket number, and the application review process is carried out. NRC can request further information or specification from the applicant and can require that modifications to the application be made in order to receive approval. NRC issues the license if the licensee is judged to have demonstrated the ability to meet the appropriate regulations without adversely affecting the potential health and safety of the public.

Additional material required on the application, if loose materials are requested, can include

- waste generation
- intended manner of disposal of any waste
- whether onsite burial will occur
- whether there will be disposal in accordance with 10 CFR 20

This information was not present on early licenses (the best available estimate from examination of documentation is that this change in either regulation or practice occurred some time in the 1960's). For licenses inventoried in the latter half of the TLR project, there was a formal means of recording the application information regarding intended waste generation and intended disposal in the license inventory process.

1.2.3.2 Amendments

Licenses are issued for a specific period of time specified by the NRC at license issuance, as determined by the type of license. License amendments and renewals are often issued during the course of the active license period as the licensee's needs change or the expiration date comes due. Any change in licensing specifications (including changes to licensee name, site of use, authorized user, etc.) must be documented by a license amendment. The NRC can also amend the license, as needed, for changes in standards and regulations. It is not uncommon for a license to have as many as 30 amendments before termination. The average number of amendments is probably about three or four. Changes to material authorizations are estimated to account for between 40 and 50 percent of amendments to the license⁴. Amendments that modify the license period, possibly with other changes, account for the majority of the rest.

1.2.3.3 Authorizations

The basic authorizations contained in each material license are

- the type of material(s) that can be used (isotope), the form of the material (e.g., sealed, loose, any form, shielding), and the limits of possession (activity in Curie units, or amount in grams or pounds)
- the place(s) where the material can be used (sites of use)
- the person(s) who can use the material (authorized users)

³ It is not clear whether this is currently done with licensing material or not.

⁴ This is the author's estimate based on experience only, and it is not verified by actual project data. In practice, there is nothing that specifies why an amendment was issued, and amendments often include several changes to the license stipulations.

- the authorized use(s) of the material
- the expiration date of the license
- Other specifications on a case-by-case basis

There is considerable variability in the nature of other specifications included on a material license, as well as considerable variation in the specificity of the above information. The NRC often adds additional requirements and specifications to the license based on the licensee's application information.

1.2.4 License Content

1.2.4.1 Material Specifications

The most fundamental part of a material license is the specification of authorized materials. There is a wide variety in how these specifications are made, across material types and license types, as well as wide variation in practices across time. A large challenge in the development of a scheme for evaluating potential site contamination problems arose in the attempt to deal with the wide variations in both materials and material specifications.

A license ordinarily specifies three types of information for authorized materials on the license: the material, the form(s) of the material authorized for use, and the 'possession limit' for the material. The possession limit is specified as the maximum activity or amount of the specific material that can be possessed *at any one time*.

Material Type Specifications

Material licenses specify each of the authorized materials to be used under the license. In some instances, categories of like materials, or regulatory categories, are grouped together for licensing purposes. For example, certain categories of materials under routine medical use are often grouped together on the license authorization and are generally referenced by the portion of the 10 CFR regulations that defines and specifies that category.

Additionally, a byproduct material license often authorizes the licensee to possess a broad range of materials, generally specified as any material between a range of atomic numbers or atomic weights. The most common specification on modern licenses is to allow the licensee to possess 'Any byproduct material between Atomic Nos. 1 and 83'. This range includes all byproduct materials except transuranics. Sometimes, the specification simply states 'Any byproduct material'.

Material authorizations by broad category do also occur on Source material licenses, and less frequently on SNM licenses. These material categories have a much narrower scope and generally are more specific about what is included in the authorization.

Specification of Form

Allowable forms of the material are also specified on the license or amendment. Often this specification is given only as 'Sealed', or as 'Any'. Sometimes, more specific constraints are included. For sealed sources, an example of a specific form might be 'Plated alpha sources'. Another example might be specification of a source contained in an instrument, given by maker and model number. For loose materials, a more specific form, such as 'gas,' or a specification of a particular product is sometimes made. Material specified as 'any' is generally possessed by the licensee in unsealed form, and authorizations specified as 'any' assume that the material was or is unsealed.

Possession Limits

With rare exceptions, possession limits for byproduct materials are given in curie units, possession limits for source materials are given in pounds (or sometimes kilograms or tons), and possession limits for SNM are given in gram units. On licenses issued after the mid-1950's, possession limits always specify the upper limit of possession at any point in time. Before the mid-1950's, a cumulative possession limit over a period of time was often specified, particularly for Source material licenses.

The use of 'point-in-time' limits probably leads to more efficient management and oversight of licenses, as well as more reasonable bookkeeping for licensees. However, information on cumulative possession over a period of time would be considerably better for making *a posteriori* estimates of the public health hazard that might be associated with the operations under a particular license. The estimation system developed to make decisions about licenses took into account

the uncertainty about cumulative possession in its structure by attempting to make estimates, where appropriate, of the rapidity of turnover of the authorized material. However, this is a large part of the uncertainty attached to any *post-hoc* estimate of hazard based on the licensing information.

1.2.4.2 Licensee and Authorized Users

The designated licensee is always the applicant and is always the responsible party for the conduct of operations authorized under the license and for the custody of material used under the license. The licensee can be an individual, a business, or an institution. Licenses issued to institutions vary widely in scope and may cover activities limited to a single individual up to the entire range of activities involving a certain material type (e.g. byproduct material) at a large university. This type of license is often called a broad-scope license.

The license also generally, but not always, specifies individuals who are authorized to be actual users of material. This specification is more common with sealed source licenses than with licenses involving use of loose material (processing licenses, for example). There are a broad range of requirements that authorized users must satisfy, depending on the materials authorized and the requested uses. A change in authorized users ordinarily requires NRC approval, and consequently, an amendment to the license.

1.2.4.3 Specification of Uses

There are several levels of specification of use on licenses. The broadest specification is a system of assigning license types, or license use-types, through a scheme of Program Codes. The Appendix gives a list of current Program Codes used for NRC material licenses. Although the Program Code may now be listed on all issued licenses or in the Document Control form of the license document file, this was not historically the case. Because of the frequency with which information on assigned program codes was missing in the license files, the Terminated License Review project was unable to use this existing use categorization scheme in its inventory and review process. A facility-type assignment scheme, which served much the same purpose, was derived locally and used within the inventory and assignment process. That scheme is also given in the Appendix. However, this facility-type scheme was not developed until midway in the license inventory process, and only about one-third of the over 37,000 inventoried records have facility assignments.

1.2.5 Licensing Practice for Sealed Sources

1.2.5.1 Sealed Source Licensing

Material licenses specify the authorized materials to be used under the license. As a general rule, the form of the material is also specified (e.g., material is specified as available for possession in sealed form only). Although the specification of allowed forms is sometimes more specific, most licenses specify only 'Sealed' or 'Any' for the allowed forms of authorized material. Material specified as 'any' is generally possessed by the licensee in unsealed form, and authorizations specified as 'any' assume that the material was or is unsealed and treats it as such.

The sealed sources authorized under each license must be accounted for by the licensee at the time of license closeout. That is, all sources possessed by the licensee must be sent for authorized disposal or transferred to another licensee. Part of the purpose of the evaluation system is to determine whether sealed sources listed on each license were indeed accounted for by the licensee at closeout. If not, then a numeric hazard value is computed by the system and assigned to each source that is not accounted for.

1.2.5.2 Authorizations for Sealed Sources

Material form is specified on licenses in a variety of ways. Particularly for byproduct licenses, authorization generally specifies that material is to be "sealed form only" or was authorized as "any" form. Authorized material not specifically classified as "sealed" on the license was generally assumed to be in "loose" form for evaluation purposes. Specific categories assumed to be sealed were 'alpha plates,' 'calibration sources,' and any other material specified as a 'source.' Depleted uranium shielding was treated by the system as "sealed" material from a decision-making and scoring standpoint, although it is not specifically sealed.

The authorization for sealed sources was specified in four ways. Often, each authorized source was specified by the isotope, the activity, manufacturer and/or model number, and number of sources. This was typical of the license authorizations in the 1950s and 1960s. Later, the AEC began to authorize a maximum activity per source and a total

number of sources. Still later, licenses authorized the maximum activity per source without a limit on the number of sources to be possessed. This was another major source of uncertainty when attempting to track the disposition of sources; it generally was not possible to know or even estimate how many sources the licensee might have had at any time or over the period of the license.

1.2.5.3 Documentation of Disposition of Sources

Documentation Description

Documentation of source disposition at termination or retirement of the license was typically done on a Certificate of Disposition or Certificate of Status form. Ideally, the licensee would describe the disposition of any and all sealed sources used during the entire period of the license, although this was rarely done if the license was held for a long period of time.

Problems that occurred with evaluating source disposition information included the following:

- Information about the nature of the disposition of actual sources was often incomplete or extremely vague, did not cover intermediate disposition of sources, and/or did not give an accounting of sources actually possessed over the term of the license in order to ascertain the completeness of the information.
- Licensing authorizations often did not include a specific number of sources allowed, only a total upper limit on activity (see Section 2.3.1). In those cases, even if disposition information gave a specific account of disposition of sources in a certain category, there was no basis for comparing that information with the total number of sources that might be possessed.
- Amendments to the license often modified the authorization limits downward without specification of whether sources that might be possessed over the new limit had been disposed of⁵.

Review Sources of Information about Source Disposition

Intermediate disposition of sources was sometimes documented in an inspection report if the inspector provided detailed information on the sources possessed. Licensee letters and renewal applications were also sources of information, especially if the licensee requested removal of an authorization for a particular source.

1.2.6 Licensing Practice for Loose Materials

1.2.6.1 License Authorizations for Loose Material

Materials are seldom authorized on a material license as 'loose.' Rather, the specification is given as 'any,' the nature of the material makes it a certainty that it is unsealed (i.e., most source material), or the specification implies that the material is not sealed (i.e., tritium specified as gas).

1.2.6.2 Application Information for Loose Material

The licensee's application was often used to attempt to estimate specific authorization limits for materials, if the license authorization did not give specific limits. If the licensee's request seemed to correspond to the actual authorizations on the license, then the requested limits specified in the application were sometimes used as the best available estimate of upper-limits on material possession.

1.2.6.3 Waste Generation

The question of waste generation applies to loose material licenses. This also is a major question in the evaluation of potential site contamination for a terminated license. Questions about the volume and type of waste generated, its hazard level, and how it was handled and disposed are often more relevant to the issue of the likelihood and magnitude of possible current site contamination than the nature of the materials authorized and possessed under the license.

Reporting Requirements

Currently, licensees are required to keep detailed records of the radioactive wastes generated by them for inspection by NRC personnel. It is not required, however, that the information be submitted to NRC. For this reason, the information

⁵ Example: An amendment might change the limit from 10 Cs-137 sources of a certain type with a maximum activity of 100 mCi each to a new authorization limit specifying a total of 2 Cs-137 sources of the same type having a maximum activity of 100 mCi activity each. There may be no specification of whether the additional sources were actually possessed.

was not routinely contained in the license file documentation, except as noted by the NRC inspector in inspection reports, as discussed in the next section.

Sources of Information

The first source of information about possible waste generation is the application; the licensee is supposed to respond to questions on the generation of radioactive wastes. For the larger licensees with broader scope in use, the information was typically very thorough and complete. However, for some of the smaller licensees, this information was often very sketchy, particularly during the 1950s and 1960s.

Information on waste generation was also obtained from AEC or NRC inspection reports. Sometimes, detailed reports of the actual amount of waste generated were provided to the inspectors for inclusion in the inspection report. Again, the information was usually very complete for licensees with large operations, but the information on the smaller licensees was often vague and incomplete. The information on the inspection reports also became more thorough and useful during the more recent years.

1.2.6.4 Onsite Disposal Practices

Sources of Information

Information about onsite disposal was obtained from both intermediate inspections and closeout inspections. If onsite disposal was carried out, a notation of that fact within the closeout inspection report was generally available. However, the amount and quality of information about onsite disposal varied widely, and it was frequently necessary for the evaluator to do considerable guessing about the magnitude and potential hazard represented by onsite disposal practices. Presence of a burial site was particularly noted in the evaluation process. However, both the presence and the quality of information about burial sites varied widely, over time and among licenses or license documents.

Information was often particularly sketchy, when available, for disposal using the sanitary sewer system, since Section 10 CFR 20 allows disposal through the sanitary sewer system up to certain limits. An applicant is required to declare an intent to practice 10 CFR 20 disposal on the application; the applicant's declaration of intent was recorded in the application section of the inventory record.

1.2.7 License Termination and the Site Closure Process

1.2.7.1 Site Decommissioning

One of the most important pieces of information in the license termination and closeout process is whether the site of use under that license will become an inactive site. If so, the site is said to be *decommissioned*, and the license termination process includes the site decommissioning process. The complexity of the decommissioning process varies widely, depending on the nature of the license and the site uses. For many licenses, there is no actual decommissioning process. Licenses authorizing only small sealed sources, for example, do not ordinarily require site decommissioning.

Site decommissioning may also not be required at license termination if the site of use remains under a valid license. There are several scenarios under which this happens. First, the terminating license may be superseded by another license to carry out operations at the same site, or the license may be transferred to the Agreement State. Finally, the licensee might hold multiple licenses to carry out operations at the site, so that termination of the license does not lead to the site itself becoming inactive. However, each license termination involves a determination of whether the site of use for that license will require active oversight by the regulatory agency.

1.2.7.2 Sources of Information

Several factors lead to uncertainty and inconsistency in the closeout and decommissioning process, particularly when considering licenses and sites issued, used, and closed out over a fifty-year period of time. Over that time span, there have been substantial changes in both laws and decommissioning regulations. Practices in waste generation and onsite disposal, as well as applicable regulations, have changed over the period. Further, there is a vast diversity in material licensing and many different licensing situations.

Both historically and currently, a licensee terminating a material license or a licensee whose license is involuntarily terminated is required to submit documentation regarding both the disposition of the licensed material and the current

status of the site. NRC reviews the licensing information and licensee's closeout submittal at the appropriate level, either the Region or Headquarters, and determines the required actions. The actions range from the license being terminated to requirements, including licensee surveys of a specified nature, NRC or contractor radiological surveys of the site, mandated cleanup, and verification surveys. Historically, licenses were typically terminated after file review.

2. THE EVALUATION SCHEME

2.1 General Overview

This chapter describes the general scheme and the structure of the application developed for evaluating material licenses. The evaluation system is a numerically-based context-sensitive decision-making program for desktop IBM-compatible computers, and it is designed to interact with a user during the evaluation process for each license. The application was named License Evaluation and Data Information System (LEADIS).

2.1.1 System Decisions versus User Decisions

The user makes the *substantive* decisions for the evaluation, while the system makes the *tactical and strategic* decisions.

Examples of substantive decisions made by the user are:

'How hazardous do I believe the onsite burial practices were?'

'How frequently do I think the licensee might have "turned over" the authorized material?'

'Is the nature of the operation at this facility of sufficient hazard for me to override administrative removal from consideration because the license was superceded?'

'Does there appear to be any possibility of significant onsite burial, based on my judgment of what I find in the license file(s)?'

Examples of tactical decisions include such decisions as:

'Does this license need to be evaluated for both sealed source accounting and for site decommissioning?'

'Given the current knowledge about the site, what question needs to be asked next?'

'Is there enough information to conclude that these sealed sources are not a current danger to the public, even if not actively accounted for?'

2.1.2 System Structure

The evaluation system has a detailed 'knowledge' about material licenses, as well as the factors leading to both potential site contamination and potential hazards from sealed sources. To a limited degree, knowledge is also built into the system about how such factors interact, so that the system can combine and compare multiple information about various factors to arrive at more complex decisions.

The system operates using an underlying decision pattern, with specific actions determined by interaction with the user. The user directs the course of the evaluation, based on his or her information from the physical folders and his/her best judgment regarding the meaning of the contents of the license file(s). A complex license and a resulting complex evaluation may require the user to make many complex judgments in the course of the evaluation.

The user also records the supporting information from the file, by including relevant non-inventory information in the evaluation record. Each substantive decision is made by the user, with tactical decisions about structure and direction of the evaluation made by the system. The basic information in the inventory record is available throughout. The system acquires and incorporates further information during the process by querying the user with specific questions.

Figure 2.1 outlines the basic structure of a site (or loose materials) evaluation. The level of complexity in the system's logic, as well as the amount of information utilized and requested, varies significantly among evaluations. The higher the risk and the larger the amount of available information, the more detailed the subsequent evaluation.

The system is written so that the nature of the license, the site(s) and/or the possessed sources determine the level of detail and the amount of time required to complete the evaluation. The level of detail is also determined by the amount of information available. Thus, the variation in the complexity of evaluation required by the system depends on two factors: (1) need - the system's best estimate of the potential hazard presented by the license and (2) quantity - the

amount of information actually available. There is little point in making a detailed evaluation of a license with limited information.

The system uses a heuristically-determined numeric scoring scheme to arrive at an overall final Summary Site Score for a given license. Throughout the evaluation process, the current site score is modified based on the interaction of system and user. A license is removed from further site evaluation at the time its site score goes to zero and from further sealed source evaluation when its Total Sealed Source Score becomes zero (if sealed sources are possessed). Conversely, if a license is eliminated from further evaluation, the Total Site Score assigned at that time is zero.

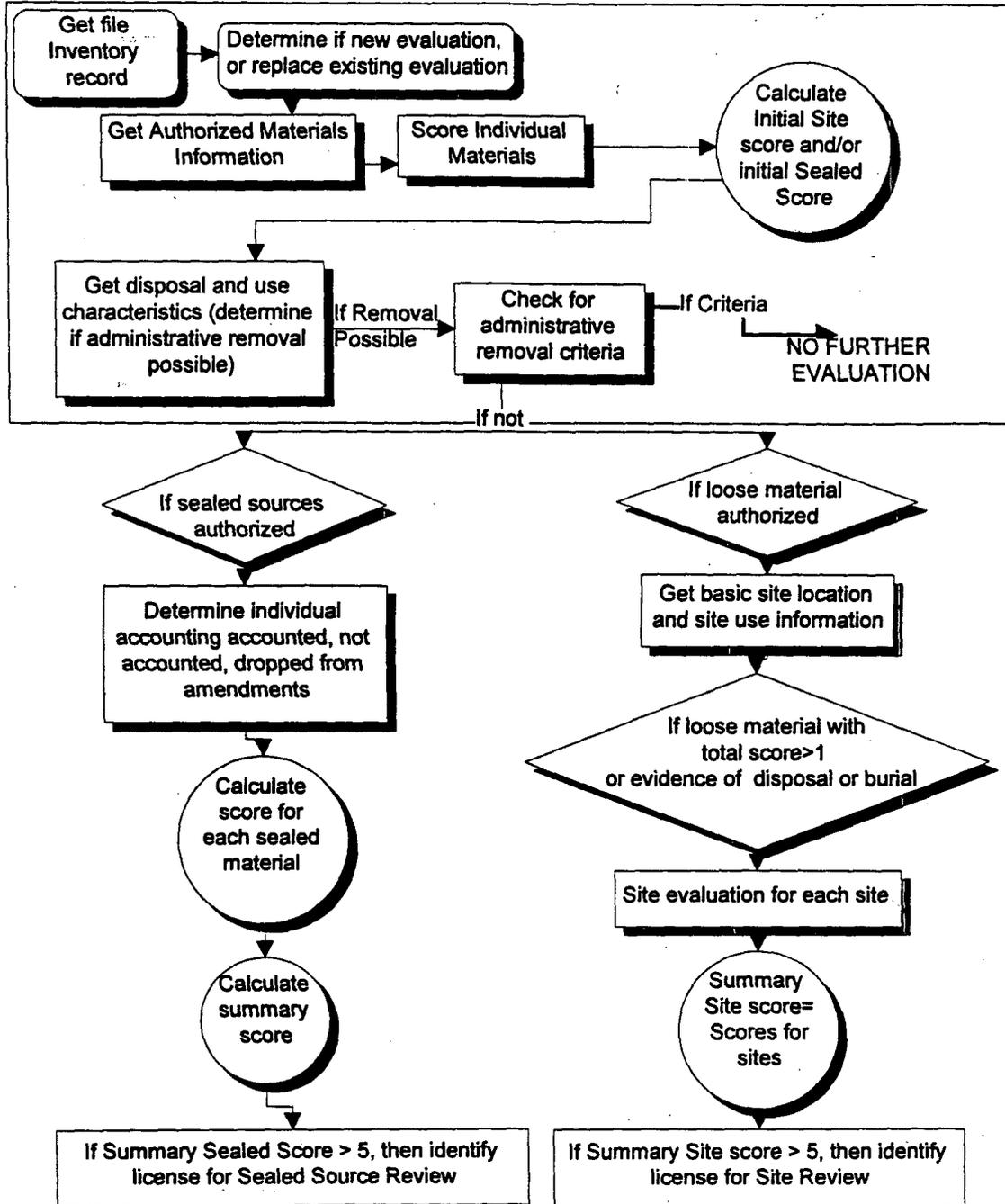


Figure 2.1 The General Evaluation Process

2.2 The Evaluation Scheme

2.2.1 The Initial Evaluation

The following steps are carried out in the initial evaluation process, regardless of the nature and types of material possession.

