ECONOMIC IMPACT ANALYSIS FOR THE PROPOSED REPORTABLE QUANTITY ADJUSTMENTS FOR RADIONUCLIDES UNDER SECTION 102 OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

A Report to the

EMERGENCY RESPONSE DIVISION
Office of Emergency and Remedial Response
U.S. Environmental Protection Agency

Prepared by

ICF INCORPORATED
under subcontract to
Combustion Engineering, Inc.
EPA Contract 68-03-3182

December 1986

ICF INCORPORATED International Square
1850 K Street, Northwest, Washington, D. C. 20006

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D C. 20460

APR _ 8 1987

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Publication of Proposed Reportable Quantity (RQ) Adjustment Regulations for CERCLA Potential Carcinogens and Radionuclides

FROM: Timothy Fields, Jr., Director
Emergency Response Division (WH-548/B)

TO: EPA Regional Libraries

On March 16, 1987, the Agency published two regulations proposing RQ adjustments for potential carcinogens and radionuclides in accordance with section 102 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended (see 52 FR 8140-8186). Attached for your information are copies of the Federal Register notice and the technical and economic background documents for each proposed rulemaking.

The public comment period for both proposed rules is scheduled to end on May 15, 1987. Please make the FR Notice and technical and economic background documents available to the interested public upon request. If you need additional information, please contact Dr. K. Jack Kooyoomjian at (202) 382-4130 (carcinogen regulation) or Ms. Barbara Hostage at (202) 382-2198 (radionuclides regulation).

Attachments

ECONOMIC IMPACT ANALYSIS FOR THE PROPOSED REPORTABLE QUANTITY ADJUSTMENTS FOR RADIONUCLIDES UNDER SECTION 102 OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

A Report to the

EMERGENCY RESPONSE DIVISION
Office of Emergency and Remedial Response
U.S. Environmental Protection Agency

Prepared by

ICF INCORPORATED
under subcontract to
Combustion Engineering, Inc.
EPA Contract 68-03-3182

December 1986

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF EXHIBITS

CHAPTER 1

BACKGROUND AND INTRODUCTION

The purpose of an Economic Impact Analysis (EIA) is to estimate the incremental costs and benefits resulting from a regulatory action. Any regulation requiring behavior changes will usually result in some elements of society which will benefit from the regulation and some elements of society which will incur costs. An EIA analyzes those benefits and costs and estimates the net gain or net loss under the proposed regulation.

This chapter describes the general reporting requirements under Sections 103(a) and (b) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and describes the reporting requirements for radionuclides in particular. It explains the purpose of the proposed regulation and introduces this report to the reader. Section 1.1 describes CERCLA reporting requirements and the ranges of potential response activities triggered by CERCLA reporting; Section 1.2 describes the statutory authority for and the intended purpose of the RQ adjustment for radionuclides; and Section 1.3 describes the remaining chapters of this report.

1.1 BACKGROUND ON CERCLA AND RQ NOTIFICATION REQUIREMENTS

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) establishes broad federal authority to respond to releases or threats of releases of hazardous substances from vessels and facilities. The Act requires immediate notification to the National Response Center when a hazardous substance designated under CERCLA is released into the environment in an amount equal to or greater than the reportable quantity (RQ) for that substance.

Section 101(14) of CERCLA defines as a CERCLA hazardous substance any substance designated under:

- Sections 307 and 311 of the Clean Water Act;
- Section 3001 of the Resource Conservation and Recovery Act;
- Section 112 of the Clean Air Act; and
- Section 7 of the Toxic Substances Control Act.

In addition, the Environmental Protection Agency (EPA) has the authority under Section 102 of CERCLA to designate additional hazardous substances. Currently, there are 717 CERCLA hazardous substances. Section 102(b) of the statute establishes a one-pound RQ for each of these substances, except those for which an RQ was established pursuant to Section 311 of the Clean Water

Act. Section 102(a) of CERCLA authorizes EPA to adjust statutory RQs by regulation.[1]

Under regulations implementing the general reporting requirements of Sections 103(a) and (b) of CERCLA, a person in charge of a vessel or facility is required to notify the National Response Center immediately when there is a release of a designated hazardous substance in an amount equal to or exceeding the reportable quantity (RQ) for that substance (40 CFR Section 302.6(a)). Those persons required to notify but who fail to report immediately to the National Response Center are subject to criminal penalties under CERCLA Section 103(b). Releases that are federally permitted are exempt from the Section 103 notification requirements.

The purpose of RQ notification is to alert the federal government to releases of hazardous substances that may require rapid response to protect public health and welfare and the environment. Under Section 104 of CERCLA, the federal government may take response action whenever there is a release or a substantial threat of a release of a hazardous substance or of any pollutant or contaminant which may present an imminent and substantial danger to public health or welfare.[2] Notification based on RQs serves to inform the government of a release, thereby enabling an evaluation of the incident and a timely field response should one be deemed necessary. Notification does not necessarily mean that a federal field response will occur, nor does it eliminate liability or responsibility for response costs or natural resource damages associated with the release.

1.2 RQ ADJUSTMENTS FOR RADIONUCLIDES

There are approximately 1800 radionuclides. A radionuclide is an element with an unstable combination of protons and neutrons in its nucleus. Instability is the net effect of forces between these two types of nuclear particles. To achieve a more stable configuration, the nucleus releases energy in the form of particles or rays by a process of decay called radioactivity. Each radionuclide decays at a different rate and, as a result, a pound of two different radionuclides could represent significantly different levels of radioactivity.

---

[1] The RQs for 340 hazardous substances were adjusted by EPA on April 4, 1985 (50 FR 13456). RQ adjustments for an additional 102 substances were established in a final rule published September 29, 1986 (51 FR 34534).

[2] Notification to the National Response Center pursuant to CERCLA Section 103 is limited to releases of designated hazardous substances in amounts that equal or exceed the applicable RQ. Releases consisting solely of pollutants or contaminants that are not designated as hazardous substances under CERCLA need not be reported to the National Response Center.

Radionuclides are designated as hazardous air pollutants under Section 112 of the Clean Air Act and, as such, are designated CERCLA hazardous substances. Section 102 of CERCLA establishes a one-pound RQ for radionuclides, as a generic class of substances, but authorizes EPA to adjust the RQ by regulation if appropriate. EPA recognizes that an RQ of one pound for radionuclides is not appropriate in most cases because releases of less than one pound may present a substantial hazard to public health and welfare and to the environment. In addition, "pound" units for measuring radionuclides are not commonly used for the purpose of radiation protection.

All other CERCLA hazardous substances have RQs in units of pounds, ranging from one pound to 5000 pounds. For these substances, the principal health concerns are chemical toxicity, ignitability, reactivity, or potential carcinogenicity, which may be related to some number of pounds released of the hazardous substance. Radionuclides are different in this respect from other CERCLA hazardous substances. The principal health hazard associated with exposure to radionuclides is carcinogenicity, but the hazard is related more closely to the radioactivity emitted rather than the mass of the substance. Although the level of radioactivity is directly proportional to the mass (i.e., the number of pounds) of the radionuclide released, activity levels are generally used as indicators of radiation hazard. The quantity of radioactivity is measured in units of curies[3] (Ci) and, for each radionuclide, the same number of pounds translates into a different number of curies. Thus, the statutory one-pound RQ translates into a wide range of curies for different radionuclides, covering twenty orders of magnitude.

Besides curies, another widely used radiation measurement is the Roentgen Equivalent Man (rem).[4] The rem is a unit measure of radiation dose and is often expressed as some number of rem to a specific organ such as the lungs, thyroid, or whole body. The difference between curies and rem is that the latter considers the routes of exposure and biological effects and, therefore, directly reflects the levels of tissue damage. Curies can be converted into rem by identifying the radionuclide, mode and duration of exposure, quantity of intake, tissues most acutely affected, and other factors.

The nuclear industry generally works with units of curies and rem and, in fact, most existing reporting triggers for radionuclide releases are expressed in terms of one of these two units. In addition, essentially all existing regulations and controls established by the Nuclear Regulatory Commission and the Department of Energy, which govern a major portion of the nuclear industry, are based in units of curies or rem. Therefore, in order for the RQ under CERCLA to be consistent and meaningful, and to ensure that the radionuclide RQ

---

[3] The curie is a measure of the rate of radioactive decay, with one curie equal to 3.7×10^{10} disintegrations per second.

[4] Radiation measurements can also be expressed in international metric units of becquerels or sieverts, however, these terms are less common in the United States.

allows for timely reporting and timely field response, if necessary, the statutory one-pound RQ is being adjusted in a proposed regulation.

The proposed RQs are in units of curies and are not uniform across all radionuclides. The Agency is proposing to divide radionuclides into seven RQ groups: 0.001 curie, 0.01 curie, 0 1 curie, 1 curie, 10 curies, 100 curies, and 1000 curies. The Agency is proposing RQs for 757 individual radionuclides for which there are metabolic data presented in the International Commission on Radiation Protection (ICRP) Report Number 30. The Agency is also proposing an RQ for all radionuclides not listed by the ICRP. These other radionuclides have a proposed RQ of 1 curie for the entire class.

For most radionuclides, the proposed RQ adjustments would require reporting releases that are considerably smaller than one pound. The proposed regulation, therefore, will impose additional reporting and report processing costs on the regulated community and the government respectively. This analysis discusses and quantifies, to the extent possible, the costs and benefits that will result from the proposed RQ adjustments.

1.3 ORGANIZATION OF THIS REPORT

This report analyzes the economic effects of the proposed RQ adjustments for radionuclides. It analyzes the costs and benefits and estimates the net gain or net loss under the proposed regulation. The remainder of this report is organized as follows:

Chapter 2 -- **Alternative Approaches Considered for Adjusting Radionuclide RQs** -- a discussion of the regulatory options considered during the proposed rulemaking development process;

Chapter 3 -- **Baseline Reportable Releases** -- an analysis of baseline (pre-regulatory) reportable releases, including a discussion of available release data, size distribution of releases, and the estimated number of baseline reportable releases;

Chapter 4 -- **Valuation of the Effects of the Proposed RQ Adjustments** -- an explanation of the unit values used in estimating the incremental costs and benefits of the proposed regulation;

Chapter 5 -- **Estimated Annual Costs of the Proposed RQ Adjustments** -- an analysis of the additional costs that would be incurred by both the regulated community and government as a result of the proposed regulation;

Chapter 6 -- **Estimated Benefits of the Proposed RQ Adjustments** -- a qualitative assessment of the additional benefits under the proposed regulation;

Chapter 7 -- **Sensitivity Analysis** -- a test of the assumptions used throughout this report to determine sensitivity of the results to various assumptions; and

Appendix A -- **Profiles of Facilities that Release Radionuclides** -- a general discussion of the types and number of facilities that potentially release radionuclides.

CHAPTER 2

ALTERNATIVE APPROACHES CONSIDERED FOR ADJUSTING RADIONUCLIDE REPORTABLE QUANTITIES

Radionuclide production and use in the United States is presently regulated and controlled by the Nuclear Regulatory Commission and the Departments of Energy and Transportation. These agencies were asked by EPA to participate actively in an interagency work group[1] whose purpose was to explore the relative advantages and disadvantages of alternative approaches for adjusting the radionuclide RQ. The work group carefully considered numerous RQ adjustment options including:

- Option 1: Allowing the radionuclide RQ to remain at one pound;
- Option 2: Assigning no RQ to radionuclides;
- Option 3: Establishing a dose-equivalent level (i.e., units of rem) as the radionuclide RQ;
- Option 4: Establishing a single level of activity as an RQ for all radionuclides;
- Option 5: Grouping radionuclides into categories and assigning an RQ in terms of activity to each category; and
- Option 6: Establishing an RQ for individual radionuclides based on activity levels (i.e., units of curies).

The option of leaving the RQ at one pound was rejected because pound units are not meaningful for radiation protection and a quantity of one pound often represents potentially high levels of radiation contamination. The second option, establishing no RQ for radionuclides, was rejected because it would have to be supported by a finding that existing reporting requirements adequately cover releases of all radionuclides, and, at present, EPA could not make such a finding. In particular, many releases of naturally occurring and accelerator produced radionuclides (NARM) are not required to be reported under existing federal regulations, and many existing reporting requirements do not require immediate telephone notification.

Option 3 was seriously considered as it is presently the basis of existing reporting requirements by the Department of Energy and the Nuclear Regulatory

---

[1]Work group membership also included representatives from the U.S. Coast Guard and several offices within EPA.

Commission. It was determined, however, that this reporting option required too much judgment on the part of the person in charge of the facility or vessel and, for purposes of CERCLA reporting, may not produce timely reports. Option 4, establishing a single level of activity for all radionuclides, and Option 5, grouping radionuclides using specific criteria and assigning activity-level RQs to each group, were determined to be inappropriate because neither option accounted for the varying degrees of hazard posed by the same activity level of different radionuclides. These options would not have required radionuclide by radionuclide evaluation to develop an RQ, but rather would have required analysis of large groups of radionuclides based on a single characteristic. Because of the lack of homogeneity among radionuclides, grouping the radionuclides into meaningful categories for purposes of RQ development became difficult.

EPA ultimately selected in the proposed regulation the last option, establishing a proposed RQ based on activity levels for selected radionuclides. This final option involved an analysis of individual radionuclides, evaluating their individual characteristics to determine appropriate proposed RQs. Ultimately, all radionuclides were grouped into one of seven RQ categories, but only after completion of the individual radionuclide evaluations.

This chapter discusses briefly options 3 and 6, the two adjustment options considered most seriously for determining radionuclide RQs. The chapter begins with a discussion of the relative advantages and disadvantages of establishing dose-equivalent levels as the radionuclide RQ. The chapter then discusses the selected option, assigning proposed RQs based on the activity levels of individual radionuclides.[2]

2.1 Establishment of a Dose-Equivalent Level as the Radionuclide RQ

EPA explored the option of establishing a radionuclide proposed RQ based on a single dose-equivalent level or a set of dose-equivalent levels assigned to all radionuclides. A dose equivalent is a direct measure of the amount of biological damage resulting from exposure to ionizing radiation. Dose equivalent is measured generally in terms of rem or sieverts. A dose-equivalent level is not a measure of emitted radiation, but is a method of normalizing the effect of an absorbed dose of radiation in tissue, regardless of the type of radiation. It is therefore useful from a health and environmental protection perspective because the number of rem can be related directly to the amount of damage likely to be incurred. The Agency seriously considered establishing a proposed RQ for radionuclides in terms of rem because most reporting requirements of the Nuclear Regulatory Commission and the Department of Energy are in terms of rem.

---

[2]The other adjustment alternatives not specifically presented in this chapter are discussed in depth in: ICF, Incorporated and Environmental Monitoring & Services, Inc., Technical Background Document to Support Rulemaking Pursuant to CERCLA Section 102: Radionuclides, Report to the Environmental Protection Agency, Office of Solid Waste and Emergency Response, October 1986.

To assign proposed RQs in terms of dose equivalent or rem, the Agency first had to determine which dose-equivalent level is most appropriate for a radionuclide RQ. Several agencies of the U.S. Government and other national and international organizations have developed different estimates of the appropriate dose-equivalent level. Many of these dose-equivalent levels vary substantially. For example, the Federal Radiation Protection Guidance recommends a limiting exposure of 500 millirem per year for the general public and the ICRP recommends a limit of 5 rem per year for employees of nuclear facilities. EPA established an annual dose-equivalent level of 4 millirem per year in 40 CFR Part 141 (promulgated under the Safe Drinking Water Act). Therefore, there did not appear to be a universally accepted dose-equivalent reporting trigger for use under CERCLA.

A second major issue faced by the Agency when considering this alternative involved the development of a standardized methodology for estimating dose-equivalent levels. A standardized methodology was considered desirable because a dose equivalent is not measurable directly. For a given release, different judgments regarding exposure pathways, intake quantity, and other factors could lead to different dose-equivalent estimates and, thus, different determinations of whether the release is reportable to the National Response Center under CERCLA.

The advantages of establishing radionuclide RQs based on dose-equivalent levels are twofold. First, a dose-equivalent value can be related directly to potential health effects without having to make further assumptions or performing additional calculations. Second, a dose-equivalent level RQ could be established for all radionuclides, including mixtures, because one RQ level would suffice for all radionuclide releases.

