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DOE STANDARD

DOE-HDBK-xxxx-97
June 1997

DRAFT HANDBOOK FOR CONTROLLING RELEASE FOR REUSE OR RECYCLE OF NON-REAL PROPERTY CONTAINING RESIDUAL RADIOACTIVE MATERIAL

ASSISTANT SECRETARY for
ENVIRONMENT, SAFETY AND HEALTH
and
ASSISTANT SECRETARY for
ENVIRONMENTAL MANAGEMENT

U.S. Department of Energy
Washington, D.C. 20585

AREA SAFT

INTERIM GUIDE - FOR INTERIM USE AND COMMENT

FOREWORD

1. This Department of Energy (DOE) standard was prepared by the Office of the Assistant Secretary for Environment, Safety and Health (EH) and the Office of the Assistant Secretary for Environmental Management (EM) with the assistance of Argonne National Laboratory for interim use and comment by all DOE components and their contractors.

2. Beneficial comments (recommendations, additions, and deletions) and any pertinent data that may improve this document should be sent to Kenneth C. Duvall, Office of Environmental Policy and Assistance, (EH-41), Forrestal Building, Room GA-098, U.S. Department of Energy, Washington, D.C., 20585.

HANDBOOK FOR CONTROLLING RELEASE FOR REUSE OR RECYCLE OF NON-REAL PROPERTY CONTAINING RESIDUAL RADIOACTIVE MATERIAL

June 1997

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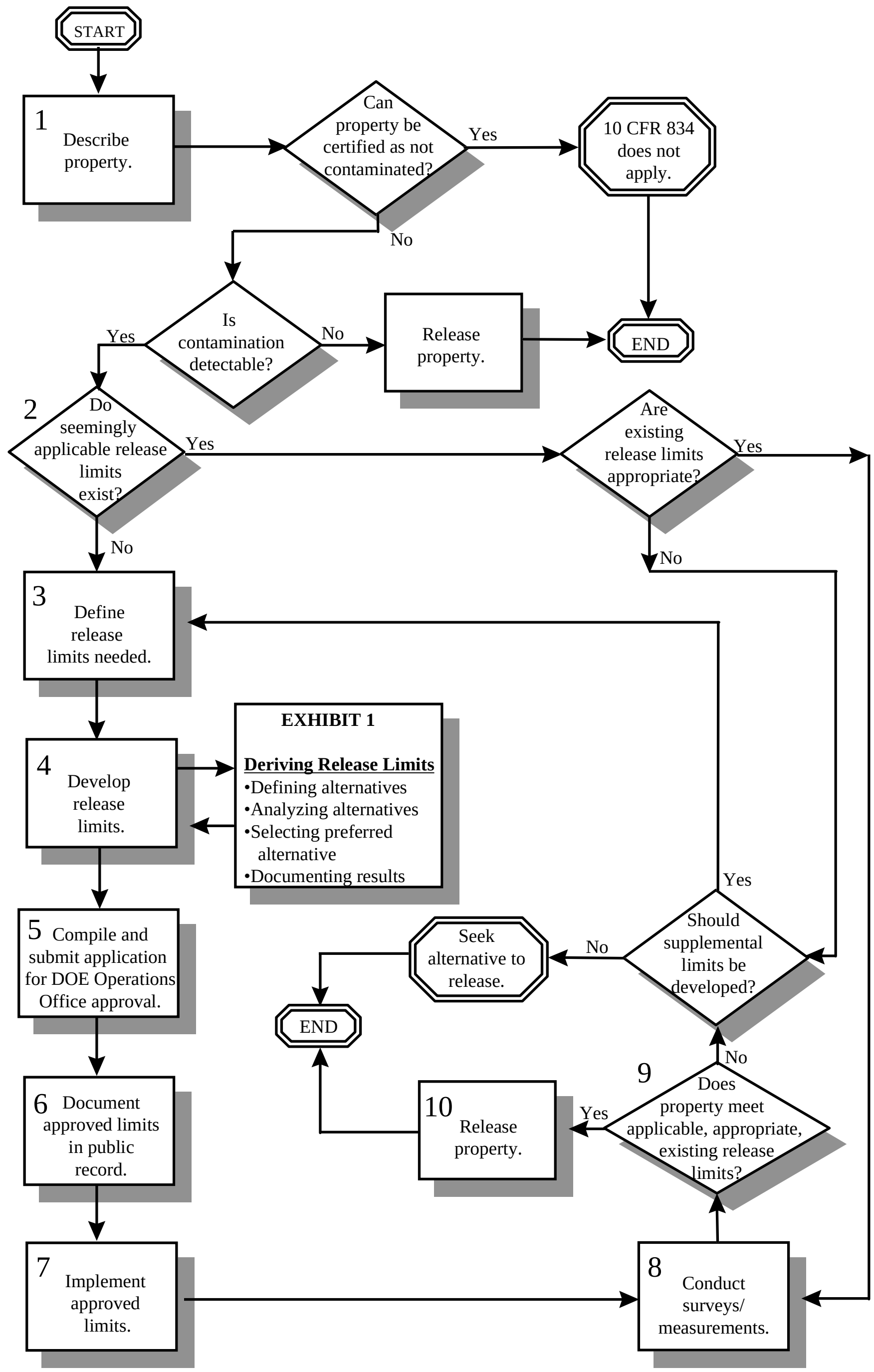
FOR DOE NON-REAL PROPERTY
CONTAINING RESIDUAL RADIOACTIVE MATERIAL



HANDBOOK OVERVIEW

> The process for controlling release for reuse
> or recycle of non-real property containing residual radioactive material
> described in this *Handbook* is designed to fulfill
> the requirements of Order DOE 5400.5,
> "Radiation Protection of the Public and the Environment,"
> and 10 CFR Part 834
> (*proposed* at 58 FR 16268, Mar. 25, 1993), which
> will codify and clarify DOE 5400.5.

Objective

The objective of this *Handbook for Controlling Release for Reuse or Recycle of Non-Real Property Containing Residual Radioactive Material* is to describe a step-by-step process that, if followed, will assist in ensuring radiological doses to the public from recycle or reuse of released non-real property containing residual radioactive material meet applicable regulatory standards, are as low as reasonably achievable (ALARA), and meet U.S. Department of Energy (DOE) requirements for release of such material.

Scope and Applicability

The release process described by this *Handbook* applies only to non-real DOE property for which the preferred future use involves reuse or recycle. Examples of categories of such property include consumable items, personal items, office items, tools and equipment, and reusable debris. The box below lists specific items that could fall within each category. The process does not apply to wastes released for disposal, released soils, liquid discharges, radon emissions, or released real property.

EXAMPLES OF NON-REAL PROPERTY THAT COULD BE REUSED OR RECYCLED

- *Consumable Items* such as wood, containers, labwares and paper
- *Personal Items* such as clothing, brief cases, bags, respirators and gloves
- *Office Items* such as computers, telecommunication equipment, unused office supplies and furniture
- *Tools/Equipment* such as hand tools, power tools, construction machinery, vehicles, tool boxes, ladders and scales
- *Debris* such as wood, tanks, scrap metal, concrete, wiring, doors and windows

The release process described by this *Handbook* is based on the requirements for protection of the public and environment from radiation exposure resulting from DOE activities. These requirements are currently found in Order DOE 5400.5, "Radiation Protection of the Public and the Environment," and will be codified and clarified in 10 CFR Part 834, which was proposed by DOE in 1993 (58 FR 16268, Mar. 25, 1993). The steps of the process are designed to satisfy either set of requirements. However, the steps are not designed to cover ***all*** regulatory and policy requirements that apply to releasing non-real property containing residual radioactive material.

Other laws, regulations and policies with which responsible DOE personnel must ensure compliance before releasing non-real property containing residual radioactive material include:

- Federal Property Management Regulations (FPMR) [41 CFR Part 101];
- DOE Property Management Regulations (PMR) [41 CFR Part 109];
- Department of Energy Acquisition Regulations (DEAR);
- DOE Personal Property Letter (PPL) 970-3 (Mar. 25, 1996; Control of "High-Risk" Personal Property);
- National Environmental Policy Act (NEPA) [10 CFR Part 1021]; and
- Resource Conservation and Recovery Act (RCRA) [40 CFR Parts 260 through 271].

Approach and Structure

This *Handbook* relies, as appropriate, on flowcharts, step-by-step discussion, tables, examples, references and checklists to present the process for releasing non-real property containing residual radioactive material. Each step of the release process is explained by showing (on an even-numbered page) its position on an overview flowchart, and then discussing (on subsequent pages) actions recommended to implement the process step and regulatory requirements and policy considerations making the process step necessary. In conjunction with the discussion of each step, detailed instructions, examples and references may be provided.

Summary

For purposes of this *Handbook*, a release of non-real DOE property occurs when the property is transferred out of DOE control by sale, lease, gift or other disposition, provided that the property does not remain under the radiological control of DOE, the U.S. Nuclear Regulatory Commission (NRC), or a responsible Agreement State. Releases may be restricted or unrestricted. A restricted release occurs when non-real property is removed from DOE control for a limited, specifically-stated application. A restricted release may include controls or restrictions on use that are implemented by a designated party or through a specific process.

Under the requirements of both DOE 5400.5 and 10 CFR Part 834, releasing contaminated non-real DOE property is prohibited unless authorized or supplemental limits have been developed and approved by DOE and the following four actions are taken to protect the public and environment:

1. The non-real property is appropriately surveyed/measured to identify and characterize its radiological condition;
2. Residual radioactive material on non-real property surfaces or interior is determined to meet applicable authorized or supplemental limits;
3. Required documentation is completed; and
4. The owner or recipient of the released non-real property is appropriately notified of the radiological status of the property and the availability of required documentation.

A graphic overview (page iv) illustrates the ten-step release process for non-real property presented in this *Handbook.* Importantly, authorized or supplemental limits may be derived for individual releases of non-real property (e.g., one-time sale of reusable copper wire), or for categories of non-real property (e.g., scrap metal or office machines) that are routinely released over time. In the latter case, once authorized or supplemental limits have been approved for the category, individual releases of non-real property within the category are assumed to meet ALARA requirements if compliance with the limits has been demonstrated.

Major steps of the release process for non-real property include:

- Characterize property and prepare a description.
- Determine whether applicable authorized or supplemental limits exist.
- Define authorized or supplemental limits needed.
- Develop authorized or supplemental limits.
- Compile and submit application for DOE Operations Office approval.
- Document approved limits in the public record.
- Implement approved limits.
- Conduct surveys/measurements.
- Verify that applicable authorized or supplemental limits have been met.
- Release property.

For each step, the *Handbook* recommends actions to guide field personnel in implementing the step. For some steps, more detailed instructions and examples are provided.

Authorized and supplemental limits must be developed using the ALARA process to determine acceptable concentrations of residual radioactive material on the surfaces of, or within, property that will be released from DOE control. If seemingly applicable authorized limits exist but are either inappropriate or not practicable, supplemental limits may be developed, also using the ALARA process. In either case, unless the transfer is to a licensee of the NRC or an Agreement State and the transferred material is covered by the license, coordination with the NRC, or the responsible Agreement State, is required to ensure that DOE-approved authorized or supplemental limits will not result in the release of quantities of radionuclides that would otherwise be licensable.

Instructions for using the ALARA process to develop authorized and supplemental limits are provided by Exhibit 1. Other exhibits explain the consultation among DOE organizations during the process of approving authorized and supplemental limits, provide outlines of applications for approval of authorized and supplemental release limits, provide examples of the content of an application for approval of authorized limits, and provide information on conducting radiological surveys.

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GLOSSARY OF TERMS AND ACRONYMS

ALARA - As Low as Reasonably Achievable, which is an approach used for radiation protection to manage and control exposures (both individual and collective to the work force and to the general public) and releases of radioactive material to the environment so that the levels are as low as is reasonable taking into account social, technical, economic, practical and public policy considerations.