- **Acquire initial materials information.** An initial materials score is calculated for each licensed material. The calculation of score for individual materials will be discussed in further detail in a subsequent section. Figure 2.2 shows the basic material scoring structure as it relates to the overall evaluation.

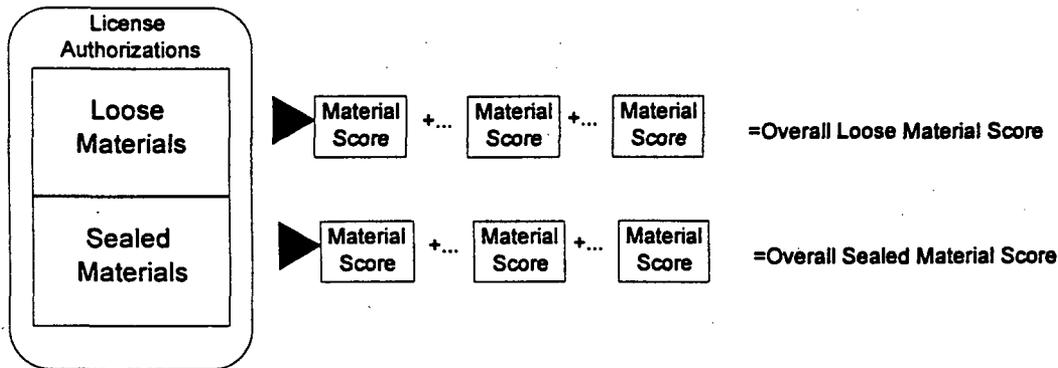


Figure 2.2 Material Scoring Scheme

- **Initial Summary Material Score and/or Initial Summary Sealed Score.** Separate overall scores are calculated for authorized sealed sources and for all authorized loose materials that are based on individual scores for authorized materials in each category.

Individual loose material scores form the basis for the Initial Summary Material Score, which in turn is the initial 'seed' value for specific site evaluations. The initial Summary Sealed Score is the sum of the individual sealed source scores. At this point in the evaluation, individual materials authorizations are entered by the user, with some further information on the form for loose materials (e.g., gas, powder, liquid, solid). Individual material scores are then calculated, based on the authorized material, estimated decay of the material to the present time, and the estimated human health hazard of the material. For loose materials, the specific form also affects the material score.

As an example, consider the calculation of the raw material score for 100 millicuries of Cs-137, authorized only as 'any' form on a license terminated in 1964. The initial score is based on the nature of the material Cs-137, its half-life, and the general hazard estimated from the dose factors for that particular material. The initial calculation of material score is the same for both sealed and loose material authorizations. If the authorization is loose, there can be some adjustment of score for specific form.

- **Score adjustment for basic site characteristics (site evaluation only).** For licenses with loose materials only, certain basic questions are now asked about the number of sites used under the license, the nature of the facility, and the operations at each of the site(s). Depending on the responses to the questions, the initial Material Score may be adjusted upward or downward.

A determination is made at this point of the number of sites, when and if closure of the site occurred, and certain relevant characteristics of the site that can be summarized in a yes/no format. Questions about characteristics of the site are:

1. Was there clear evidence of no material use?
2. Were there operations conducted in buildings?
3. Were there operations conducted outdoors?
4. Is there evidence of contamination outdoors?

5. Is there evidence of releases that could lead to outdoor contamination?
 6. Was there use of machinery and equipment?
 7. Was there use of transportation equipment?
 8. Was there evidence of meaningful waste generation?
 9. Was there evidence of meaningful onsite disposal?
 10. Is there information in the file regarding cleanup?
 11. Is there information or evidence in the file pertaining to decommissioning?
 12. Was the site closed prior to termination of the license?
- **Questions about sewer disposal, burial, incineration, loss of source containment.** The system now requests information from the user about these four specific categories of information. A positive response to any of them serves as a flag to the system that disallows administrative removal of the license, and forces a detailed evaluation.
 - **Removal for administrative reasons.** This avenue of reasoning is pursued by the system if three conditions are met: 1) there is some administrative criterion for removal given in the inventory record that would allow the license to be removed from further evaluation; 2) there are no reasons presently available to the system, either user-entered or contained in the inventory record, that automatically prevent elimination; and 3) the user does not override the decision to eliminate the license from further review.

The following single characteristics are valid administrative criteria for removal:

Superceding license – if the material, activities, and site(s) used under the license were transferred directly to another license, the license is said to be superceded. In this case, to prevent multiple reviews of the same sites, the evaluation is effectively deferred to the other license (which may be active, or may itself have already been terminated).

Agreement state transfer – if transfer occurred to an agreement state license, with the same stipulations as above, then the evaluation is not carried out except in cases for which the site(s) clearly needs to be flagged as having potential or known contamination.

Transfer to general license – if general license is issued for small devices when only exempt quantities are to be possessed.

Certain administrative reasons for removal from consideration – if licenses are: used at power reactors (power reactor sites are not of primary interest for this project); civil defense licenses (seldom involve loose materials, very low activity); import/export licenses (difficult to evaluate, seldom of primary concern for site contamination); general licenses (very rare use of significant materials); and mining licenses (usually multiple unidentified sites, cannot reasonably be evaluated).

Criteria Preventing Administrative Removal

The system queries the user about preliminary evidence or indications of contamination or of activities potentially leading to contamination. These include sewer disposal activities, onsite disposal, loss of containment for sealed sources, or significant incineration. If any such activities or conditions are indicated, a detailed evaluation will be mandated. Not all indications produce a change in current score, since the seriousness of the problem has not yet been assessed. This program section is intended to prevent licenses from being prematurely eliminated for administrative reasons when the license characteristics indicate that such removal is inappropriate.

User Decision to Override Removal

The user can override any decision to eliminate the license, if the user has information not yet available to the system. Examples of this information can include

1. information about the superceding license, or information contained in the file about the superceding process, that tells the reviewer there is some uncertainty in the supercession process
2. information in the file, but not yet entered into the system, that leads the reviewer to feel that site contamination is possible

- **Disqualification Criteria for Removal (Loose Materials only).** A license is also a candidate for removal from further consideration if it reaches this point in the evaluation with all the following characteristics
 1. low Initial Material Summary Score (below 5)
 2. no indications of contamination, disposal, or other problems
 3. presence of a minimum of some information regarding disposition of the licensed materials
 4. no intermediate site closeout

After completion of the above tasks, the system moves on to the sealed source accounting module, if applicable. The site-specific evaluation scheme is then triggered, provided the Initial Material Summary Score is above a nominal level⁶ and the license has not been removed from further consideration.

2.2.2 The Site Detail Evaluation

If the license reaches this point in the evaluation without being removed, EACH of the sites being used under the license is evaluated. The Initial Material Summary Score is used to 'seed' the evaluation for each site receiving a specific evaluation. The system saves a record for each site that details the characteristics of the site, as specified by the evaluator. Thus, a permanent record of the site(s) and the evaluator's summary of each site is kept for future reference.

2.2.2.1 Materials Scoring Details

Figure 2.2 (see Section 2.2.1) shows the basic scheme for translating the materials information on the license and amendments into a score for the evaluation system. Materials were scored individually within the Loose category and within the Sealed category by a hazard calculation scheme based on the inhalation and ingestion dose factors for humans. Dose factors are taken from Eckerman et.al. (1988). Individual material scores are based on 1) the specific material; 2) the form; 3) the highest authorization limit at any period of the license; and 4) the decay from termination of the license to the present time. Because decay until present time was considered, very short-lived materials did not receive scores, even if their hazard, as measured by the dose factor, was fairly high.

Material hazard estimates were made within the two categories of loose and sealed. Even within the broad categories, a given license often authorizes multiple materials of widely varying hazard.

The initial score is determined by an overall materials score, which is the sum of the individual material hazard scores.

Materials Information Data. Score calculation for a particular material is carried out using a formula based on the hazard factors described below. For sealed sources, the same calculation is used, but the resulting material score is divided by 10.

Table 2.1 gives the underlying materials information available to the system, and describes the primary ways that LEADIS uses the information.

⁶ Current cutoff value is 1, which is a very small loose material score

Table 2.1. System Information about Materials

| Category | Description |
|--------------------|--|
| Half life | The activity or amount used in making score calculations that would be remaining at the present time, assuming that the license authorization limit was possessed at the time of termination. The system uses the material half life and the known termination date of the license to calculate this value. |
| Estimate of hazard | <p><u>Byproduct materials</u>: Estimate of hazard is derived from the largest of the dose conversion factors for inhalation and ingestion, as presented in reference 1. For certain special cases of licensed byproduct materials, either (1) values derived from other sources were used, (2) custom values were chosen, or (3) the system takes into account the context of the license in scoring. Tritium is the most notable example of the last case.</p> <p><u>Source materials</u> -For uranium and thorium, and their various derivatives, custom values needed to be used rather than the dose conversion factors. Source materials are licensed from 25 pounds up to hundreds of thousands of pounds. Use of dose conversion factors would have resulted in disproportionate scores for source materials. The increment in score decreased with larger amounts of material, and was assigned using a series of logarithmic-type functions. The functions assign, for example, a zero score to any amount below 25 lb., a score of 2 to 400 pounds, a score of 20 to 10,000 pounds, and a score of 200 to $1 \cdot 10^8$ pounds.</p> <p><u>Special nuclear materials</u> - Much the same type of considerations applied in scoring as for source material licenses. In all cases, custom values were derived, because of the enormous range in licensing authorizations, and because use of dose conversion factors would have led to scoring that designated only certain materials for follow-up.</p> |
| Standard Unit | For byproduct materials, the system expects a standard unit of curies; for source materials, pounds; for SNM grams. The materials data contains the expected unit, to allow the system to prompt user for those units. |

Facilities Information Data. The system has information regarding types of facilities and activities that are typical of certain licenses, as well as a detailed facilities table. The user determines a facility type at inventory time. The system then uses information about the facility type, including information about the general hazard level and materials types ordinarily carried out at that type of facility. This information is used to guide the evaluation in the initial stages. If necessary, further information is obtained from the user, who can modify the facility characteristics attributed to that particular license.

2.3 The Site Scoring Structure

2.3.1 Accounting for Site Characteristics

2.3.1.1 Dealing with a 'No site' license

Some licenses do not have an identifiable site. For those cases specified as having no site, but for which the overall material score is sufficient to trigger a detailed evaluation, a subset of relevant questions is asked. The final score calculated in this instance is actually a summed loose materials score, and is assigned as the final Summary Site Score.

2.3.1.2 Time of Site Closure

A site can be designated as being closed out

- prior to license termination (also called intermediate decommissioning) – the licensee is required to notify the agency that use will no longer occur, and an amendment is issued. In certain instances, however, a site(s) is apparently dropped in the license and amendment process without information being included in the file regarding the site or the nature of its closure. With or without notification, a dropped site is treated within the system as having been closed out prior to license termination.
- at or around time of license termination (the usual instance if no license transfer)
- not closed out at time of license termination (the usual instance if the license is transferred to another licensee).

An indication of onsite disposal at the site will trigger a detailed evaluation of the site, regardless of the loose material score or the time of closeout.

2.3.2 System Protocol for Site Closure

The system has the protocols described below for dealing with sites and for triggering a detailed evaluation according to time of closure:

1. Site closed PRIOR TO or AT termination – these sites will be evaluated any time the system reaches the detailed site evaluation stage. Because the time of site closure is collected early in the evaluation, the system examines the record for site closures before it allows an administrative removal of the license.
2. Site not closed out under current license – if there was a license transfer, the site(s) is not ordinarily closed out. An assumption of license transfer is that sites under the present license are also to be covered under the new license.

Any sites closed out prior to transfer will receive the detailed site evaluation, if license characteristics (as reflected in overall materials score or certain flags that force evaluation) justify the detail. If the evaluator overrode the decision to remove (i.e., the license was not removed for administrative reasons), then the decision to carry out a detailed site evaluation is the same as for any other license.

2.3.3 Structure of a Site Detail Evaluation

Figure 2.3 shows the structure of a site detail evaluation for a specific site. For each site NOT closed out in the period of the license, the evaluator is queried about whether there is a need to carry out a detailed evaluation of the site. If the evaluator chooses to evaluate, the site routine is triggered. Otherwise, the overall material score is assigned to this site.

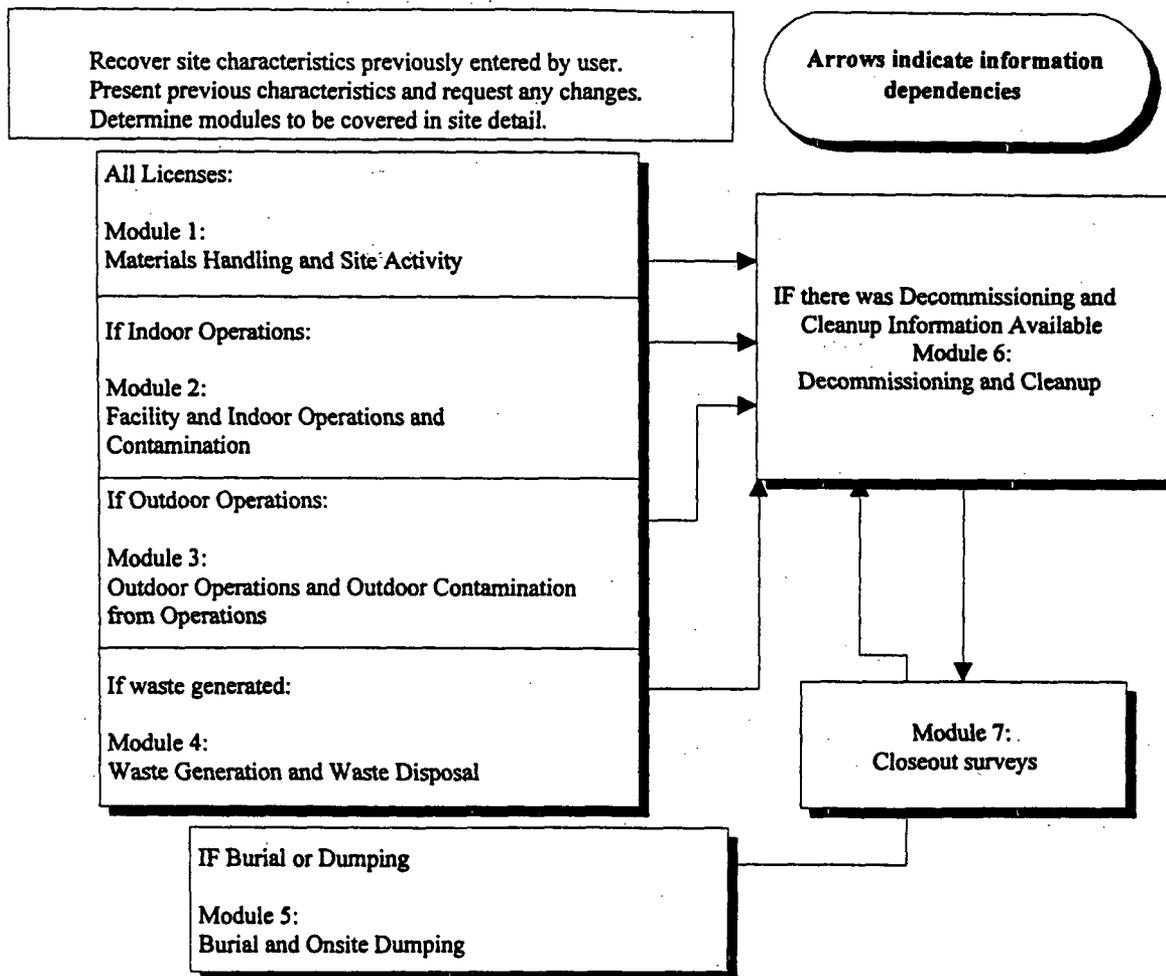


Figure 2.3 Structure of a Site Detail Operation

2.3.3.1 Categories of the Site Detail Evaluation

There are up to six categories of information included in the site detail evaluation. These categories include

1. Materials Handling and Site Activity
2. Facility and Indoor Operations and Contamination
3. Outdoor Operations and Outdoor Contamination from Operations
4. Waste Generation and Waste Disposal
5. Burial and Onsite Dumping
6. Decommissioning and Cleanup
7. Closeout Surveys

Materials Handling and Site Activity. The Materials Handling and Site Activity query category is triggered every time a specific site evaluation is entered. Questions in this category are always included, regardless of the known characteristics of the site or license or the current material score. The following information is included in the Materials Handling section: Rapidity of material turnover; Disposition of licensed material at closeout; and Nature of the operations conducted at the site.

The next evaluation categories are: Facility and Indoor Operations and Contamination, Outdoor Operations and Outdoor Contamination from Operations, Waste Generation and Waste Disposal, and Burial and Onsite Dumping.

Each of these categories is triggered only if the evaluator's entered summary for that site indicated that that category was relevant.

Facility and Indoor Operations and Contamination. This module includes: Nature of the operations in buildings; Number of buildings and rooms in actual use; Areas likely to be problems; Accidents and releases; and Evaluator's general assessment of contamination likelihood.

Outdoor Operations or Outdoor Contamination from Operations. This module includes: Nature of the outdoor operations; Physical areas with highest potential for contamination; Accidents and releases; and Evaluator's estimate of likelihood of significant contamination.

Waste Generation and Waste Disposal. This module includes: Types of waste generated and Qualitative estimate of volume generated for each type of waste.

Burial and Onsite Dumping. Since the vast majority of onsite disposal involves waste, rather than licensed material, the onsite disposal module refers back to the information on types of waste generated. For each waste type, the system requests the location(s) of the possible disposal, along with the evaluator's best estimate of volume (qualitative).

Decommissioning and Cleanup. For each specific category of concern for the site (e.g. buildings, onsite disposal areas), the cleanup and decommissioning module asks the user to select from a menu of categories pertaining to cleanup and decommissioning of that area. The menu categories include all types of information or activities that could pertain to the determination of whether the site meets or does not meet current standards in that particular category or area of the site. The selections range from NRC regional letters of verification and closeout inspections to cleanup and verification surveys. For each type of information available, the system requests an estimate of how pertinent or thorough was the information or activity. The combination of the general degree of applicability of that particular information or activity and the evaluator's estimate of thoroughness determines the degree of reduction of the category score.

The Cleanup and Decommissioning questions occur in the context of the responses for the first four modules. Each site detail category that receives a score triggers the cleanup and decommissioning question set. The responses in the cleanup and decommissioning module modify the score for that particular category.

2.3.4 The Total Site Score

The Site-specific score for a particular site is the sum of the five final category scores. The overall site score for the license, referred to as the Total Site Score, is the sum of all Site-specific scores.

For a license that receives a Site-specific score and a Total Site Score, several comparisons allow potential problem areas to be identified by the evaluator and system:

1. For each site used under the license, the system uses the scores to identify areas of concern in the summary report. While this does not mean that these areas are in fact contaminated, it does indicate those areas of the facility and site that are of the greatest potential concern.
2. For the sites used under a license, the comparison of the Site-specific scores for the sites can delineate which of the sites have contamination potential and closeout deficiencies.
3. The Total Site Scores can be compared across licenses to provide prioritization guidelines for determining which licenses have the highest priority for review and consideration by the responsible agency.

2.4 The Sealed Source Scoring Structure

The sealed source evaluation process is considerably simpler from a schematic standpoint than the site evaluation process for two reasons. First, there are fewer factors that can affect the fate of sealed sources. Second, the documentation contained in the license file for sealed sources is usually much less complex than documentation for sites and site contamination.

There are two major categories of uncertainty in sealed source evaluations:

1. Tracking individual sources is often impossible, because license authorizations do not state a number of authorized sources. The manner in which sealed source authorizations are specified on the license or its amendments is often

quite different from the manner in which sealed source possession and accounting at closeout are handled. For example, if the licensee intends to possess three 200 millicurie Cs-137 sources, the license authorization may simply be given as an authorization of 600 millicuries of Cs-137 in sealed form, with no specification of a number of sources. Even more likely is that the authorization would be for 1 curie of Cs-137 in sealed form, so that the licensee could possess up to five sources. However, the intended number of sources may never be stated anywhere on the license or amendments.