The disadvantages of the option, however, were perceived to be substantial. Among the primary disadvantages was that estimating a dose-equivalent level can be quite complicated and its magnitude may vary substantially for different circumstances involving the release of the same amount of the same radionuclide. For example, different exposure pathways, periods of exposure, and bodily organs exposed may yield order-of-magnitude differences in dose-equivalent estimates for the same release quantity. Moreover, dose-equivalent levels would be more difficult than an activity level to estimate quickly during an actual release event.

For these reasons, the Agency decided to remove the dose-equivalent alternative from further consideration, favoring instead the determination of proposed RQs for individual radionuclides based on activity levels.

2.2 The Selected Approach -- Setting RQs in Terms of Activity Levels

The Agency ultimately decided to propose radionuclide RQ adjustments based on levels of activity. A level of activity, in units of curies (or becquerels), is a measure of the rate of radioactive decay and thus the amount of radiation given off by a substance.

There are several advantages to basing radionuclide RQs on activity levels. For example, a level of radioactivity is much easier to measure than a dose equivalent. A common survey instrument such as a Geiger counter can be used to measure directly the ionizing radiation. The Agency believes setting RQs in terms of activity would, therefore, provide more timely reporting than an RQ expressed in terms of dose equivalent.

A second advantage of using activity levels is that establishing RQs for radionuclides individually would allow consideration of individual radionuclide characteristics (e.g., nuclide forms and the potential to migrate through the environment). An RQ in terms of dose equivalent (rem) would also (by definition) have considered nuclide form and migration but would have left much greater judgment to the person in charge of the vessel or facility. Activity level RQs (curies) also consider each radionuclide individually but minimizes judgments by the person in charge of the vessel or facility. The option to establish RQs in terms of curies, therefore, was considered advantageous.

The nuclide-specific RQ approach also has disadvantages however. Primarily, unlike a dose-equivalent value, a level of activity by itself does not necessarily reflect a level of danger to human health. As is presently the case for RQs for non-radioactive substances, a case-by-case evaluation by the On-Scene Coordinator will be necessary to estimate the health and welfare and environmental hazards associated with a radionuclide release, and to determine if a federal response is required.

The general methodology used by the Agency to develop proposed RQs began with the ALIs listed in ICRP's Publication 30. These values are annual intake limits, in units of curies, that would result in radiation exposure of 5 rem. The ALIs were adjusted by EPA to reflect (1) the difference between intake levels and release levels and (2) a lower dose equivalent of 500 millirem (0.5 rem), a more protective release level. Using conservative assumptions regarding different releases to air and water, and analyzing exposure through inhalation, ingestion, and direct exposure, EPA estimated the smallest number of curies for each radionuclide which, if released to the environment, could result in a person being exposed to a dose equivalent of 500 millirem.

The inhalation equation derives a Release Value by dividing the ALI for inhalation developed by the ICRP by the product of the following factors:

- The release fraction that describes the portion of radioactive materials that could become airborne in a release;

- The Atmospheric Relative Concentration Value corresponding to a ground-level relative concentration at 30 meters from a ground-level release under stable meteorological conditions;

- The breathing rate of "Reference Man"; and

Several numerical factors to account for a 500 millirem dose limit for members of the general public and the conversion from microcuries to curies.

The ingestion equation is based on a ground-water release scenario using an advection-dispersion model combined with conservative estimates for such parameters as ground-water flow velocities, retardation factors, and transverse and longitudinal dispersion. The resulting equation, like the one for inhalation, derives a Release Value by dividing the ALI for ingestion by the product of an assumed dilution factor, contact time, and water consumption, as well as the same numerical factors as the inhalation equation.

A set of equations were also developed to calculate Release Values for a third route of exposure, direct exposure to a release of a radionuclide. One direct exposure equation derives the quantity of material intercepted by "Reference Man" at a distance 30 meters from a point source release, assuming an exposure of 500 millirem. Release Values are derived by dividing the product of the squared distance and the absorbed dose by the duration of exposure and the product of photon energy emitted and the fraction of the encountered radiation absorbed.

A second direct exposure equation was derived for releases of noble gases which result in exposure by submersion in a cloud of radioactive material. This second equation uses air concentration values rather than ALIs and, therefore, also incorporates the Atmospheric Relative Concentration Value mentioned above.

For each radionuclide, three Release Values were derived: inhalation, ingestion, and direct exposure.[3] To simplify the administration and implementation of RQ reporting, the radionuclides were then assigned to seven groups based on the lowest Release Values:

- 6 radionuclides (0.8%) have a proposed RQ of 0.001 curie;
- 25 radionuclides (3.3%) have a proposed RQ of 0.01 curie;
- 24 radionuclides (3.2%) have a proposed RQ of 0.1 curie;
- 35 radionuclides (4.6%) have a proposed RQ of 1 curie;

---

[3]For further detail on the methodology used in developing the radionuclide proposed RQs, see ICF Incorporated and Environmental Monitoring and Services, Inc., Technical Background Document to Support Rulemaking Pursuant to CERCLA Section 102: Radionuclides, Report to the Environmental Protection Agency, Office of Solid Waste and Emergency Response.

- 342 radionuclides (45.2%) have a proposed RQ of 10 curies;
- 242 radionuclides (31 2%) have a proposed RQ of 100 curies; and
- 89 radionuclides (11.8%) have a proposed RQ of 1000 curies.

In addition, radionuclides not listed by the ICRP have a proposed RQ of 1 curie. For all but 30 of the radionuclides with a specific proposed RQ adjustment, the proposed RQ is smaller than one pound. It is expected that the number of reportable releases for these radionuclides will increase, resulting in notification, recordkeeping, and response costs for the affected community and notification processing and other response costs for the government. Increased benefits of more efficient and timely responses are also to be expected.

For the 30 radionuclides whose proposed RQ is greater than one pound, the number of reportable releases are expected to decrease. This should result in lower costs to both the affected community and the government, and incremental threats to public health and welfare and the environment. Chapter 3 begins by discussing the baseline (pre-regulatory) reporting requirements and lays the foundation for estimating the incremental costs and benefits resulting from changes in the number of reportable releases under the proposed regulation.

CHAPTER 3

BASELINE REPORTABLE RELEASES

A regulatory baseline is the starting point for any economic analysis. The baseline provides a measurement of the estimated costs and benefits that the affected community would incur if the proposed regulation were not to take effect. Once the baseline has been estimated, we can then model the effects of the proposed regulation and estimate the post-regulatory costs and benefits incurred by society. The difference between the post-regulation costs and benefits and the baseline represents the incremental costs and benefits of the proposed regulation.

Baseline costs and benefits are related directly to the number of reportable radionuclide releases with a radionuclide reportable quantity (RQ) of one pound. The baseline costs are the values placed on actions resulting from a reportable release and the benefits are the values placed on cleanup of reportable releases. This chapter describes the methodology used to estimate baseline reportable releases and presents the baseline release estimates. Section 3.1 defines the regulatory baseline for the proposed regulation; Section 3.2 describes the data sets available for estimating baseline releases of radionuclides; Section 3.3 estimates the number of historical radionuclide releases; and Section 3.4 estimates the baseline number of reportable releases of radionuclides.

3.1 BASELINE DEFINITION

The baseline is an estimate of the costs and benefits the affected community would incur if the proposed regulation were not to take effect. It is related directly to the number of reportable releases under current reporting requirements.

Many facilities that produce and use radionuclides are regulated already by a number of different federal agencies. The Nuclear Regulatory Commission, the Department of Energy, the Department of Transportation, and the Environmental Protection Agency all impose reporting requirements and/or release limitations on facilities under their auspices. In addition, local and state license and registration programs also control the regulated community. Each agency's reporting requirements are different, frequently involving different time frames for reporting.

An important consideration in analyzing baseline reporting is that Section 103(a) of CERCLA requires immediate notification to the National Response Center by the person in charge of a facility or vessel if a release equals or exceeds an RQ. Therefore, reports to other agencies are not a substitute for directly telephoning the National Response Center.

For purposes of this analysis, therefore, the regulatory baseline is defined as the costs and benefits associated with reporting releases of radionuclides to the National Response Center prior to the proposed regulation. Releases of radionuclides need to be reported immediately to the National Response Center under (1) Department of Transportation regulations (49 CFR Parts 171-177), and (2) Sections 103(a) and (b) of CERCLA.

The Department of Transportation (DOT) requires that all transportation incidents "involving the shipment of radioactive material in which fire, breakage, spillage, or suspected radioactive contamination occurs" shall be reported by telephone to the National Response Center "at the earliest practicable moment." (49 CFR Section 171.51(a))

Sections 103(a) and (b) of CERCLA require immediate notification to the National Response Center of all releases of radionuclides (and other CERCLA hazardous substances) in an amount that equals or exceeds the applicable RQ. The present statutory RQ for radionuclides is one pound. Section 102(a) authorizes EPA to adjust the statutory RQs for all CERCLA hazardous substances, including radionuclides.

There are two important exclusions to CERCLA notification requirements that pertain to radionuclides:

(1) Section 101(22)(C) of CERCLA excludes from the definition of release, any release of "... source, byproduct, or special nuclear material from a nuclear incident, as those terms are defined in the Atomic Energy Act of 1954, if such release is subject to requirements with respect to financial protection established by the Nuclear Regulatory Commission under Section 170 of such Act..."

(2) Section 101(10)(K) of CERCLA defines a federally permitted release (such releases need not be reported to the National Response Center) to include "any release of source, special nuclear, or byproduct material, as those terms are defined in the Atomic Energy Act of 1954, in compliance with a legally enforceable license, permit, regulation, or order issued pursuant to the Atomic Energy Act of 1954."

The first exclusion refers primarily to reactor incidents. The second exclusion has been interpreted by the Agency to mean any release that is in compliance with a regulation, license, or order from EPA, the Nuclear Regulatory Commission, an agreement state, or the Department of Energy.

EPA has issued a proposed regulation defining the scope of the federally permitted release reporting exemption (48 FR 23552, May 25, 1983) This regulation is scheduled to be reproposed in the near future. The draft reproposal states that any release of a CERCLA hazardous substance must be reported immediately to the National Response Center if the release exceeds federally permitted levels by an RQ or more. If the release is less than an RQ above permitted levels, the release is not considered federally permitted but nonetheless need not be reported to the National Response Center under

Sections 103(a) and (b) of CERCLA. Releases in compliance with EPA regulations, Nuclear Regulatory Commission licenses, agreement state licenses, and Department of Energy Orders are considered federally permitted under Section 101(10)(K) of CERCLA, and therefore do not need to be reported to the National Response Center.

Given these baseline reporting requirements, the following radionuclide releases would be, strictly speaking, baseline reportable releases:

- All reportable transportation incidents;
- All federally permitted releases that equal or exceed permitted levels by the statutory one-pound RQ; and
- All non-federally permitted releases that equal or exceed the statutory one-pound RQ.

However, we focus the analysis on non-transportation releases because all transportation incidents are already required to be reported to the National Response Center and, thus, the proposed regulation should not generate any increased reporting of transportation incidents. Adjustment of the radionuclide RQ, however, could affect the number of reports from facilities with and without federal permits because the reporting trigger is being adjusted in the proposed regulation.

3.2 AVAILABLE DATA SETS FOR ESTIMATING RADIONUCLIDE RELEASES

A radionuclide release data base was created for this analysis. The data base contains information describing radionuclide releases in the United States. Included in the information assembled in the data base are the date of each release and, when available, the radionuclide and quantity (in curies) released. These data were used to develop size and frequency distributions for radionuclide releases. We estimated the expected number and size of future radionuclide releases using data on the number and size of past radionuclide releases.

In developing the radionuclide release data base, release reports were incorporated from six sources:

- Reports maintained by the Nuclear Regulatory Commission's Office for Analysis and Evaluation of Operational Data (AEOD), 1981 through 1985;
- Reports maintained by the Transportation Technology Center (TTC) of Sandia National Laboratory in Albuquerque, New Mexico, 1971 through 1985;
- Data provided by the Department of Energy's Office of Environment and Health, Emergency Operations Center (EOC), March 1983 through April 1986;

- Reports to the National Response Center, 1982 through 1985;

- Reports to the Environmental Protection Agency's Office of Radiation Programs (ORP), October 1981 through September 1983; and

- Reports to the Nuclear Regulatory Commission's Operations Center, January 1983 through January 1986.

Of these six sources, the Nuclear Regulatory Commission's Office of Analysis and Evaluation of Operational Data (AEOD) incident reports were the most complete for our purposes, both in terms of release descriptions and the population of release events included in the data. These reports usually contained details on the quantity and identity of the radionuclide released. The AEOD reporting population includes all Nuclear Regulatory Commission licensees and some reports from agreement state licensees.

The release data obtained from the Transportation Technology Center (TTC) and DOE's Emergency Operations Center (EOC) are equally complete in terms of information provided. These sources, however, provide information on a much smaller subset of release events than does AEOD. The TTC data are limited to transportation accidents/incidents involving radioactive material; the EOC data are limited to the past three years (1983-1986) and include only reportable events under DOE Order 5484.1. Other events are not included in the EOC data set.

The release data from the National Response Center did not contain detailed quantity information and were, for the most part, not included in our data base. Reports examined from the Nuclear Regulatory Commission's Operation Center included only "release events" as defined by the Nuclear Regulatory Commission. The Commission's definition is narrower than CERCLA's definition of release.

Incident report duplication between the six sources appears to be relatively limited. In developing the radionuclide release data base, we tried to avoid double counting of releases by cross-checking the details about particular release events. Incompleteness of the reports in some of the sets and inconsistencies in dates of the events, however, complicated this effort. Duplicates, therefore, have probably not been totally eliminated.

The radionuclide release data base developed for this analysis includes 1,139 events. These events range in size over many orders of magnitude, from 5.0×10^{-9} curies to 56,892 curies. Of the 1,139 events in the data base, there are 455 events with no quantity information or for which units of curies could not be determined from available information. These 455 release events were used only in the estimation procedure to determine the frequency of release for particular radionuclides but could not be used to estimate the size distribution of radionuclide releases. There are also 23 events included in the data base that do not identify the radionuclide released but do have information on the quantities released. These events were used in the estimation procedure to determine the size distribution of radionuclide releases but could not be used to estimate the frequency of release for particular radionuclides. In cases where neither the radionuclide nor the quantity information was available in a data set, the event was not included in the data base of 1,139 events. Exhibit 3-1 summarizes the characteristics of the data base.

3.3 ESTIMATION OF HISTORICAL RADIONUCLIDE RELEASES

Baseline reportable releases are the number of releases that would need to be reported to the National Response Center if the proposed radionuclide RQ adjustments were not to take effect and the radionuclide RQ remained at one pound. Because it is not possible to predict the future with certainty, we rely on historical release events to characterize the likelihood of future releases of radionuclides. The number of historical radionuclide releases (both reportable and non-reportable) is the starting point in the estimation process for determining baseline annual reportable releases. We estimate baseline annual reportable releases to be a function of three factors:

(A) total number of annual releases of radionuclides;

(B) frequency of release for a particular radionuclide; and

(C) probability that a release equals or exceeds the reportable quantity of a particular radionuclide (i.e., the equivalent, in curies, of one pound or one pound above permitted or licensed levels).

In particular, the total number of baseline reportable releases can be represented as follows:

$$\text{Total Baseline Releases} = (A) * \sum_{i} [(B_i) * (C_i)]$$

The product of B_i and C_i represents the product of B_i, the probability of a release of a particular radionuclide, and C_i, the probability that any radionuclide will be equal to or above reportable levels, as that is defined for each radionuclide.

Therefore, the product $[B_i * C_i]$ represents the probability that a release of a particular radionuclide will be equal to or above reportable levels. The summation of this product represents the probability that any release will be equal to or above reportable levels. When we multiply this latter probability by (A), the total number of annual radionuclide releases at any level, we are able to derive the total number of annual radionuclide releases equal to or greater than the baseline RQ. Each of these factors is discussed in more detail below.