ALARA process - A logical procedure for evaluating alternative operations, processes, and other measures for reducing exposures to radiation and emissions of radioactive material into the environment, taking into account societal, environmental, technological, economic, practical and public policy considerations to make a judgment concerning the optimum level of public health protection.

ALARA program - The set of design specifications, operating procedures, techniques, monitoring and surveillance programs, records, and instructions used to implement the ALARA process.

authorized limits -Limits on residual radioactive material on the surfaces of or within property. Authorized limits may be expressed in any appropriate, measurable units including activity (disintegrations per unit time), concentration (activity per unit area or activity per unit mass), or count rate (counts per unit time). Authorized limits must be derived in a manner consistent with the ALARA process given the anticipated use of the property (either restricted or unrestricted), and must be authorized by DOE to permit the release of property from DOE control.

contamination - Residual radioactive material.

DOE - U.S. Department of Energy

DOE Operations Office - Formerly referred to as "DOE Field Office," this is the first-line DOE field element that carries organizational responsibility for (1) managing and executing assigned programs, (2) directing contractors who conduct the programs, and (3) assuring that environment, safety, and health are integral parts of each program (Order DOE 5400.1 and memorandum from Linda G. Sye, Acting Director of Administration and Management, Apr. 1, 1993).

EH - DOE Office of the Assistant Secretary for Environment, Safety and Health

EM - DOE Office of the Assistant Secretary for Environmental Management

NEPA - National Environmental Policy Act, Public Law 91-190, Jan. 1, 1970; 83 Stat. 852, 42 U.S.C. 4321, as amended.

non-real property - For the purpose of this *Handbook*, non-real property is DOE property that does not fall within the definition of real property. Examples of such DOE property include reusable office and industrial furniture or equipment, reusable tools, recyclable scrap metal, and recyclable concrete.

process knowledge - The use of operational understanding to evaluate whether property has been located or utilized in a way that could have caused activation or radiological contamination.

property generator - The DOE element or DOE contractor having direct management control over the activity that generates non-real property proposed for release from DOE control.

radiation control area - Any area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials.

RCRA - Resource Conservation and Recovery Act, Public Law 94-580 (Oct. 31, 1976), as amended; 90 Stat. 2795, 42 U.S.C. 6901 et seq.

real property - Land, improvements on land, and usually, equipment or fixtures (such as plumbing, electrical, heating, built-in cabinets, and elevators) that are installed in a building in a more or less permanent manner, or that are essential to the building's primary purpose (DOE O 430.1). For the purpose of this *Handbook*, if equipment or fixtures have been removed from a building into which they were originally installed, or if a building has been removed from the land on which it was constructed, the removed materials are no longer real property.

recycle - To extract useful materials from.

release - To transfer out of DOE control, and for the purpose of this *Handbook*, also out of radiological control of NRC or any responsible Agreement State.

release limits - For the purpose of this *Handbook*, release limits refers to authorized limits, supplemental limits, or both, depending on the context in which the guidance is applied.

residual radioactive material - Radioactive material that is in or on solid, liquid, or gaseous media, including soil, equipment, or structures, as a consequence of DOE activities. Residual radioactive material includes, but is not limited to, "residual radioactive material" as defined in the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA).

restricted release - Removal of an item, personal property, or real property from DOE Control for a limited, specifically-stated application including controls or restrictions on use that are implemented by a designated party or through a specific process. For the purpose of this *Handbook*, discussions of restricted releases refer only to releases of non-real property.

reuse - To restore and use anew.

supplemental limits - DOE-approved limits on residual radioactive material. Supplemental limits may be expressed in any appropriate, measurable units including activity (disintegrations per unit time), concentration (activity per unit area or activity per unit mass), or count rate (counts per unit time). When circumstances exist that cause seemingly applicable, existing authorized or supplemental limits to be inappropriate or impracticable to apply, supplemental limits may be appropriate. Supplemental limits, when appropriate, must be derived in a manner consistent with the ALARA process.

surface contamination - Residual radioactive material that is present on the surfaces of material or property, whether or not such surfaces can be accessed for purposes of survey/measurement.

UMTRCA - Uranium Mill Tailings Radiation Control Act of 1978, P.L. 95-604, as amended; 92 Stat. 3021.

volumetric contamination - Residual radioactive material that is distributed throughout the volume of the property as a result of smelting or activation.

RELEASE PROCESS
for
NON-REAL PROPERTY CONTAINING
RESIDUAL RADIOACTIVE MATERIAL

INTRODUCTION

DOE owns numerous facilities where production, research, development and other operations and activities involving radioactive material and radiation are carried out. It is DOE's objective to operate its facilities and to conduct its activities so that radiation exposures to members of the public are acceptable and as low as reasonably achievable. To accomplish this, DOE has adopted Order DOE 5400.5, "Radiation Protection of the Public and the Environment," and will be promulgating 10 CFR Part 834 to codify and clarify the requirements of DOE 5400.5. Under both DOE 5400.5 and 10 CFR Part 834, all contaminated non-real DOE property is prohibited from release unless release limits* for concentrations of residual radioactive material have been developed and approved by DOE, and the following actions are taken to protect the public and environment:

1. The non-real property is appropriately surveyed/measured to identify and characterize its radiological condition;
2. Residual radioactive material on non-real property surfaces or interior has been determined to meet release limits;
3. Required documentation is completed; and
4. The owner or recipient of the non-real property is appropriately notified of the radiological status of the property and the availability of required documentation.

Steps 1 through 10 of this *Handbook* define a process for satisfying both Order DOE 5400.5 and future 10 CFR Part 834 property release restrictions when a DOE facility or activity proposes to release non-real property containing residual radioactive material for reuse or recycle. Examples of categories of such property include consumable items, personal items, office items, tools and equipment, and reusable debris. The box below lists specific items that could fall within each category. The process does not apply to wastes released for disposal, released soils, liquid discharges, radon emissions, or released real property.

EXAMPLES OF NON-REAL PROPERTY THAT COULD BE REUSED OR RECYCLED

- *Consumable Items* such as wood, containers, labwares and paper
- *Personal Items* such as clothing, brief cases, bags, respirators and gloves
- *Office Items* such as computers, telecommunication equipment, unused office supplies and furniture
- *Tools/Equipment* such as hand tools, power tools, construction machinery, vehicles, tool boxes, ladders and scales
- *Debris* such as wood, tanks, scrap metal, concrete, wiring, doors and windows

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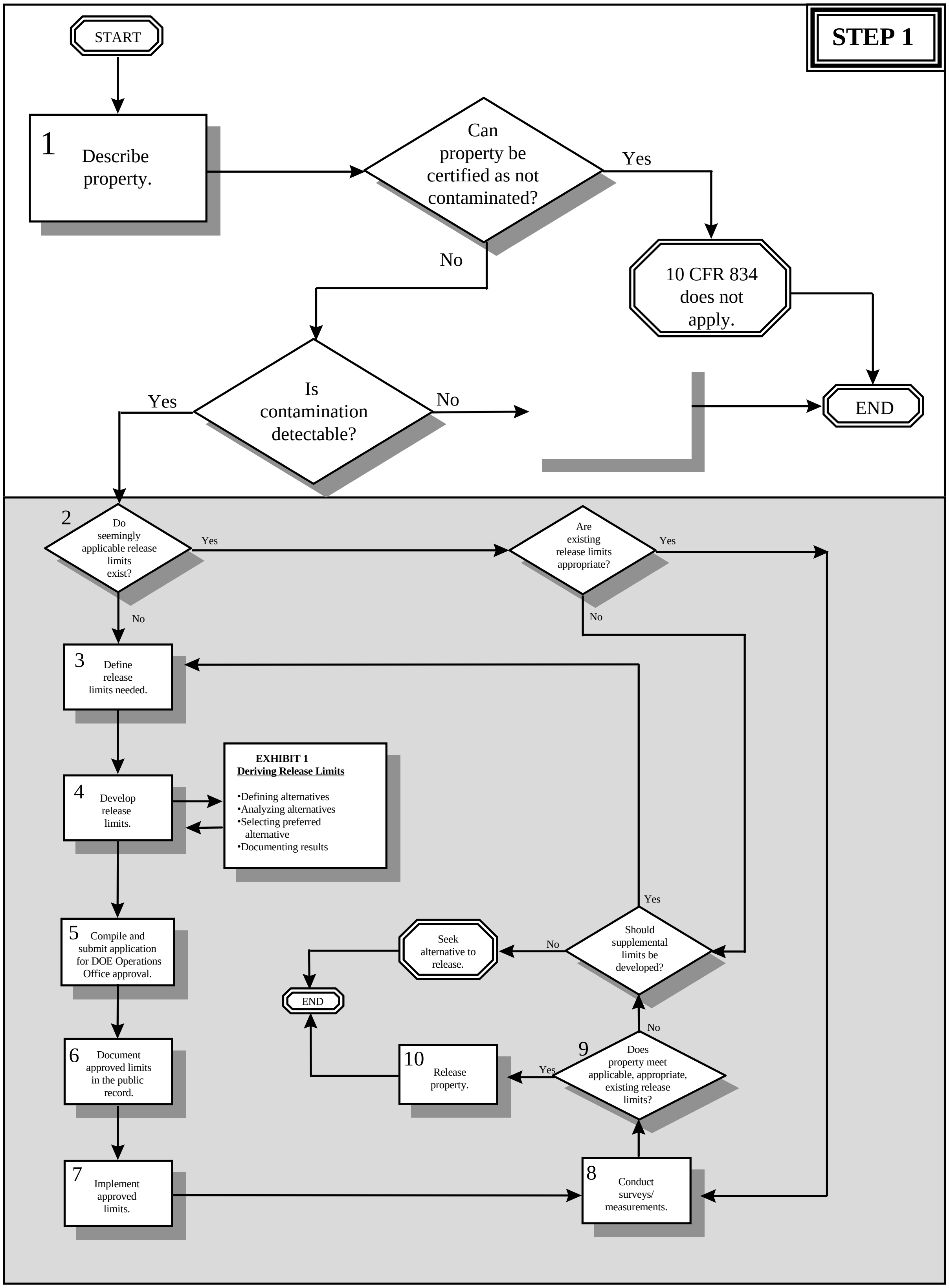
* For the purpose of this *Handbook*, release limits refers to authorized limits, supplemental limits, or both, depending on the context in which the guidance is applied.


STEP 1
START
1 Describe property.
Can property be certified as not contaminated?
Yes
10 CFR 834 does not apply.
No
Is contamination detectable?
Yes
No
END
2 Do seemingly applicable release limits exist?
Yes
Are existing release limits appropriate?
Yes
No
No
3 Define release limits needed.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
4 Develop release limits.
5 Compile and submit application for DOE Operations Office approval.
Yes
Should supplemental limits be developed?
No
Seek alternative to release.
END
No
9 Does property meet applicable, appropriate, existing release limits?
Yes
10 Release property.
6 Document approved limits in the public record.
7 Implement approved limits.
8 Conduct surveys/ measurements.

STEP 1 - Characterize and describe non-real DOE property proposed for release.

Actions Recommended:

1. Use process knowledge to develop a written radiological history of the non-real property.

2. If the radiological history supports certification that the non-real property is not radioactive or radioactively contaminated, prepare a certification statement and release the property.

3. If the process-knowledge-based radiological history will not support certification that the non-real property does not contain residual radioactive material, then the property must be treated as either (1) known to be contaminated or previously contaminated, or (2) possibly contaminated. In either case, release must follow the process presented in this *Handbook*.

4. If surveys/measurements of possibly contaminated non-real property detect no contamination, release the property after preparing required documentation.

5. If surveys/measurements detect contamination on possibly contaminated non-real property, a description of the non-real property must be prepared to either (1) demonstrate the applicability of existing release limits prior to release, or (2) support development of release limits when none exist.