2. A licensee often disposes of certain sealed sources during the license period, rather than at the time of license decommissioning and closeout. Documentation of the intermediate disposition of sources is often scanty or nonexistent. It appears that this is sometimes handled by issuance of an amendment reducing the authorized levels of a particular sealed material, with no accompanying explanation of whether the licensee actually possessed the source(s) or not. This is handled in the scoring system by marking one or more sources as 'dropped from license'.

Figure 2.1 (Section 2.1.1) provides an overview of the entire evaluation process, including the sealed source evaluation scheme. The specifics of a sealed source evaluation are outlined in Figure 2.4.

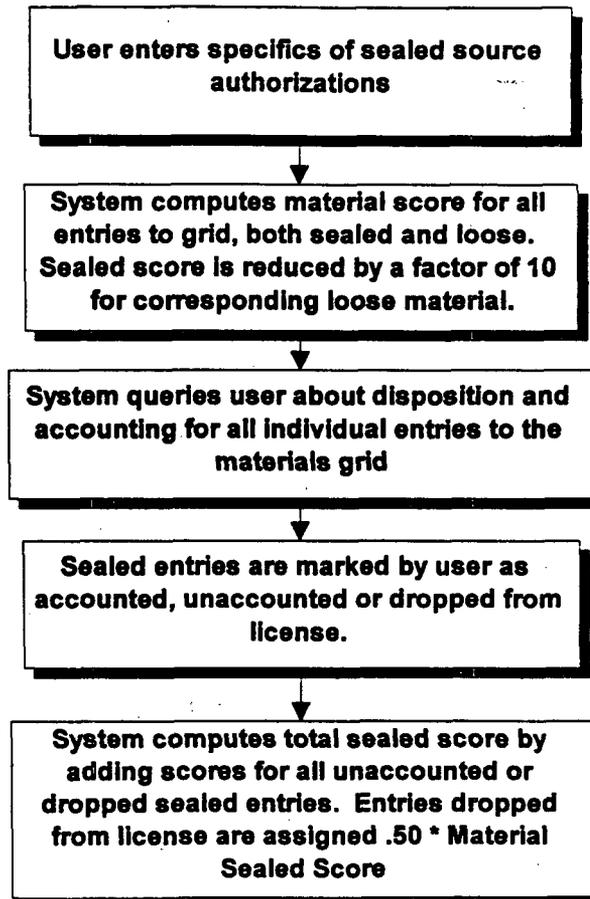


Figure 2.4 Specifics of a Sealed Source Evaluation

3. INVENTORY FINDINGS

This chapter will present the overall summary and findings about the characteristics of terminated licenses. Chapter IV will present results of the license evaluations, while Chapters V will describe the characteristics of those licenses receiving Site scores and Sealed Source scores.

3.1 Summary of Findings

This section will present a brief summary of the overall findings about the characteristics of inventoried licenses, with more detail to be given in the subsequent sections of this chapter. The findings in this chapter apply only to licenses terminated from the inception of licensing through 1994⁷.

Finding 1. NRC Region: Sixty percent of all terminated licenses for the review period (circa 1950-1994) had a primary location in either NRC Region I (36 percent of licenses) or NRC Region III (24 percent of licenses). Regions II, IV and IV (now WCFO) had 13, 16 and 10 percent of licenses, respectively. See Table 3.1 for more detail.

Finding 2. Termination by License Type: Approximately 80 percent of terminated license inventory records were byproduct material licenses (Part 30), 15 percent were Source material licenses (including mining licenses) and 5 percent were special nuclear material licenses. See Table 3.1 for details.

Finding 3. Termination Patterns: Yearly license terminations increased until the mid 1960's, then began declining until the end of the period for which information was available (circa end of 1994). During the period 1990-1995, fewer than one-third as many licenses were terminated as in the period 1960-65 (see Figure 3.1). As with most administrative findings regarding material licenses, there was considerable instability in termination patterns during the period 1970-76, during which the Atomic Energy Commission became ERDA, then was split into the Department of Energy and the Nuclear Regulatory Commission. See Figures 3.1 through 3.4 for details.

Finding 4. License Transfer at Termination: During the period from the early 1950's to 1993, 31 to 33 percent of each of the three types of material licenses were transferred at termination to either another federal license or to an agreement state license. For both Part 30 (byproduct material) licenses and Part 70 (SNM) licenses, the proportion of terminated licenses that were transferred to agreement states was between 5 and 6 percent (averaged over the entire period). For Part 40 (Source material) licenses, the proportion transferred to agreement states was lower, close to 2 percent. Source material licenses were superceded more frequently by other federal licenses than were the other two license types. See Table 3.2 for details.

Finding 5. Superceding Licenses: Between 16 and 18 percent of Part 30 licenses terminated each year were superceded by another federal license. The proportion of Part 30 licenses superceded by other licenses varied considerably over the forty year period since 1955, with considerable instability during the 1970's. The proportion of Part 40 and Part 70 licenses superceded averaged between 25 and 30 percent, with Part 70's having the highest rate of supercession. See Figures 3.5, 3.6 and 3.7 for more detail.

Finding 6. License Termination by State: The six states with the largest number of terminated licenses are: Pennsylvania (3,472), New Jersey (2,349), Massachusetts (2,348), Illinois (1,992), California (1,963), and Ohio (1,960). See the map in Figure 3.8 for more detail.

Finding 7. Licensee Type: Private companies and corporations make up 44 percent of all licensees for the 1950-1994 terminated licenses. Medical licenses, including both individual physician licenses and institutional licenses, constitute 19 percent of the total. Colleges and universities account for 12 percent of licenses, and federal licenses make up just over 9 percent of licenses. See Table 3.3 for a breakdown of more specific licensee categories.

3.2 Data Uncertainties

The information presented in this entire report was taken from historical licensing material that varied widely in detail, content, and quality of information. Conflicting information also existed, with the conflicts often identified by project personnel at different times in the inventory process.

⁷ Although the initiation date for formal licensing was probably about 1948, termination dates range from 1950 through approximately late 1994 for this series. A few licenses in the series were terminated in 1995.

Given the existing uncertainties, it was important for inventory purposes to make a 'best guess' from the information available. Certain inventory information is particularly prone to uncertainty and error when derived from the licensing documentation. Information likely to be missing or uncertain includes

1. termination date (or latest located expiration date if the license was never terminated or the termination date is unavailable)
2. the administrative or supervising NRC region
3. site or use location⁸

The nature of the licensing process, and consequently the nature and meaning of the available data, changed considerably over the forty-five years of licensing represented by the licenses reviewed; this was a great source of data uncertainty in the inventory process. Data that was frequently unavailable or seemed extremely uncertain was eventually dropped from the data model. A particular example of this was Program Code information. NRC maintains Program Codes (See Appendix) that determine the particular category of operation being licensed. Although this would be extremely useful for categorizing and evaluating the licenses, it was recorded in the file on an irregular basis. Further, the practice was instituted midway in the licensing process. For both these reasons, Program Code information was dropped from the data collection process.

3.3 License File Inventory

3.3.1 Region and License Type

The next table presents a summary of numbers of inventory records, by license type and by administrative region. The administrative region that should be assigned is actually unclear from the licensing material in a small percentage of instances (perhaps three to five percent). See the previous section for a discussion of data uncertainties.

In cases of uncertainty about the supervising region, evaluators made their best guess from any location information that might have been available for the license site or licensee. It is likely that licenses were allocated to the incorrect region for fewer than two percent of inventory records.

Table 3.1 Distribution of Identified License Inventory Records by NRC Administrative Region

| Region ⁹ | License Type | | | Total Number from Region | Percent of Total Licenses in Region |
|-------------------------------------|--|-------------------------------------|--|-----------------------------|---|
| | Part 30 – Byproduct Material (%) | Part 40 – Source material (%) | Part 70 – Special nuclear material (%) | | |
| I (Northeast) | 11268 (82) | 1621 (12) | 798 (6) | 13687 | 36 |
| II (Southeast) | 4456 (88) | 327 (6) | 267 (5) | 5050 | 13 |
| III (Midwest) | 7795 (86) | 905 (10) | 395 (4) | 9095 | 24 |
| IV (Southwest) | 4075 (68) | 1741 (29) ¹⁰ | 189 (3) | 6005 | 16 |
| V/WCFO (West) ¹¹ | 2412 (66) | 979 (27) | 250 (7) | 3641 | 10 |
| None Given | 29 (-) | 5 (-) | 6 (-) | 40 | 0.1 |
| Total | 30037 | 5580 | 1907 | 37518 | 100 |
| Percent of Total License by Part | 80 | 15 | 5 | 100 | |

⁸ Primary state of operation, which is derived from the use location, was often also uncertain. Operation in multiple states and multiple regions was also very common.

⁹ This refers to NRC Administrative Regions. A map of the NRC Regions is given in the Appendix. Information about the supervising region was important in this project primarily because any licenses identified for further review were referred to the region.

¹⁰ For Region IV, a substantial portion of Source Material licenses were Mining licenses, which were designed with a 'P'- initial license number (e.g. P-02123).

¹¹ Region V became the Walnut Creek Field Office in the early 1990's. Licenses for Region V and the Walnut Creek Field Office are combined in all analyses.

Region I (the Northeast Region) has historically been the largest region and has the largest number of non-agreement states. Consequently, that region also has the largest number of terminated material licenses. Regions IV and V have the largest proportion of terminated licenses that are Source material licenses, largely due to the preponderance of uranium and thorium mining licenses in the Southwestern and Western states. Uranium and thorium mining activity was always licensed as a source material license.

3.3.2 Dates of License Termination

Figure 3.1 shows the time period of termination for all material licenses¹². License terminations peaked in the early 1960's and declined rapidly until 1985. Since 1985, terminations have been about one-third as frequent as in the 1960's. The increase in terminations in the 1972-74 time period, with a corresponding decline in 1975-76, is undoubtedly related to the split of the Atomic Energy Commission into the Department of Energy and the Nuclear Regulatory Commission in 1974. Unfortunately, the number of licenses issued during various period of time are not all available in the LEADIS data, so it is not possible to compare terminations with license issuances. The considerable drop in number of terminations for the period 1994+ is probably an artifact of the data set. It is very likely that there were many terminated licenses for the year 1994 that were not contained in the archived files sent for review, so the value shown for 1994+ probably does not reflect all terminations.

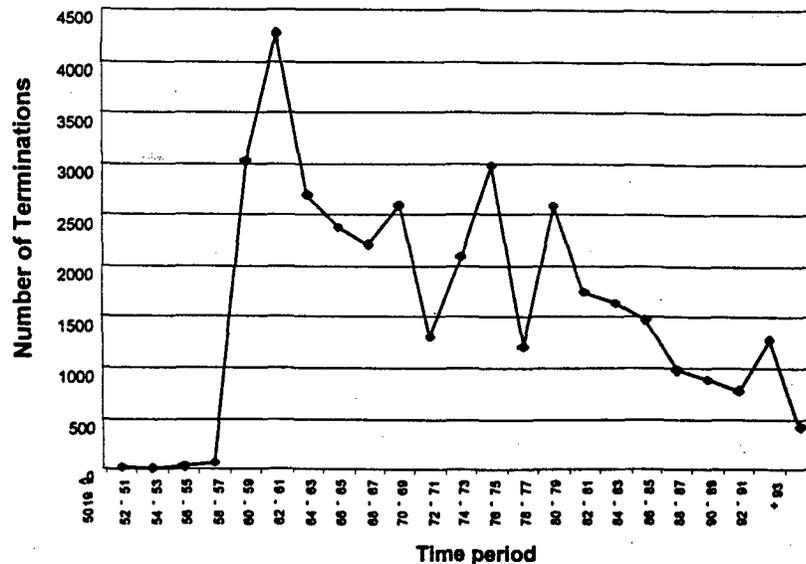


Figure 3.1 Number of Terminated Licenses, By Time Period

Figures 3.2, 3.3 and 3.4 give the number of licenses terminated for Part 30, Part 40, and Part 70 material licenses, respectively. The three kinds of licenses show different termination patterns.¹³

¹² If a termination date is not available when a record is inventoried, the expiration date given in the available folder is used.

¹³ In all the plots of termination dates, a license having multiple folders with different termination dates (or different estimated termination dates, based on the stated expiration in the folder) is counted multiple times. This is done because it is not possible to determine which of the estimated dates is the correct date for a particular case without actual physical examination of the material.

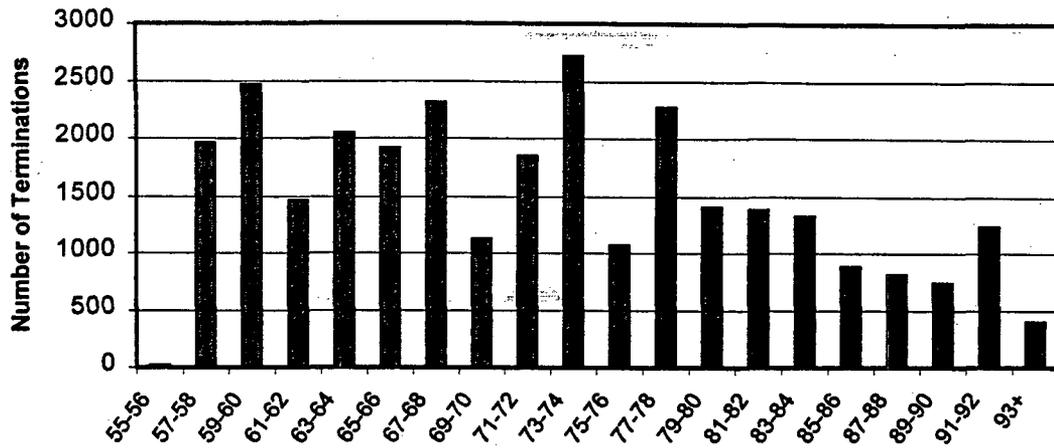


Figure 3.2 Number of Part 30 Terminations by Time Period

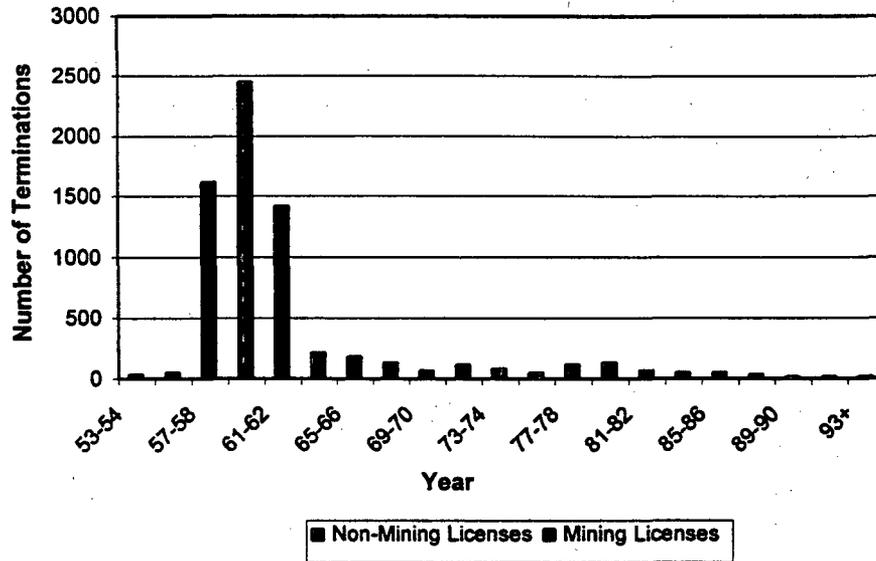


Figure 3.3 Number of Part 40 Terminations, by Time Period

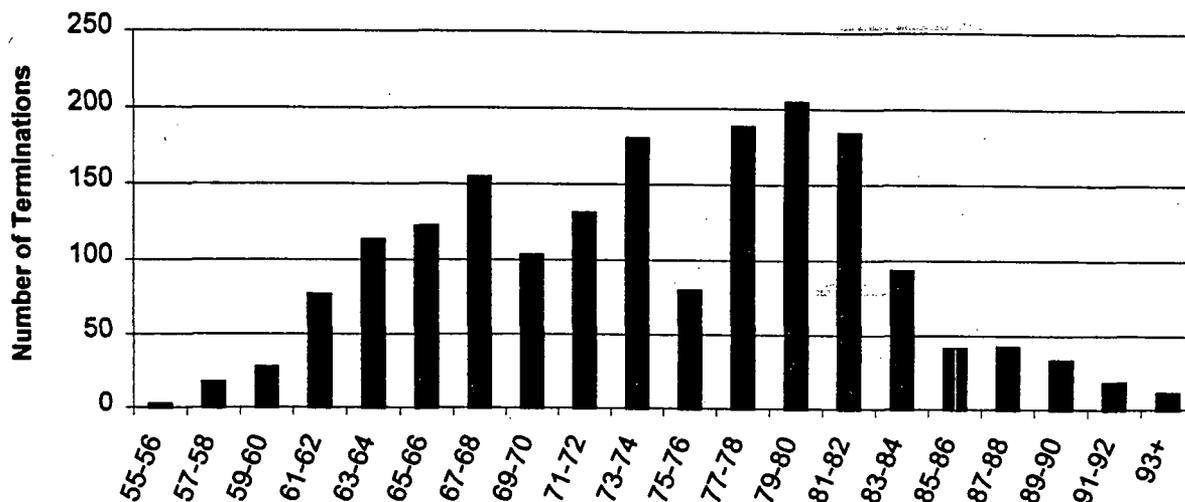


Figure 3.4 Number of Part 70 Terminations, by Time Period

In Figure 3.3, Part 40 (Source material) licenses have been separated into mining and non-mining licenses. Issuance of licenses for mining operations ended in the early 1960's, so that all or nearly all terminations for mining licenses occurred in that period. Both mining licenses and non-mining licenses were terminated most frequently in the early 1960's, with a sharp decline since that time. This pattern is undoubtedly due to the large number of post-war Source material licenses (including fuel processing and machining) issued for AEC-related work, that were then terminated in the 1960's.

Part 30 (byproduct material) and Part 70 (SNM) licenses were issued somewhat later than source material licenses. There are few terminations until 1956, and only a limited number of each type were terminated until the early 1960's.

A decline in all types of terminations has occurred since the late-1970's. Source material license terminations declined to fewer than 15 in the 1993-1994 period. SNM terminations have declined to fewer than 50 per two-year period since 1978-79.

Part 30 license terminations have declined less, remaining relatively steady since 1987-88. As stated earlier, the value for 1994+ is almost certainly not a valid indicator of total terminations for the year 1994 and above. It does, however, correctly represent the number of licenses passing through project review that had termination dates of 1994 or later.

3.3.3 License Transfers

3.3.3.1 Types of License Transfers

Licenses are often terminated because another license is being issued to cover the same material, operation, site, and/or sources. The new license is referred to as a 'superceding' license. For federal nuclear materials licensing, the new license covering the materials, site, and operation can be either a new federally-issued license, or it could be a transfer of responsibility to an agreement state¹⁴ license.

The inventory process included a considerable effort to determine whether a superceding license or agreement state transfer did occur for the license being inventoried. For older licenses (pre-1970), this was often a difficult matter, as recording of the superceding license or agreement state transfer was often very casual and irregular. After the 1970's, that information was more formally recorded, and the quality of information was probably better.

The evaluation of terminated licenses did not attempt to identify sites or sealed sources for further review if

1. there was a valid superceding license or agreement state transfer, and

¹⁴ An agreement state is a state that enters into an agreement with the Nuclear Regulatory Commission to regulate and issue nuclear material licenses for licensable activities within its state boundaries, under certain specified terms and conditions. There are currently thirty-one agreement states.

2. there were no extenuating circumstances (evidence of contamination, dropped sites, likely burial site, major unresolved questions about the license, etc.)

Chapters IV and V will further discuss the number of site licenses and sealed source licenses for which a superceding license was identified, but further review was deemed necessary.

Table 3.2 provides the number of licenses superceded by a valid federal license or transferred to an agreement state.

Table 3.2 Number of Material Licenses Superceded or Transferred to an Agreement State

| Transfer Type | Part 30 Licenses | Part 40 Licenses | Part 70 Licenses | All Licenses |
|--|------------------|------------------|------------------|--------------|
| Superceded | 7878 (26%) | 1604 (29%) | 506 (27%) | 9988 |
| Transferred to Agreement State | 1543 (5%) | 115 (2%) | 115 (6%) | 1773 |
| All Transfers | 9421 | 1719 | 621 | 11761 |
| Total Inventory Records | 30031 | 5580 | 1907 | 37518 |
| Percent of Terminations for which License Type was Transferred (Superceded or Agreement State) | 31 | 31 | 33 | 31 |

Close to the same percentage of licenses were transferred for each of the three material license types. However, the percentage of Part 40 license terminations transferred to agreement states (2 percent) is lower than the percentage of Part 30 or Part 70 licenses (5 and 6 percent, respectively). A somewhat higher proportion of Part 40 licenses are transferred to other federal Source material licenses than are Part 30's or Part 70's.