EXHIBIT 3-1

RADIONUCLIDE DATA BASE CHARACTERISTICS

Total number of release events in data base	1,139	
Number of release events without quantity information	455	1,139
Number of release events with quantity information (used to estimate size distribution of radionuclide releases)	684	
Number of release events with radionuclide unidentified	23	1,139
Number of release events with radionuclide identified (used to estimate the probability of release for a particular radionuclide)	1,116	
Number of radionuclides identified in data base	63	

Source: ICF analysis.

3.3.1 Total Number of Annual Releases of Radionuclides

The available data sets discussed in Section 3.2 above do not cover releases from all facilities that handle and are therefore likely to release radionuclides.[1] The data base established for this analysis is used primarily to develop the estimated frequency of release for particular radionuclides (factor B above) and the estimated size distribution of releases (factor C above). It is not used to estimate the total number of releases (reportable and non-reportable) of radionuclides by the affected community because a large portion of the releases by the affected community is not included in the data base (e.g., releases from facilities in agreement states are not included generally in the data base).

To estimate the total number of annual radionuclide releases, we focus the analysis on non-transportation releases because all transportation incidents are already required to be reported to the National Response Center. Thus, the proposed regulation should not generate any increased reporting of transportation incidents; the incremental increase in reportable radionuclide releases consist only of non-transportation releases.

We assume that the number of non-transportation releases is proportional to the number of facilities producing and using radionuclides in any appreciable quantity. We realize this assumption is an over-simplification and, thus, is not entirely accurate. The probability of a release event occurring at a facility is probably correlated with use levels and types and forms of radionuclides used at a facility. If a facility uses a small quantity of radionuclides in a sealed form, the likelihood of a release from that facility would be less than at a facility that uses a large quantity of radionuclides in an unsealed form. Unfortunately, facility-specific data on radionuclide production and use levels are unavailable.

To derive the number of annual non-transportation radionuclide releases, therefore, we rely on the Nuclear Regulatory Commission AEOD data. We use these data because the number of facilities required to report releases to the Nuclear Regulatory Commission is well defined and we can thus establish the relationship between the number of releases and the number of facilities required to report. The AEOD data set includes most release events from Nuclear Regulatory Commission licensees and some small fraction of the release events from agreement state licensees. Only Commission licensees are required to notify the Nuclear Regulatory Commission when there is a radionuclide release. However, some states and some facilities licensed by agreement

[1]Appendix A of this report describes the major types of facilities that produce and use radionuclides. Releases from facilities in agreement states would not be expected to be represented in the Nuclear Regulatory Commission data sets, the Sandia National Laboratory's data set, the Department of Energy data set, or the EPA's Office of Radiation Programs data set. It is possible that releases from these facilities could be represented in the data set from the National Response Center, but the data from this source are mostly qualitative and were, for the most part, not included in our data base.

states notify the Commission of a release even though they are not strictly obligated to do so.

It would not be appropriate simply to use the average number of events reported annually in the AEOD data set to represent average annual reportable releases in the baseline from Commission licensees. Because reporting an incident is relatively simple and because the nuclear industry is closely monitored and highly sensitive to public concerns, there is a tendency for the regulated community to report any incident, regardless of the quantity involved and regardless of whether the event actually results in a release to the environment. On the other hand, it is likely that some facilities may not be reporting all reportable release events. In addition, the AEOD data set does include some transportation incidents that must be elminated before we can use the data in our analysis.

A release is defined as an event where radionuclides are released into the environment. Strict determinations of releases in the AEOD data are difficult to make because the reports generally lack detail. It is difficult to determine, for example, whether a radionuclide release was contained by a structure or whether the radionuclides escaped to the environment. To promote consistency, we established criteria for categorizing the various events. These criteria are conservative to develop an upperbound estimate of the number of release events per year. These release events are not necessarily large nor do they pose a danger to public health or welfare or the environment; they are simply release events reported to the Nuclear Regulatory Commission over the last five years.

For the years 1981 through 1985, the release profile for the AEOD data set is shown in Exhibit 3-2. About 25 percent of all reports classified in this analysis as release events are clearly events involving releases to the environment. The remaining events were classified as releases to the environment in the following manner:

- Reports of loss, theft, or burial of radioactive equipment or sources (approximately 40 percent of the reports) -- Reports of lost radioactive seeds, stolen machinery, and burials of radioactive machinery or waste in landfills were classified as releases to the environment. The most commonly reported event throughout the AEOD data is the abandonment of sources in drilling holes. Because the sources are not recoverable, the Agency considers all such events to be releases to the environment, even if the sources are encapsulated with cement or slurry.

- Reports of contamination of shipped products or equipment (approximately 15 percent of all releases) -- Reports of contaminated or leaking equipment involved in shipping are considered events involving releases to the environment. They are, however, classified only as transportation releases when escape or leakage of

EXHIBIT 3-2

PROFILE OF RELEASES IN NUCLEAR REGULATORY COMMISSION AEOD DATA SET

Year	Total Number of Release Events*	Total Number of Transportation Releases	Total Number of Non-Transportation Releases from:	
			Agreement States	Commission Licensees
1981	103	7	2	94
1982	82	5	1	76
1983	103	8	8	87
1984	92	3	3	86
1985	83	9	15	59
Annual Average:	93	6	6	80

*A release event is defined as an event where radionuclides are released into the environment. It was often difficult to determine from the information in the reports whether a release to the environment actually occurred. When in doubt, for purposes of this analysis, we assumed the event did result in a release to the environment. In addition, many of the releases were exceedingly small, posing no danger to public health or welfare or the environment. The number of releases represented in this table are not necessarily reportable under either the one-pound RQ or the proposed RQs. The table simply presents the maximum number of events in the AEOD data that could be considered releases to the environment. The AEOD data sets also include additional events that were not considered to be releases. These events include, for example, reports of failure to submit monitoring data and incorrect labels on containers.

Source: ICF estimates.

radioactive materials is evident to shipping personnel and reported by them. A spill of material on a highway, for example, is considered a reportable transportation release. Damage, loss, or contamination of a package during shipping that was not clearly evident to shipping personnel, however, is assumed to be a non-transportation release. For example, if a package was received damaged, and the report does not clarify that the shipping agent was aware of the damage and had actually reported the incident, for purposes of this analysis, the report is considered a non-transportation release.

- Reports of high stack concentrations and radiation in unrestricted areas (approximately 15 percent of all reports) -- Citations of high concentrations of radioactive material in exhaust stacks and airborne radiation in unrestricted areas are both classified as releases to the environment. That is, if reports do not specify the location of airborne radioactive materials, we assume the event involved a release to the environment.

- Reports of allegations of releases (about 2 percent of all reports) -- Although not officially confirmed, allegations by personnel of release events (e.g., the burial of radioactive waste in a landfill) are considered releases to the environment.

- Report of fire (about 2 percent of all reports) -- Citation of a fire is considered evidence of a release except where a report indicates specifically no contamination.

The following events were not classified as releases to the environment:

- Reports of a leaking source -- Although it was not always possible to determine whether the leak occurred in a secure enclosure, we did not classify these events as releases to the environment.

- Reports of positive radioactivity test results -- Reports citing test results that found "removable" radiation on lab and industrial equipment were not classified as releases to the environment.

- Reports of exposure of badges or personnel -- Where badges worn by personnel reflect exposure to radioactivity, this analysis assumes exposure occurred in a contained structure. Badge exposure therefore was not classified as a release to the environment.

- Report of <u>loose packaging</u> -- Reports of loose or improper packaging used for purposes of transport were not considered evidence of a release. However, the observed escape of liquid or solid material from packaging was considered evidence of a release.

As shown in Exhibit 3-2, there are an estimated 80 annual non-transportation release events reported by Commission licensees in the AEOD data set. If we assume that 80 percent of all releases are actually reported to the Nuclear Regulatory Commission,[2] then the number of non-transportation radionuclide releases by Commission licensees is estimated to be 100 releases annually.

As discussed in Appendix A of this report, there are approximately 75,000 facilities that could potentially release radionuclides, including facilities in the following categories:

- Nuclear Regulatory Commission licensees (8,900);
- Agreement state licensees (13,000);
- DOE facilities (78); and
- Unlicensed facilities (53,475):

  Laboratories (700)
  Coal-fired utility and industrial boilers (52,500),
  Uranium mines (181 -- 21 active),
  Aluminum smelters (32),
  Copper smelters (15),
  Zinc smelters (5),
  Lead smelters (5),
  Phosphate rock plants (31), and
  Elemental phosphorous plants (6).

These industries are heterogeneous and, therefore, have very different probabilities of releasing radionuclides at levels that equal or exceed an RQ. Several of these industries are unlikely to be affected by the proposed RQ adjustments because they release radionuclides in very small quantities and only as part of their normal operations. Examples of these industries include: coal-fired boilers, aluminum, copper, zinc, and lead smelters, and phosphate rock plants. Radionuclide release cannot occur due to a spill at these facilities, but only due to the burning of the coal or ores during the production processes. The radionuclide releases may occur into water, into

---

[2]We have no data on the amount of under-reporting that occurs, but because Commission licensees are highly regulated and very sensitive to public concerns regarding radiation, we believe the assumption that 80 percent of releases are reported is reasonable. This figure is not assumed to be higher because there will always be some releases that the releaser will not report. Thus, under-reporting is taken into account here. We test the effect of this assumption in Chapter 7 of this report.

air, or through disposal of the sludge. Air releases from the facilities were examined closely by the Agency because radionuclides are a hazardous air pollutant under Section 112 of the Clean Air Act. The following discussion presents the general results of the Agency's analysis of the air releases from each of the different facilities.

Coal-fired boilers release radionuclides to the air only when they burn coal. The radionuclide quantities released during the coal-burning process are smaller than the proposed RQ levels. Radionuclides released from a large utility boiler, for example, are in the uranium and thorium series and are released at levels generally close to 0.0001 curies per day, except for radon-220 which is released at levels of close to 0.001 curie per day. These levels are below the proposed RQs for the affected radionuclides, and well below the proposed RQ of 100 curies for radon-220. For industrial boilers, which have relatively smaller thermal capacity and coal consumption, emission levels are closer to 10^{-5} curie per day,[3] well below the proposed RQs.

Similarly, aluminum, copper, zinc, and lead smelters release radionuclides to the air only when they process their respective ores. The radionuclide quantities released to air from a typical smelter vary by the type of ore processed, but range generally from close to 10^{-7} curie to 10^{-4} curie per day, well below the lowest proposed RQ of 0.001 curie per day.[4] Therefore, air releases from these industries will not be affected by the proposed RQ adjustments.

Phosphate rock plants are also not expected to be affected by the proposed RQ adjustments due to releases to air. Phosphate rock plants release radionuclides to the air during grinding and drying processes at levels no higher than 10^{-6} curie per day.[5] This is well below the lowest proposed RQ of 10^{-3} curie.

The coal-fired boilers, smelters, and phosphate rock plant air emissions have been analyzed thoroughly by EPA when the Agency was considering regulating radionuclide emissions under Section 112 of the Clean Air Act. The Agency concluded that "good reasons exist to propose not to regulate the following categories of facilities: (1) coal-fired boilers, (2) the phosphate industry, (3) other extraction industries..." (48 FR 15076, April 6, 1983). Radionuclide air emissions from these facilities do not present a potential threat to public health or welfare or the environment and will not be affected by this proposed regulation because air releases from these facilities are expected to be the result of plant operations only and to be well below the

---

[3]ICF analysis based on emissions data in U.S. Environmental Protection Agency, Radionuclides Background Information Document for Final Rule, Volume 2, EPA 520/1-84-022-2, Office of Radiation Programs, October 1984, p. 4.2-7.

[4]Ibid., pp. 7.1-8, 7.2-6, 7.3-4.

[5]Ibid., p. 6.1-11.

proposed RQs. Radionuclide releases due to contamination of sludge may be reportable under CERCLA, however, if the release is equal to or above an RQ.

Regarding releases to water, the Supreme Court rules in Train vs. Colorado Public Interest Research Group, 426 U.S. 1 (1976) that "source," "special nuclear," and "byproduct" materials are not pollutants within the meaning of the Clean Water Act. As such, specific releases of radionuclides were not considered in developing effluent limitations under the Act. However, NARM (naturally occurring and accelerator produced radioactive materials) can be limited specifically in water discharge permits, and regulation of certain key indicator pollutants can result in the control of other pollutants, including radionuclides. Therefore, water releases of radionuclides may or may not be considered federally permitted under Section 101(10) of CERCLA.

In a similar manner, unlicensed laboratories are not licensed by the Nuclear Regulatory Commission because they do not handle radionuclides in sufficient quantities to warrant concern. In particular, unlicensed laboratories do not handle radionuclides in quantities close to the proposed RQs. It would be virtually impossible, therefore, for these facilities to release radionuclides at reportable levels. Therefore, for purposes of this analysis, we assume the universe of affected facilities does not include coal-fired boilers, aluminum, copper, zinc, and lead smelters, phosphate rock plants, or small, unlicensed laboratories.

The remaining unlicensed facilities, uranium mines and elemental phosphorous plants, could be affected by the proposed regulation. These two industries were analyzed by EPA to determine the levels of radionuclide air emissions from these facilities. Unlike the boilers and smelters discussed above, uranium mines and elemental phosphorous plants were found to emit radionuclides at controllable levels. These emissions were controlled, therefore, under Section 112 of the Clean Air Act and these facilities could be releasing radionuclides in quantities greater than or equal to an RQ. However, releases in compliance with Section 112 limitations are considered federally permitted under CERCLA Section 101(10)(H) and would need to be reported to the National Response Center only if the quantities released exceed federally permitted levels by an RQ or more.[6]

Therefore, the facilities that could be affected by the proposed regulation because they could release radionuclides at levels equalling or exceeding an RQ make up a universe of approximately 22,000 facilities, consisting of 8,900 Commission licensees, 13,000 agreement state licensees, 78 DOE facilities, and approximately 25 active uranium mines and elemental phosphorous plants. Releases from these facilities could be considered

---

[6]The federally permitted release reporting regulation is scheduled to be reproposed in the near future. This proposed rule requires any federally permitted release, as defined in Section 101(10) of CERCLA to be reported to the National Response Center if it equals or exceeds licensed or permitted levels by an RQ or more.

federally permitted either under Section 101(10)(K) for releases from Commission licensees, agreement state licensees, and DOE facilities, or under Section 101(10)(H) for releases from uranium mines and elemental phorphorous plants.

Because there are 8,900 Commission licensees that are responsible for an estimated 100 radionuclide non-transportation releases annually, the total number of annual non-transportation releases of radionuclides from all 22,000 regulated facilities is approximately 250 release events per year (assuming proportionality between the number of releases and the number of regulated facilities).

It must be emphasized that this is just a gross estimate. Because these 22,000 regulated facilities are not homogeneous, they cannot be expected to have uniform release patterns. They release different radionuclides, at different propensities, and at different levels. We believe this estimate is an upperbound estimate, although not all facilities that could potentially release radionuclides have been included in this estimation procedure. In particular, facilities that use naturally occurring and accelerator produced radioactive material (NARM) are not included in this analysis. We have no data on these facilities. Nevertheless, we believe the estimate of approximately 250 release events per year is reasonable. It is based on several key assumptions:

- total releases from regulated facilities are proportional to the number of regulated facilities using and producing radionuclides;
- total number of releases per Commission licensee as reported in the AEOD data represents the average number of releases per facility for all types of regulated facilities; and
- amount of under-reporting for Commission licensees is 20 percent.

We do rely heavily on these assumptions to estimate the number of non-transportation radionuclide releases from facilities using or producing radionuclides in any sizable quantity. We believe, however, that the assumptions used are reasonable for purposes of this analysis. The estimates include both reportable and non-reportable releases. The large majority of these releases are expected to be exceedingly small, well below the proposed RQs, and would not be expected to pose a danger to public health or welfare or the environment. We test the effect of these assumptions in Chapter 7 of this report.