6. ***Go to Step 2***, which discusses the use of a description of non-real property prepared during this step to determine whether existing release limits apply.

Discussion:

When a DOE facility or activity believes that non-real DOE property should be released for reuse or recycle, the property must be radiologically characterized and described in order to qualify it for release. For this purpose, a written radiological history based on process knowledge should be developed. If DOE or DOE contractor personnel can certify based on this radiological history that non-real property proposed for release is neither radioactive nor radiologically contaminated, then Order DOE 5400.5 and 10 CFR Part 834 do not apply and the property can be released after preparing appropriate certification. If it is not possible to certify that the non-real property is neither radioactive nor radiologically contaminated, then the property falls into one of two categories: (1) known to be contaminated or previously contaminated; or (2) possibly contaminated, but with no direct evidence of contamination.

Certifying That Non-real Property Is Not Contaminated

Non-real property can be certified as not contaminated only if the person signing the certification can attest, based on ***process knowledge***, that during the property's ***radiological history***, it has not been located or utilized such that it could have become radioactive or radiologically contaminated. The certification document should be in the format shown below in the box titled "Example Certification." Process-knowledge-based certifications for release of non-real property for reuse or recycle should be signed by a responsible person designated by the property generator.

NOTE: For the purpose of this *Handbook*, non-real property not known to be contaminated should be treated as possibly contaminated if it has been used or stored in radiation areas that could contain unconfined radioactive material or that are exposed to beams of particles capable of causing activation (neutrons, protons, etc.). Items stored out of radiation control areas are not considered subject to activation due to the relatively low intensity of the beams permitted in uncontrolled areas.

Radiological History

Responses to the following questions could be used to review the radiological history of the non-real property based on process knowledge:

- Has the property been exposed to unencapsulated or unconfined radioactive material during use or storage?
- Has the property been exposed to particle fields that could be expected to radiologically activate the property?
- What radiological surveys are available for the areas in which the property was used or stored?
- What are the potential radionuclides of concern?
- Was the property maintained in sealed containers?
- Are valid comparison data available for naturally occurring radionuclides on similar property which has not been used, stored or exposed to transferrable radioactive material?

In some circumstances it may be advisable to document the radiological history to support the certification that non-real property is neither radioactive nor radioactively contaminated. The need for such documentation should be assessed on a case-by-case basis.

Process knowledge refers to the use of operational understanding to evaluate whether non-real property has been located or utilized in a way that could have caused activation or radiological contamination.

EXAMPLE CERTIFICATION

Based on my knowledge of the property, I certify that the property being released is neither radioactive nor radioactively contaminated for the following reasons:

[INSERT REASONS BASED ON RADIOLOGICAL HISTORY]

Signed: (authorized signature)

Date: ____________________

Conducting Surveys to Characterize Non-real Property

Non-real property known to be either contaminated or previously contaminated must be comprehensively surveyed prior to release to demonstrate compliance with release limits. If such limits already exist when the non-real property is proposed for release, then the survey protocols approved with the limits should be used. If applicable release limits have not been previously approved, then commonly accepted survey protocols can be used to characterize the non-real property for the purpose of developing release limits. It should be recognized, however, that in these circumstances, it may be necessary to re-survey the non-real property later, after release limits have been approved.

Possibly contaminated non-real property requires confirmatory/verification surveys to show whether detectable contamination is present. In the absence of detectable contamination, non-real property of this type can be released after documenting the survey results in accordance with applicable, site-specific procedures. If contamination is detected, then the non-real property must be comprehensively surveyed in the same manner as when contamination is known to be present either to demonstrate compliance with applicable release limits, or to provide a basis for developing such limits.

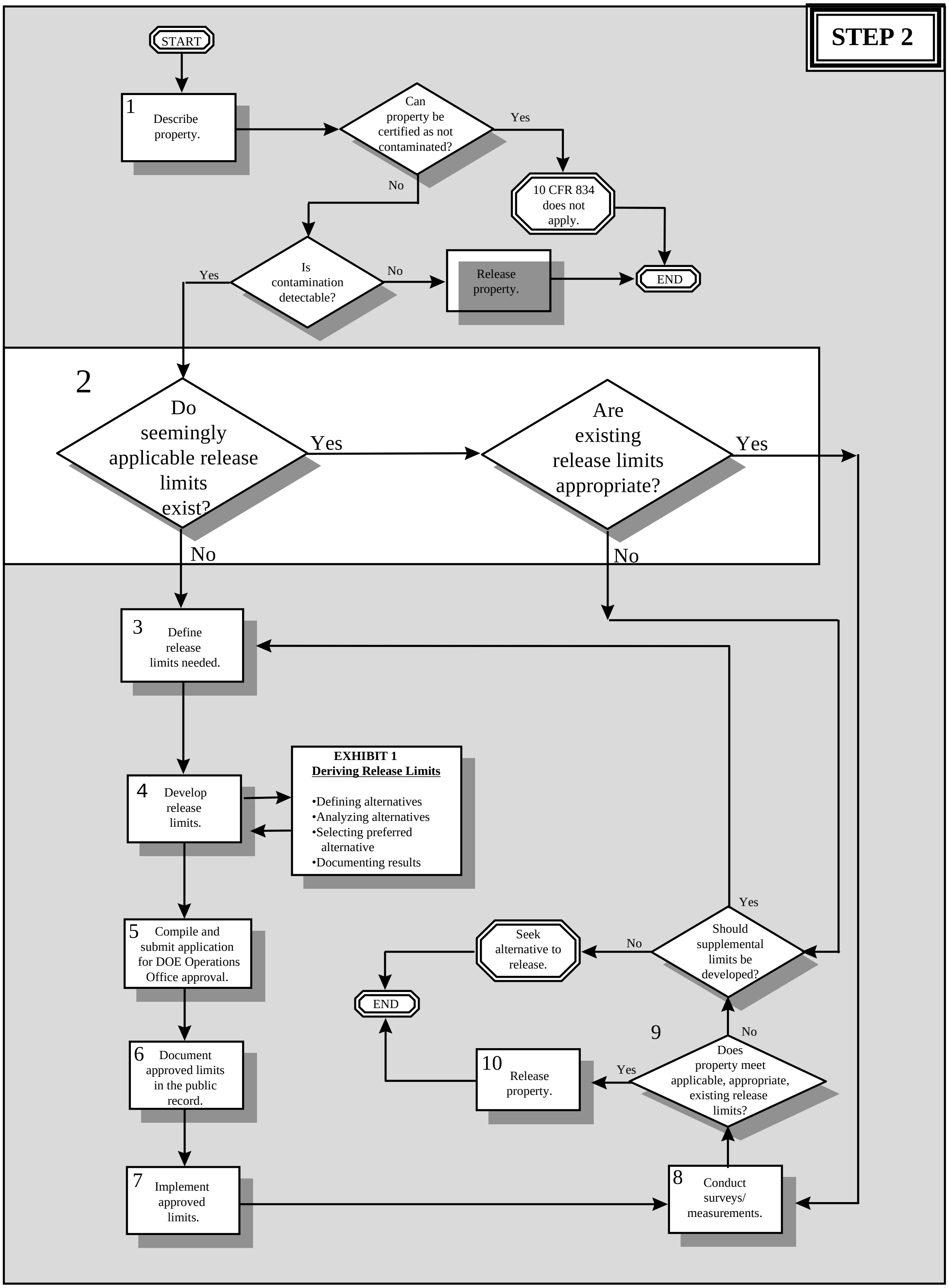
Describing Non-real Property in Order to Develop Release Limits And Demonstrate Applicability of Release Limits

Along with the radiological characterization from the surveys conducted as described above, a detailed physical description of non-real property to be released must be prepared to support development of release limits (Step 4), and/or to demonstrate that existing limits are applicable (Step 2). The nature of the physical description will differ depending on whether release limits are, or will be, applicable to an individual release of non-real property (e.g., one-time sale of reusable copper wire) or categories of non-real property that will be routinely released over time (e.g., scrap metal or office machines). In the latter case, the description will be anticipatory and cover non-real property expected to be released. Exhibit 1 discusses in more detail the components of property descriptions needed for development of release limits.

References:

Process Knowledge Certification, Facility Guidance, DOE/CH-9302, DOE R&D Laboratory Working Group (RADWG) (Aug. 13, 1993).

Draft Environmental Implementation Guide for Radiological Survey Procedures, DOE Office of Environmental Policy and Assistance (Feb. 1997; Draft Report for Comment), Sec. 4.6, "Survey of Equipment and Small Items," p. 4.28.


STEP 2
START
1 Describe property.
Can property be certified as not contaminated?
Yes
No
10 CFR 834 does not apply.
END
Is contamination detectable?
Yes
No
Release property.
END
2
Do seemingly applicable release limits exist?
Yes
No
Are existing release limits appropriate?
Yes
No
3 Define release limits needed.
4 Develop release limits.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
5 Compile and submit application for DOE Operations Office approval.
6 Document approved limits in the public record.
7 Implement approved limits.
8 Conduct surveys/ measurements.
9
Does property meet applicable, appropriate, existing release limits?
Yes
No
10 Release property.
END
Should supplemental limits be developed?
Yes
No
Seek alternative to release.

STEP 2 - Do release limits exist?

Actions Recommended:

1. If applicable release limits do not exist for non-real property proposed for release, ***go to Step 3.***

2. If release limits exist that seem applicable, evaluate whether such limits are appropriate. If they are, ***go to Step 8*** and conduct surveys or measurements to evaluate whether the existing limits are met.

3. If surveys or measurements show that applicable, appropriate, existing release limits are not met, evaluate whether new or amended supplemental limits should be developed. If yes, document the basis for this decision and ***return to Step 3.***

4. If seemingly applicable, existing release limits are not appropriate, evaluate whether new or amended supplemental limits should be developed. If they should, document the basis for this decision and ***return to Step 3***.

Discussion:

Based on the property description prepared as described by Step 1,an evaluation should be made of whehter any existing release limits seem applicable to the non-real property proposed for release. If existing limits apply and are appropriate, then the process for release is shortened because development of new limits is unnecessary. However, if release limits do not exist, are not applicable, or are inappropriate, new or amended limits.

There are two types of release limits: authorized and supplemental. Authorized limits, which may be measured in any appropriate units including activity, concentration or count rate) are placed on residual radioactive material on the surfaces, or within (internal to), property. These limits must be developed using the ALARA process (*see* Exhibit 1), given the anticipated use of the property (either restricted or unrestricted). Authorized limits must be approved by DOE (*see* Steps 5, 6, and 7), and are used for the purpose of evaluating whether property that contains residual radioactive material should be released from DOE control.

NOTE ABOUT SURFACE ACTIVITY LIMITS

DOE requirements under Order DOE 5400.5 and 10 CFR Part 834 allow the use of the Surface Activity Guidelines (*see* Exhibit 1, Table 1) as authorized limits only after ALARA process requirements taking site-specific circumstances into account have been met. Therefore, the activity levels given in the Surface Activity Guidelines table **should not** be treated as existing authorized limits until ALARA process requirements have been fulfilled. Exhibit 1 provides additional information about meeting ALARA process requirements for authorized limits based on the Surface Activity Guidelines.

Supplemental limits, which like authorized limits may be measured in any appropriate units including activity, concentration, or count rate, are also DOE-approved limits on residual radioactive material developed using the ALARA process. The difference between authorized and supplemental limits is that supplemental limits are developed when seemingly applicable, existing, authorized or supplemental limits are not appropriate. For example, supplemental limits might be warranted if existing authorized limits apply to the same type of property as is proposed for release, but the scenarios or assumptions used to establish the existing authorized limits are not appropriate for the property identified for release. Generally, however, every reasonable effort must be made to minimize the use of supplemental limits, which may be more or less restrictive than the existing authorized limits.