3.3.3.2 Superceded Part 30 Licenses

Figure 3.5 shows the trend in license supercession for Part 30 licenses over time, as well as the trend in number of Part 30 licenses terminated by two-year period. The total number of Part 30 licenses terminated in the year is shown in the linear graph, with the proportion superceded by other federal licenses in the same period given by the bar. Clearly the proportion superceded has varied considerably through the years with recent stabilization. Since 1988, the proportion of terminated licenses that have been superceded has remained very stable at between 16 and 18 percent.

The proportion of Part 30 licenses that were superceded has been relatively stable, ranging between 15 and 25 percent, since 1976-1977. The one exception was the two-year period 1986-87, when the proportion superceded was 38 percent. Prior to 1963, the proportion superceded tended to follow the number terminated – the larger the number of licenses terminated, the larger the proportion of licenses that were superceded by other licenses. However, that pattern changed in the 1964-65 period, and there seems to have been little relationship since.

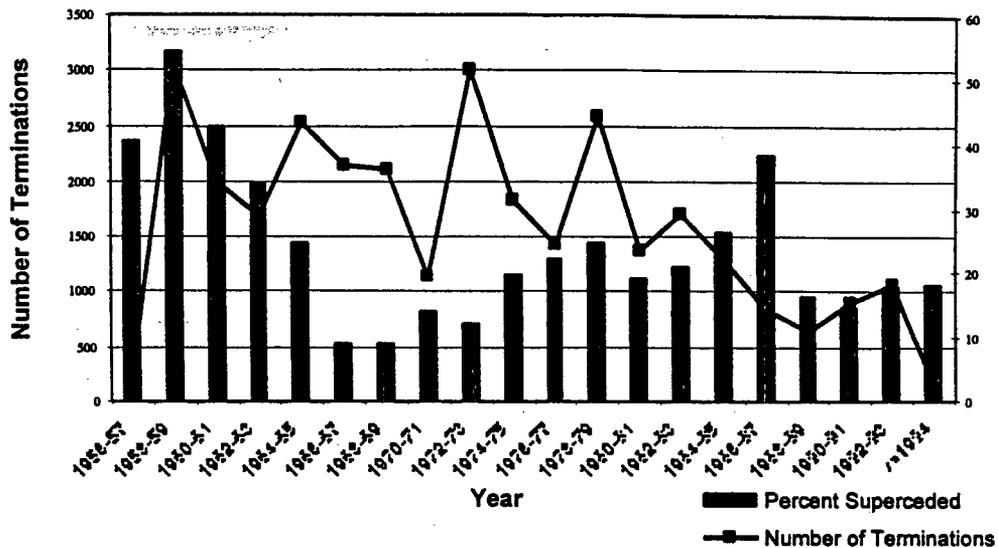


Figure 3.5 Federal Superceding Licenses for Part 30 Terminations

3.3.3.3 Superceded Part 40 Licenses

Figure 3.6 shows the pattern of supercession for Part 40 licenses. A higher proportion of Part 40 licenses is superceded than are the other two types of material licenses. The high proportion of Part 40's superceded during the 1960-61 period is probably not a real phenomenon. During that time period, a changeover in the license numbering system by the AEC was made, a high proportion of Source material licenses were terminated, and a license was issued with the new numbering system.

The high proportion of terminations that were superceded in the 1978-83 time frame is not as easily explained, particularly given the very low proportions occurring just before that time. There may have been some administrative changeover at that time, as well. The total number of Part 30 terminations dropped below 100 per year for the period following 1978, and has stayed below 70 per year since 1982.

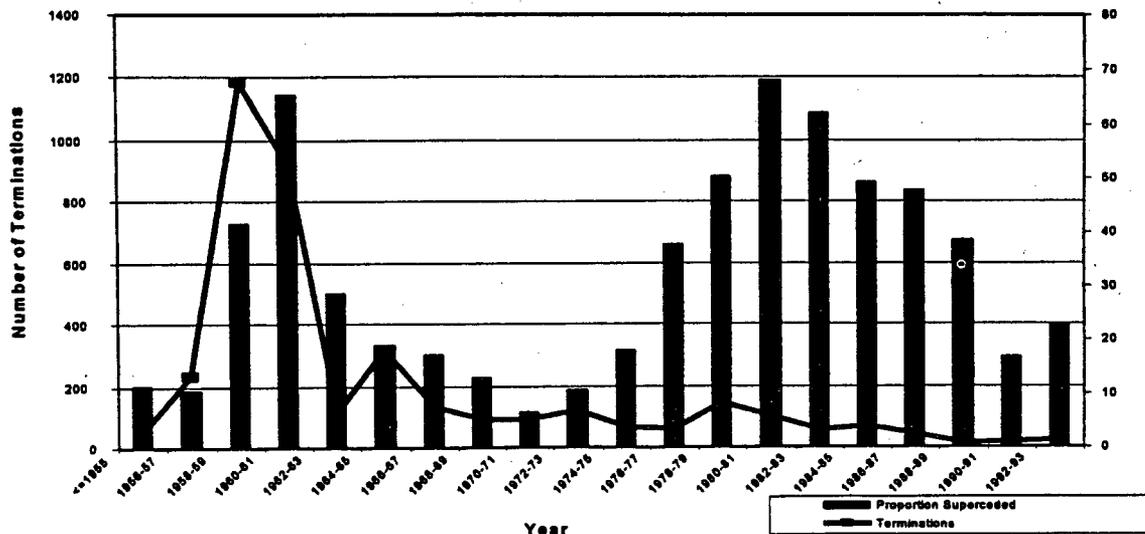


Figure 3.6 Federal Superceding Licenses for Part 40 Terminations

3.3.3.4 Superceded Part 70 Licenses

According to figure 3.7, the proportion of Part 70 license terminations that have been superceded has varied less than for Part 30's and Part 40's, with the average remaining close to 25 percent during the entire period. The exceptions to this were during the years 1978-79 and 1984-85, when over 40 percent of SNM terminations were superceded, and 1986-87, when 37 percent were superceded.

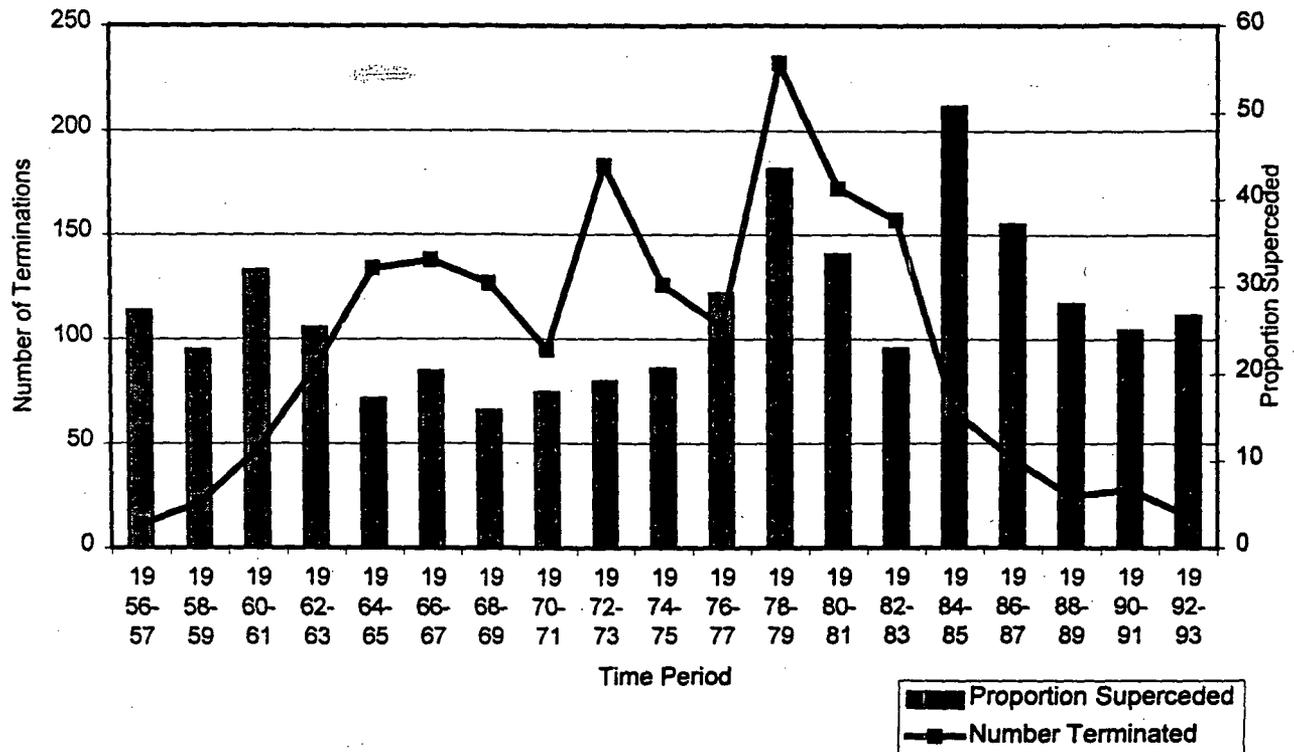


Figure 3.7 Federal Superceding Licenses for Part 70 Terminations

3.3.4 License Distribution by State

Figure 3.8 shows the estimated number of terminated licenses by primary state of licensee operation. The six states having the largest number of licenses were Pennsylvania, New Jersey, Massachusetts, Illinois, California, and Ohio, in that order. Pennsylvania had a total of 3,472 licenses terminated through the end of the period of observation. The bulk of licenses in Colorado and Utah are mining licenses. The large number of licenses in California is something of a surprise, because California was one of the first states to become an agreement state in 1965; at least one factor contributing to this is the large number of military licenses situated in the state of California. Federal licenses, including military licenses, are not transferred to the agreement states.

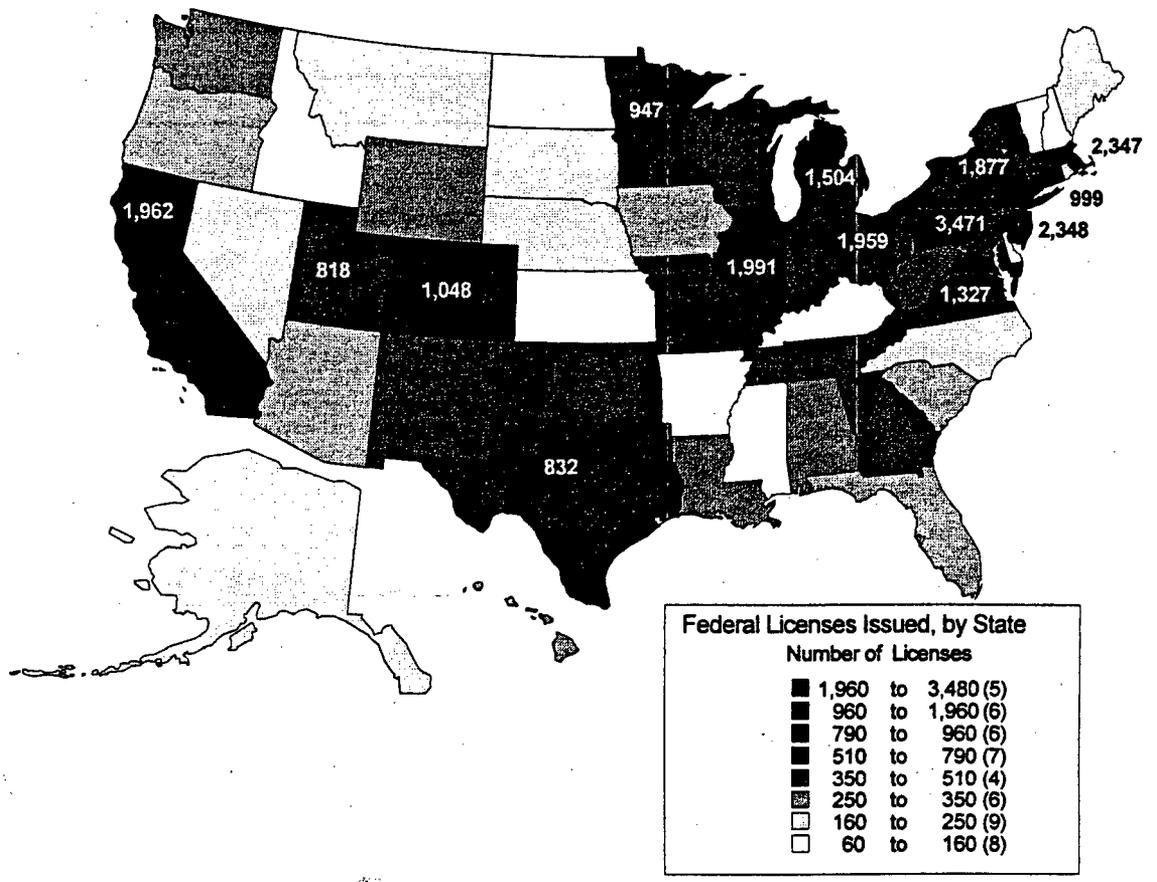


Figure 3.8 Number of Licenses By State

3.3.5 Licensee Institutional Category

The next table shows the distribution of terminated material license records by licensee category. Private companies make up the largest single licensee group, with 44 percent of the 37,518 material license records. Medical licenses, including hospitals, physicians, and all medical centers and offices, make up 19 percent of the terminated records. Federal agencies held 9.3 percent of the licenses, with military groups (Army, Navy, Air Force, and Coast Guard) making up 5.1 percent of all licenses. Colleges and universities are another large category, holding nearly 12 percent of all the terminated material licenses.

Table 3.3 Number of Licensees, by Institutional Category

| Licensee Category | Type ID | Subtype ID | Number of Licenses |
|---|---------|------------|--------------------|
| Federal Licenses | | | |
| Federal/Not Otherwise Classified | 001 | 000 | 100 |
| Federal/Army | 001 | 001 | 564 |
| Federal/Navy | 001 | 002 | 1029 |
| Federal/Air Force | 001 | 003 | 309 |
| Federal/Coast Guard | 001 | 004 | 6 |
| Federal/Bureau of Mines | 001 | 006 | 14 |
| Federal/HEW | 001 | 007 | 74 |
| Federal/Health and Human Services | 001 | 008 | 33 |
| Federal/TVA | 001 | 009 | 79 |
| Federal/Commerce Dept | 001 | 010 | 67 |
| Federal/Treasury Dept | 001 | 011 | 33 |
| Federal/EPA | 001 | 012 | 70 |
| Federal/NASA | 001 | 013 | 137 |
| Federal/Veterans Administration | 001 | 014 | 378 |
| Federal/Civil Aeronautics Admin | 001 | 015 | 38 |
| Federal/Department of Justice | 001 | 016 | 21 |
| Federal/Defense Logistics Agency | 001 | 017 | 4 |
| Federal/Customs | 001 | 018 | 3 |
| Federal/Transportation Dept | 001 | 019 | 30 |
| Federal/Bureau of Standards | 001 | 020 | 18 |
| Federal/Dept of Interior | 001 | 021 | 323 |
| Federal/Dept of Agriculture | 001 | 023 | 45 |
| Federal/Defense Nuclear Agency | 001 | 024 | 31 |
| Federal/General Services Administration | 001 | 025 | 46 |
| Federal/NIH | 001 | 026 | 19 |
| Federal/Federal Reserve Bank | 001 | 027 | 17 |
| Federal/Smithsonian | 001 | 028 | 26 |

Table 3.3 (continued).

| Licensee Category | Type ID | Subtype ID | Number of Licenses |
|---|---------|------------|--------------------|
| Total Federal Licenses (including military) | | | 3503 (9.3%) |
| Total Military Licenses | | | 1908 (5.1%) |
| Total Nonmilitary Licenses | | | 1595 (4.2%) |
| Other Government | | | |
| Government/Nonfederal | 002 | 000 | 586 |
| Total Nonfederal Government Licenses | | | 586 (1.6%) |
| Schools | | | |
| Schools/University and College | 003 | 000 | 4418 |
| Schools/Non-University | 004 | 000 | 140 |
| Total Schools Licenses | | | 4558 (12%) |
| Industrial and other Privately-held Licenses | | | |
| Industrial/Private | 005 | 002 | 16441 (44%) |
| Civil Defense Licenses | | | |
| Civil Defense licenses | 006 | 000 | 2067(5.5 %) |
| Medical Licenses | | | |
| Medical/Individual | 007 | 001 | 2976 |
| Medical/Institutional | 007 | 002 | 949 |
| Medical/Hospital | 007 | 003 | 3189 |
| Total Medical Licenses | | | 7114 (19%) |
| Other License Types | | | |
| Individual and Other | 008 | 000 | 2519 |
| Institutes/Research/Foundations | 009 | 000 | 286 |
| Mining | 010 | 000 | 444 |
| Total Miscellaneous Types | | | 3249 (8.6%) |

4. EVALUATION FINDINGS

4.1 Summary of Findings

This chapter will report findings from the 31,482 evaluations of inventoried licenses. The purposes of the license evaluation task were to

1. identify licenses with use sites that require further review in order to verify that contamination above present guidelines does not exist
2. identify authorized sealed sources with uncertain fates and potential public health hazard

The set of evaluations included 31,482 total licenses¹⁵. Major findings of the evaluations include the following:

General Findings

Finding 1: Evaluations by License Type. A total of 79 percent of evaluations were conducted for byproduct material licenses, 16 percent were conducted for source material licenses, and 5 percent of evaluations were for special nuclear material licenses. These proportions in the three license types are the same as those for the 37,518 inventoried records.

Finding 2: States with Large Numbers of Licenses. The states of California, Illinois, Massachusetts, Michigan, New Jersey, New York, Ohio, and Pennsylvania each had over 1,000 retired license evaluations. Pennsylvania was the primary state of operation for 2,704 licenses, nearly nine percent of all evaluations.

Site Review Findings

Finding 3: Identified Site Review Licenses by License Type. The project identified 675 licenses above the designated cutoff value for further site review. Special nuclear material and source material licenses had the highest proportion of licenses requiring site review, close to eight percent and seven percent, respectively. Byproduct material licenses were identified for site review in approximately 1 percent of instances.

Finding 4: Institutional Categories for Site Review Licenses. A total of 84 percent of the evaluated licenses identified for site review were in the Industrial/Private category, although only 44 percent of all inventory records fell into that category. The next most commonly-identified category was Federal licenses, which made up eight percent of the site review identifications. University and college sites constituted six percent of the site review identifications.

Finding 5: Identified Site Licenses by State. The highest *proportion* of reviewed licenses identified for site review were in agreement states with relatively few licenses evaluated. North Dakota, Kansas, Kentucky, Idaho¹⁶, California, and Arkansas all had a rate of identification for site review at or above three percent of licenses in the state. California had a large number of licenses evaluated, although California was an early agreement state.

Finding 6: Distribution of Total Site Scores. The median score for identified site licenses (those having a Total Site Score above 5) was 52.7. Thirty-seven percent of identified site licenses had a score below 25; however, 201 of the 675 site licenses (30 percent) had scores above 150, and 74 licenses (11 percent) had a total score above 1,000.

Finding 7: Time Trends in Site Identification. The highest proportion of identified site licenses was in the 1960-69 terminations. Proportion of licenses identified for site review declined for later terminations to a value of 1.4 percent for licenses terminated after 1980.

Finding 8: SNM Licenses with Loose Material. Forty-three (43) percent of SNM licenses that had loose material were identified for further site review. This is primarily because SNM licenses with loose material tend to have significant quantities of high-hazard, long-lived materials that received a high material score.

Sealed Source Findings

Finding 9: Total Licenses Identified for Sealed Source Follow-up. A total of 564 licenses were identified for sealed source review and follow-up, or 1.8 percent of all evaluations.

¹⁵ The total number of inventoried records is 37,518. From these records 31,482 evaluations were carried out. The difference is due to two factors: 1) Licenses had multiple record folders in different boxes, from which a single evaluation was carried out and 2) Some inventoried records had inadequate information to carry out a basic evaluation.

¹⁶ Idaho is not currently an agreement state. However, during the period of the majority of this review, Idaho was an agreement state.

Finding 10: Proportion of Licenses Identified for Sealed Source Follow-up. The proportion of licenses identified for sealed source follow-up varied from 0.6 percent to 2.8 percent over the termination periods from 1955 to 1994. The termination period with the highest identification rate was the period 1970-74. Identification rates declined steadily since that period.