3.3.2 Frequency of Release for a Particular Radionuclide

The data base assembled for this analysis identifies 63 radionuclides in 1,139 release events. We assume that if a release of a particular radionuclide occurred in the past, it serves as an indication of the likelihood that the radionuclide will be released in the future. For each of the 63 radionuclides identified in our data base, we assume the probability of a future release can be derived from the frequency of past reported releases for that particular radionuclide. For example, uranium-238 (U-238) is involved in 129 of the 1,116 events with identified radionuclides in our data base. We assume, therefore, that the probability a radionuclide release is specifically a release of uranium-238 is 129/1,116 or .116. Iodine-125 (I-125) is involved in 64 events. We assume the probability that a radionuclide release is specifically a release of iodine-125 is .057 (64/1,116). This calculation is performed for each of the 63 radionuclides and is shown in Exhibit 3-3. All other radionuclides have been assigned a zero probability of release because we have no data on past releases for these radionuclides.

3.3.3 Size Distribution of Releases

The 684 release events in our data base that have quantity information are used to develop a size distribution of releases for radionuclides. By taking the logarithms of the release events in the data base, a log normal distribution develops, with a mean of 0.15 curies and standard deviation of 2.7 curies. The data are skewed, reflecting a much higher probability of a small release and a small probability of a large release. Exhibit 3-4 displays the size distribution of the releases in the data base. The frequency distribution shows, for example, that there are 152 release events in our data base where the quantity released is greater than 1 curie and less than or equal to 10 curies. There are 110 release events in our data base where the quantity released is greater than 10 curies and less than or equal to 100 curies. There are only 7 release events in our data base where the quantity released is greater than 1000 curies.

3.4 BASELINE REPORTABLE RELEASE ESTIMATION

Baseline non-transportation radionuclide releases include all radionuclide releases that exceed permitted levels by one pound or more at licensed or regulated facilities. We have already estimated annual non-transportation radionuclide releases to be approximately 250 releases per year. We now determine the fraction of these releases that are required to be reported in the baseline to the National Response Center.

We estimate in Appendix A that there are about 21,900 Commission and agreement state licensees, 78 DOE facilities, and approximately 25 active uranium mines and elemental phosphorous plants. In addition, there are approximately 53,000 facilities without federal permits that could release radionuclides but only at extremely low levels. Although we estimate that there are about 250 annual releases of radionuclides, not all of these releases are reportable presently under CERCLA; only releases that equal or exceed one pound for releases that are not federally permitted, and releases that exceed permit or license levels by one pound or more need be reported to the National Response Center.

EXHIBIT 3-3

FREQUENCY OF RELEASE FOR RADIONUCLIDES IN DATA BASE

Radionuclide	Number of Events Per Radionuclide	Probability of Release Per Radionuclide
AM-241	65	0.0582
AM/BE	74	0 0663
AR-41	1	0.0009
BA-133	6	0.0054
C-14	10	0.0090
CA-45	3	0 0027
CD-109	1	0.0009
CE-141	2	0.0018
CM-244	2	0.0018
CO-57	6	0.0054
CO-58	2	0.0018
CO-60	68	0.0609
CR-51	3	0.0027
CS-131	1	0.0009
CS-134	1	0.0009
CS-137	225	0.2016
EU-152	2	0.0018
EU-154	1	0.0009
F-18	1	0.0009
FE-55	6	0.0054
FE-59	2	0.0018
GA-67	7	0.0063
GE-77	1	0.0009
H-3	41	0.0367
HG-197	2	0.0018
I-123	2	0.0018
I-125	64	0.0573
I-129	1	0.0009
I-131	32	0.0287
IN-111	1	0.0009
IR-192	91	0 0815
K-42	1	0.0009
KR-81	1	0.0009
KR-85	27	0 0242
MO-99	15	0.0134
NA-24	5	0.0045
NI-59	1	0.0009
NI-63	33	0.0296

EXHIBIT 3-3

FREQUENCY OF RELEASE FOR RADIONUCLIDES IN DATA BASE
(Continued)

Radionuclide	Number of Events Per Radionuclide	Probability of Release Per Radionuclide
OS-185	2	0.0018
OS-191	1	0.0009
P-32	9	0.0081
PB-210	1	0.0009
PB-212	1	0 0009
PM-147	14	0.0125
PO-210	17	0.0152
PU-238	3	0.0027
PU-239	9	0.0081
RA-226	4	0.0036
RB-88	1	0.0009
RU-106	2	0.0018
S-35	4	0.0036
SB-125	1	0.0009
SR-90	17	0.0152
TA-182	2	0.0018
TC-99	37	0.0332
TH-232	12	0.0108
TH-234	1	0.0009
TL-201	2	0.0018
TL-204	4	0.0036
U-235	18	0.0161
U-238	129	0.1156
XE-133	15	0.0134
ZN-65	3	0.0027
Subtotal	1,116	1
Unknown isotopes	23	
TOTAL	1,139	

Source: ICF estimates.

EXHIBIT 3-4

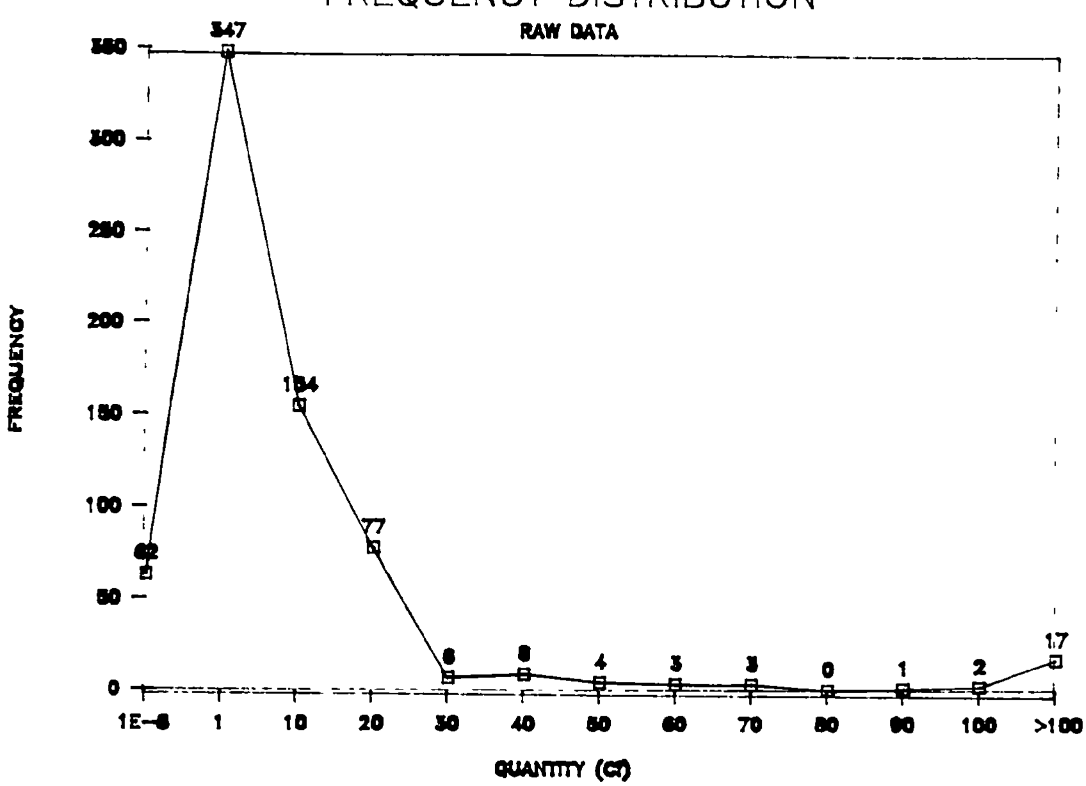
SIZE DISTRIBUTION OF RADIONUCLIDE RELEASES IN DATA BASE

Quantity (Curies)	Number of Releases in Data Base that Equals or Exceeds Quantity	Probability that Release Will Equal or Exceed Quantity [1]
0.001	521	0.762
0.01	437	0.639
0.1	337	0.493
1	280	0.409
10	128	0.187
100	18	0.026
1000	7	0.010

[1] Derived by dividing 684 into the number of releases in the data base that equals or exceeds that quantity. There is a total of 684 releases with quantity information in the data base.

Source: ICF analysis.

FREQUENCY DISTRIBUTION



Federally permitted releases are assumed to be all releases from Commission licensees, agreement state licensees, and DOE facilities that are in compliance with 10 CFR Part 20 limitations and other license or contract requirements, and releases from uranium mines and elemental phosphorous plants that are specified in and in compliance with regulations under Section 112 of the Clean Air Act. As discussed in Chapter 2 of this report, the proposed RQs were derived from the Annual Limits of Intake (ALI) developed by the ICRP. These have been adopted by the Nuclear Regulatory Commission in its proposed revision to 10 CFR Part 20. For purposes of this analysis, therefore, we assume that the 10 CFR Part 20 limitations are equivalent to the proposed RQs. Because of the conservative assumptions used in the development of the proposed RQs, and because the ALIs are based on a dose equivalent of 5 rem, not 500 millirem, it is expected that, under most circumstances, facilities can release more than the proposed RQ without exceeding the 500 millirem per year limit for exposure to the general public (i.e., without exceeding federally permitted levels for licensees). The assumption that the proposed RQs equal the federally permitted release levels would, therefore, over-estimate the number of reportable releases at facilities with federal licenses in both the baseline and post-regulation situations. The incremental number of reportable releases should, however, remain unchanged. The sensitivity of our results to the number of reportable releases is addresssed in Chapter 7 of this report.

The federally permitted release levels for uranium mines and elemental phosphorous plants have been established by EPA under Section 112 of the Clean Air Act. These levels are independent of the ALIs. However, for purposes of this analysis, we treat all facilities that have federally permitted releases in the same manner; we assume the propensity to release radionuclides is uniform and that federally permitted release levels can be represented reasonably as being equivalent to the proposed RQs. Therefore, because baseline reportable releases from facilities with federal permits are all releases from these facilities that equal or exceed permitted or licensed levels by one pound, and because for any particular radionuclide, the federally permitted release level is assumed to equal the proposed RQ, a release of a radionuclide would need to be reported to the National Response Center if it equals or exeeds the proposed RQ plus one pound.

For each radionuclide in our data base, the frequency of release shown in Exhibit 3-2 was multiplied by the probability that a release will equal or exceed the proposed RQ plus one pound for that radionuclide (all expressed in curies). This probability is derived from the size distribution of releases shown in Exhibit 3-4. By multiplying the frequency of release for a particular radionuclide by the probability that any radionuclide release will equal or exceed the equivalent, in curies, of the proposed RQ plus one pound, we derive the probability that a release of a particular radionuclide will be reportable.

For example, radium-226 has an estimated frequency of release of 0.0036 because it was reported released in our data base 4 times. Radium-226 has a proposed RQ of 1 curie and one pound of radium-226 is equivalent to 449 curies. By examining all 684 releases with quantity information in our data base, we determine that there are 10 radionuclide releases in the data base that equal or exceed 450 curies, the proposed RQ plus one pound for radium-226. We estimate, therefore, that there is a 0.0146 (10/684) probability that a release of 450 curies or greater will occur. The estimated probability that radium-226 will be released at levels that equal or exceed the proposed RQ plus one pound, therefore, is equal to 0.00005 (0.0036 x 0.0146).

By performing this calculation for each radionuclide and summing, we derive the probability that a radionuclide will be released at levels exceeding its federally permitted level by one pound or more. Multiplying this sum by the number of annual radionuclide releases (250) from facilities that have federal permits, we estimate the baseline number of reportable releases to be 19 releases annually.

Once again, we must emphasize that this figure is an estimate. It is based on a number of key assumptions that are, to some extent, over-simplifications, and should not be expected to be correct in every aspect. Chapter 7 of this report demonstrates the sensitivity of our results to this estimate of reportable radionuclide releases.

Baseline costs and benefits are the estimated value of actions taken by both the regulated community and the government when baseline reportable releases occur. The value of these actions are discussed in Chapter 4 of this report.

CHAPTER 4

VALUATION OF THE EFFECTS OF THE PROPOSED RQ ADJUSTMENTS

The purpose of an Economic Impact Analysis is to estimate the incremental costs and benefits resulting from a regulatory action. Any regulation requiring behavioral changes will usually lead to some elements of society benefiting from the regulation and some elements of society incurring costs. This report analyzes those benefits and costs and estimates the net gain or net loss resulting from the proposed regulation. Section 4.1 describes actions that could be taken by both the regulated community and government as a result of a reportable release and describes the actions that are attributable to the proposed RQ adjustments for radionuclides; Section 4.2 discusses the valuation of the costs; and Section 4.3 discusses the valuation of the benefits.

4.1 ACTIONS TAKEN WITH A REPORTABLE RELEASE

For all radionuclides whose RQ adjustment is downward, the proposed regulation is expected to result in an increased number of releases reported to the National Response Center. This increased reporting requirement will impose costs on the regulated community and on the government. It could also result in benefits for society if reporting radionuclide releases result in faster and more efficient cleanups of the releases.

For the 30 radionuclides whose RQ adjustment is upward, the proposed regulation is expected to result in cost savings (benefits) for both the regulated community and the government, as fewer releases will be reportable to the National Response Center. It could, however, result in fewer cleanups which may impose a cost on society due to a lower level of protection of public health and the environment. These costs and benefits are the result of actions taken by the regulated community and the government when a release occurs and is reported by a facility to the National Response Center. The remainder of this section describes the likely actions by both the regulated community and the government as a result of a reportable release and describes the actions that are attributable to the proposed RQ adjustments.

4.1.1 Actions Undertaken By the Regulated Community

When a radionuclide release occurs, three categories of actions are undertaken by regulated parties. These actions can be classified as notification, recordkeeping, and response. The notification action is required by CERCLA in response to a reportable release. Recordkeeping and response actions, however, occur indirectly and are not required by the statute.

Notification includes the notification of the National Response Center by the responsible party if a reportable release occurs, as is required by Section 103(a) of CERCLA. This action includes activities beyond the time spent by facility managers in a telephone conversation with the National Response Center. There is often subsequent interaction with the government by various levels of firm personnel as the government evaluates and determines the appropriateness of a response action.

Recordkeeping is often associated with notification. Although CERCLA does not require that records of releases be kept, regulated parties often maintain logs of calls to the National Response Center. These logs might include a description of the incident, its cause, a brief account of conversations with government officials, and a description of the outcome of the incident, as well as cleanup actions taken.

Response includes actions taken by the responsible party to mitigate the effects of the release. Typical response actions might include sampling the air, water, or soil; evaluating the necessity for evacuation and relocation; directly containing the release; and removing and/or neutralizing the release.

4.1.2 Actions Undertaken by the Government

Actions undertaken by the government in response to a release can be divided into four categories. They include notification processing, off-scene monitoring, on-scene monitoring, and direct removal. Each category is directly caused by the notification of a release.

Notification processing includes the initial communication with the person who calls in the report to the National Response Center. It also includes evaluation of the information, determination of an appropriate government response, and subsequent recordkeeping.

Off-scene monitoring includes supervision and monitoring of the responsible party's actions through telephone and data monitoring.

On-scene monitoring includes a government official providing advice and assistance in person to the cleanup team, coordinating communications among agencies, providing information to the public, and ensuring that the Agency's concerns are represented in determining the appropriate response.

Direct removal is necessary when the responsible party cannot or will not adequately clean up the radionuclide release and the release represents a hazard to public health or welfare or to the environment. Although the government response agency will normally use a private contractor to clean up the release, government response teams nevertheless have sampling, monitoring, containment, and safety equipment to deal with the initial emergency and to assist the contractors in the cleanup. Direct removals also could require more than one government agency.[1]

---

[1]For example, EPA, the Coast Guard, the Nuclear Regulatory Commission, the Department of Energy, the Federal Emergency Management Agency, state response agencies, state and local police and highway resources, or local fire departments could become involved in a release event.

4.1.3 Incremental Actions Attributable to the Radionuclide RQ Adjustments

Section 103(a) of CERCLA requires any release of an RQ or more of a hazardous substance to be reported immediately to the National Response Center. The proposed regulation is adjusting the RQ for radionuclides, resulting in a change in the number of reportable releases. For those radionuclides whose RQ decreases, the proposed regulation will result in an increase in the number of reportable releases to the National Response Center. For those radionuclides whose RQ increases, the proposed regulation will result in a decrease in the number of reportable releases to the National Response Center. This will affect notification costs, recordkeeping, and response costs incurred by the affected facilities and it will affect notification processing costs, off-scene and on-scene monitoring costs, and removal costs incurred by the government.