EXAMPLE OF CIRCUMSTANCES WARRANTING SUPPLEMENTAL LIMITS

DOE has a general standard for releasing non-real property, including office equipment. The standard was developed for the expected reuse of this property, but has also been applied to release for reuse of laboratory equipment. DOE has some laboratory hoods that are extremely valuable (relative to desks), and it has not been possible to clean the hoods to meet the authorized office equipment release limit. However, based on the planned use of the laboratory hoods noted by the potential end user, it is clear that the assumptions made for the dose assessment used to develop the authorized limits for office equipment would drastically over-estimate the potential doses from the laboratory hoods. In such a case, a supplemental limit may be justified on the basis of a specific dose estimate, or known restrictions on future use.

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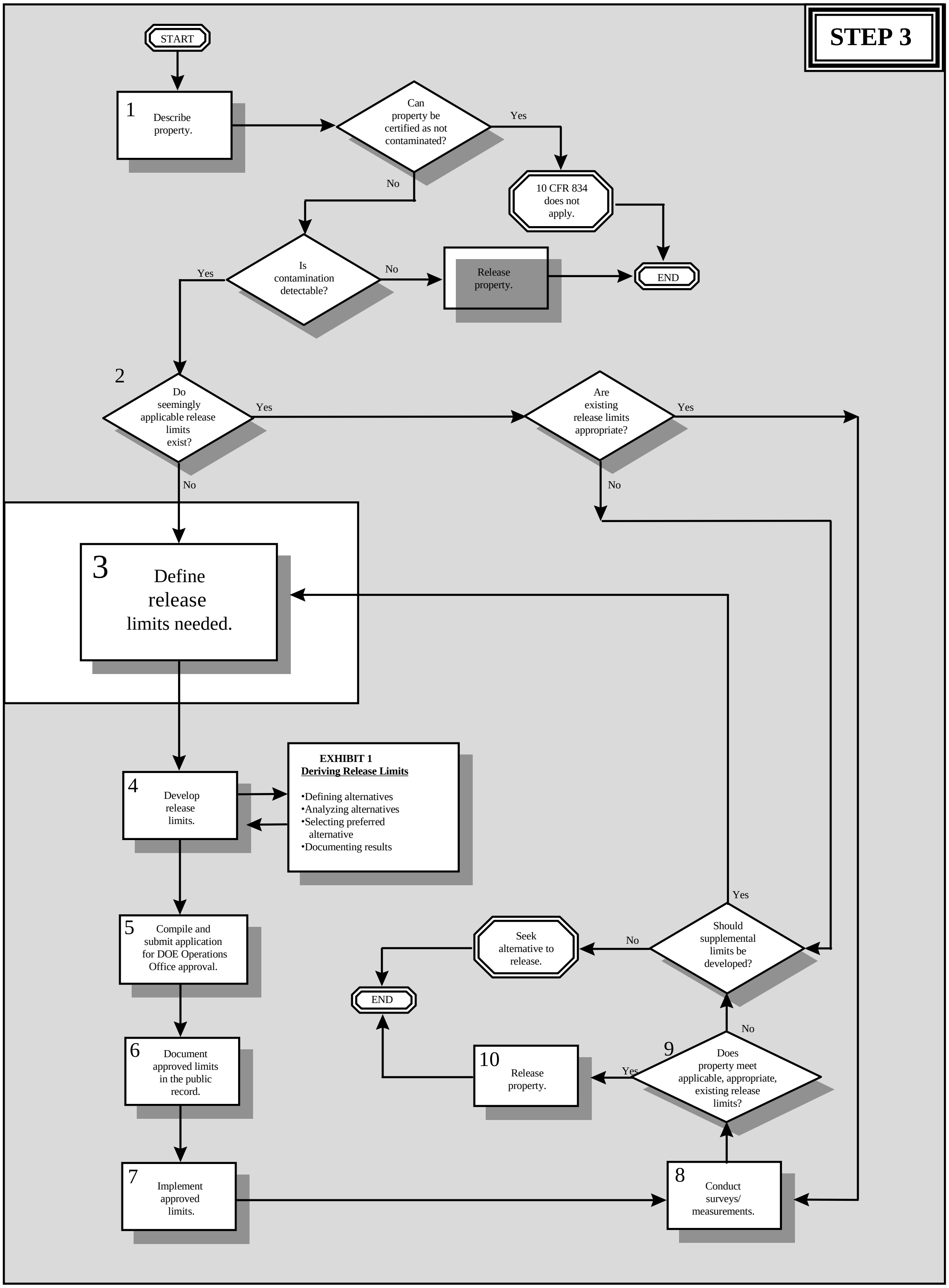

STEP 3
START
1 Describe property.
Can property be certified as not contaminated?
Yes
No
10 CFR 834 does not apply.
END
Is contamination detectable?
Yes
No
Release property.
END
2 Do seemingly applicable release limits exist?
Yes
No
Are existing release limits appropriate?
Yes
No
3 Define release limits needed.
4 Develop release limits.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
5 Compile and submit application for DOE Operations Office approval.
6 Document approved limits in the public record.
7 Implement approved limits.
8 Conduct surveys/ measurements.
9 Does property meet applicable, appropriate, existing release limits?
Yes
No
10 Release property.
END
Should supplemental limits be developed?
Yes
No
Seek alternative to release.

STEP 3 - Define release limits needed.

Actions Recommended:

1. Define the release limits needed.

2. ***Go to Step 4.***

Discussion:

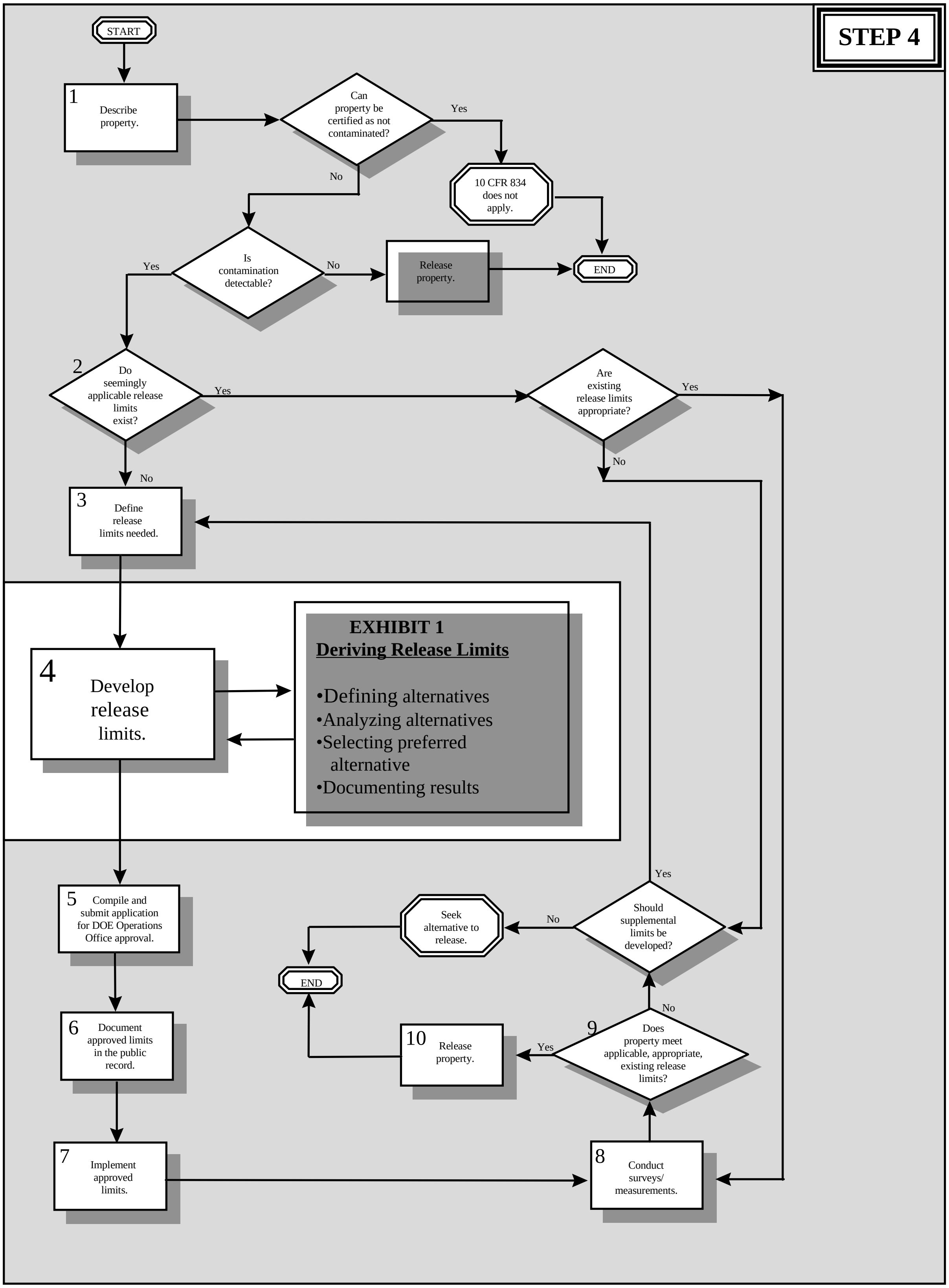
If release limits do not exist for non-real property proposed for release, or existing limits are not appropriate, then as was explained in Step 2, authorized limits or supplemental limits must be developed. The specifications of such limits may vary depending on (1) the physical and radiological characteristics of the non-real property proposed for release; (2) whether the release will be a one-time release of non-real property of a particular type, or routine releases over time of non-real property within a category; and (3) whether restrictions will be placed on the use of the non-real property following release or not. For example, if non-real property proposed for release would be contaminated with known radionuclides (e.g., U-238, U-235, Pu-240, Ra-22), and exhibit surface rather than volumetric contamination, release limits would probably specify allowable residual surface concentrations (disintegrations per minute per square centimeter) for the known radionuclides. Also, such allowable residual surface concentrations would probably be specified for both removable and fixed contamination. Acceptable methods of survey or measurement to be used for demonstrating compliance would be designated. If the non-real property proposed for release would be contaminated on surfaces not accessible for survey/measurement, the release limits would probably specify a methodology other than direct survey or measurement for demonstrating compliance with respect to the inaccessible surfaces. Alternatively, in this situation it might be possible to fashion release limits not involving residual surface concentration values for inaccessible surfaces if doses could be shown to be acceptable in required scenarios. The acceptability of any such alternative must be evaluated as part of the ALARA process.

Non-real property proposed for release may exhibit a variety of physical shapes and sizes, making release limits particular to categories of materials appropriate. If so, it would be important to group the property so that the items in each category would be as similar as possible with respect to both material and origin. The release limits would then specify to which categories of non-real property the residual contamination ceilings would apply.

EXAMPLES OF NON-REAL PROPERTY CATEGORIES

- *Consumable Items* such as wood, containers, labwares and paper
- *Personal Items* such as clothing, brief cases, bags, respirators and gloves
- *Office Items* such as computers, telecommunication equipment, unused office supplies and furniture
- *Tools/Equipment* such as hand tools, power tools, construction machinery, vehicles, tool boxes, ladders and scales
- *Debris* such as wood, tanks, scrap metal, concrete, wiring, doors and windows

If restrictions would be placed on the use of non-real property following release, the release limits must fully specify the restrictions.


STEP 4
START
1 Describe property.
Can property be certified as not contaminated?
Yes
No
10 CFR 834 does not apply.
END
Is contamination detectable?
Yes
No
Release property.
2 Do seemingly applicable release limits exist?
Are existing release limits appropriate?
3 Define release limits needed.
4 Develop release limits.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
5 Compile and submit application for DOE Operations Office approval.
6 Document approved limits in the public record.
7 Implement approved limits.
8 Conduct surveys/ measurements.
9 Does property meet applicable, appropriate, existing release limits?
10 Release property.
Should supplemental limits be developed?
Seek alternative to release.

STEP 4 - Develop release limits.