Finding 11: Types of Licenses Identified for Sealed Source Follow-up. Byproduct material licenses were most likely to be identified for sealed source follow-up, SNM licenses were next, and source material licenses least likely to be identified.

Finding 12: Institutional Category of Identified Sealed Source Licenses. License categories or types most likely to be identified for sealed source follow-up were Industrial and Private Company licenses and University and College licenses. These two categories were also the most over-represented in the group of identified sealed source licenses. Medical and hospital licenses had the lowest likelihood among the significant license categories of being identified for sealed source review.

4.2 Data Uncertainties and Characteristics

This section provides a quick summary and explanation of the most important points regarding site score values. These points should be kept in mind in interpreting the results of this chapter. Refer to Chapter II for a detailed description of the evaluation system, the site scoring process, and detailed explanations of the points given in this section.

- Cutoff value for further site review. *The cutoff value for a Total Site Score that triggered NRC review was 5.* The majority of licenses identified with a score near 5 probably did not require further review. This is particularly true for recently terminated licenses. Many licenses receiving a site score near 5 may not represent a significant hazard, but received that score because the closeout documentation was judged (by the system, primarily) to be inadequate for the level of materials authorized.
- Total Site Score. This is the final site score for a license. Phase 1 and 2 reviews (which covered licenses terminated through 1985, approximately) did not evaluate sites used under the same license separately. Phase 3 reviews did evaluate those sites separately. For Phase 1 and 2 reviews, the Site Score for the license was a somewhat amorphous combination of the findings and scores determined by the evaluator for the specific sites used under the license. In Phase 3, site review was carried out separately for the sites, and *the Total Site Score was the sum of the scores received for individual sites used under the license.* A license used at multiple sites was far more likely to be identified for further review, particularly in Phase 3 reviews.
- Collection of Material Authorization and Possession Information. The collection and recording of the material authorization information was one of the most time-consuming activities of the evaluation process. For this reason, during the period of time with the largest numbers of evaluations (Phase 1 reviews), material authorization information was only collected for licenses that needed the information to complete the evaluation successfully. For Phase 1 evaluations, material authorization information was not recorded for licenses satisfying two conditions: (1) the license had a characteristic allowing administrative removal (see Chapter II *Administrative Removal Characteristics*) and (2) there was no overriding factor that caused the system or the reviewer to override administrative removal of the license from further consideration. Overriding factors might include evidence of onsite burial, a superceding license that did not cover a site of use under the present license, and other factors.

For Phase 2 and Phase 3 evaluations, material information was collected for all licenses. However, summary statistics regarding material possession are not possible for the entire collection of evaluated licenses, because information is not available for a significant block of evaluated licenses.

Material authorization was generally concrete information. Valid estimates of actual material possession was far more difficult to estimate for the majority of evaluated licenses. Both site scoring and sealed source scoring were driven by the authorization values on the license, unless very concrete information was available about actual possession. For purposes of calculating decay until the present, the assumption was made that the licensee possessed the authorized limit on the day of termination of the license.

4.3 Site Review Summary

4.3.1 Number of Site Licenses

The project ultimately identified 675 licenses with one or more sites judged to need further site review.

Of the 675 site review licenses, 219 (32 percent) were byproduct material licenses, 343 (51 percent) were source material licenses, and 113 (17 percent) were SNM licenses. Less than one percent of Part 30 (byproduct material) licenses were identified for site review, while Part 40 (source material) licenses and Part 70 (SNM) licenses had approximately a 7 percent and 8 percent likelihood, respectively, of being flagged for further review. Removal of the 1538 mining licenses from the source material license group results in over a nine percent likelihood of identification for site review for non-mining source material licenses. Source material licenses were also the most likely to include loose material in the license materials authorizations and therefore to receive a site review (see Table 4.1).

4.3.2 Material Authorizations

Table 4.1 shows the form of material authorized for each type of license. When a license is evaluated, it may have a sealed source evaluation, a site evaluation, or both, depending on the nature of the materials possessed. The two types of evaluations are conducted independently, except where loss of containment for a source(s) results in sealed material being treated as loose.

In Phase I of the review process, materials information was not collected for licenses that were administratively removed from further consideration. There are consequently four categories of material information available under a given evaluation, as outlined in Table 4.1. Of the 20,469 licenses for which material information was recorded, 10,397 (51 percent) had at least one material authorized as loose material. A total of 10,075 licenses (49 percent) authorized sealed sources only. For both Part 70 and Part 30 licenses, approximately 40 percent authorized sealed source possession only. About five percent of licenses authorize both sealed sources and loose material, for both Part 30 and Part 70 licenses. Part 40 licenses are primarily loose material licenses - less than five percent of source material licenses have sealed material, either with or without loose material.

Table 4.1 Nature of Materials Authorizations for Materials Licenses

| Materials Authorization | All Evaluations (%) | Part 30 Evaluations (%) | Part 40 Evaluations (%) | Part 70 Evaluations (%) |
|-------------------------|---------------------|-------------------------|-------------------------|-------------------------|
| Loose only | 8968 (28) | 6011 (24) | 2792 (54) | 179 (12) |
| Sealed only | 10075 (32) | 9294 (37) | 213 (4) | 587 (41) |
| Sealed and Loose | 1426 (5) | 1327 (5) | 19 (<1) | 81 (6) |
| Not recorded | 10982 (35) | 8317 (34) | 2097 (41) | 568 (41) |

4.4 Demographic Characteristics of Evaluated Licenses

Table 4.2 shows the number of evaluations attributed to each NRC Region, by license part. Evaluations were distributed similarly, except for two major differences: Regions IV and V (WCFO) had considerably fewer Part 30 licenses and higher levels of Part 40 licenses. In the case of Region V/WCFO, there was also a higher proportion of SNM licenses than for the other regions. Part of this difference is due to the presence of mining licenses (primarily in Region IV), and to the large number of agreement states in Region V/WCFO. Agreement states are less likely to take or be given jurisdiction of Part 40 and Part 70 licenses, leaving a larger proportion of those types of licenses in Region V.

Table 4.2 Number of Evaluations by NRC Region

| Region | Part 30 | % of Region Licenses | Part 40 | % of Region Licenses | Part 70 | % of Region Licenses | Total for Region |
|------------|---------|----------------------|---------|----------------------|---------|----------------------|------------------|
| Region I | 9033 | 82 | 1418 | 13 | 550 | 5 | 11001 |
| Region II | 3555 | 88 | 286 | 7 | 185 | 5 | 4026 |
| Region III | 7047 | 86 | 836 | 10 | 332 | 4 | 8215 |
| Region IV | 3418 | 66 | 1647 | 32 | 150 | 3 | 5215 |
| WCFO/V | 1866 | 62 | 926 | 31 | 197 | 7 | 2989 |
| Not given | 30 | | 5 | | 1 | | 36 |
| Total | 24949 | | 5118 | | 1415 | | 31482 |

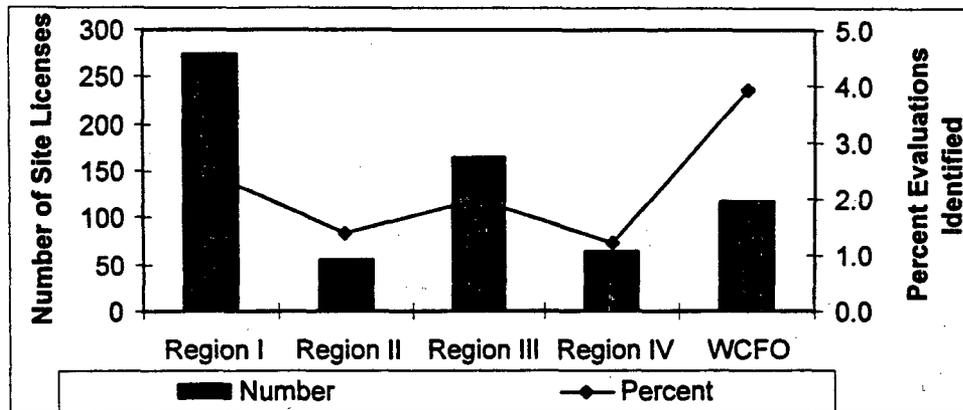


Figure 4.1 Number of Site Licenses by NRC Region

Figure 4.1 gives the breakdown by NRC Region of site licenses and percent of evaluations identified for site review. Regions I and III have the largest number of licenses and evaluations, as Table 4.2 showed. Those two regions also have the largest total number of site licenses. However, the highest proportion of identified site licenses is in the Western region, labeled as WCFO, the former Region V. Part of this high value is probably due to the different license types administered by the former Region V.

Table 4.3 shows the institutional category of the licenses identified, both for the entire group of 675 site licenses and for the five Regions. Over all the regions, 84 percent of the licenses were in the Industrial/Private category. The highest value was in Region III, where 91 percent of the identified licenses were in the Industrial category. The lowest proportion was in Region II. Region II's breakdown of identified site licenses generally follows the institutional breakdown of all evaluations for that region (see Table 3.4).

Figure 4.2 shows the proportion of licenses identified for site review for each of the major institutional categories. The highest proportion of licenses identified was in the Industrial/Private category, with 4.1 percent of such licenses identified for further site review. The next most common categories were research institutions¹⁷ (2.5 percent), federal government licenses (2.0 percent), and university and college licenses. Licenses issued to individuals, medical and hospital licenses, and licenses for schools other than university-level were much less likely to be identified for site review. Civil defense licenses ordinarily were issued for sealed sources only, and were automatically removed from further review, so that the finding of no identifications is automatic.

¹⁷ Excluding governmental, university and hospital-affiliated institutions, at least as far as the licensee identification allowed.

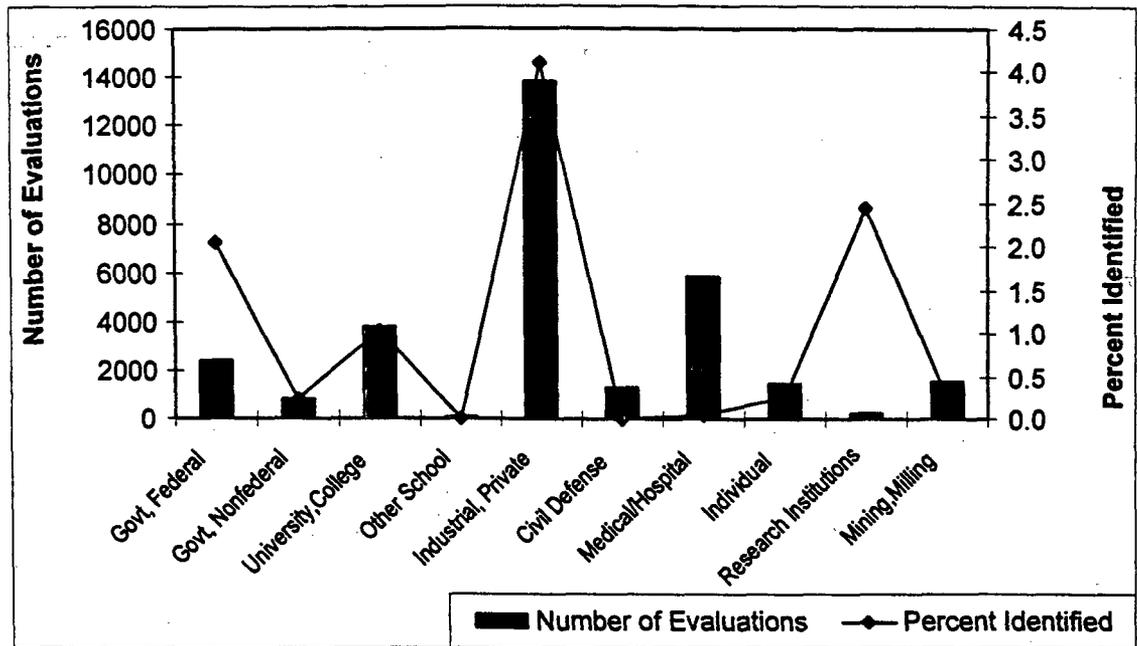


Figure 4.2 Percentage of Evaluations Identified for Site Review, by Institutional Category

Table 4.3 Licenses Identified for Site Review by Institutional Category and NRC Region

| Institutional Category | I | | II | | III | | IV | | WCFO | | Total in Category | |
|----------------------------------|-----|----|----|----|-----|----|----|----|------|----|-------------------|-------|
| | | % | | % | | % | | % | | % | | % |
| All Federal | 13 | 5 | 17 | 30 | 5 | 3 | 7 | 11 | 9 | 8 | 51 | 8 |
| Government, Nonfederal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 0 |
| University and College | 13 | 5 | 8 | 14 | 7 | 4 | 5 | 8 | 6 | 5 | 39 | 6 |
| Industrial/Private | 237 | 87 | 31 | 55 | 150 | 91 | 49 | 74 | 99 | 85 | 566 | 84 |
| Medical Centers/Clinics/Groups | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Hospital Licenses | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| Individual | 2 | 1 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 4 | 1 |
| Foundations, Research Institutes | 4 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 6 | 1 |
| Mining/Milling | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 1 | 1 | 4 | 1 |
| Total Site Licenses in Region | 272 | | 56 | | 164 | | 66 | | 117 | | 675 | 100.0 |

Table 4.4 shows the total number of evaluations performed by principal state of operation and the number and proportion of licenses in each state that were identified for either site review or for sealed source review. The discussion in Section 4.2 regarding uncertainties about licensee sites and states of operation should be kept in mind when examining this data. However, it is probable that errors and uncertainties in assigning state of operation are not systematic and are not sufficiently frequent to skew the results given in the table.

Table 4.4 Evaluation Results by State of Principal Operation.

Table Notes: State Names in italics have over 1000 total evaluations. Percentages in italics indicate greater than 3 percent.

| State Name | Total Evaluations | Site Licenses (% of Total) | Sealed Source Licenses (% of Total) | Notes |
|----------------------|-------------------|----------------------------|-------------------------------------|---|
| Alabama | 423 | 3 (0.7) | 14 (0.3) | |
| Arizona | 276 | 3 (1.1) | 1 (0.4) | |
| Alaska | 143 | 1 (0.7) | 1 (0.7) | |
| Arkansas | 58 | 2 (3.4) | 5 (8.6) | Small number of licenses. Early agreement state |
| <i>California</i> | 1619 | 100 (6.2) | 52 (3.2) | Large number of federal and military licenses. Early agreement state. |
| Colorado | 939 | 14 (1.5) | 6 (0.6) | |
| Connecticut | 779 | 18 (2.3) | 15 (1.9) | |
| Delaware | 156 | 5 (3.2) | 2 (1.3) | Not an agreement state. |
| District of Columbia | 558 | 5 (0.9) | 11 (1.8) | |
| Florida | 263 | 2 (0.8) | 6 (2.3) | |
| Georgia | 508 | 5 (1.0) | 3 (0.6) | |
| Hawaii | 201 | 1 (0.5) | 2 (1.0) | |
| Idaho | 102 | 5 (4.9) | 0 (-) | Formerly an agreement state. |
| <i>Illinois</i> | 1786 | 34 (1.9) | 23 (1.3) | |
| Indiana | 721 | 14 (1.9) | 12 (1.6) | |
| Iowa | 327 | 0 (-) | 4 (0.1) | |
| Kansas | 130 | 6 (4.6) | 5 (3.8) | Became an agreement state in 1965. |
| Kentucky | 99 | 3 (3.0) | 5 (5.0) | Became an agreement state in 1962. |
| Louisiana | 377 | 1 (0.3) | 1 (0.3) | |
| Maine | 180 | 2 (1.1) | 2 (1.1) | |
| Maryland | 826 | 25 (3.0) | 27 (3.3) | |
| <i>Massachusetts</i> | 1916 | 52 (2.7) | 26 (1.4) | |
| Michigan | 1371 | 23 (1.7) | 17 (1.2) | |
| Minnesota | 897 | 8 (0.9) | 8 (0.9) | |
| Mississippi | 74 | 0 (-) | 5 (6.8) | |
| Missouri | 799 | 22 (2.8) | 8 (1.0) | |
| Montana | 176 | 1 (0.6) | 5 (2.8) | |
| Nebraska | 200 | 2 (1.0) | 1 (0.5) | |
| Nevada | 142 | 4 (2.8) | 0 (-) | |
| New Hampshire | 115 | 3 (2.6) | 0 (-) | |
| <i>New Jersey</i> | 1842 | 50 (2.7) | 31 (1.7) | |
| New Mexico | 426 | 6 (1.4) | 4 (0.9) | |

Table 4.4 (continued).

| State Name | Total Evaluations | Site Licenses (% of Total) | Sealed Source Licenses (% of Total) | Notes |
|---------------------|---------------------|----------------------------|-------------------------------------|------------------------------------|
| <i>New York</i> | 1664 | 40 (2.4) | 49 (2.9) | |
| North Carolina | 203 | 2 (1.0) | 3 (1.5) | |
| North Dakota | 88 | 3 (3.4) | 1 (1.1) | Became an agreement state in 1969. |
| <i>Ohio</i> | 1755 | 60 (3.4) | 23 (1.3) | Not an agreement state. |
| Oklahoma | 539 | 6 (1.1) | 13 (2.4) | |
| Oregon | 306 | 2 (0.7) | 2 (0.7) | |
| <i>Pennsylvania</i> | 2704 | 71 (2.6) | 53 (2.0) | |
| Puerto Rico | 186 | 2 (1.1) | 7 (3.8) | |
| Rhode Island | 200 | 3 (1.5) | 6 (3.0) | |
| South Carolina | 245 | 2 (0.8) | 2 (0.8) | |
| South Dakota | 219 | 1 (0.5) | 1 (0.5) | |
| Tennessee | 438 | 12 (2.7) | 11 (2.5) | |
| Texas | 698 | 10 (1.4) | 25 (3.6) | |
| Utah | 726 | 6 (0.8) | 7 (1.0) | |
| Vermont | 95 | 0 (-) | 0 (-) | |
| Virginia | 950 | 13 (1.4) | 20 (2.1) | |
| Washington | 440 | 7 (1.6) | 9 (2.0) | |
| West Virginia | 480 | 9 (1.9) | 11 (2.3) | |
| Wisconsin | 587 | 2 (0.3) | 6 (1.0) | |
| Wyoming | 437 | 3 (0.7) | 7 (1.6) | |
| Virgin Islands | 25 | 0 (-) | 0 (-) | |
| Guam | 16 | 0 (-) | 0 (-) | |
| Canada | 42 | 0 (-) | 1 (2.4) | |
| Total | 31472 ¹⁸ | 674 ¹⁹ | 559 | |

4.5 Site Evaluation Findings

4.5.1 Evaluation Scores

A total of 1,572 licenses received a nonzero Total Site Score, with 897 below the cutoff value of five. Figure 4.3 gives the distribution of all nonzero Total Site Scores, while Figure 4.4 summarizes the distribution of scores above 5 – the designated cutoff point for further review.

¹⁸ Does not add up to the total because no geographic identification was available for a few licenses.

¹⁹ Does not include one site license identified in the Canal Zone.