The production, use, and transportation of radionuclides are already regulated and controlled. For the most part, facilities already face some reporting requirements for releases of radionuclides. All transportation releases, regardless of quantity, must already be reported to the National Response Center (49 CFR Parts 171-177). Therefore, the proposed regulation adjusting the radionuclide RQ from one pound to some new level will have no effect on transporters of radionuclides.

The proposed regulation could increase notification, recordkeeping, and response activities for facilities handling and releasing radionuclides with a proposed RQ less than one pound. Similarly, it could decrease notification, recordkeeping, and response activities for facilities handling and releasing radionuclides with a proposed RQ exceeding one pound. The additional cost (or cost savings) any facility will incur is related to the number of reportable releases from that facility, which is a function of the handling practices at the facility, the quantity and type of radionuclides handled at the facility, and the forms of the radionuclides (e.g., sealed sources, solids, liquids, or gases). It is difficult to predict which facilities will be most affected by the proposed RQ adjustments, but it is reasonable to expect a change in the number of releases of radionuclides reported to the National Response Center as a result of the proposed regulation. The change in the number of reportable releases will directly affect the costs and benefits that accrue to both the regulated community and government.

In addition to the direct economic costs and cost savings resulting from the change in the number of releases reported to the National Response Center, the proposed RQ adjustments can affect public health and welfare and environmental quality. If the likelihood of a cleanup response is greater when notification to the National Response Center is required, then RQ adjustments could have the following effects:

- Raising RQs for particular radionuclides will decrease the number of reportable releases. Assuming that some releasers are less likely to clean up releases of radionuclides below the RQ, more public health and welfare and environmental damages could occur with higher RQs. These incremental damages are costs of raising the RQs for some radionuclides.

Lowering RQs for a particular radionuclide will increase the number of reportable releases for that substance. If these lower RQs lead to increased and earlier notifications of releases and to appropriate and timely response actions that would not otherwise have occurred, public health and welfare and environmental damages could be mitigated. These decreased or avoided damages can be considered to be a benefit of lowering the RQs for some radionuclides.

Identifying, predicting, and measuring the public health and welfare and environmental effects of raising or lowering RQs is inherently difficult. An analysis of these effects is not included in this report because of serious information constraints. Although this report estimates the change in the number of reportable releases under the proposed regulation, reliable information is unavailable on the damages that have been associated with past radionuclide releases. There is no information regarding the role (if any) that RQ levels or reporting requirements played in contributing to these effects. Therefore, little information exists upon which to base a quantitative analysis of public health and welfare and environmental effects, and we discuss these changes in qualitative terms only.

4.2 VALUATION OF COSTS

This section describes the method of attaching values to the actions caused by changes in the RQs. The values associated with one reportable release are the resources that are consumed during the notification, recordkeeping, and response activities by both the regulated community and the government and also include the changes in public health and welfare and environmental quality that may be produced by a response. In general, estimates throughout this study of the resources consumed as a result of performing each action are quantitative, and the estimates of changes in public health and welfare and environmental quality are qualitative. The remainder of this section provides estimates of the value of the actions performed by regulated parties and the government. These estimates are examined more closely in Chapter 7 of this report, where we test the sensitivity of our results to each of the frequency estimates discussed below.

4.2.1 Values of Actions Performed by Regulated Parties

We base most of our cost estimates for each action on the estimates derived in the Regulatory Impact Analysis (RIA) supporting the RQ adjustment for 340 CERCLA hazardous substances.[2]

---

[2]ICF Incorporated, Regulatory Impact Analysis of Reportable Quantity Adjustments Under Sections 102 and 103 of the Comprehensive Environmental Response, Compensation, and Liability Act, Volume I, March 1985.

Notification. Section 103(a) of CERCLA places the responsibility for notification of the National Response Center on the person in charge of the vessel or facility from which a hazardous substance is released. It is reasonable to assume, therefore, that a plant manager or representative will become involved in the notification process soon after a release is reported. In addition to the plant manager, the time expended and the type of other people who become involved in notification activities depend on the following four factors: the amount, identity, and form (solid, liquid, or gas) of radionuclide released; the location where it is released; the responses of government officials and the releaser of the radionuclide; and the size and organizational structure of the responsible party.

The RIA in support of the RQ adjustment for 340 CERCLA hazardous substances assumed notification costs for releases of less than 55 gallons are $121, and notification costs for releases over 55 gallons are $323.[3] It would not be appropriate to differentiate notification costs for radionuclide releases on the basis of whether the releases are above or below 55 gallons. As discussed earlier, a radionuclide release well below one pound could generate a great deal of concern and public interest, resulting in relatively high notification costs. Radionuclide releases in general engender public concern and scrutiny because of the lack of understanding and general fear felt by the public at large regarding radiation and radioactive contamination. The responsible party may have to respond to more calls from state and local government officials and from the press, for example, than would be the case for a chemical release. It seems more appropriate, therefore, to assume notification costs to industry for a radionuclide release are closer to $323, which includes three hours of managerial time and two hours of technical time, than it is to $121 which includes one hour of managerial time and one hour of technical time. We will assume, therefore, that each release notification costs the regulated community $323 (1983 dollars).

Recordkeeping. The resources required to perform internal recordkeeping responsibilities were estimated in the RIA supporting the RQ adjustment for 340 CERCLA hazardous substances to be 1 clerical hour per release, and assumes a ratio of 1 supervisory hour to each 10 hours of clerical time.[4] This estimate implies a cost of $28.10 per release, assuming $20 per hour for clerical time and $81 per hour for managerial time. Recordkeeping associated with a chemical release notification and recordkeeping associated with a radionuclide release notification should not differ substantially. We adopt this same unit cost estimate in this analysis of the proposed RQ adjustments for radionuclides.

---

[3]Ibid, p. 3-11. The larger releases are assumed to take 3 hours of managerial time at $81 an hour and 2 hours of technical time at $40 an hour. The smaller releases, which are usually less serious, are assumed to take 1 hour of managerial time and 1 hour of technical time. All estimates are expressed in 1983 dollars.

[4]Ibid, p. 3-11.

Response. No public health and welfare or environmental costs or benefits are associated with notification and recordkeeping, per se. The public health and welfare and environmental effects of the proposed regulation are caused solely by the cleanup of releases that would not otherwise have been cleaned up, or which would have been cleaned up improperly, without the advice given to the releaser by the government because of the notification.

Although accurate data are generally unavailable, Nuclear Regulatory Commission, Department of Energy, and Environmental Protection Agency sources agree generally that responsible parties currently respond adequately to a very large percentage of releases. Responsible parties are liable for response costs and natural resource damages for all releases of radionuclides, whether these releases are above or below the RQs. It is logical to assume, however, that a responsible party is more likely to respond to a release that is above the RQ than it is to a release that is below the RQ simply because the release is larger and the National Response Center must be notified of the release. For purposes of this analysis, therefore, we assume that responsible parties adequately respond to 90 percent of radionuclide releases below the RQ and adequately respond to 95 percent of radionuclide releases above the RQ. Hence, if the RQ is lowered, we might expect a 5 percent increase in response activities for those releases that are now reportable. For those radionuclides whose proposed RQ is greater than one pound, we would expect a 5 percent decrease in response activities for releases that are greater than one pound but are no longer reportable under the proposed regulation.

The Regulatory Impact Analysis (RIA) for RQ adjustments of 340 CERCLA hazardous substances estimated the range of response costs incurred by regulated parties to be between $185 and $2,093 per release (1983 dollars).[5] The costs are a function of the size of the release. Radionuclide releases are, in general, much smaller than the chemical releases considered in the RIA, which range from one pound to 5000 pounds. Radionuclide release responses, however, often require special equipment and protective clothing, resulting in higher response costs. To estimate radionuclide response costs, therefore, we did not rely on the RIA estimates. Instead, we developed three model release scenarios. We based our model scenarios on release reports in the data sets and tried to select scenarios which reasonably represented a fair number of the events in the radionuclide data base. The three scenarios represent a range of response actions and response costs.

Scenario 1 represents a small radionuclide release resulting from a faulty valve, for example, at a conversion facility or laboratory. The radionuclide released could conceivably be uranium-238, tritium, or krypton-85. The appropriate response for scenario 1 would probably be no more than monitoring for an 8-hour period. Costs for scenario 1 are used for all releases whose response costs would be expected to be minimal.

---

[5] Ibid, p. 3-13.

Scenario 2 represents a laboratory or hospital situation where a radionuclide is accidently disposed of with the regular garbage. The radioactive material is then shredded and put in a dumpster. Radionuclide releases likely to be represented by this model include cobalt-60, iodine-125, iodine-131, and iridium-192. Scenario 2 costs include monitoring and decontamination.

Scenario 3 involves a hypothetical release of uranium-238 to surface water. The release may have resulted from a pipe failure or lagoon overflow and involves major response actions including monitoring and dredging of contaminated sediment.

For each scenario, we have estimated the costs of hypothetical responses, shown in Exhibit 4-1. All costs are in 1986 dollars. Based on the frequency of occurrence of different types of releases in our data base, we assume scenario 1 costs are representative costs for 66 percent of response actions; scenario 2 costs are representative costs for 27 percent of response actions; and scenario 3 costs are representative costs for 7 percent of response actions. Using these percents as weights for each of the cost estimates, we derive an average weighted response cost for radionuclide releases of about $5,400 per response ((.66 x $160) + (.27 x $5,720) + (.07 x $53,600)). These estimates were deliberately based on small release scenarios, because large decontamination actions would occur regardless of the RQs involved and are therefore expected to be unaffected by the proposed RQ adjustments. We realize that this estimation process is very imprecise, however, and in Chapter 7 of this report, we test the sensitivity of our results to the response cost estimates.

4.2.2 Value of Actions Performed by the Government

Most of the actions performed by the government involve costs which do not vary with the type of CERCLA hazardous substance released. Notification processing, off-scene monitoring, and on-scene monitoring costs for radionuclide releases are assumed to be similar to costs incurred for other CERCLA hazardous substance releases. The RIA in support of the RQ adjustment for 340 CERCLA hazardous substances assumed the government actions were valued at $70 for process notifications, $235 for off-scene monitoring, and $2,761 for on-scene monitoring.[6] We adopt these estimates in this analysis of the effects of the proposed RQ adjustments for radionuclides.

The RIA also assumes that the likelihood of off-scene monitoring and on-scene monitoring by the government varies with the size of the reported release. For off-scene monitoring, the RIA assumes government response is likely between forty percent and seventy percent of the time. For on-scene monitoring, the RIA assumes government response is likely between five and twenty percent of the time. Because we believe a government response action is probably more likely for a radionuclide release than for the average chemical release simply because of public awareness and concern over radiation

---

[6] Ibid, p. 3-17.

EXHIBIT 4-1

RELEASE SCENARIO 1

CIRCUMSTANCE: A small radionuclide release from a failed valve at a conversion facility or laboratory

TYPICAL RADIONUCLIDES: 10^{-2} curies of Uranium-238, Tritium, or Krypton-85

RESPONSE ACTIVITIES AND COST ESTIMATES:

A response may not be necessary nor appropriate for air releases of this size. However, we assume the response requires 8 hours of monitoring.

Total estimated cost = $160

RELEASE SCENARIO 2

CIRCUMSTANCE: Radionuclide source accidently disposed of as standard solid waste, shredded, and put in dumpster.

TYPICAL RADIONUCLIDES: 10^{-2} curies of Cobalt-60, Iodine-125, Iodine-131, or Iridium-192

RESPONSE ACTIVITIES AND COST ESTIMATES:

Monitoring and decontamination of bench, trash can, and janitor cart -- $320
Monitoring and decontamination of shredder and dumpster -- $5,400

Total estimated cost = $5,720

EXHIBIT 4-1 (continued)

RELEASE SCENARIO 3

CIRCUMSTANCE: Radionuclide release from process discharge pipe to stream which feeds into a river.

TYPICAL RADIONUCLIDES: 20 curies of Uranium-238

RESPONSE ACTIVITIES AND COST ESTIMATES:

Monitoring (1 wk.) at outfall, ditch, stream, and river -- $1,600
Ground water monitoring well (drilling and sampling) -- $1,000
Treatment of 5,000 gallons of contaminated water ($0.20/gal, including mobilization for ion-exchange resin) -- $1,000
Dredging and disposal of contaminated sediments (1000 cu ft) -- $50,000

Total estimated cost = $53,600

Source: ICF analysis based on the following sources: U.S. Environmental Protection Agency, Remedial Response at Hazardous Waste Sites (EPA 540/2-84-002), March 1984; Tawil, J J. et al., Off-Site Consequences of Radiological Accidents: Methods, Costs, and Schedules for Decontamination, Battelle Northwest Laboratories, Prepared for U.S. Nuclear Regulatory Commission, August 1985; ICF 1986.

contamination, we assume, for purposes of this analysis, that the likelihood of an off-scene monitoring response by the government is seventy percent and the likelihood of an on-scene monitoring response by the government is twenty percent, the high end of the assumed ranges for chemical releases. We test the sensitivity of our results to these assumptions in Chapter 7 of this report.

Direct removal cost estimates in the RIA for 340 CERCLA hazardous substances were assumed to be $39,273.[7] We modify this cost estimate in this analysis because direct response actions for radionuclide releases tend to be very different from direct response actions for other chemical releases; for example, decontamination procedures often involve special equipment and protective clothing.

For purposes of this analysis, therefore, we rely on the model cost scenarios discussed earlier in the chapter and described in Exhibit 4-1. We assume the government would get involved in only the most costly scenario and so assume scenario 3 costs ($53,600) are appropriate for government removal actions. We further assume that five percent of all radionuclide releases will involve government response activities.[8]

The unit cost estimates are not precise, relying on estimates that may not be totally applicable for radionuclide release actions. We have made very conservative assumptions regarding likelihood of a response action and have tried to cost each action conservatively so as to err on the side of higher cost estimates. We discuss, in Chapter 7 of this report, the sensitivity of our results to these assumptions.

4.3 VALUATION OF BENEFITS

The economic benefits of adjustments are the decreased industry and government costs that result from raising RQs for some radionuclides. Assuming that industry generally reports and responds to a release at or exceeding the RQ, raising the RQ should decrease industry's and government's notification, recordkeeping, processing, monitoring, and response costs. The unit cost savings are the same as the unit cost estimates discussed in Section 4.2 above.

The public health and welfare and environmental benefits of RQ adjustments are the avoided or decreased damage costs that result from lowering RQs for most radionuclides. Assuming that a releaser generally reports (or is more

---

[7]Ibid, p. 3-17.

[8]The RIA for the 340 CERCLA hazardous substances assumed the likelihood of a direct government response action was between one and five percent. We assume the high end of the range is more appropriate for radionuclide releases. We test this assumption in Chapter 7 of this report.

likely to report) a release at or exceeding the RQ, lowering the RQ should both increase the number of notifications and provide incentives for earlier responses to releases.

The public health and welfare and environmental effects of adjusting RQs for some substances are difficult to identify, predict, and measure for several reasons.

- The only certain effect of lowering RQs is that it increases the number of reportable releases. The costs and benefits of RQ adjustments are several steps removed from changes in the number of reportable releases and depend upon uncertain regulated party and government behavior.

- Even if it could be established that lowering RQs generally decreases public health and welfare and environmental damages, it is difficult to specify the nature, magnitude, and value of those changes. Almost no data exist on the damages associated with past releases of small quantities of radionuclides. There is even less information on the role (if any) that reporting levels or notifications play in augmenting these damages. Therefore, there is hardly any information upon which to base prediction of effects.

If lowering RQs for most radionuclides leads to more or earlier notifications and more effective response actions, then the following benefits could occur:

- **Reductions in the threat of mortality and acute or chronic morbidity.** These include reductions in human exposure (ingestion, inhalation, or physical contact) to radiation contamination.

- **Reductions in the threat of general environmental damages such as plant and animal damages.** These include reductions in the adverse impact of released radionuclides on crop yields, non-crop vegetation, fish, wildlife, and farm and commercial animal production.