Actions Recommended:

1. Develop proposed release limits using the ALARA process as defined by the responsible DOE Operations Office or DOE activity and Exhibit 1.

2. ***Go to Step 5.***

Discussion:

> ***ALARA Program***
>
> Requirements in 10 CFR Part 834 include establishment by DOE activities of an Environmental Radiological Protection Plan (ERPP). The content of the ERPP must include an ALARA program. Order DOE 5400.5 also imposes the requirement for an ALARA program. The ALARA program must address the means to be used to implement the ALARA process. The ALARA process used by DOE ALARA programs to control and manage releases of radioactive materials and radiation exposures to members of the public is a tool to support decision making. The analysis inherent to the ALARA process balances societal, environmental, technological, economic, public policy and risk factors, and the results must be documented.

If release limits must be developed, Order DOE 5400.5 and 10 CFR Part 834 require that the ALARA process be used. The ALARA process is an optimization process intended to identify one alternative that would reduce radiation exposures to levels that are as low as practicable from among several alternatives that are reasonably expected to meet regulatory dose limits. In addition to dose, the process takes economic, social, environmental, technological and public policy factors into account with the goal of maximizing total benefits. The means by which a DOE contractor or operating organization implements the ALARA process at a DOE facility where activities routinely involve radiation or radioactive materials must be addressed by the organization's ***ALARA program***. Therefore, DOE and DOE contractor personnel should consult their site-specific ALARA program to identify procedural requirements for conducting the ALARA process. It is not the purpose of this *Handbook* to provide detailed guidance on developing or implementing ALARA programs. However, guidance concerning aspects of the ALARA process that are particular to development of release limits are provided by Exhibit 1.

DOE contractor and Operations Office personnel responsible for developing release limits should consult the following references for guidance on developing and implementing ALARA programs:

DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with DOE 5400.5, Interim Guidance, DOE Assistant Secretary of Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41) [formerly Office of Environmental Guidance (EH-23)] (March 8, 1991).

Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material), DOE Assistant Secretary of Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41) (Nov. 17, 1995).

DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with 10 CFR Part 834, DOE Assistant Secretary of Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41) (This document is under development; for information, contact EH-41).

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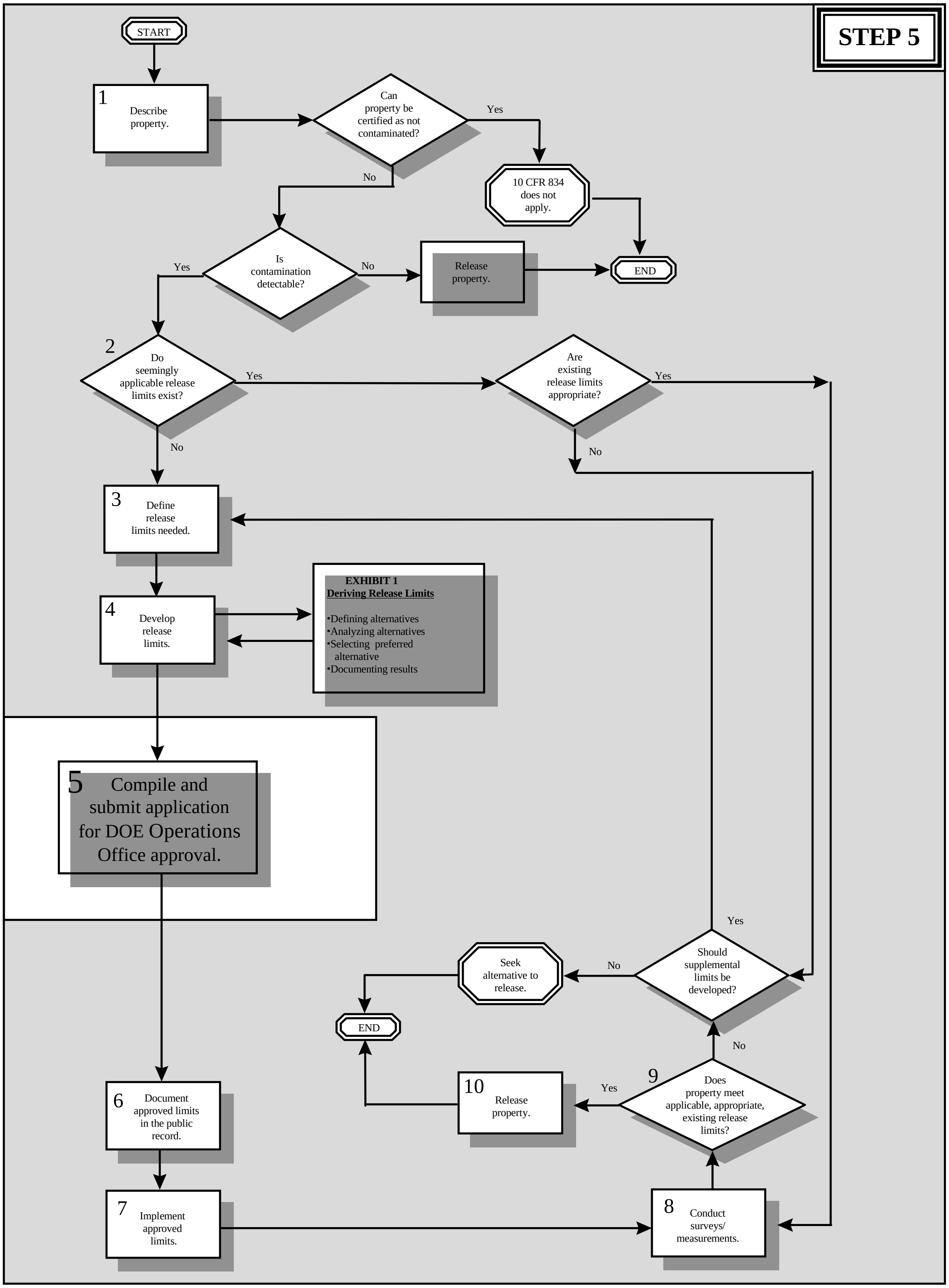

STEP 5
START
1 Describe property.
Can property be certified as not contaminated?
Yes
No
10 CFR 834 does not apply.
END
Is contamination detectable?
Yes
No
Release property.
END
2 Do seemingly applicable release limits exist?
Yes
No
Are existing release limits appropriate?
Yes
No
3 Define release limits needed.
4 Develop release limits.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
5 Compile and submit application for DOE Operations Office approval.
Yes
Should supplemental limits be developed?
No
Seek alternative to release.
END
No
9 Does property meet applicable, appropriate, existing release limits?
Yes
10 Release property.
6 Document approved limits in the public record.
7 Implement approved limits.
8 Conduct surveys/ measurements.

STEP 5 - Compile and submit application for DOE Operations Office approval.

Actions Recommended:

1. Coordinate with the responsible DOE Operations Office (i.e., the Operations Office with direct responsibility for oversight of the activity proposing that non-real property be released) during preparation of background documents and compilation of the application for approval of authorized or supplemental release limits.

2. If questions arise concerning the adequacy of documentation, or if DOE program-specific concerns are identified, initiate discussions and raise such questions or concerns with the DOE Headquarters lead program office prior to finalizing the application for approval.

3. If technical questions arise concerning the substantive content of documentation required to support approval of authorized or supplemental limits, seek technical support from EH-412 (EH Office of Environmental Policy and Assistance, Air, Water and Radiation Division).

4. Consult with NRC or Agreement State personnel, as appropriate, to obtain agreement that proposed authorized or supplemental limits will not result in release of types and quantities of radioactive materials that would otherwise require licensing.

5. Compile appropriate information into an application for DOE approval of authorized or supplemental limits (*see* Exhibit 2 for outline of application for authorized limits and Exhibit 3 for outline of application for supplemental limits).

6. Submit application for DOE approval of authorized or supplemental limits to the responsible DOE Operations Office.

7. ***Go to Step 6.***

Discussion:

An application for approval of authorized or supplemental limits must be submitted to the DOE Operations Office having direct responsibility for oversight of the activity proposing the release. Such DOE Operations Offices have primary responsibility for review and approval of release limits. An aspect of such responsibility includes involving other DOE organizations in the approval process. Until 10 CFR Part 834 is promulgated, the sequence whereby the responsible DOE Operations Office will involve other DOE organizations in approval of release limits remains as required by Order DOE 5400.5. After promulgation of 10 CFR Part 834, some details of the sequence will change. For ease of reference, both sequences are presented in Exhibit 4.

In brief, under DOE 5400.5, unless certain conditions are met, EH-1 approval is required for: (1) authorized limits applicable to the release of residual radioactive material in mass or volume; and (2) authorized limits applicable to the release of residual radioactive material as surface contamination when such limits are sought in lieu of the Surface Activity Guidelines (*see* Exhibit 1, Table 1). The conditions that the responsible DOE Operations Office must meet under DOE 5400.5 to exempt authorized limits from the requirement for written EH-1 approval include: (1) ensuring that DOE and related commercial release criteria have been appropriately addressed; (2) demonstrating that doses to members of the public meet specified requirements and that required records will be kept; and (3) providing specified documentation to EH-4 at least 40 working days prior to the anticipated effective date for the authorized limits. Upon receiving the documentation, EH-4 provides written notice of receipt to the Operations Office submitting the documentation. If EH-4 fails to notify the responsible Operations Office that the authorized limits or supporting materials are not acceptable within 20 days after receipt, the Operations Office may consider the authorized limits to be approved by EH-1. If a DOE Operations Office needs technical assistance from EH-4 during development of the supporting documentation for authorized limits, a request should be made as early as possible, but must be made at least 90 working days before the anticipated effective date for the authorized limits.

After 10 CFR Part 834 is promulgated, a revised consultation sequence will be implemented. Under 10 CFR Part 834, specified documentation in the form of an application for approval of release limits must be provided by the responsible DOE Operations Office to the Headquarters lead program office, with a copy to EH-4. The Headquarters lead program office will be responsible for identifying concerns that approval of the proposed release limits might pose to the complex-wide program. If the Headquarters lead program office does not communicate any such concerns to the responsible Operations Office within 60 days after the date that the Headquarters lead program office verifies receipt of the application, then the responsible Operations Office may implement the release limits. EH will only be responsible for compiling and maintaining a database of all documents received from DOE Operations Offices.

Applications for authorized and supplemental limits should be prepared using the concept of a ***graded approach***. In other words, the level of detail for analyses and information presented in such applications should be consistent with the complexity of the proposal and its potential to create risk to human health and the environment. While a formal grading process for deciding the level of detail needed in applications for release limits should not be necessary, using the concept of a graded approach in scoping the content of applications for approval of release limits should help optimize the allocation of effort and resources during their preparation.

Graded Approach

Examples of DOE's use of a graded approach to decide on appropriate levels of analytical effort and associated documentation detail include the graded approach for preparation of safety analysis reports (SARs) pursuant to Order DOE 5480.23, "Nuclear Safety Analysis Reports," and the graded approach for defining mitigation requirements for natural phenomena hazards under Order DOE 420.1 Chng 2, "Facility Safety." Guidance information concerning these applications of a graded approach are available on the Internet at https://www.directives.doe.gov/news/new-doe-o-420-1c-chg-2-minchg-facility-safety.