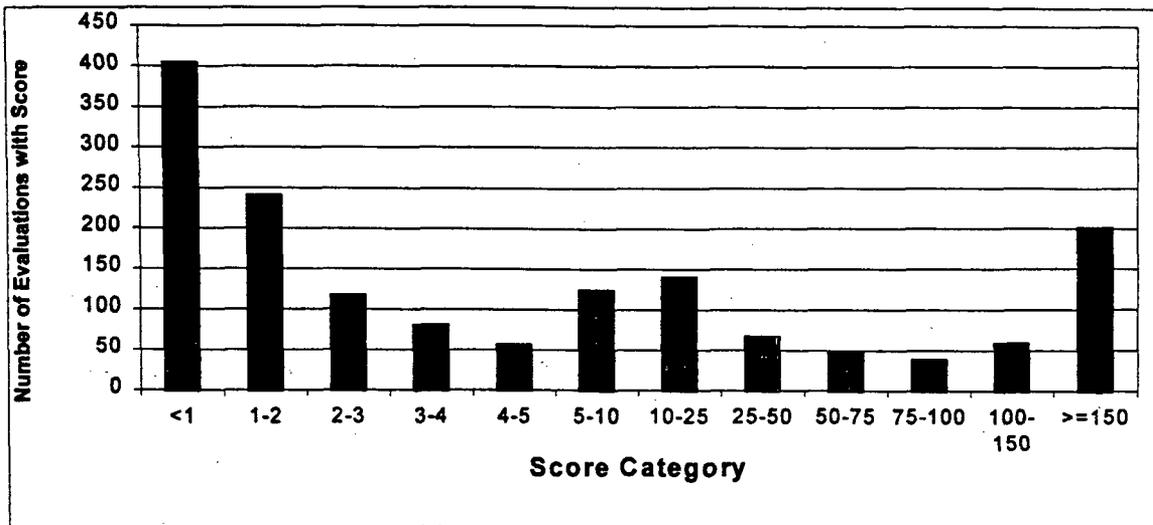


Figure 4.3 Distribution of All Nonzero Site Scores

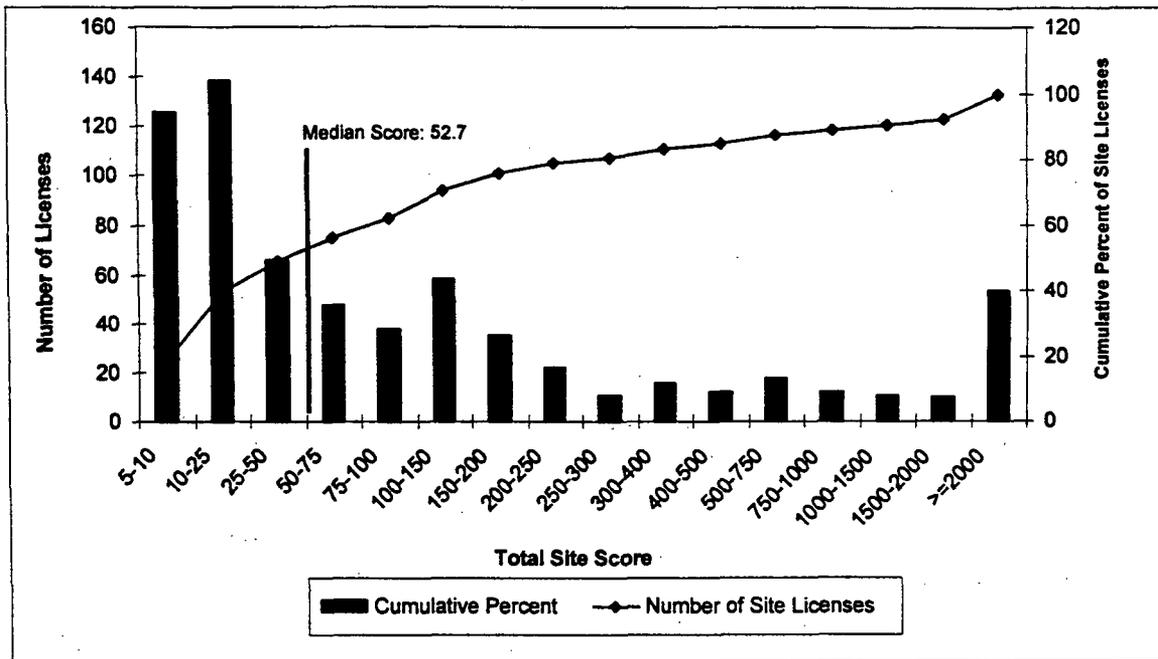


Figure 4.4 Distribution of Total Site Score for Identified Site Licenses

The median score for identified licenses (those having a Total Site Score above 5) was 52.7. The maximum score was 480,736, received by an SNM license with very large quantities of both Plutonium and U-235. A total of 74 licenses received a total score above 1000.

4.5.2 Time Trends

Figure 4.5 shows the number of site licenses identified by score for each of four time periods of license termination: pre-1960, 1960-69, 1970-79, and 1980 and later. The termination period 1960-69 had the largest number of site licenses identified, with the second largest number being among licenses terminated in 1970-79. The distribution of site scores for identified site licenses is quite similar across all time periods.

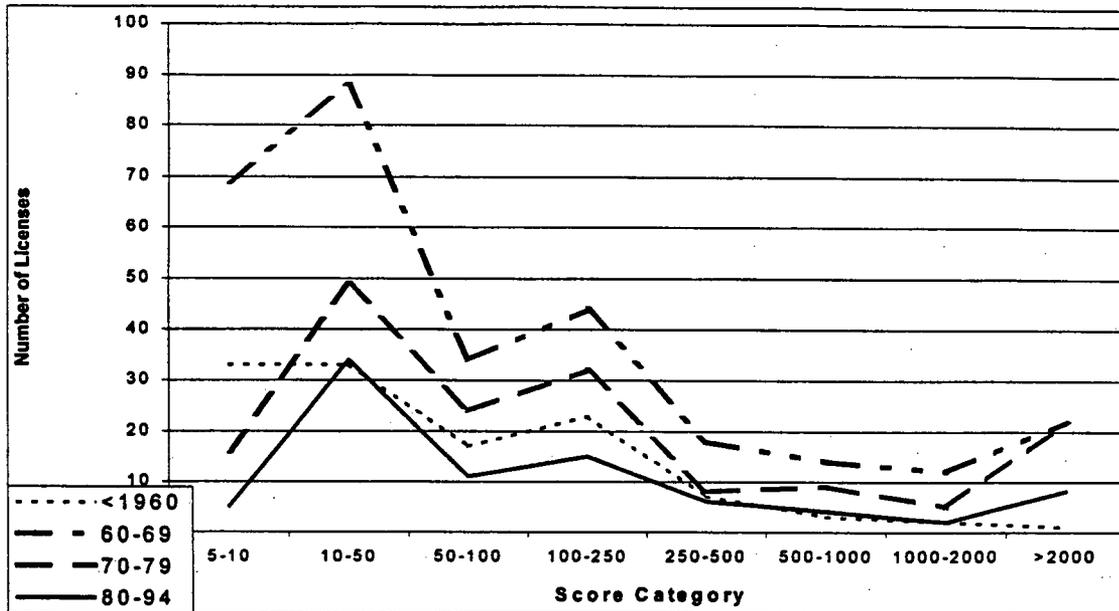


Figure 4.5 Time Trends in Site Score Values

Figure 4.6 shows the number of site licenses identified by time period, with the percent site identifications shown by the line graph. The rate of identification tracks the number of evaluations made – the higher the number of terminations, the higher the rate at which sites were identified. The exception is the period 1970-74, which had a fairly high rate of identification. Since this was the transition period between agencies, it is likely that there was a lower level of oversight during that period.

The rate of identification declined for more recently terminated licenses, with a 1.4 percent identification rate for post-1985 terminations. This compares to a rate nearly twice as high in the period 1960-64, which had the highest rate of site identification.

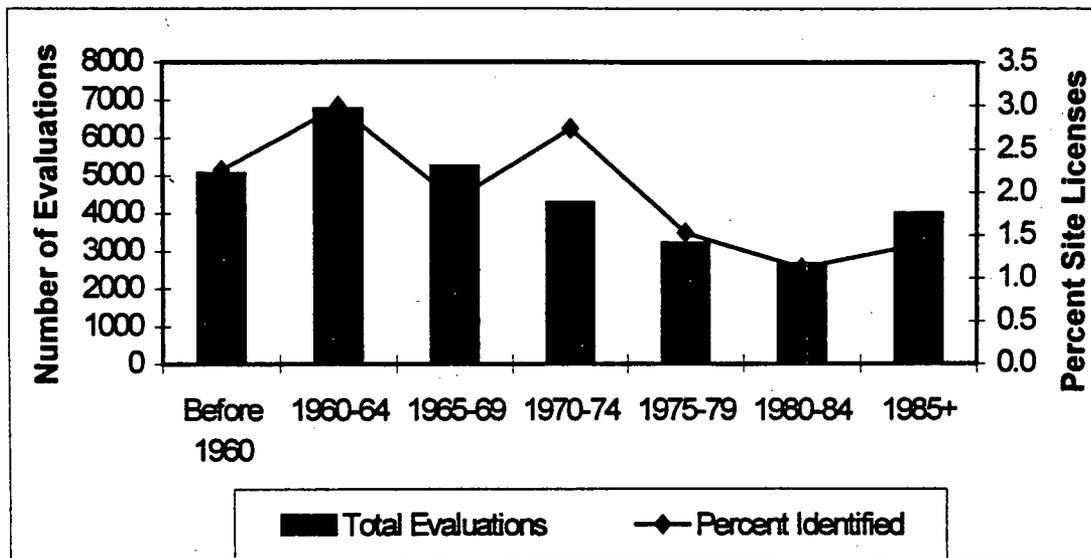


Figure 4.6 Proportion of Evaluations Identified for Site Review

Figure 4.7 shows the number of identified site licenses terminated by five-year time periods. Clearly the total number of identified sites dropped considerably after 1980.

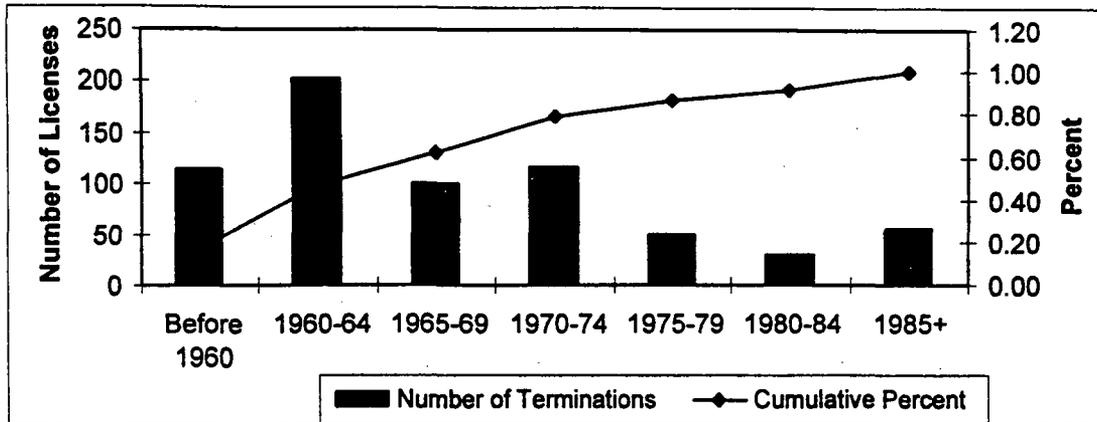


Figure 4.7 Sites Identified by Time Period

4.6 Byproduct Material License Site Evaluations

Figure 4.8 shows the distribution of site scores for the 219 Part 30 licenses. The median Total Site Score for Part 30 licenses was 76.9; however, a total of 15 licenses received a site score above 2,000. Chapter V will discuss the characteristics of identified site licenses, the reasons for the assignment of site scores, and the types of licenses most likely to receive a site score.

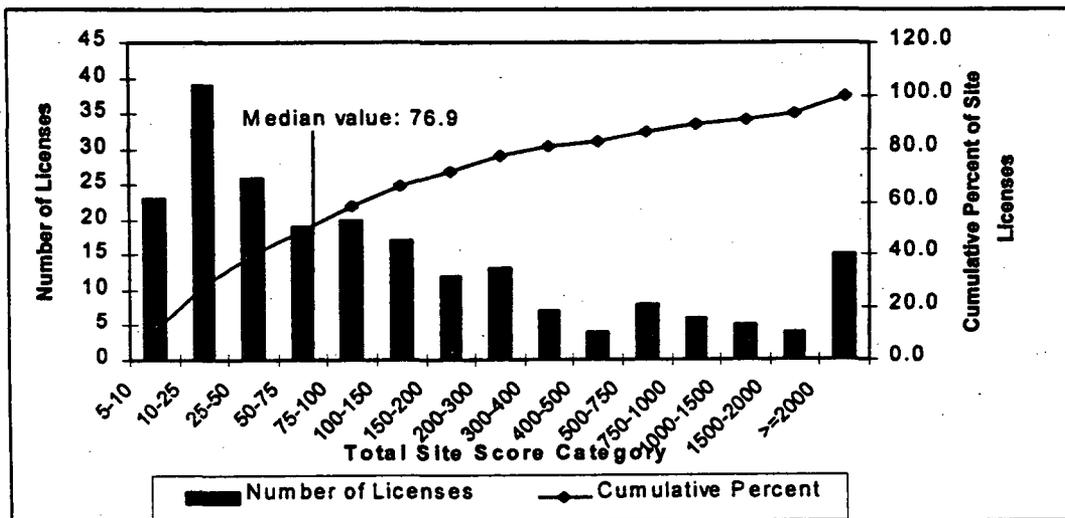


Figure 4.8 Frequency Distribution of Site Scores for Part 30 Licenses

4.7 Source Material License Site Evaluations

A total of 343 of the 5,118 Part 40 license evaluations (6.7 percent) resulted in Total Site Scores above 5. After removal of the 1538 mining licenses, over 9 percent of the remaining 3,580 Part 40 licenses were identified for site review. The distribution of scores for Part 40 licenses is shown in Figure 4.9. The median score for Part 40 licenses was considerably lower than those for Part 30 or Part 70²⁰. Fewer Part 40 licenses received very high scores (above

²⁰ This is partly due to the fact that the material scoring scheme for source materials was developed separately from that for both byproduct materials and SNM. See Chapter 2 for further information.

1,000), indicating a very high priority for review. Thus, while Part 40 licenses had the highest likelihood of being identified for site review, they had an overall lower priority for review, if priority is measured by the Total Site Score.

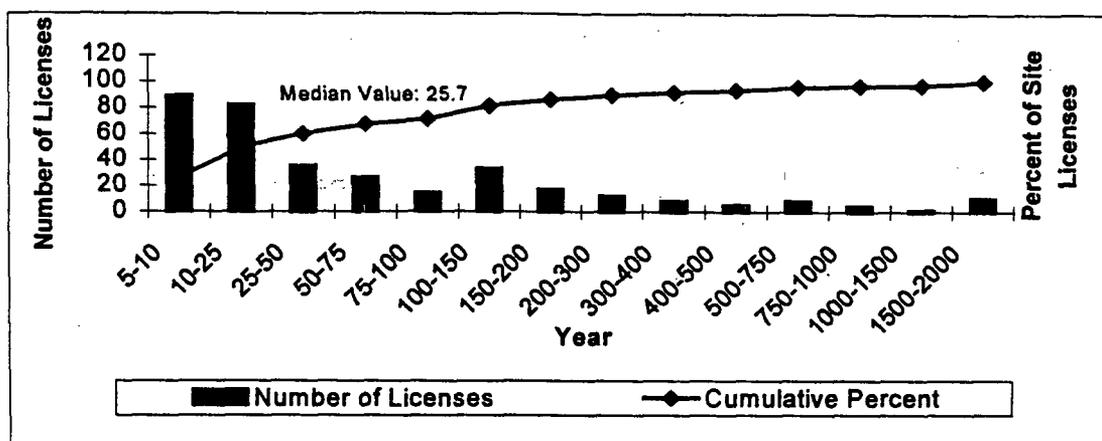


Figure 4.9 Distribution of Total Site Scores for Identified Source Material Licenses

4.8 Special Nuclear Material Site License Evaluations

4.8.1 SNM Evaluation Scores

There were fewer terminated Part 70, or SNM licenses, than the other two categories. A total of 1,415 SNM evaluations were conducted, with 260 Part 70 licenses having loose material (see Table 4.1). The likelihood of an SNM license with loose material being flagged for site review was high: a total of 113 evaluations (43 percent of the 260) resulted in further site review. The Total Site Score values for SNM licenses were also the highest of the three license types, as shown in Figure 4.10.

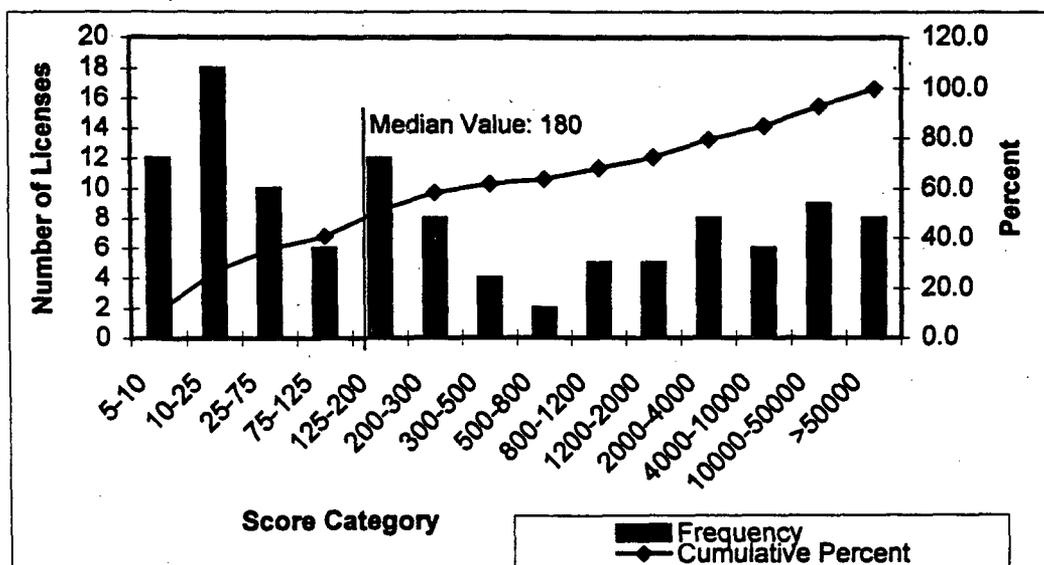


Figure 4.10 Distribution of Site Scores for Identified SNM Site Licenses

4.8.2 SNM Evaluations by Region

SNM licenses located in Regions I and III accounted for 883 of the 1,415 total SNM evaluations, almost 65 percent. Regions I, III, and the Walnut Creek Field Office (formerly Region V) all had close to a 12 percent identification rate

for SNM licenses, while Region II and Region IV had considerably lower rates of identification. These results are displayed in Table 4.5.

Table 4.5 SNM License Evaluations, by Region and Score Category

Values in italics represent the number of SNM licenses identified for further site review.

| Score | Region I | Region II | Region III | Region IV | WCFO | All SNM Evaluations |
|---|------------|------------|------------|------------|------------|---------------------|
| Total SNM Evaluations. (% in Region) | 551 (39.0) | 184 (13.0) | 332 (25.6) | 150 (10.6) | 197 (13.9) | 1415 |
| Zero Score | 485 (88) | 173 (94) | 295(89) | 144(96) | 173(88) | 1270 (90) |
| <5 | 15 | 3 | 8 | 1 | 4 | 31 (2.2) |
| 5-10 | 6 | 0 | 2 | 1 | 3 | 12 (0.8) |
| 10-50 | 13 | 3 | 4 | 0 | 3 | 23 (1.6) |
| 50-100 | 5 | 0 | 3 | 0 | 1 | 9 (0.6) |
| 100-500 | 12 | 1 | 9 | 1 | 3 | 26 (1.8) |
| 500-1000 | 2 | 0 | 1 | 0 | 1 | 4 (0.3) |
| 1000-10000 | 5 | 3 | 6 | 2 | 6 | 22 (1.6) |
| 10000-100000 | 5 | 1 | 4 | 0 | 3 | 13 (0.9) |
| >=100000 | 3 | 0 | 0 | 1 | 0 | 4 (0.3) |
| Percent of SNM Licenses Identified for Further Site Review | 12 | 6 | 11 | 4 | 12 | 8 |

4.9 Material Authorizations

4.9.1 Loose Material Authorizations

Table 4.6 shows the number of authorizations for loose material (or 'any' form, assumed to be loose). Materials with more than 50 authorizations are included.

Table 4.6 Most Commonly Authorized Loose Materials

| Material or Material Category | Number of Authorizations | Median Amount or Activity Authorized (in Curies unless given) |
|---|--------------------------|--|
| C-14 | 1946 | 0.0100 |
| I-131 | 1762 | 0.0300 |
| CO-60 | 1596 | 0.0010 |
| P-32 | 1523 | 0.0200 |
| SOURCE MATERIAL (not specified as Uranium or Thorium) | 820 | 50.0000 lbs |
| H-3 | 785 | 0.1000 |
| CR-51 | 674 | 0.0050 |
| THOR-MAG ALLOY | 586 | 40.0000 lbs |

Table 4.6 (continued).

| Material or Material Category | Number of Authorizations | Median Amount or Activity Authorized (in Curies unless given) |
|---|--------------------------|---|
| S-35 | 565 | 0.0100 |
| CS-137 | 495 | 0.0010 |
| AU-198 | 483 | 0.2000 |
| ANY BYPROD MATERIAL (between Atomic Nos. 1-83) | 478 | 0.1000 |
| FE-59 | 425 | 0.0020 |
| URANIUM (Natural or Normal) | 391 | 34.2000 lbs |
| THORIUM (or Th-232) | 291 | 100.0000 lbs |
| CA-45 | 283 | 0.0050 |
| CL-36 | 262 | 0.0020 |
| SR-90 | 220 | 0.0100 |
| NA-24 | 218 | 0.0100 |
| FE-55 | 202 | 0.0050 |
| K-42 | 195 | 0.0100 |
| U-235 | 187 | 100.0000 gms |
| ZN-65 | 152 | 0.0050 |
| NI-63 | 139 | 0.0100 |
| CO-58 | 114 | 0.0010 |
| DEPLETED URANIUM | 114 | 235.0000 lbs |
| MEDICAL GROUP | 98 | 1.0000 |
| OTHER BYPRODUCT MATERIAL | 98 | 0.0200 |
| PLUTONIUM or PU-239 | 98 | 0.0029 gms |
| PM-147 | 94 | 0.0650 |
| BA-133 | 93 | 0.0010 |
| HG-203 | 84 | 0.0050 |
| AM-241 | 78 | 0.0010 |
| KR-85 | 71 | 1.0000 |
| CS-134 | 68 | 0.0100 |
| CU-64 | 66 | 0.0200 |
| RB-86 | 64 | 0.0100 |
| I-125 | 62 | 0.0100 |
| AG-110 | 60 | 0.0100 |
| CE-144 | 58 | 0.0050 |
| SR-89 | 56 | 0.0025 |
| SE-75 | 54 | 0.0050 |
| TL-204 | 54 | 0.0040 |

The four most commonly authorized materials are all byproduct materials of varying but generally low hazard. In fact, six of the seven most frequent materials were byproduct materials that are generally used in loose form as tracers in medical and other applications.