- **Reductions in the threat of public damages.** These include mitigation of property damages, recreational damages, and lost productivity.

Without data on release damages and the possible relationship of notification to damages, it is not possible to quantify the public health and welfare and environmental costs and benefits under the proposed regulation. However, if greater non-economic benefits result from more reporting, then the public health and welfare and the environmental benefits provided by the proposed regulation will probably be positive because 96 percent of all specific radionuclide RQ adjustments are downward, resulting in a net increase in expected reports to the National Response Center.

The unit costs and cost savings estimates can now be combined with the estimated number of baseline reportable releases to determining the baseline and incremental costs and benefits attributable to the proposed regulation. Chapter 5 presents the cost estimates and Chapter 6 presents the benefits estimates.

CHAPTER 5

ESTIMATED ANNUAL COSTS OF THE PROPOSED RQ ADJUSTMENTS

This chapter discusses the costs of reportable quantity (RQ) adjustments, including the potential increased economic burden on society that may be caused by lowering most of the radionuclide RQs, and the potential reduction in public health and welfare and the environmental quality that may be caused by raising some radionuclide RQs. The analysis in this chapter combines the information presented in Chapters 3 and 4 to compute the annual cost of RQ adjustments.

The costs of RQ adjustments are a result of the change in the number of releases reportable to the National Response Center. Reporting a release causes both the regulated community and the government to incur costs for notification, recordkeeping, and possible response activities; not reporting a release could affect human health and welfare and environmental quality. Section 5.1 presents the estimates of the change in reportable releases under the proposed regulation; Section 5.2 presents the estimate of the incremental costs of the proposed RQ adjustments; and Section 5.3 presents firm-level economic effects of the proposed regulation.

5.1 THE ESTIMATED CHANGE IN THE NUMBER OF REPORTABLE RELEASES

The estimated change in the number of reportable releases is equal to the difference between baseline reportable releases (19) (derived in Chapter 3) and reportable releases under the proposed regulation. In the baseline, a radionuclide release at a licensed or regulated facility is reportable to the National Response Center if it equals or exceeds permitted levels by one pound. Under the proposed regulation, a radionuclide release is reportable to the National Response Center if it equals or exceeds permitted levels by the proposed RQ.

Most licensed or regulated facilities must comply with the Nuclear Regultory Commission 10 CFR Part 20 release limitations. Because the ALIs in 10 CFR Part 20 are the basis for the derivation of the proposed RQ adjustments, for purposes of this analysis, federally permitted levels are assumed to equal the proposed RQs.[1] Thus, a reportable radionuclide release under the proposed regulation from a facility holding a federal permit is assumed, for purposes of this analysis, to be all radionuclide releases that

---

[1]This is a simplification because the 10 CFR Part 20 intake limitations are based on a dose of 5 rem for nuclear facility workers. EPA based its proposed RQs on a dose-equivalent of 500 millirem and then made several conservative assumptions to calculate the release levels for the proposed RQs. We examine in Chapter 7 of this report the sensitivity of our results to the number of reportable releases.

equal or exceed twice the proposed RQ. Because the proposed RQs are being used as a proxy for the federally permitted release levels and releases exceeding these levels by an RQ or more must be reported to the National Response Center, all releases from facilities holding federal permits that equal or exceed twice the proposed RQ must be reported to the National Response Center.

To estimate the expected number of releases above two times the proposed RQ, we rely on the size distribution of releases in our data base and each radionuclide's frequency of release shown in Exhibit 3-2 of this report. The probability that a particular radionuclide release will equal or exceed two times the proposed RQ is estimated to be the frequency of release of that radionuclide in our data base, multiplied by the fraction of releases in our data base that equal or exceed two times the proposed RQ. This calculation is performed for each of the radionuclides identified in our data base. We then sum across the radionuclides. Hence, reportable radionuclide releases under the proposed regulation is estimated to be the number of annual releases (250), multiplied by the probability that a radionuclide will be released in quantities equal to or exceeding two times the proposed RQ. Reportable releases are estimated to be approximately 62 releases annually. Thus, the RQ adjustments result in 43 (62-19) incremental reportable releases.

Although 30 radionuclides have upward adjustments of their RQs, there is no change in the number of reportable releases for these radionuclides in our data base. In both the baseline and with the proposed RQs, we estimate there will be approximately 18 reportable releases annually of these radionuclides. We estimate there will be no change in the number of releases that must be reported to the National Response Center. That is, based on the release information in our data base, 18 releases would be required to be reported in the baseline and 18 releases will be required to be reported under the proposed regulation. Therefore, there is no expected increase in the threat to public health or welfare or the environment. The remainder of this chapter will estimate the incremental costs associated with the downward adjustment of 727 radionuclide RQs.

5.2 ESTIMATED COSTS OF THE PROPOSED RQ ADJUSTMENTS

Because we estimate that the 30 radionuclides whose proposed RQ exceeds one pound have no expected change in the number of reportable releases, all of the costs under the proposed regulation are due to the reduction in the proposed radionuclide RQs and economic costs associated with increases in reportable releases to the National Response Center. The cost calculation is shown in Exhibit 5-1. Many of the unit costs described in Chapter 3 were derived from estimates in the RIA supporting the RQ adjustments for 340 CERCLA hazardous substances. Those cost estimates were in 1983 dollars. For purposes of this analysis, we have converted all cost estimates to 1986 dollars.

EXHIBIT 5-1

CALCULATIONS OF ANNUAL COSTS OF RQ ADJUSTMENTS UNDER THE PROPOSED REGULATION

COSTS TO BE REGULATED PARTIES

A. Cost of Notification		
(43 incremental reports) x $336 =	$	14,448
B. Cost of Recordkeeping		
(43 incremental records) x $29.24 =	$	1,257
C. Cost of Response		
(43 incremental releases) x (.05) x ($5,400) =	$	11,610
TOTAL COST TO REGULATED PARTIES	$	27,315

COSTS TO GOVERNMENT

D. Cost of Notification Processing		
(43 incremental reports) x $73 =	$	3,139
E. Cost of Off-Scene Monitoring		
(43 incremental releases) x (.70) x ($245) =	$	7,375
F. Cost of On-Scene Monitoring		
(43 incremental releases) x (.20) x (2,873) =	$	24,708
G. Cost of Direct Removal		
(43 incremental releases) x (05) x ($53,600) =	$	115,240
TOTAL COST TO GOVERNMENT	$	150,462
TOTAL COST OF PROPOSED REGULATION (1986 dollars)*	$	177,777

*The RIA cost estimates supporting the RQ adjustment for 340 CERCLA hazardous substances are in 1983 dollars. The 1983 dollars were converted to 1986 dollars using the Construction Cost Index. March 1986 dollars equal 4219 and 1983 dollars equal 4055; Engineering News Record, March 1986, p. 107.

Source: ICF estimates.

The total cost to regulated parties is the sum of notification, recordkeeping, and response costs. The costs of the proposed regulation are calculated in the following manner:

A. Notification. There are 43 incremental reportable radionuclide releases and each report costs an estimated $336, yielding a total annual cost of about $14,500.

B. Recordkeeping. Multiplying 43 incremental reportable releases by $29.24, the cost of recordkeeping per reportable release, yields total annual recordkeeping costs of about $1,260.

C. Response. It is assumed in this analysis that the probability of response to a given release is 90 percent if the release is below the RQ and 95 percent if the release is above the RQ. Therefore, an extra 5 percent of incremental reportable releases will be responded to as a result of lowering RQs. Multiplying the number of incremental reportable releases (43) by the incremental probability of response (0.05) and by the weighted average cost per response ($5,400), equals total annual response costs of about $11,600.[2]

The total cost to regulated parties, which is the sum of notification costs, recordkeeping costs, and response costs, is about $27,300.

The total cost to the government of RQ adjustments is the sum of notification processing, off-scene monitoring, on-scene monitoring, and direct removal costs. These costs are calculated in the following manner:

- Notification Processing. A total annual notification processing cost of approximately $3,140 is calculated by multiplying 43 incremental reportable releases by $73 (the estimated cost of processing one notification).

- Off-Scene Monitoring. Multiplying 43 incremental reportable releases by the probability that off-scene monitoring is required[3] (.70), by the cost of off-scene monitoring per release ($245), yields a total annual off-scene monitoring cost of about $7,400.

---

[2]The sensitivity analysis in Chapter 7 tests the results of assuming different probabilities of response to releases below and above the RQ.

[3]The sensitivity analysis in Chapter 7 tests the results of assuming different probabilities of off-scene monitoring.

- On-Scene Monitoring. Multiplying 43 incremental reportable releases by the probability that on-scene monitoring is required[4] (.20), by the cost of on-scene monitoring per release ($2,873) yields a total annual on-scene monitoring cost of about $24,700.

- Direct Removal. Multiplying 43 incremental reportable releases by the probability of direct response by the government (.05) and the estimated cost of direct removal ($53,600) yields a total annual cost for direct responses of about $115,000.[5]

The total cost to the government, which is the sum of notification processing costs, off-scene monitoring costs, on-scene monitoring costs, and direct response costs is approximately $150,500.

The sum of the total costs to the government and to regulated parties equals the total costs of all effects, which is approximately $178,000.

5.3 FIRM-LEVEL ECONOMIC EFFECTS

The estimated costs of the proposed regulation are small relative to the sales and revenues generated by the industries most likely to be affected by the proposed regulation. The average facility handling radionuclides is not expected to experience a radionuclide release above the proposed RQ. We estimate that there will be about 43 incremental reportable releases annually, and there are as many as 22,000 facilities potentially affected by the proposed regulation. The probability that any particular facility will experience a reportable release is a function of the types, quantities, and forms of radionuclides used and produced at the facility, and the facility's handling procedures.

The types of facilities affected by the proposed regulation vary widely, from laboratories to large uranium mining operations. It is not possible to predict with any degree of accuracy the facilities most likely to experience reportable radionuclide releases and, therefore, it is not possible to develop a financial model of a typical releaser. We can discuss in general terms, however, the magnitude of costs for a facility experiencing a reportable release under the proposed regulation. These cost estimates are as follows:

- Notification costs --- $336
- Recordkeeping costs --- $30
- Cleanup costs --- $5,400

---

[4]The sensitivity analysis in Chapter 7 tests the results of assuming different probabilities of on-scene monitoring.

[5]The sensitivity analysis in Chapter 7 tests the results of assuming different probabilities of direct response.

The total cost to a facility or vessel experiencing a reportable radionuclide release is, therefore, estimated to be about $5,800. The cost to the facility will depend directly upon the cleanup costs, estimated to range between zero and $54,000, with a weighted average cleanup cost of about $5,400.

The total annual burden under the proposed RQ adjustments experienced by all affected entities depends on the size and number of reportable releases. The burden imposed by the CERCLA notification requirements on an individual business depends directly on the number of reportable releases that occur at that facility. Most of the facilities potentially affected would, in fact, experience no costs from the notification requirements because they would have no reportable releases. Even assuming a reportable release occurs at a facility, the likely costs incurred are so small that we must conclude that the proposed regulation will not adversely affect any facility, large or small.

The largest costs under the proposed regulation is due to cleanup costs. Most releases are cleaned up regardless of whether the release is above or below the RQ. Cleanup of large releases will probably not be affected by the proposed RQ adjustments because they would be reportable even without the proposed regulation and cleanup would probably occur regardless of the RQ. To put the magnitude of the costs attributable to the proposed regulation into prospective, it is important to consider the benefits of the proposed RQ adjustments as well. These are discussed in Chapter 6 of this report.

CHAPTER 6

ESTIMATED BENEFITS OF THE PROPOSED RQ ADJUSTMENTS

This chapter analyzes the benefits of adjusting the reportable quantities (RQs) for radionuclides. The benefits fall into two categories:

(1) Cost savings to affected parties. Raising RQs for some radionuclides could decrease the number of reportable releases. This decrease in turn reduces the costs to regulated parties and government for notification, recordkeeping, response, and monitoring.

(2) Public health and welfare and environmental benefits. Lowering RQs for some radionuclides increases the number of reportable releases. This increase in turn decreases the probability of public health or welfare or environmental damage if earlier or more notifications of releases are followed by prompt, appropriate response actions by the responsible party (or in some cases, by the various local, state, or federal agencies involved).

Benefits of the proposed regulation flow from government and regulated party responses to changes in the number of reportable releases. If we assume that industry normally reports and responds to a radionuclide release equal to or exceeding its RQ, then raising the RQ level should decrease the notification, recordkeeping, processing, monitoring, and response costs of the regulated community and government.

Of the 757 radionuclides whose RQs are individually adjusted in the proposed regulation, only 30 radionuclides have a proposed RQ greater than one pound. Exhibit 6-1 displays these 30 radionuclides and their proposed RQs. Six of these 30 radionuclides are represented in our data base. These six radionuclides with proposed RQs that are greater than the curie equivalent of one pound were reported released 198 times in the recent past in the data sets we examined. However, because we estimate there will be no change in the number of reportable releases of these 30 radionuclides as a result of the proposed RQ adjustments, there are no cost savings attributable to the proposed regulation.

The public health and welfare and environmental benefits of RQ adjustments are, therefore, the avoided or decreased damage costs that result from the lower RQs for 727 radionuclides. Assuming that a responsible party is more likely to respond to a release at or exceeding the RQ, lowering reporting levels for a substance should increase the number of notifications and provide incentives for earlier responses to releases. These notifications may lead to more prompt, effective cleanup or containment of releases, thus avoiding or mitigating damages that would otherwise occur.

EXHIBIT 6-1

RADIONUCLIDES WITH PROPOSED RQs GREATER THAN ONE POUND

Radionuclide	Proposed RQ Curies	Proposed RQ Pounds
Aluminum-26	10	1.2
Cadmium-113	1	905,000,000
Calcium-41	1000	25.3
Cesium-135	100	250
Chlorine-36	100	6.7
Gadolinium-152	0.001	103,000
Hafnium-182	0.1	1
Indium-115	0.1	31,200,000
*Krypton-81	1000	104
Lanthanum-138	1	90,100
Lead-205	100	1,910
Lutetium-176	1	39,000
Manganese-53	1000	1,200
*Nickel-59	1000	32.7
Palladium-107	100	428
Plutonium-244	0.01	1.2
Potassium-40	100	30,800
Rhenium-187	1000	51,900,000
Rubidium-87	1000	26,200,000
Samarium-147	0.01	978
Selenium-79	100	2.9
Tantalum-180	10	111,000,000
Technetium-97	1000	1,550
Technetium-98	10	25.3
*Technetium-99	100	13
Tellurium-123	100	985,000,000
*Thorium-232	0.001	20
*Uranium-235	0.1	103
Uranium-236	0.1	3.4
*Uranium-238	0.1	654

*Radionuclides represented in our data base.

Source: Memorandum from Alan Messing, Environmental Monitoring and Services, Inc. to Ellen Warhit, ICF, "Radionuclides with Proposed RQs in Greater Than or Equal to one pound," October 1986.

If lowering RQs for certain radionuclides leads to more or earlier notifications and more effective response actions, then the following benefits may occur:

- Reductions in the threat of mortality and acute chronic morbidity;
- Reductions in the threat of general environmental damages such as plant and animal damages; and
- Reductions in the threat to public welfare damages (including property damage, recreational damage, and lost productivity).

Unfortunately, we have no data on release damages nor on the possible relationship of the timing of notifications to the extent of damages. It is not possible, therefore, to quantify the benefits of the proposed regulation. The direction of all but 30 of the 757 individual proposed RQ adjustments is downward, however, resulting in an expected increase in the future number of radionuclide releases reported to the National Response Center. We anticipate that the earlier notification will result in faster and more appropriate response actions, yielding benefits to both the regulated community (in terms of lower response costs) and to society in general (in terms of reduced theats to human health and welfare and the environment).

Our analysis of both costs and benefits under the proposed regulation is based on several key assumptions which, if inaccurate, could cause the estimates to misrepresent the effects of the proposed regulation. We, therefore, test the major assumptions to determine the sensitivity of our results to each assumption. The results of this analysis are presented in Chapter 7 of this report.