<u>REMEMBER: COORDINATION WITH NRC</u>
<u>or AGREEMENT STATE IS REQUIRED</u>

Unless the transfer is to a licensee of the NRC or an Agreement State and the transferred material would be covered by the license, DOE policy prohibits releasing types and quantities of radioactive materials that would otherwise require licensing pursuant to U.S. Nuclear Regulatory Commission (NRC) regulations. Therefore, applications for authorized and supplemental release limits applicable to non-real property should contain documentation that NRC personnel, or Agreement State representatives where appropriate, have been consulted during development of the proposed limits, and that they agree that the proposed release limits are not inconsistent with radioactive material licensing requirements. [*Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material),* DOE Assistant Secretary for Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41), p. 5, Nov. 17, 1995]

Applications for Approval of Authorized Limits

Exhibit 2 provides an annotated outline suggesting a format and describing the required content of an application for approval of authorized limits. Examples are also provided to illustrate how the required information might be presented in several situations. As Exhibit 2 indicates, an application for DOE approval of authorized limits must contain the following information:

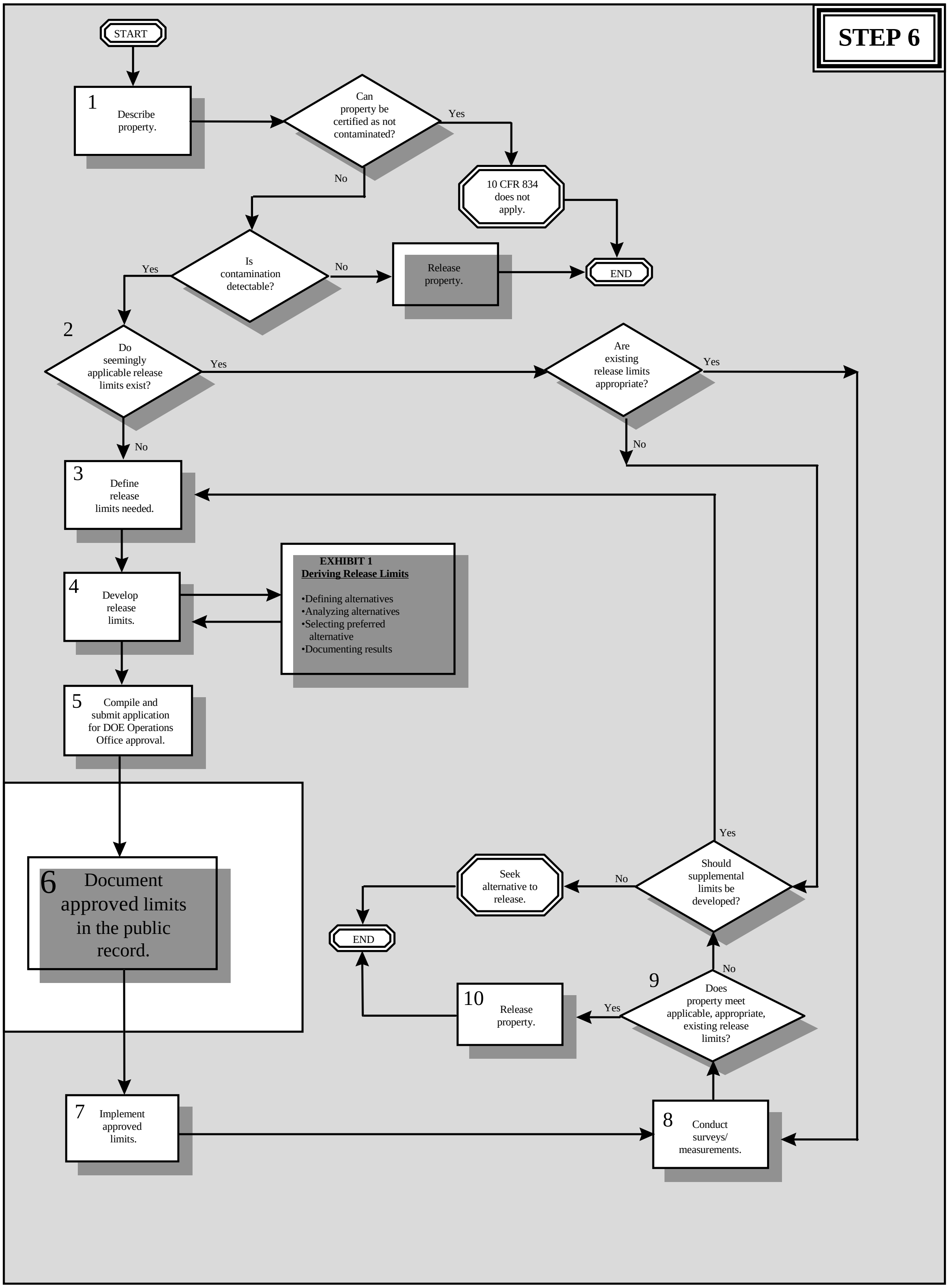
1. The nature of the non-real property to which the proposed limits will apply and its potentially restricted or unrestricted use (*see* Step 1);
2. The potential collective dose to the exposed population and the dose to those individual members of the public most likely to receive the highest dose in the actual and likely use scenario and the worst plausible use scenario (*see* Exhibit 1);
3. The cost and impact of actions necessary to reduce levels of residual radioactive material and the dose reduction resulting from these actions (*see* Exhibit 1);
4. Other factors that relate to the ALARA process and the approval decisions (*see* Exhibit 1);
5. The limits requested for residual radioactive contaminants (*see* Exhibit 1), including any restrictions on use following release;
6. The measurement protocols and evaluation techniques proposed to determine compliance with contamination limits (*see* Step 8); and
7. The mechanism(s) by which DOE will reasonably assure that restrictions on use following release will be implemented.

Additionally, the application should be accompanied by a summary that: (1) indicates the proposed release limits for which approval is sought, including contaminant concentration levels and any restrictions on use following release; (2) summarizes the broad scope of the process for the release of common material from various DOE activities at the site; and (3) identifies any unusual site-specific issues.

Applications for Approval of Supplemental Limits

An application for supplemental limits should contain similar information, and be structured like an application for authorized limits. Hence, the application must demonstrate that the proposed supplemental limits will comply with the requirements of Order DOE 5400.5 or 10 CFR Part 834, giving due consideration to health and safety, the environment, costs and public policy considerations. In addition, the application must include an adequately documented justification for the decision that existing authorized limits are not appropriate (*see* Step 2, above). If the only difference between the proposed supplemental limits and existing authorized limits is the imposition of restrictions on use of the non-real property following release, the documentation must show clearly that the existing limits cannot reasonably be achieved and that restrictions are necessary and will protect members of the public. The application must present the mechanism(s) by which DOE will reasonably assure that restrictions on use following release will be implemented.

Exhibit 3 contains an annotated sample Table of Contents for an application for approval of supplemental limits.


STEP 6
START
1 Describe property.
Can property be certified as not contaminated?
Yes
10 CFR 834 does not apply.
No
Is contamination detectable?
No
Release property.
END
Yes
2 Do seemingly applicable release limits exist?
Yes
Are existing release limits appropriate?
Yes
No
No
3 Define release limits needed.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
4 Develop release limits.
5 Compile and submit application for DOE Operations Office approval.
6 Document approved limits in the public record.
Yes
Seek alternative to release.
No
Should supplemental limits be developed?
END
No
9 Does property meet applicable, appropriate, existing release limits?
Yes
10 Release property.
7 Implement approved limits.
8 Conduct surveys/ measurements.

STEP 6 - Document approved limits in the public record.

Actions Recommended:

1. Consult with the DOE site's designated public liaison to identify the most appropriate method for making the approved release limits available in the public record.

2. Place the application for approval of release limits and any associated correspondence, including documentation of DOE approval, in the appropriate location identified in consultation with the DOE site's designated public liaison (e.g., in the DOE site's public reading room or public information repository).

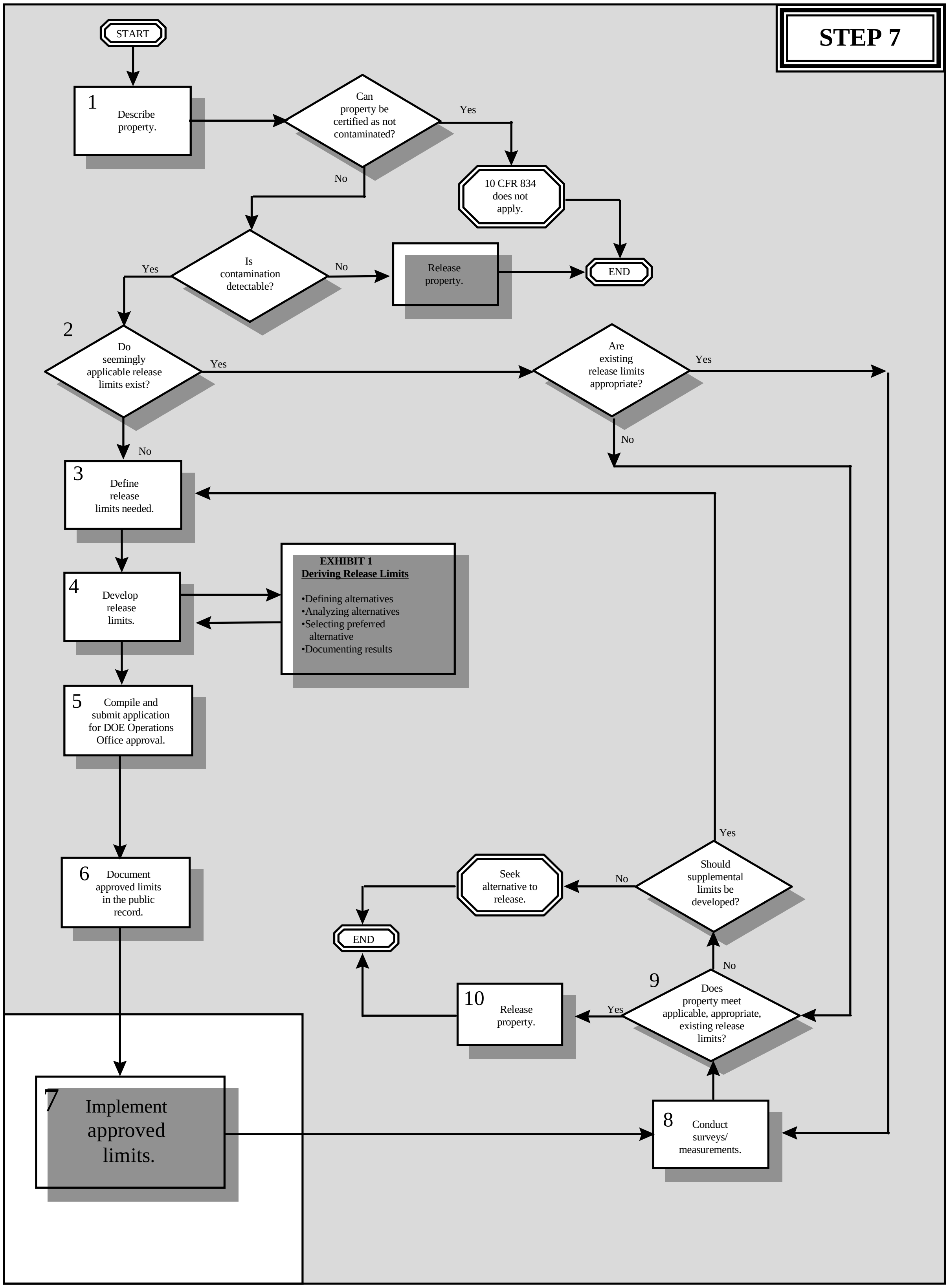
3. ***Go to Step 7.***

Discussion:

Approved release limits must be made part of the public record. As a matter of policy, DOE recognizes that public participation must be a fundamental component of the Department's program operations, planning activities, and decision-making [Directive DOE P 1210.1 (July 29, 1994)]. As a result, each DOE site is responsible for developing its own public participation program and plans in consultation with stakeholders and with the concurrence of appropriate Headquarters program offices. As part of their plans, many sites may already have established public information repositories and/or public reading rooms. Almost all DOE sites already have a designated public liaison.

The responsible DOE Operations Office should consult with the designated public liaison at the site applying for release limits in order to determine a method and location consistent with the site's public participation plan for making approved release limits available in the public record. Materials that should be available to the public include, but are not limited to, the application for approval of release limits and any associated correspondence, including documentation of DOE approval.