The most commonly authorized material was C-14, which in loose form is ordinarily used as a tracer in multiple types of applications. Although long-lived, it has a very low human hazard and required very large authorizations to receive a nonzero material score. Both I-131 and P-32 are used primarily for medical purposes and are relatively short-lived. Consequently, neither material contributed to score values for site score evaluations. Co-60 does have a fairly long half-life (~5 years) and does represent some hazard. The very low median authorization level (1 millicurie) reflects the fact that the majority of authorizations for the material were very low. Nevertheless, Co-60 did contribute to the material score for a number of licenses.

The most common material category was source material (without specification of either Uranium or thorium). The median authorization level was 50 pounds. The next most commonly authorized source material was thorium-magnesium alloy, followed by specific authorizations of uranium or thorium.

The most commonly authorized SNM in loose form was U-235, followed by the combined category of Pu-239 or plutonium without further specification. Am-241 was authorized on both Part 70 and Part 30 licenses, and the median authorization value given is in Curie units.

4.10 Sealed Source Evaluations

4.10.1 Sealed Source Scoring System Summary

This section provides a quick summary of the pertinent information regarding the scoring system for sealed sources. The following points should be considered when examining the results in this section.

- **Sealed Source Score.** Initial material scoring for sealed sources use the same calculation as for loose material. The score for sealed material is calculated as one-tenth of the score that would result for the same material in loose form, decremented for decay. Thus, the sealed score reflects both containment and some measure of current hazard, because decay has been considered.
- **Final Total Sealed Source Score.** For Phase 3 evaluations, an individual assessment of the disposition of specific sealed sources authorized under the license was available. The final Total Sealed Source Score for Phase 3 evaluations (roughly post-1985 terminations) was the sum of the individual material scores for those sealed sources without complete accounting only. For Phase 1 and Phase 2 evaluations (pre-1985 terminations), the option of marking individual sources as accounted/not accounted was not available. Thus, for Phase 1 and 2 evaluations, if any sealed source was not accounted for at the time of license termination, the Total Sealed Source Score was the sum of all individual sealed source scores.
- **Cutoff Value for Sealed Source Review.** Because of the changes in the scoring scheme and the distribution of sealed source scores, the cutoff value for further sealed source review was modified after Phases I and II, from a value of 1 to a value of 5. Thus a Total Sealed Source Score of 5, combined over those sources with incomplete accounting, was required for further review.

4.10.2 Characteristics of Identified Sealed Source Licenses

A total of 564 sealed source licenses were identified for further follow-up to determine final accounting of the sources. Identified licenses authorized a highly variable number of sources. A total of 382 (68 percent) of the identified Sealed licenses were Part 30 licenses, 145 (26 percent) were Part 70 licenses, and 37 (6 percent) were Part 40 licenses.

The pattern is different when only considering licenses that were recorded as possessing sealed material. For all sealed source licenses, 3.6 percent of Part 30 licenses were identified for review (382 of 10,621), 22 percent of SNM licenses authorizing sealed sources were identified for review (145 of 668), and 17 percent of source material licenses were identified (37 of 232). Thus, after considering type of possession, byproduct material licenses were far less likely to be identified for sealed source follow-up than were either SNM licenses or source material licenses.

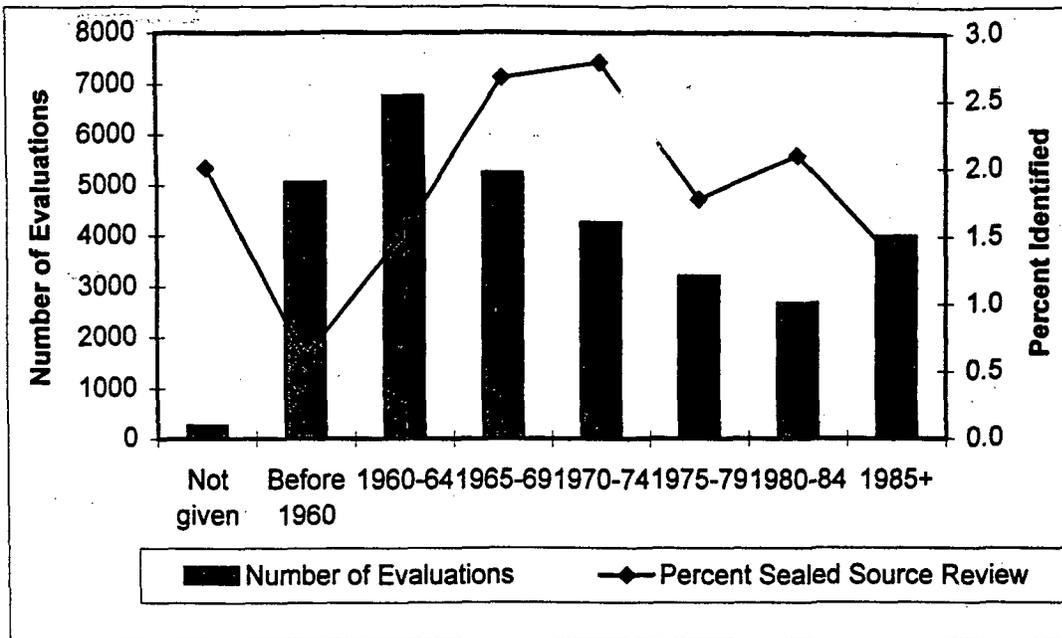


Figure 4.11 Rate of Identification for Sealed Source Followup, by Time Period of Termination

Figure 4.11 shows the number of evaluations by time period and the rate of identification of sealed source licenses for follow-up of unaccounted sources. Unlike site identification, sealed source license identification rates continued to climb through the 1970-74 period, but then declined. The sealed source identification rate for post-1985 is 1.3 percent, nearly the same as the value of 1.4 percent for site identifications in the 1985+ period.

4.10.3 Termination Dates for Identified Sealed Source Licenses

Figure 4.12 shows the termination dates for the identified Sealed Source licenses. This figure can be compared to Figure 4.1, which shows termination dates for all evaluations, and to Figure 4.6, showing termination dates for identified site licenses. Sealed source license identifications rose consistently through the 1970-74 termination period, and declined to almost half the peak rate for 1985+ terminations.

The general patterns in identifications over termination period are similar for site licenses and sealed source licenses – a general rise through the 1970-74 period and a decline thereafter. Both the pre-1974 rise and the post-1974 decline in proportion identified are more consistent for the sealed source licenses than for identified site licenses.

The overall proportion of licenses identified for sealed source review is somewhat lower than that for site review, with 1.8 percent of licenses identified for sealed source review, versus 2.1 percent of licenses identified for site review. For recent terminations, the proportions were very similar, but considerably fewer of the pre-1974 terminations were identified for sealed source review than for site review.

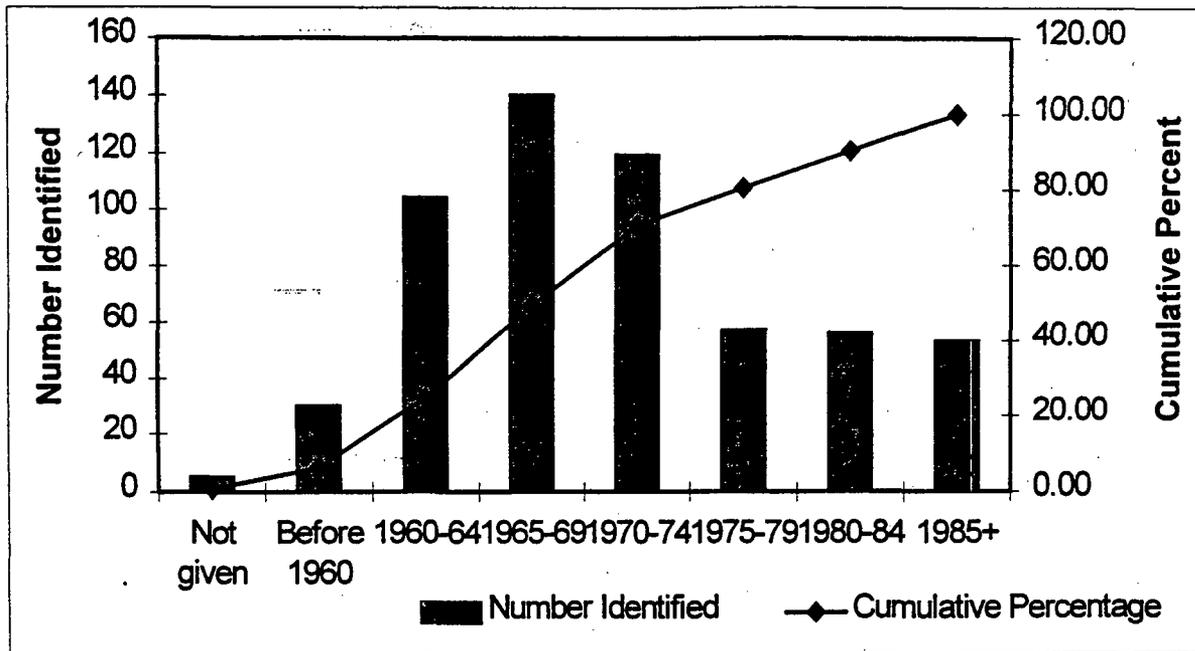


Figure 4.12 Termination Dates for Identified Sealed Source Licenses

Termination dates are important in this case for several reasons. Most important is the fact that the longer the elapsed time since license termination, the greater the level of difficulty that may exist in following up the license to determine sealed source fate. As Figure 4.12 shows, nearly 80 percent of the identified sealed source licenses were terminated before 1974, or a minimum of 25 years ago. Follow-up of these licenses may be a difficult process. The largest number of identified sealed source licenses was from the 1960-74 period, during which 363 (64 percent) of the 564 licenses identified for follow-up were terminated.

4.10.4 Institutional Category of Sealed Source Identifications

Table 4.7 shows the distribution of identified sealed source licenses by institutional category. Categories clearly over-represented are Universities and Colleges (23 percent of identified sealed source licenses versus a representation of only 12 percent of all records), and Industrial and Private (company) licenses (53.7 percent of the sealed source identifications, but 43.8 percent of the records). Clearly less likely to be identified for sealed source follow-up were medical and hospital licenses, which formed 19 percent of the records, but only 6.9 percent of the sealed source identifications. This is somewhat surprising, since hospital and physician licenses are likely to include sealed source authorizations. On the other hand, authorized material on medical licenses, both sealed and loose, is probably more likely to be small quantities of short-lived material than authorized material for other categories.

Table 4.7 Institutional Category for Identified Sealed Source Licenses

| Category ²¹ | Number of Identifications | Percent of Identified Licenses in Category | Percent of All License Records in Category |
|-----------------------------------|---------------------------|--|--|
| Federal Licenses | 60 | 10.6 | 9.3 |
| Other Government | 11 | 2.0 | 1.6 |
| Universities, Colleges | 131 | 23.2 | 12.0 |
| Other Schools | 5 | 0.9 | 0.4 |
| Industrial, Private | 303 | 53.7 | 43.8 |
| Medical and Hospital | 39 | 6.9 | 19.0 |
| Individual (excluding physicians) | 12 | 2.1 | 6.7 |
| Institutes, Research, Foundations | 3 | 0.5 | 0.8 |

4.11 Sealed Source Material Authorizations

Table 4.8 shows the frequency of specific material authorizations for sealed sources, again limited to those materials with a minimum frequency of 50.

Not surprisingly, the median activity authorized is higher for sealed sources. The nature of the most commonly authorized materials is also different; in general, more hazardous materials are authorized for sealed sources than for loose materials. The four most commonly authorized sealed sources are Cobalt-60, Cesium-137, Americium-241 and Strontium-90, all byproduct materials possessing some hazard. Nickel-63, the next most commonly authorized sealed source, rarely received a material score. Plutonium-Beryllium (Pu-Be) pellets and Plutonium or Pu-239 sources are the most commonly authorized sealed sources on Part 40 and Part 70 licenses, respectively. The range of Plutonium authorization amounts is very large. Authorized amount of Plutonium is quite low for most sealed source licenses, as shown by the median value given.

²¹ Only the categories listed had sealed source identifications.

Table 4.8 Commonly Authorized Materials in Sealed Source Authorizations

| Material or Authorization Category | Number of Authorizations | Median Activity or Amount Authorized (in Curies unless given) |
|------------------------------------|--------------------------|---|
| CO-60 | 3187 | 0.030 |
| CS-137 | 2390 | 0.095 |
| AM-241 | 1402 | 0.050 |
| SR-90 | 953 | 0.020 |
| NI-63 | 657 | 0.030 |
| H-3 | 448 | 1.250 |
| IR-192 | 372 | 58.00 |
| URANIUM | 228 | 4.35 lb |
| KR-85 | 195 | 0.250 |
| PU-BE PELLETS | 162 | 80.00 gm |
| PO-210 | 159 | 0.210 |
| PLUTONIUM OR PU-239 | 149 | 0.0024 gm |
| DEPLETED URANIUM | 126 | 404 lb |
| CD-109 | 90 | 0.020 |
| PM-147 | 88 | 0.500 |
| GD-153 | 87 | 3.000 |
| ANY BYPRODUCT MATERIAL | 69 | 0.100 |
| U-235 | 69 | 58.00 gm |
| FE-55 | 67 | 0.050 |
| SHORT-LIVED ONLY | 66 | NA |
| TL-204 | 60 | 0.020 |
| C-14 | 59 | 0.003 |
| BA-133 | 58 | 0.001 |
| CF-252 | 53 | 0.010 |
| U-235 | 50 | 52.50 gm |
| SB-124 | 46 | 0.50 |
| TM-170 | 41 | 55.00 |
| I-125 | 36 | 0.550 |
| PART 35.500 | 24 | 0.500 |
| CM-244 | 21 | 0.040 |

5. FINDINGS FOR IDENTIFIED LICENSES

This chapter will present detailed information regarding licenses identified for site score review and for sealed source review. The former are referred to as site licenses, while the latter are referred to in the text as identified sealed licenses.

5.1 Site Licenses

There were a total of 1,392 separate loose material authorizations for the 675 site licenses, an average of 2.1 loose material entries per license. Table 5.1 shows the unsealed (loose) materials that were authorized on more than 20 of the 675 identified site licenses. The materials given in Table 5.1 account for 74 percent of the authorized materials on site licenses. For a complete list of authorized materials for site licenses, see Table A.2 in The Appendix.

Authorizations can be either for specific isotopes or for broad categories of materials. Entries to Table 5.1 reflect actual authorizations, as they are given on the licenses.

Table 5.1 Materials Frequently Authorized on Site Score Licenses

| Material Authorized | Number of Site Score Licenses | Percent of site licenses authorizing material |
|---|-------------------------------|---|
| Any byproduct material (or any with Atomic Number 1-83 or 3-83) | 187 | 18 |
| U-235 | 113 | 11 |
| Source material, NOS | 111 | 11 |
| Th-232 or Thorium NOS | 98 | 9 |
| Thorium-Magnesium Alloy | 68 | 7 |
| Natural or Normal Uranium | 67 | 7 |
| H-3 | 48 | 5 |
| Co-60 | 48 | 5 |
| Sr-90 | 45 | 4 |
| Cs-137 | 43 | 4 |
| Pu-239 or Plutonium, Not otherwise specified | 42 | 4 |
| Depleted Uranium (other than shielding) | 37 | 3 |
| Am-241 | 33 | 3 |
| Pm-147 | 25 | 2 |
| Total (for listed materials) | 1032 | |

The most commonly licensed material or group authorized on the site licenses was 'Any byproduct material.' This specification is usually limited to materials between Atomic Numbers 1-83 or 3-83. Licenses issued for 'any byproduct material' were particularly difficult to evaluate because of the nonspecific nature of the authorization. This is the fundamental reason why such byproduct material licenses were more likely to be identified than other byproduct material licenses. In the absence of information, it is necessary to make conservative assumptions regarding possession. For the 'any byproduct material' authorization, an assumption was made that the material actually possessed was of the equivalent hazard and longevity of Pb-210 (Lead-210). This is rarely the case. Therefore, licenses authorizing the broad range of byproduct materials had a disproportionately high likelihood of being identified.

The next most commonly authorized materials on identified licenses were U-235, Source Material without further specification, and Thorium or Th-232.

5.2 Sealed Source Licenses

Table 5.2 shows the most commonly authorized material for identified sealed source licenses. Bear in mind that the identification of a license does not necessarily imply that all the sources used under that license are unaccounted, only that the total score for the unaccounted sources was above the total required for identification. Thus, not all the materials given in the table can be assumed to be unaccounted.

Table 4.8 in Chapter 4 gave the distribution of sealed source authorizations for all evaluations. Table 5.2 may be compared to that distribution. Interestingly, the distribution of source types for the identified sealed source licenses is quite similar to the distribution of all sealed source authorizations. Cobalt-60, Cesium-137 and Americium-241 are the three most frequent on both lists, although Cesium-137 appeared most frequently on the identified licenses, whereas Cobalt-60 appeared most frequently for the total evaluation group. The following are notable differences in the two distributions:

1. Authorization of Plutonium-Beryllium Pellets is relatively more frequent among the identified sealed sources than in the entire authorizations list. In fact, of 162 Plutonium-Beryllium pellet authorizations, 108 were identified for sealed source follow-up. This is not surprising, since reviewer observation indicated that follow-up for Plutonium-Beryllium pellets often was fairly lax, particularly with universities and colleges. Further, Plutonium-Beryllium pellets ordinarily contain 80 grams of Plutonium, and thus received a sizeable material hazard score.
2. Uranium-235 was also more frequently authorized on identified licenses: a total of 42 times on the identified list, with only 69 total entries to materials licenses in general.
3. Nickel 63 was the fifth most commonly authorized sealed source material for all evaluations, but appeared only a total of eight times on identified licenses. Since Nickel-63 is relatively nonhazardous, its material score is quite low, which probably explains the lack of frequency on the identified licenses. The eight appearances are probably accounted for by multiple authorizations on those licenses, including material more hazardous than Nickel-63.
4. Not surprisingly, the median amounts authorized were considerably higher for the identified licenses than for the total pool. Of particular note is Cobalt-60, which was authorized at a median of 31.5 Curies on identified sealed source licenses, nearly a thousand times higher than the overall median authorization limit of 30 millicuries (Table 4.8). For Cesium-137 and Americium-241, the difference in median amounts between all license authorizations and identified licenses was much less, because these two isotopes are longer-lived and have a higher hazard value.