CHAPTER 7

SENSITIVITY ANALYSIS

Several times in this analysis, data have been used whose margin of error could have been improved through further research. Similarly, in several instances, key study assumptions were made which used the best available information from a very limited data base. Under these circumstances, therefore, it is important to conduct a sensitivity analysis to test the impact that changing key study assumptions would have upon the results of the analysis. The first two sections of this chapter present a sensitivity analysis on the results of this analysis. The first section discusses the importance of a sensitivity analysis and establishes the ranges for the key variables and assumptions that will be tested. The second section presents the results of the sensitivity analysis using these ranges. The third section, Section 7.3, describes our statistical analysis of our radionuclide release data base; and Section 7.4 summarizes our results.

7.1 CONCEPTS AND KEY VARIABLES

In general, a sensitivity analysis indicates how the results of an analysis might vary if some of the basic building blocks of the study had been different. If, for example, the analyst is reasonably certain that one of two particular values for a key variable is correct but does not know which one, or that two values will bracket the true value, each may be used in the sensitivity analysis. The result is then presented twice -- once for each value of the key variable.

In other situations, there may be very little guidance on a particular key variable. A reasonable guess can be made about the likely value for the variable; other values may be selected to determine the sensitivity of the results to this choice. This technique has the virtue of indicating the range of possible results, although it does not indicate whether the "true" results are included.

A sensitivity analysis is sometimes thought to add information, and it does in the sense of bracketing a range. Nonetheless, the range may be too small or too large, depending on the quality of the values used in the sensitivity analysis. Thus, the value of the analysis still depends on the quality of the input data.

This sensitivity analysis tests the impact of changing six basic assumptions that have been used during this analysis. These assumptions include: (1) the number of incremental reportable releases; (2) the hours required and, therefore, the unit cost per release notification; (3) the frequency of on-scene monitoring; (4) the frequency of direct removal; (5) the frequency of off-scene monitoring; and (6) the frequency of cleanups by responsible parties. We test the frequency of actions rather than the unit costs of performing such actions because the cost estimates are considered reasonable and adjustments in the cost estimates are overwhelmed by the frequency estimates.

Assumptions regarding each of these key variables are varied in the following manner in the sensitivity analysis:

1. Number of incremental reportable releases. The number of incremental reportable releases is perhaps the most important single variable on which costs are estimated. The analysis in Chapter 5 assumes there will be 43 annual incremental reportable releases of radionuclides. This estimate may vary because the estimates of under-reporting could be inaccurate, the AEOD data set may not contain representative facilities, or the number of releases may not be proportional to the number of facilities. To reflect the order-of-magnitude changes in costs that would result from large differences in the numbers of incremental reportable releases, the sensitivity analysis will estimate the results of halving and doubling this figure. Thus, the following assumption is tested:

Number of Incremental Releases		
Low Estimate	Base Case	High Estimate
20	43	100

2. Notification hours. The costs associated with notification represent over 50 percent of total costs to regulated parties. The base case analysis in Chapter 5 assumes that 3 hours of managerial time and 2 hours of technical time would be required for each release. To estimate a range of notification costs that might be experienced by industry and individual firms, the estimate of hours are halved and doubled for the senstivity analysis, resulting in the following unit cost estimates:

Managerial and Technical Hours Required for Reporting		
Low Estimate	Base Case	High Estimate
$168	$336	$672

No variation of the hourly cost of managerial and technical time is available. The average hourly rates used in the base case analysis are considered to be reasonably accurate. Moreover, potential variations in the magnitude of these rates is overwhelmed by the potential variation in hours required for reporting.

3. Frequency of cleanups. The base case analysis assumes that there is a measurable difference in responses to releases that are above or below the RQ. If this assumption is inaccurate (i.e., if responsible parties would not respond differently to releases above or below the RQ), then no costs or benefits of cleanup can be attributed to regulations that adjust RQs. In the sensitivity analysis, various assumptions are used relating to this difference in percentage of releases cleaned up above and below RQs to estimate response costs.

Frequency of Cleanups		
Low Estimate	Base Case	High Estimate
.00	.05	.20

4. Frequency of off-scene monitoring. In Chapter 5, it is assumed that all releases require notification processing but that some of these releases require no further action. The three sets of estimates for frequency of off-scene monitoring that will be used in the sensitivity analysis are as follows:

Frequency of Off-Scene Monitoring		
Low Estimate	Base Case	High Estimate
.35	.70	.90

5. Frequency of on-scene monitoring. It is also important to examine the sensitivity of estimates of the frequency with which on-scene monitoring efforts will be needed (i.e., the percent of incidents that results in federal government on-scene monitoring) both because the government share of costs is about 85 percent of total effects, and because on-scene monitoring activities account for about 16 percent of government effects.

Based on judgments of the likelihood of need for on-scene monitoring and the availability of resources, the following "low" and "high" estimates have been formulated.

Frequency of On-Scene Monitoring		
Low Estimate	Base Case	High Estimate
.10	.20	.40

6. Frequency of direct removal. The following estimates of frequency of direct removal are constructed and used in the sensitivity analysis. Direct removal costs represent about 77 percent of government costs.

Frequency of Direct Removal		
Low Estimate	Base Case	High Estimate
.025	.05	.20

7.2 RESULTS OF THE SENSITIVITY ANALYSIS

This section presents the results of the sensitivity analysis. The section includes a description of changes in estimated costs to the government and regulated parties that occur from reporting and cleanup activities using the assumptions which were described in Section 7.1. The results of this analysis are organized in the same manner as the previous section and presented in Exhibit 7-1.

EXHIBIT 7-1

SENSITIVITY ANALYSIS RESULTS

	Low Estimate	Base Case	High Estimate
1. Number of incremental Reportable releases			
Assumption :	20	43	100
Cost of proposed regulation:	$ 82,700	$178,000	$ 413,400
2. Notification hours			
Assumption .	168	336	672
Notification Costs :	$ 7,200	$ 14,500	$ 28,900
Cost of proposed regulation:	$170,700	$178,000	$ 192,400
3. Incremental frequency of cleanups by responsible parties			
Assumptions :	00	.05	.20
Cost of Cleanups :	$ 0	$ 11,600	$ 46,400
Cost of proposed regulation:	$166,200	$178,000	$ 212,800
4. Frequency of off-scene monitoring			
Assumption :	.35	.70	.90
Off-scene monitoring costs :	$ 3,700	$ 7,400	$ 9,500
Cost of proposed regulation:	$174,300	$178,000	$ 180,000
5. Frequency of on-scene monitoring			
Assumption :	.10	.20	.40
On-scene monitoring costs :	$ 12,350	$ 24,700	$ 49,400
Cost of proposed regulation:	$165,400	$178,000	$ 202,500
6. Frequency of direct government removal			
Assumption :	.025	.05	.20
Direct removal costs :	$ 57,600	$115,240	$ 461,000
Cost of proposed regulation:	$120,200	$178,000	$ 523,500
7. Cost of Proposed Regulation with All assumptions varied :	$ 40,000	$178,000	$1,400,000

Source: ICF estimates.

1. Number of incremental reportable releases. Estimates of the number of reportable releases affect all of the estimates of costs that result from increased notification, recordkeeping, and response activities on the part of government and regulated parties. Exhibit 7-1 presents the results of changing the estimated number of incremental reportable releases and compares the cost of the proposed regulation to the base case estimate of 43 incremental reportable releases.

2. Notification hours. Varying the estimated number of hours required to report releases will affect the cost estimates associated with notification activities. Exhibit 7-1 presents the results of the sensitivity analysis, in which the base case hours estimates are halved and doubled. Note that this sensitivity analysis pertains only to effects on regulated parties; the costs to government do not change with variations in industry hours.

3. Frequency of responsible party cleanups. Varying the assumption concerning the difference in responsible parties' cleanup efforts for reported versus unreported releases leads to different response costs for regulated parties. The difference in industry response to reported releases versus unreported releases is shown in Exhibit 7-1.

4. Frequency of off-scene monitoring. Variations in the assumed frequency of off-scene monitoring affect the costs associated with government off-scene monitoring activities. Exhibit 7-1 shows the effect on government costs.

5. Frequency of on-scene monitoring. Variations in the assumed frequency of on-scene monitoring for radionuclide releases affect the costs associated with government on-scene monitoring activities for each alternative. Exhibit 7-1 shows the effect on on-scene monitoring costs of the base case frequencies and of lower and higher frequency estimates.

6. Frequency of government direct response. Variations in the assumed frequency of direct response affect the costs of the proposed regulation. Exhibit 7-1 shows the effect on direct response costs of the base case frequencies and of changing the frequency estimates.

By varying all assumptions simultaneously, we estimate that the proposed regulation will cost between $40,000 and $1,400,000 annually, with a most likely annual cost of about $178,000.

7.3 STATISTICAL ANALYSIS OF RADIONUCLIDE DATA BASE

The analysis for estimating the number of reportable releases in both the baseline situation and under the proposed regulation implicitly assumes that there is no correlation between the size of a release and the identity of the radionuclide released. We have tested this hypothesis.

An analysis of variance model (ANOVA) was used to test this hypothesis on a formal basis. The release observations were grouped by isotope and the

General Linear Model (GLM) procedure of the Statistical Analysis System (SAS) was used for the test. The results indicated[1] that we could not reject the hypothesis of no association between isotope and mean release amount. Therefore, we have assumed that there is no such association.

7.4 SUMMARY

A sensitivity analysis is as enlightening as the data that cause the estimates to change. The results in this chapter suggest that halving and doubling many of the effects and altering other key assumptions would not change the overall conclusions of the analysis that the estimated cost of the regulation is small. Because data on the health and welfare and environmental effects of altering RQs are not available, this sensitivity analysis does not vary these effects.

---

[1]The F-statistic was 1.05 (d.f. of 52;632) which was a p-value of 0.39.

APPENDIX A

PROFILES OF FACILITIES THAT RELEASE RADIONUCLIDES

Radionuclide emissions are most closely identified with the nuclear power industry, but are commonly released from other activities as well. The Nuclear Regulatory Commission, agreement states delegated authority by the Commission, and the Department of Energy (DOE) all license or oversee a variety of industrial facilities and non-industrial operations that emit radionuclides. In addition, several industrial categories not licensed by the Commission or an agreement state could also potentially release radionuclides at levels equalling or exceeding an RQ. Coal-fired utilities and industrial boilers, and mineral extraction industries such as uranium, aluminum, zinc, copper, lead, and phosphorous mining all release certain amounts of radionuclides during their operations.

The following sections briefly discuss each of the release categories cited above, describing the source of radionuclide emissions, the number of facilities within each category, and, where available, general trends in the industries. Discussion in A.1 encompasses most of the Nuclear Regulatory Commission and agreement state licensees, Section A.2 discusses Department of Defense facilities; Section A.3 discusses Department of Energy facilities; and Sections A.4 and A.5 discuss coal-fired utility and industrial boilers, and the primary mineral extraction industries, respectively.

A.1 NUCLEAR REGULATORY COMMISSION AND AGREEMENT STATE LICENSEES

The Nuclear Regulatory Commission has authority under the Atomic Energy Act to license source, byproduct, and special nuclear materials. Agreement states have been delegated licensing authority by the Commission to license source, byproduct, and special nuclear materials for facilities within their boundaries. As of 1984, there were 8,900 Commission licensees and 13,000 agreement state licensees.[1] All licensees are subject to the radioactive material release limits specified in 10 CFR Part 20, as well as other controls specified by the license. For purposes of this discussion, licensees have been divided into five general categories: power reactors, research and test reactors, radiopharmaceuticals, radiation source manufacturing, and other licensees. Most Department of Defense facilities are also licensed by the Commission but are discussed separately in Section A.2 of this report.

A.1.1 Power Reactors

Power reactors are units which utilize a controlled fission reaction of uranium fuel to produce heat. The heat converts water to steam, which

---

[1] U.S. Nuclear Regulatory Commission, 1984 Annual Report, p. 73.

provides the force to spin a turbine-generator to produce electricity. The nuclear fission chain reaction is controlled by the reactor's control rods. The movement of the control rods up or down within the fuel assemblies sustains the chain reaction at a desired power level. There are over 100 nuclear plants in the United States in operation, generating approximately 13 percent of electricity consumption.

Releases resulting from "nuclear incidents" (see Section 11(q) of the Atomic Energy Act) at facilities covered by the Price-Anderson Act are exempt from CERCLA reporting requirements. Releases at these facilities that are an RQ or more, but do not constitute a nuclear incident, must be reported under CERCLA to the National Response Center.

A.1.2 Research and Test Reactors

As of 1983, there were 70 reactors in operation in the United States for basic and applied research and for teaching purposes. The research conducted includes testing of reactor designs, components, and safety features, as well as work in the fields of physics, biology, and chemistry.

A.1.3 Radiopharmaceuticals

Radiopharmaceuticals are radioactive chemicals used for medical applications and research. In 1979, there were twenty-six industrial suppliers of radiopharmaceuticals producing sixty-five generally used radionuclides. These twenty-six firms exclude firms that purchase radiopharmaceutical products in bulk and repackage them into smaller containers (repackagers).

In 1984, there were over 2,800 medical facilities licensed by the Commission to use radiopharmaceuticals, and approximately another 7,000 facilities licensed by agreement states.[2] In 1946, almost 40 years earlier, only thirty-eight medical facilities were licensed. Medical facilities use radionuclides in all forms including solids, liquids, and gases; uses include diagnostic and therapeutic procedures.

A.1.4 Radiation Source Manufacturing

"Radiation sources" refer to radioactive materials enclosed in sealed containers. They are found in a number of industrial and consumer products

---

[2] The number of medical facilities that are Commission licensees is reported on page 73 of the 1984 U.S. Nuclear Regulatory Commission Annual Report, but the publication does not report the number of medical facilities that are agreement state licensees. The U.S. EPA estimated the total number of radiopharmaceutical manufacturers and users to be over 10,000 in 1977 (U.S. Environmental Protection Agency, Radionuclides Background Information Document for Final Rules, Volume II, October 1984, p. 3.3-5.). Subtracting the 2800 Commission licensees from the total estimate of 10,000, yields rougly 7,000 agreement state licensees.

such as radioisotope gauges used to measure thickness, static eliminators for industrial machinery, testing equipment, self-illuminating signs and watch dials, and smoke detectors.

Manufacturers of radiation sources process bulk quantities of radioactive materials received from radionuclide production facilities such as accelerators or reactors. The radiation source manufacturers keep inventories of radioactive materials in quantities ranging from ten curies to 100,000 curies.

A.1.5 Other Commission or Agreement State Licensees

Other Nuclear Regulatory Commission or agreement state licensees include laboratories, low-level waste disposal sites, mineral and metal processing facilities, fuel cycle facilities, and uranium mills. They are all subject to the emission requirements of 10 CFR Part 20, Appendix B, Table II.

Laboratories

Approximately 700 laboratories are licensed to handle radioisotopes in unsealed form, and it is assumed that an equal number of smaller laboratories that are unlicensed handle unsealed radioisotopes, resulting in an estimated total of 1400 laboratories that are potential sources of low-level radioactive emissions.[3] These laboratories are established in industry, government agencies, and academic and research institutions. They perform testing and research and development, and vary a great deal in size. While some facilities have only one small, multi-purpose laboratory, others have up to 300 individual laboratories in several buildings.

Small laboratories tend to specialize in a limited use of radionuclides for a single specific testing purpose. Academic and industrial laboratories use byproduct materials in research and testing. Medical laboratories conduct basic chemical and applied radionuclide research related to disease and health problems. Government laboratory facilities may use radionuclides for purposes such as food and drug testing or water and air quality monitoring. The most commonly used radionuclides in laboratory work are tritium, carbon-14, xenon-133, iodine-125, and iodine-131. Testing and industrial laboratories tend to use larger quantities of radionuclides than academic or other research laboratories; conversely, academic and research laboratories tend to use a wider variety of radionuclides.