In the event a responsible DOE Operations Office needs other assistance determining how to make approved release limits available in the public record, Operations Office personnel should contact the appropriate Headquarters lead program office.


STEP 7
START
1
Describe property.
Can property be certified as not contaminated?
Yes
No
10 CFR 834 does not apply.
Is contamination detectable?
Yes
No
Release property.
END
2
Do seemingly applicable release limits exist?
Yes
No
Are existing release limits appropriate?
Yes
No
3
Define release limits needed.
4
Develop release limits.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
5
Compile and submit application for DOE Operations Office approval.
6
Document approved limits in the public record.
7
Implement approved limits.
8
Conduct surveys/ measurements.
9
Does property meet applicable, appropriate, existing release limits?
Yes
No
10
Release property.
END
Should supplemental limits be developed?
Yes
No
Seek alternative to release.

STEP 7 - Implement approved limits.

Actions Recommended:

1. DOE activity or contractor personnel should identify new site-specific procedures or procedural changes, if any, necessary to execute approved release limits.

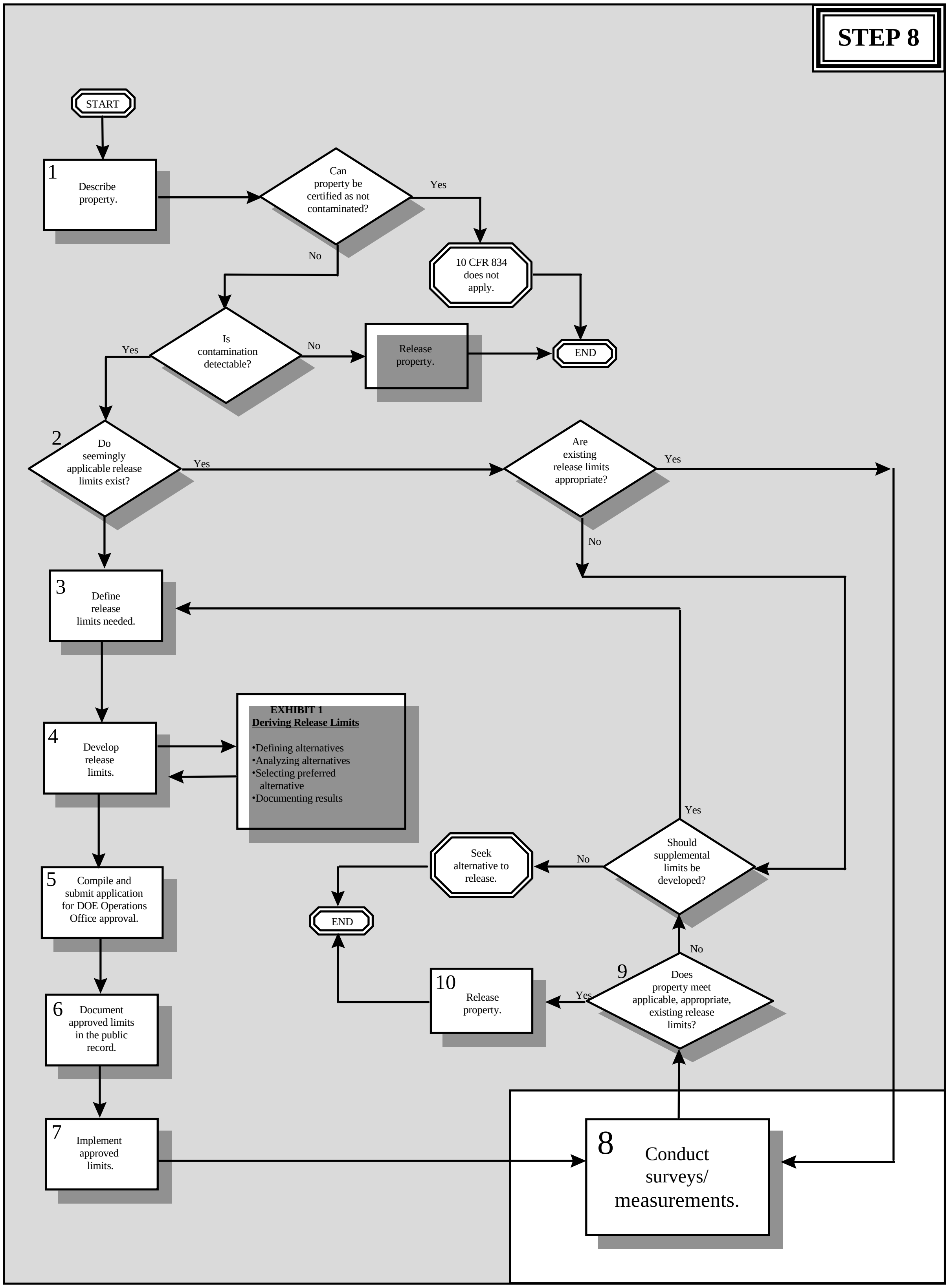
2. The existing site-specific administrative process should be followed to develop, approve, and activate new or modified site-specific procedures, if any.

3. After the responsible DOE Operations Office confirms approval of proposed authorized or supplemental limits, non-real property may be released consistent with appropriate new, modified or existing site-specific procedures.

2. ***Go to Step 8.***

Discussion:

The DOE activity or contractor proposing the release of non-real property containing residual radioactive contamination can implement release limits as soon as DOE approval has been communicated. Implementation of release limits may require development of new site-specific procedures, or modification of existing site-specific procedures. In any event, it is the responsibility of the DOE activity or contractor to identify necessary procedural changes, if any, and to follow the existing site-specific administrative process for making and activating such changes before releasing non-real property pursuant to newly approved release limits.


STEP 8
START
1 Describe property.
Can property be certified as not contaminated?
Yes
No
10 CFR 834 does not apply.
END
Is contamination detectable?
No
Yes
Release property.
END
2 Do seemingly applicable release limits exist?
Yes
Are existing release limits appropriate?
Yes
No
3 Define release limits needed.
4 Develop release limits.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
5 Compile and submit application for DOE Operations Office approval.
6 Document approved limits in the public record.
7 Implement approved limits.
Should supplemental limits be developed?
Yes
No
Seek alternative to release.
END
9 Does property meet applicable, appropriate, existing release limits?
No
Yes
10 Release property.
8 Conduct surveys/ measurements.

STEP 8 - Conduct surveys/measurements.

Actions Recommended:

1. If prior surveys/measurements will be used, compile the appropriate documentation.

2. If surveys/measurements have not been previously conducted, conduct them, as appropriate, to either confirm that contamination is not present, or confirm compliance with applicable release limits. Verify results in accordance with appropriate site-specific procedures specifying protocols and QA/QC procedures.

3. Document that surveys were performed, including the following information:

   - Date of the survey;
   - Identity of the surveyor;
   - Type and identification numbers of the instruments used; and
   - Survey results, indicating compliance with applicable release limits.

   Exhibit 6 provides a generic report format for radiological surveys that could be used to meet Order DOE 5400.5 or 10 CFR Part 834 requirements.

   Documentation should be retained in a manner and location consistent with existing DOE site-specific and complex-wide procedures applicable to documents that demonstrate regulatory compliance.

4. ***Go to Step 9.***

Discussion:

Non-real property to be released must be surveyed, or measurements must be made, either to verify that surface and internal residual radioactive material concentrations do not exceed applicable release limits, or to verify whether radioactivity can be detected on or within possibly contaminated property. Previously conducted surveys/measurements can be used when documentation sufficient to meet Order DOE 5400.5 and 10 CFR Part 834 requirements exists for such surveys/measurements. To show compliance with release limits, the documentation must include survey protocols and survey results. To show the absence of detectable radioactivity, the documentation should show that surveys were completed in accordance with existing site-specific procedures and should include survey results.

As part of normal operations, DOE activities will usually have already developed a Quality Assurance/Quality Control (QA/QC) program and procedures for conducting and documenting the results of radiological surveys/measurements. Such programs and procedures can be applied to surveys and measurements required for this step of the release process for non-real property containing residual radioactive material.

Exhibit 5 discusses and provides a flowchart for an example of the survey process. The document from which Exhibit 5 was excerpted [*Draft Environmental Implementation Guide for Radiological Survey Procedures*, DOE Office of Environmental Policy and Assistnace (Feb. 1997; Draft Report for Comment)] contains a set of guidelines for DOE and DOE contractors to use in planning, conducting and/or evaluating a radiological survey. It should be consulted for guidance on developing quality control procedures and survey/measurement protocols applicable to releasing non-real property containing residual radioactive material for reuse or recycle. Other measurement and data reporting references are listed below.

<u>References:</u>

Performance of Surveys for Unrestricted Release, Facility Guidance, DOE/CH-9401, U.S. Department of Energy, R&D Laboratory Working Group (RADWG), Sept. 1993.

Draft Environmental Implementation Guide for Radiological Survey Procedures, DOE Office of Environmental Policy and Assistance (Feb. 1997; Draft Report for Comment)

Environmental Guide for Radiological Effluent Monitoring and Environmental Surveillance, DOE/EH-0173T, U.S. Department of Energy, Jan. 1991.

Manual for Conducting Radiological Surveys in Support of License Termination, NUREG/CR-5849, U.S. Nuclear Regulatory Commission, June 1992.

A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys, Draft Report, NUREG-1505, U.S. Nuclear Regulatory Commission, Aug. 1995.

Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria, Draft Report, NUREG-1506, U.S. Nuclear Regulatory Commission, Aug. 1995.

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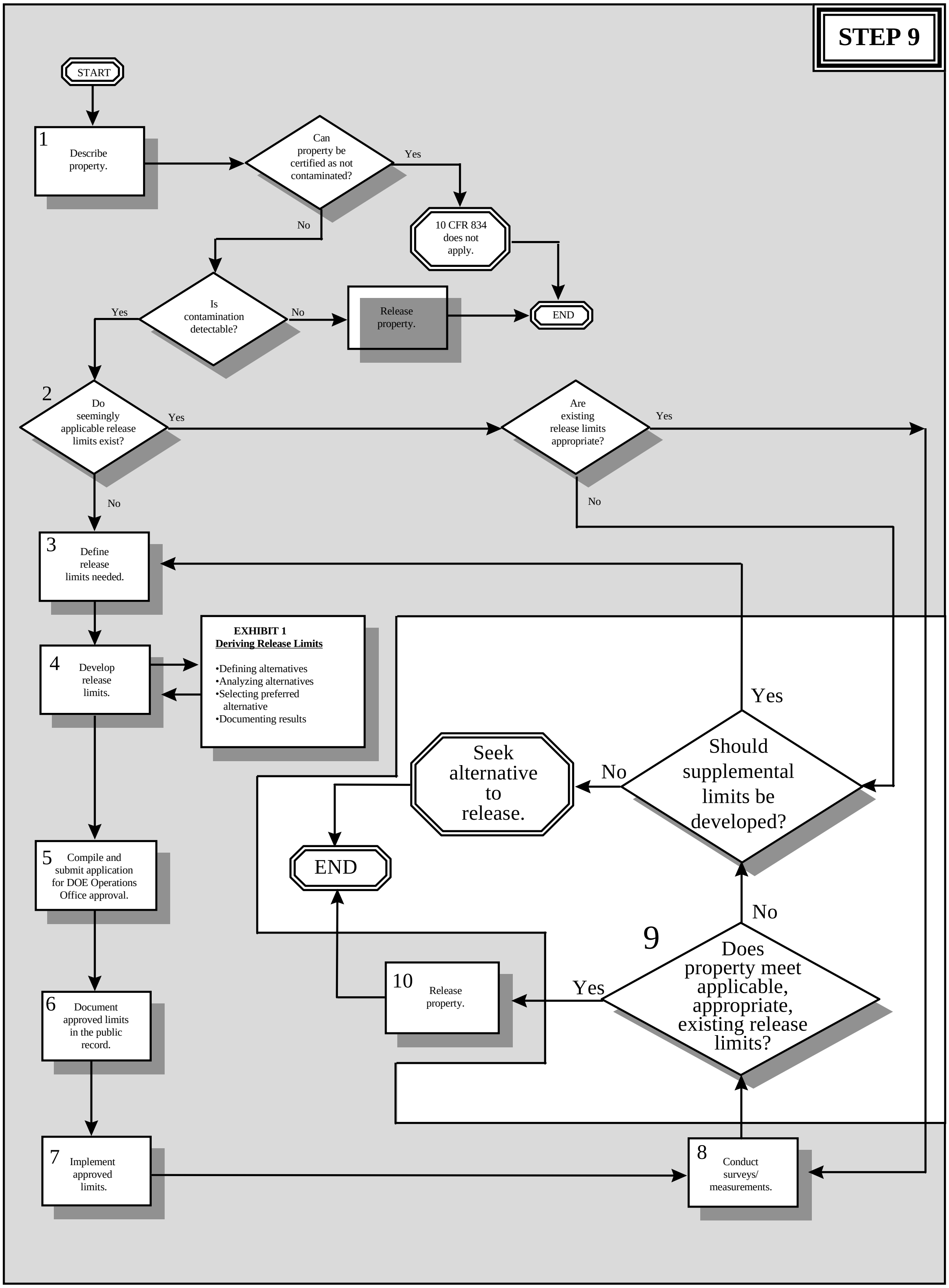