Table 5.2 Materials Frequently Authorized under Identified Sealed Source Licenses²²

| Material or Category | Authorization Unit | Number of Authorizations | Amount/Activity Authorized | | |
|------------------------|--------------------|--------------------------|-----------------------------|--------------|-----------------------------|
| | | | 20 th Percentile | Median value | 80 th Percentile |
| CS-137 | Curies | 274 | 0.02 | 1.005 | 25.0 |
| CO-60 | Curies | 243 | 0.7 | 31.5 | 1000.0 |
| AM-241 | Curies | 143 | 0.03 | 0.05 | 0.33 |
| PU-BE PELLETS | Grams | 108 | 32.0 | 80.0 | 146.5 |
| SR-90 | Curies | 81 | 0.001 | 0.2 | 2.0 |
| URANIUM | Pounds | 73 | 0.21 | 2500. | 5500. |
| PLUTONIUM/PU-239 | Grams | 39 | 0.000001 | 0.21 | 20.0 |
| IR-192 | Curies | 30 | 16.0 | 120.0 | 301.0 |
| U-235 | Grams | 42 | 4.0 | 56.0 | 4500. |
| Any byproduct material | Curies | 13 | 0.05 | 0.5 | 200.0 |
| H-3 | Curies | 12 | 0.15 | 2.1250000 | 20.0 |
| PM-147 | Curies | 11 | 1.0 | 5.0 | 500.0 |
| FE-55 | Curies | 10 | 0.0011636 | 0.0120000 | 0.06 |
| NI-63 | Curies | 8 | 0.01 | 0.04 | 0.15 |
| TM-170 | Curies | 8 | 1.0 | 32.7 | 100.0 |
| KR-85 | Curies | 7 | 0.02 | 0.5 | 10.0 |
| CF-252 | Curies | 6 | 0.0000014 | 0.1303 | 0.26 |
| C-14 | Curies | 5 | 0.0025000 | 0.02 | 0.06 |
| CD-109 | Curies | 5 | 0.0000252 | 0.001 | 0.035 |
| PO-210 | Curies | 5 | 0.525 | 1.5 | 46.5 |
| U-233 | Grams | 4 | 0.001 | 2.0 | 15.0 |

²² All other materials had fewer than 4 entries on the identified sealed source licenses.

REFERENCES

1 Eckerman, K.E., Anthony B. Wolbarst, and Allan C.B. Richardson. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion*. Federal Guidance Report No. 11, EPA 520/1-88-020, September, 1988.

Appendix . Data and Detailed Results

A.1 Data Descriptions

There are two basic data sets – the Inventory and Evaluation data sets. Each data set has many related databases. This appendix gives data definitions and relationship definitions for both data sets.

A.1.1 Inventory Data

Inventory data was originally maintained by the project in xBase (.dbf) format. Beginning with Phase 3, inventory data was collected as an MSAccess95 data set. All common inventory data from the three phases has now been merged into common data sets, and is available in the following formats:

1). Microsoft Access 97; 2) Microsoft Access 2.0 (for 16-bit architectures); 3) dbf format; and 4) SAS data set.

The schematic in Figure A.1 shows the data layout for license file and supplemental file inventory.

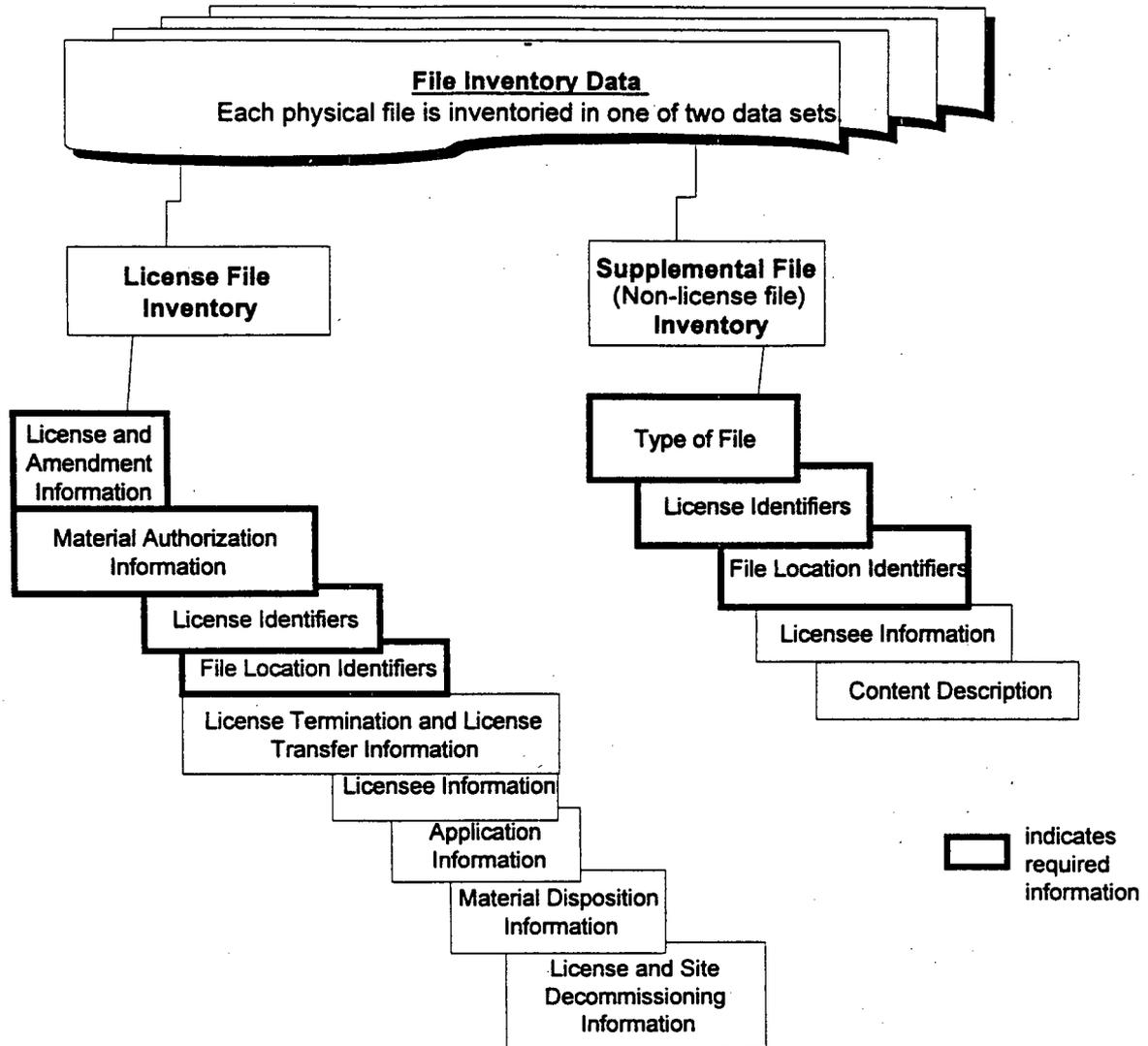


Figure A.1 Schematic of Inventory Data

A.1.2 Evaluation Data

Figure A.2 shows the general scheme for evaluation data.

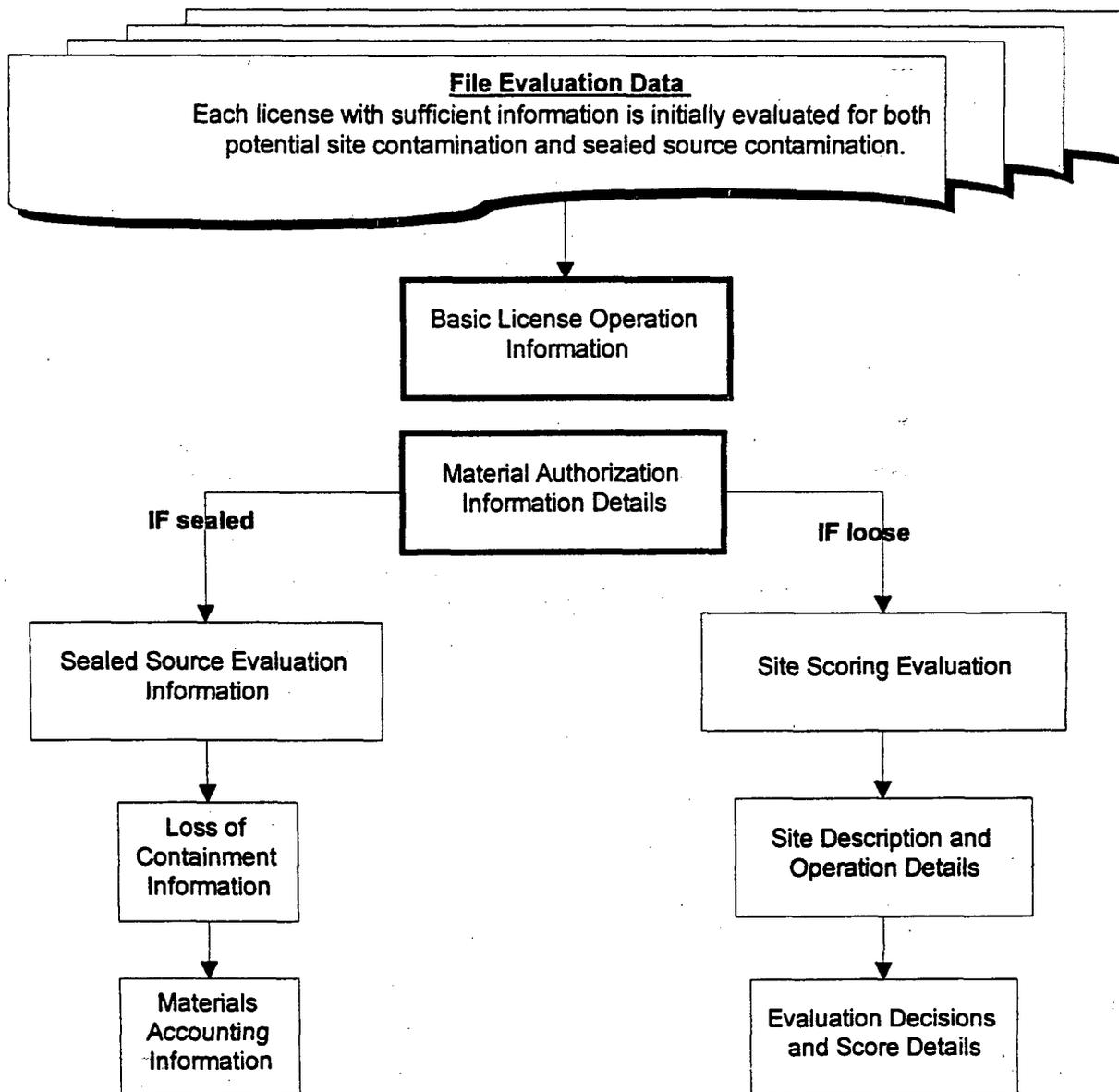


Figure A.2 Evaluation Data Organization Scheme

A.2 NRC Regions and Program Codes

The following map shows the states in the four NRC Regions and in the Walnut Creek Field Office (formerly Region V)

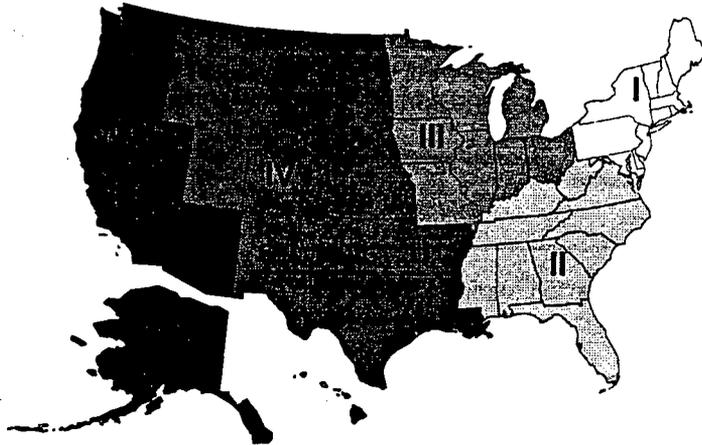


Figure A.3 Map of NRC Regions

Table A.1 is a comprehensive list of all NRC material license program codes and their associated priority levels.

Table A.1 NRC Material License Program Codes

| Program Code | Description | 10 CFR Citation | Priority Level |
|--------------|---|---------------------|----------------|
| 01100 | Academic Broad Type A | 33.13 | 2 |
| 01110 | Academic Broad Type B | 33.14 | 2 |
| 01120 | Academic Broad Type C | 33.15 | 5 |
| 01200 | Academic Other | 30 | 0 |
| | SECONDARY CODE ONLY | | |
| 02110 | Medical Institution Broad | 33.13, 33.14, 33.15 | 1 |
| 02120 | Medical Institution Limited | 35.11 | 3 |
| 02121 | Medical Institution Custom | 35 | 4 |
| 02200 | Medical Private Practice Limited | 35.11 | 4 |
| 02201 | Medical Private Practice Custom | 35.11 | 4 |
| 02209 | Grandfathered In-vivo General Medical Use | 35.31 | 4 |
| 02210 | Eye Applicators Sr-90 | 35.11 | 5 |
| 02220 | Mobile Nuclear Medicine Service | 35.11, 35.29 | 2 |
| 02300 | Teletherapy | 35.11 | 1 |

Table A.1 (continued).

| Program Code | Description | 10 CFR Citation | Priority Level |
|--------------|--|-----------------|--|
| 02400 | Veterinary Non-human | 30 | 5 |
| 02410 | In-vitro Testing Laboratories | 30 | 5 |
| 02500 | Nuclear Pharmacies | 32.72 | 1 |
| 02511 | Medical Product Distribution 32.72 | 32.72 | 3 |
| 02512 | Medical Product Distribution 32.73 | 32.73 | 5 |
| 02513 | Medical Product Distribution 32.74 | 32.74 | 3 |
| 03110 | Well Logging Byproduct and/or SNM Tracer and Sealed Sources | 39.11, 39.13 | 3 |
| 03111 | Well Logging Byproduct and/or SNM Sealed Sources Only | 39.13, 39.11 | 3 |
| 03112 | Well Logging Byproduct Only - Tracer Only | 39.13, 38.11 | 3 |
| 03113 | Field Flooding Studies | 39.11, 39.13 | 3 |
| 03120 | Measuring Systems Fixed Gauges | 30.33 | 7 |
| 03121 | Measuring Systems Portable Gauges | 30.33 | Industrial Lixiscope - 5; Moisture/Density Gauge-4 |
| 03122 | Measuring Systems Analytical Instruments | 30.33 | 6 |
| 03123 | Measuring Systems Gas Chromatographs | 30.33 | 7 |
| 03124 | Measuring Systems Other | 30.33 | 7 |
| 03211 | Manufacturing and Distribution Broad Type A | 33.13 | 1 |
| 03212 | Manufacturing and Distribution Broad Type B | 33.14 | 3 |
| 03213 | Manufacturing and Distribution Broad Type C | 33.15 | 5 |
| 03214 | Manufacturing and Distribution Other | 30.33 | 6 |
| 03218 | Nuclear Laundry | 30.33 | 3 |
| 03220 | Leak Test Service Only | 30.33 | 7 |
| 03221 | Instrument Calibration Service Only, Source Less Than 100 curies | 30.33 | 7 |
| 03222 | Instrument Calibration Service Only, Source Greater Than 100 curies | 30.33 | 3 |
| 03223 | Leak Test and Instrument Calibration Service, Source Less Than 100 Curies | 30.33 | 7 |
| 03224 | Leak Test and Instrument Calibration Service, Source Greater Than 100 Curies | 30.33 | 3 |
| 03225 | Other Services | 30.33 | Soil & Water Analysis - 7 ; Repair Teletherapy Units, Irradiators, Large gauges - 4 |
| 03231 | Waste Disposal (Burial) | 61 | 0 |
| 03232 | Waste Disposal Service Prepackaged Only | 30.33 | 2 |

Table A.1 (continued).

| Program Code | Description | 10 CFR Citation | Priority Level |
|--------------|--|------------------|-----------------------------|
| 03233 | Waste Disposal Service Incineration | 20.305 and 30.33 | 1 |
| 03234 | Waste Disposal Service Processing and/or Repackaging | 30.33 | 1 |
| 03235 | Incineration, Noncommercial | 20.305 and 30 | 0 |
| 03240 | General License Distribution 32.51 | 32.51 | 4 |
| 03241 | General License Distribution 32.53 | 32.53 | 4 |
| 03242 | General License Distribution 32.57 | 32.57 | 4 |
| 03243 | General License Distribution 32.61 | 32.61 | 5 |
| 03244 | General License Distribution 32.71 | 32.71 | 3 |
| 03250 | Exempt Distribution -Exempt Concentrations and Items | 32.11 | 6 |
| 03251 | Exempt Distribution - Certain Items | 32.14 | 5 |
| 03252 | Exempt Distribution - Resins | 32.17 | 5 |
| 03253 | Exempt Distribution - Small Quantities | 32.18 | 5 |
| 03254 | Exempt Distribution - Self Luminous Products | 32.22 | 5 |
| 03255 | Exempt Distribution - Smoke Detectors | 32.26 | 5 |
| 03310 | Industrial Radiography Fixed Location | 34.11 | 1 |
| 03320 | Industrial Radiography Temporary Job Site | 34.11 | 1 |
| 03510 | Irradiators Self Shielded Less Than 10,000 Curies | 30.33 | 3 |
| 03511 | Irradiators Other Less than 10,000 Curies | 30.33 | 3 |
| 03520 | Irradiators Self Shielded Greater Than 10,000 Curies | 30.33 | 3 |
| 03521 | Irradiators Other Greater Than 10,000 Curies | 30.33 | 3; Pool Type and Other 1 |
| 03610 | Research and Development Broad - Type A | 33.13 | 2 |
| 03611 | Research and Development Broad - Type B | 33.14 | 3 |
| 03612 | Research and Development Broad - Type C | 33.15 | 5 |
| 03613 | Research and Development Broad-Multisite-Multiregional | 33 | 1 |
| 03620 | Research and Development Other | 30.33 | 5 |
| 03710 | Civil Defense | 30.33 | 7 |
| 06100 | Low-Level Waste Storage | 30 | 0 |
| 11100 | Mills | 40 | 1/0 |
| 11200 | Source material Other Less Than 150 Kilograms | 40 | 3 |
| 11210 | Source material Shielding | 40 | 7 |
| 11220 | Source material Military Munition Testing | 40 | Indoors 7; Outdoors 3 |
| 11230 | Source material General License Distribution | 40.34 | 5 |
| 11300 | Source material Other Greater Than 150 Kilograms | 40.32 | 3 |

Table A.1 (continued).

| Program Code | Description | 10 CFR Citation | Priority Level |
|--------------|---|-----------------|----------------------------------|
| 11400 | Uranium Hexafluoride Production Plants | 40.32 | 1/0 |
| | Solution Mining (R&D and Commercial Facilities) | 40.32 | 1/0 |
| 11500 | | | |
| 11600 | Heap Leach, Ore Buying Stations and Byproduct Recovery | 40.32 | 1/0 |
| 11700 | Rare Earth Extraction and Processing | 40 | 3 |
| 11800 | Source material | 40 | 0 |
| 21130 | Hot Cell Operations | 70 | 1/0 |
| 21210 | Uranium Fuel Processing Plants | 70 | 1/0 |
| 21240 | Uranium Fuel Research and Development and Pilot Plants | 70 | 1/0 |
| 21310 | Critical Mass Material | 70 | 5 |
| 21320 | Critical Mass Material | 70 | 5 |
| 22110 | Special nuclear material Plutonium-Unsealed, Less Than A Critical Mass | 70 | Unsealed 2; Less than 15 grams 3 |
| 22111 | Special nuclear material, U-235 and/or U-233-unsealed, Less Than a Critical Mass | 70 | Unsealed 2; Less Than 15 Grams 3 |
| 22120 | Special nuclear material, Plutonium Neutron Sources, Less Than 200 Grams | 70 | 6 |
| 22130 | Power Sources with Byproduct and/or special nuclear material | 30 and 70 | 7 |
| 22140 | Special nuclear material, Plutonium, Sealed Source in Devices | 70 | 6 |
| 22150 | Special nuclear material, Plutonium, Sealed Sources, Less Than a Critical Mass | 70 | 6 |
| 22151 | Special nuclear material, U-235 and/or U-233 Sealed Sources Less Than A Critical Mass | 70 | 6 |
| 22160 | Pacemaker-Byproduct and/or special nuclear material - Medical Institution | 30 and 70 | 7 |
| 22161 | Pacemaker-Byproduct and/or special nuclear material - Individual | 30 and 70 | 7 |
| 22162 | Pacemaker-Byproduct and/or special nuclear material - Manufacturing and Distribution | 30 and 70 | 1 |
| 22170 | Special nuclear material, General License Distribution | 70.39 | 5 |
| 23100 | Fresh Fuel Storage at Reactor Sites | 70 | 1/0 |
| 23200 | Interim Spent Fuel Storage | 72 | 1/0 |
| 25110 | Transport-Private Carriage | 30, 40 and 70 | 0 |

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

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11. ABSTRACT (200 words or less)

This report presents the results of a six-year project that reviewed material licenses that had been terminated during the period from inception of licensing until approximately late 1994. The material licenses covered in the review project were Part 30, or byproduct material licenses, Part 40, or source material licenses and Part 70, or special nuclear material licenses. The report describes the methodology developed for the project, summarizes the findings of the license file inventory process, and describes the findings of the reviews or evaluations of the license files. The review identified sites of nuclear material use for which either review of the licensing material or more direct follow-up of some type was judged to be needed. The review process also identified licenses authorized to possess sealed sources for which there was incomplete or missing documentation of the fate of the sources.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

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