Waste Disposal Sites

Although there are six low-level radioactive waste disposal sites licensed, only three are operational. These sites accept low-level radioactive wastes in a stabilized form from three major sources: power-reactor and fuel cycle

---

[3] Corbit C.D., Herrington W.N., Higby D.P., Stout L.A., and Corley J.P., Background Information on Sources of Low-Level Radionuclides Emissions to Air, PNL-4670, Prepared for EPA under U.S. DOE Contract by Battelle Memorial Institute, September 1983.

operations, laboratory research, and medical facilities. Wastes accepted by these facilities for disposal by shallow-land burial must meet specific site acceptance criteria. The disposal sites do not accept special nuclear materials, transuranics (elements having a higher atomic number than uranium), or spent reactor fuel. Wastes are buried at the disposal site in the transport containers in which they arrive.

Mineral and Metal Processing Facilities

Commission and agreement state licensees include facilities which extract metals from thorium- and uranium-bearing ores. Ten such facilities are licensed in the following nine states: Alabama, California, Colorado, Florida, Illinois, New Mexico, Oregon, Pennsylvania, and Tennessee. These facilities generally process ores for either refractory metals and their oxides (such as zirconium, columbium/niobium, tantalum, and hafnium), or for rare earths (such as cerium, praseodymium, neodymium, dysprosium, and ytterbium). Thorium is also used in some of these facilities to manufacture welding rods and to cast machine parts.

Fuel Cycle Facilities

The Commission and agreement states also license the use of source, byproduct, and special nuclear material at facilities engaged in the production of nuclear fuel. These facilities include operating uranium mills, uranium hexafluoride conversion plants, and uranium fuel fabrication plants. There is currently no plutonium fuel fabrication being done in the United States.

Uranium Milling

Uranium ore is delivered to mills where it is crushed and ground, and uranium oxide is chemically extracted. The mill product, also called uranium concentrate or yellow cake, is then sent to conversion facilities, where it is chemically converted to uranium hexafluoride. Uranium milling activity is a declining industry. As of November 1985, there were only three active uranium mills in the U.S. (one of which is expected to go on standby status). An additional 17 mills are already on standby status. Total uranium oxide production from mills was about 7,400 tons in 1984, down from a high of 21,800 tons in 1980.[4]

A.2 DEPARTMENT OF DEFENSE (DOD) FACILITIES

Department of Defense (DOD) facilities are also licensed by the Nuclear Regulatory Commission and must comply with limits for airborne and liquid discharges to unrestricted areas under 10 CFR Part 20, Appendix B, Table II.

---

[4] U.S. Environmental Protection Agency, Proposed Standard for Radon-222 Emissions from Licensed Uranium Mill Tailings; Draft Economic Analysis, Office of Radiation Programs, EPA 520/1-86-002, January 1986.

The Armed Forces Radiobiology Research Institute (AFRRI), located at the National Naval Medical Center in Bethesda, Maryland, operates both a thermal research reactor and a linear accelerator (linac), mainly in support of research on the medical effects of nuclear radiation and the effects of transient radiation on electronics and other equipment. The U.S. Army Test and Evaluation Command operates two reactors which are similar in design and are used to support studies in the effects of nuclear radiation. Both are fueled with enriched uranium.

Nine naval shipyards contribute almost all the radionuclide releases from U.S. Navy facilities. Pressurized water reactors power the nuclear fleet at the naval shipyards. Standard operations at the shipyards include construction, startup testing, refueling, and maintenance of the reactors. Radioactive wastes generated by these operations are processed and sealed, then shipped to commercial waste disposal sites.

A.3 DEPARTMENT OF ENERGY (DOE) FACILITIES

The U.S. Department of Energy (DOE) is given authority by the Atomic Energy Act of 1954 (Section 161 of Public Law 83-703) "to protect the public health and safety" with respect to the operation of so-called "GOCO" facilities -- facilities which are "government owned, contractor operated."

Major DOE facilities include national laboratories, facilities associated with the Formerly Utilized Sites Remedial Action Program (FUSRAP), the Uranium Mill Tailings Remedial Action Program (UMTRAP), the Grand Junction Remedial Action Program (GJRAP), the Surplus Facilities Management Program (SFMP), and facilities involved in specific research and development programs.[5] DOE is also responsible for operating uranium enrichment facilities, a step in the nuclear fuel cycle. Other DOE operations involving radionuclides include nuclear weapons research, development, and production; medical and biological research; and industrial applications and development.

As of 1980, 78 GOCO facilities in 24 states were subject to the health and safety requirements contained in DOE Order 5484.1. In 1982, there were thirty "active" DOE complexes, many of which have several operating facilities. ("Active" is defined to mean facilities currently generating radioactive waste.) Fourteen of these complexes are laboratories operating diversified programs. The other complexes operate programs including primarily weapons production and testing, nuclear materials production, and physical research.

A.4 COAL-FIRED UTILITY AND INDUSTRIAL BOILERS

Large coal-fired boilers are used to generate electricity for public and industrial use and to provide process steam, process hot water, and space heat. Boilers used in the utility industry are designated as utility boilers, and those used to generate process steam, process hot water, space heat, or electricity for in-house use are designated as industrial boilers.

---

[5] Rogers and Associates Engineering Corp., Radioactive Contamination at Federally Owned Facilities, June 1982, pp. 3-2, 3-3.

In 1983, coal-fired steam electric power units accounted for 63 percent of total capacity and 55 percent of total energy generation by U.S. electric utility generating units.[6] In early 1985, there were 1,281 coal-fired units on-line with a total generating capacity of 281 gigawatts.[7]

Coal-fired industrial boilers are used mainly to produce process steam and hot water, generate electricity (for the producer's own use), and provide space heat. Major users of industrial boilers include the steel, aluminum, chemical, and paper industries. There are approximately 51,200 coal-fired industrial boilers operating in the United States.[8]

More than 600 million tons of coal are burned each year in utility and industrial boilers. Coal contains mineral matter including trace quantities of naturally occurring radionuclides. Uranium-238 and thorium-232 and their decay products are found in relatively large quantities in coal.[9]

The emission of radionuclides to the air from coal-fired utility and industrial boilers is small. In promulgating radionuclide emission standards under the National Emission Standards for Hazardous Air Pollutants (NESHAP), EPA did not regulate radionuclide emissions from these boilers (50 FR 5190).

Coal-fired steam electric power generators and industrial boilers are not considered affected by the proposed RQ adjustments because radionuclide emissions to the air from these facilities are small. Quantities of all radionuclides expected to be released are well below the proposed RQ values.

A.5 MINERAL EXTRACTION INDUSTRY

Almost all mineral extraction industries that involve the removal and processing of ores to recover metal release some radionuclides. EPA has identified the following mineral extraction industries as having potential for releases of radionuclides: the uranium mining industry, the aluminum industry, the copper industry, the zinc industry, the lead industry, and the phosphate industry. These industries were identified because of the large quantity of ore mined domestically and because the mining processes used

---

[6] U.S. Department of Commerce, Statistical Abstract of the U S. (1985), 105th Edition. Government Printing Office, Washington, D.C., p. 564.

[7] ICF Energy Service, Summer/Fall 1985 Coal and Electric Utilities Market Assessment, p. I-2 (1985).

[8] U.S. Environmental Protection Agency, The Radiological Impact of Coal-Fired Industrial Boilers (Draft), Office of Radiation Programs, Washington, D.C., October 1981.

[9] U.S. Environmental Protection Agency, Radionuclides Background Information Document for Final Rules, Volume II, October 1984, p. 4.0-1.

create a likelihood for radionuclide emissions.[10] Only underground uranium mining and elemental phosphorus plants were found to warrant radionuclide emission standards under the Clean Air Act (50 FR 5190). Each mineral extraction industry is discussed below.

A.5.1 Uranium Mining

There are several different types of uranium mines and extraction processes. These include: open pit, underground, and in-situ (solution) mining operations. In 1982, there were 24 open pit uranium mines, 139 underground uranium mines, and 18 in-situ mines in operation, producing about 86 percent of the total uranium oxide domestic production in that year. Total uranium oxide production was 13,400 tons.[11]

Domestic uranium is almost exclusively mined in the western portion of the United States, mostly in New Mexico, Wyoming, and Texas. As of 1984, uranium production in these states collectively accounted for approximately 65 percent of the national total. Several other states (including Arizona, Colorado, Florida, South Dakota, Utah, and Washington) together accounted for the remaining 35 percent of the total.[12]

The majority of the uranium industry is owned by large, publicly held corporations. During the early and mid-1970's, the industry experienced rapid growth, spurred by expectations of increasing demand. This demand, however, did not materialize and, as a result, the industry is presently faced with an excess of capacity and supply, and the potential for increased competition from imports.

A.5.2 Aluminum Industry

Several materials are used in the production of aluminum. Bauxite is the principal aluminum ore found in nature. Bauxite contains elevated levels of both uranium-238 and thorium-232. The ore is processed at the mine to produce alumina, the basic feed in the aluminum reduction process. Twelve domestic firms produce primary aluminum. Almost all of the bauxite ore used in aluminum production is imported. Only five of the twelve firms that own primary aluminum plants also own domestic plants that produce alumina. These five firms own 73 percent of the current U.S. primary aluminum capacity. Currently, there are 32 operating primary aluminum smelters in the United States. With one exception, all of the plants are located in rural areas.

---

[10] U.S. Environmental Protection Agency, Radionuclide Background Information Document for Final Rules, Volume II, October 1984, p. 7.1-1.

[11] U.S. Department of Energy, Statistical Data of the Uranium Industry, GJO-100(83), Grand Junction, Colorado, January 1983, p. 9.

[12] Ibid., p. 9.

These smelters release radionuclides to the air from the uranium and thorium series at extremely low levels, however. A typical aluminum smelting operation releases radionuclides in a range from close to 10^{-6} curie per day to nearly 10^{-7} curie per day,[13] which is well below the lowest proposed RQ value. Therefore, these facilities are not affected by the proposed RQ adjustments.

A.5.3 Copper Industry

Most firms in the copper industry perform all production processes from mining through refining. Copper mills and smelters are located near copper mines. There are fifteen operating primary smelters in the United States. All smelters are located in rural areas with low population densities. Ninety percent of U.S. copper smelter capacity is located in Arizona, Montana, Nevada, New Mexico, Texas, and Utah. The sites tend to be large and generally contain associated mining and milling operations. In 1978, 1.5 million metric tons of primary copper was produced.[14] Copper smelters also release radionuclides to the air at very small levels. At a typical copper smelter, radionuclides are released principally from the uranium and thorium series at levels ranging from 1.4×10^{-4} to 5.4×10^{-6} curies per day.[15] These levels are well below the lowest proposed RQ value of 0.001 curie per day, and therefore, these facilities are not affected by the proposed RQ adjustments.

A.5.4 Zinc Industry

Zinc is usually found in nature as a sulfide ore called sphalerite. The ores are processed at the mine to form concentrates typically containing 62 percent zinc and 32 percent sulfur. In the past 10 years, U.S. demand for zinc metal has grown slowly, but U.S. smelting capacity has declined by more than 50 percent. Plants closed because they were obsolete, could not meet environmental standards, or could not obtain sufficient concentrate feed. Consequently, the metal has replaced concentrate as the major form of import. This situation is expected to continue. There are five operating primary zinc production facilities in the United States. Radionuclides in the uranium and thorium series are released from zinc smelters at extremely low levels, except for radon-222. Most radionuclides from zinc smelters to the air are released in levels ranging from 1.1×10^{-4} curie to 1.5×10^{-6} curie per day, all well below the proposed RQ values. Radon-222 is released at an expected level of

---

[13]U.S. Environmental Protection Agency, Radionuclide Background Information Document for Final Rules, Volume II, October 1984, p. 7 1-8.

[14] Schroeder H.J., Mineral Commodity Profiles -- Copper, U.S. Department of the Interior, Bureau of Mines, Washington, D.C., 1979.

[15]U.S. Environmental Protection Agency, Radionuclide Background Information Document for Final Rules, Volume II, October 1984, p. 7.2-6.

0.001 curie per day.[16] The proposed RQ for radon-222 is 100 curies, however, so the expected release is well below the proposed RQ. Therefore, zinc smelters are excluded from the universe of facilities affected by the proposed regulation.

A.5.5 Lead Industry

Galena is the principle lead-bearing ore found in nature. It contains small amounts of copper, iron, zinc, and other trace elements (including radionuclides). Lead smelting involves three processes: sintering, furnacing, and drossing. Sintering converts the ore from a sulfide to an oxide or sulfate form and prepares the feed materials for furnacing. Furnacing reduces the oxide feed to lead metal. Drossing reduces the copper content of the lead bullion from the furnace. After drossing, additional refining steps, which are dictated by the specific impurities present and the intended end-use of the product, are performed to produce the purified lead metal.

There are five primary lead smelters in the United States. Three facilities have integrated smelter/refining complexes; two facilities ship their drossed lead bullion away for final processing. Three of the smelters are located in Missouri and process only ores from the Missouri lead belt. The remaining smelters are located in Texas and Montana. The two western smelters are custom smelters that are designed to handle larger variations in ore composition than the Missouri smelters. Both domestic and foreign ores are smelted at the western plants. In 1979, total production from primary lead smelters was 594,000 tons.[17]

Radionuclides expected to be released from lead smelters are from the uranium and thorium series. Radionuclide releases to the air are expected to range from 1.2×10^{-4} curies per day to 2.7×10^{-6} curies per day, which are well below the proposed RQs.[18]

A.5.6 Phosphate Industry

The two major components of the phosphate industry which release radionuclides into the environment are phosphate rock processing plants and elemental phosphorous production.

---

[16] Ibid., p. 7.3-4.

[17] U.S. Department of Commerce, U.S. Industrial Outlook for 200 Industries with Projections for 1984, Washington, D.C., 1980.

[18] U.S. Environmental Protection Agency, Radionuclide Background Information Document for Final Rules, Volume II, October 1984, p. 7.4-4.

Phosphate Rock Processing Plants

Mining of phosphate rock is the fifth largest mining industry in the United States in terms of quantity of material mined. Total 1978 production was approximately 57.9 million metric tons. Prior to 1983, twenty firms were operational, with plants in thirty-one locations. The ten largest producers control about 84 percent of the capacity, with the two largest firms controlling over 34 percent.[19]

Phosphate rock processing plants emit radionuclides into the air in the uranium series during the drying and grinding of the rock. However, levels of emissions are not expected to be above 4.5×10^{-6} curies per day for any of the radionuclides.[20] These levels are well below the lowest proposed RQ adjustment, so these facilities will not be affected by the proposed RQ adjustments.

Elemental Phosphorus Plants

Another type of phosphorus plant produces elemental phosphorus, which is used primarily in the production of high grade phosphoric acid, phosphate-based detergents, and organic chemicals. Almost half of the elemental phosphorus produced domestically is used in the production of detergents. Metal treatment, foods and beverages, and chemicals are the other major end uses for elemental phosphorus. Approximately ten percent of the total U.S. marketable phosphate rock mined is used for elemental phosphorus production. Four major corporations operate six plants in the U.S. The total amount of elemental phosphorus produced in 1983 was approximately 366,000 tons.[21]

A.6 SUMMARY OF RADIONUCLIDE INDUSTRY

Exhibit A-1 displays the estimated number of facilities that release radionuclides. These facilities do not necessarily release radionuclides at levels exceeding the proposed RQs, but they produce or use radionuclides and are, therefore, likely to release radionuclides at some levels.

---

[19]U.S. Environmental Protection Agency, Phosphate Rock Plants, Background Information for Proposed Standards, EPA 450/3-79-017, Office of Air Quality Planning and Standards, 1979, p. 7-5.

[20]U.S. Environmental Protection Agency, Radionuclide Background Information Document for Final Rules, Volume II, October 1984, p. 6.1-11.

[21]Ibid., p. 6.3-1.

EXHIBIT A-1

FACILITIES USING OR PRODUCING RADIONUCLIDES

Category of Facilities	Number of Facilities
Commission Licensees	8,900
Agreement State Licensees	13,000
Department of Energy Facilities	78
UNLICENSED FACILITIES (53,456)	
Laboratories	700
Utility Boilers	1,281
Industrial Boilers	51,200
Uranium Mines	181 (21 active)
Aluminum Smelters	32
Copper Smelters	15
Zinc Smelters	5
Lead Smelters	5
Phosphate Rock Processing	31
Elemental Phosphorus Plants	6
TOTAL	75,400

Source: See Appendix A text.