STEP 9
START
1 Describe property.
Can property be certified as not contaminated?
Yes
No
10 CFR 834 does not apply.
END
Is contamination detectable?
Yes
No
Release property.
END
2 Do seemingly applicable release limits exist?
Yes
No
Are existing release limits appropriate?
Yes
No
3 Define release limits needed.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
4 Develop release limits.
Yes
Should supplemental limits be developed?
No
Seek alternative to release.
END
5 Compile and submit application for DOE Operations Office approval.
No
9 Does property meet applicable, appropriate, existing release limits?
Yes
10 Release property.
6 Document approved limits in the public record.
7 Implement approved limits.
8 Conduct surveys/ measurements.

STEP 9 - Does property meet release limits?

Actions Recommended:

1. Compare the documented results of the surveys/measurements from Step 8, above, with applicable release limits.

2. Document the results of the comparison.

3. If applicable release limits are met, ***go to Step 10.***

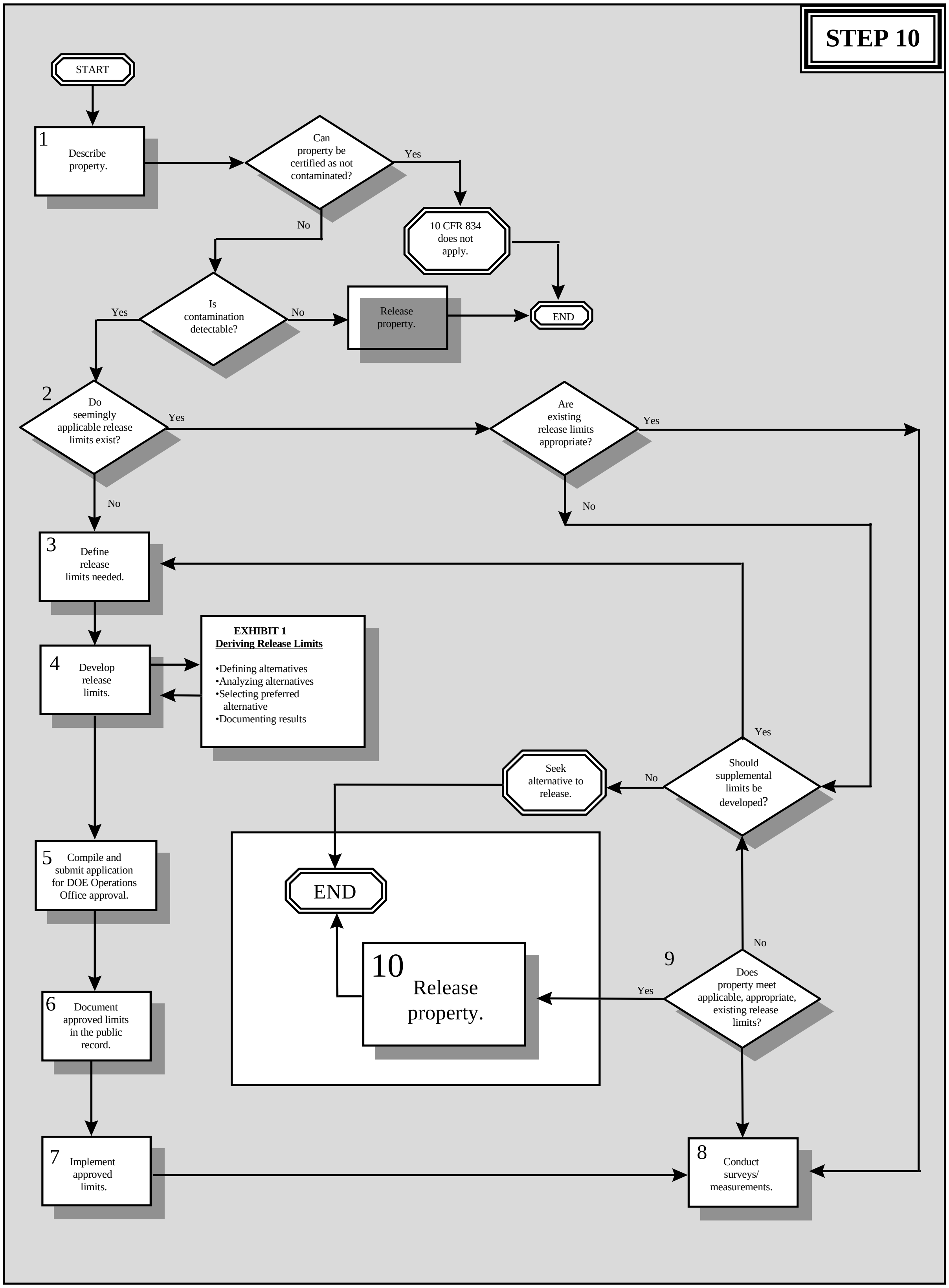
4. If surveys or measurements show that seemingly applicable, appropriate, existing release limits are not net, evaluate whether new or amended supplemental limits should be developed. If yes, document the basis for this decision and ***return to Step 3.***

5. If existing release limits are not met, but new or amended supplemental limits would not be appropriate, the non-real property cannot be released for reuse or recycle. Hence, an alternative management approach (e.g., disposal as radioactive waste) must be pursued. ***END.***

Discussion:

The documented results of surveys/measurements should be compared with seemingly applicable, appropriate, existing release limits to determine whether non-real property proposed for release meets the limits. The results of this determination must be documented. Non-real property that has been demonstrated to meet applicable, appropriate, existing authorized or supplemental release limits can be released for reuse or recycle provided that all other release requirements have been met (*see* Step 10). Non-real property shown to contain no detectable radioactivity can be released for any purpose after survey results have been documented in accordance with applicable site-specific procedures.

If applicable, appropriate, existing authorized limits are not met, an evaluation should be made of whether new or amended supplemental limits should be developed (see Step 2). If yes, the basis for the decision should be documented and Step 3 should be revisited to begin the process for developing the new or amended supplemental limits. If it is decided that supplemental limits should not be developed, the non-real property cannot be released for reuse or recycle. In such circumstances, an alternative management approach would be necessary.


STEP 10
START
1 Describe property.
Can property be certified as not contaminated?
Yes
No
10 CFR 834 does not apply.
END
Is contamination detectable?
Yes
No
Release property.
END
2 Do seemingly applicable release limits exist?
Yes
No
Are existing release limits appropriate?
Yes
No
3 Define release limits needed.
4 Develop release limits.
EXHIBIT 1
Deriving Release Limits
•Defining alternatives
•Analyzing alternatives
•Selecting preferred alternative
•Documenting results
Should supplemental limits be developed?
Yes
No
Seek alternative to release.
5 Compile and submit application for DOE Operations Office approval.
END
10 Release property.
9 Does property meet applicable, appropriate, existing release limits?
Yes
No
6 Document approved limits in the public record.
7 Implement approved limits.
8 Conduct surveys/ measurements.

STEP 10 - Release property.

Actions Recommended:

1. Use documentation prepared as a result of Steps 1 and 8 to verify that non-real property has been appropriately surveyed/measured to identify and characterize its radiological condition.

2. Use documentation prepared as a result of Step 9 to verify that non-real property surfaces and interior have been determined to meet release limits for concentrations of residual radioactive material.

3. Verify that all required documentation has been completed.

LIST OF DOCUMENTED INFORMATION
REQUIRED TO SUPPORT NON-REAL PROPERTY RELEASES

1. Description of property
2. Radiological history of property
3. Criteria for release (i.e., applicable authorized or supplemental limits); bases for the criteria; DOE's approval of the criteria; and the determination that the criteria are not inconsistent with NRC or agreement State radioactive material licensing requirements.
4. Restrictions on property use or disposition following release and explanation of the mechanism(s) that provide a reasonable expectation that the restrictions will be implemented
5. Description of property surveys/measurements, including date, surveyor, instruments used, and results
6. Quantity and disposition of waste from any decontamination effort
7. Recipient of property, its destination, or its disposition

4. Verify that the owner or recipient of released non-real property has been appropriately notified of the radiological status of the property and of the availability of documentation regarding that status.

5. Confirm that any legal and DOE policy considerations not covered by this *Handbook* have been addressed. Examples of laws, regulations and policy statements that may create such considerations include:

   - National Environmental Policy Act (NEPA);
   - Resource Conservation and Recovery Act (RCRA);
   - Federal Property Management Regulations (FPMR);
   - DOE Property Management Regulations (PMR);
   - DOE Acquisition Regulations (DEAR); and
   - DOE Personal Property Letter (PPL) 970-3 (Mar. 25, 1996, Control of "High-Risk" Personal Property).

   This list is not intended to be comprehensive. DOE personnel responsible for releasing non-real property must determine which laws, regulations and policy statements apply on a site-specific basis.

6. Release non-real property. ***END***

Discussion:

DOE Order 5400.5 and 10 CFR Part 834 prohibit the release of DOE non-real property unless the following actions have been taken to protect the public and environment:

1. The non-real property has been appropriately surveyed/measured to identify and characterize its radiological condition;
2. Residual radioactive material on non-real property surfaces or interior has been determined to meet applicable release limits;
3. Required documentation has been completed; and
4. The owner or recipient of the released non-real property has been appropriately notified of the radiological status of the property and the availability of required documentation.

Therefore, before releasing non-real property for reuse or recycle, responsible DOE activity or contractor personnel must verify that these conditions have been met. Additionally, responsible personnel must ensure compliance with other applicable laws, regulations and policies that may not be covered by this *Handbook.* When compliance has been verified and documented, the non-real property may be released.

EXHIBITS

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EXHIBIT 1
DERIVING RELEASE LIMITS

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EXHIBIT 1
DERIVING RELEASE LIMITS

E1.1 BACKGROUND

Release from DOE control of property containing residual radioactive material is prohibited unless, among other things, the residual radioactive material on the property's surfaces or interior meets release limits[1] that have been developed using the ALARA process. Such release limits (authorized or supplemental, as appropriate) must be approved by DOE (see Exhibit 4).

The ALARA process is an optimization process intended to identify from among several alternatives reasonably expected to meet regulatory dose limits, one alternative that would reduce radiation exposures to levels that are as low as practicable, taking into account economic, social, environmental, technological and public policy factors. The goal is to maximize total benefits, or if presented in terms of cost (benefits being negative costs), to minimize total cost of the action. This exhibit provides information about applying the ALARA process when developing release limits applicable to non-real property that will be reused or recycled after release from DOE control.

E1.2 GOALS

Generically, 10 CFR Part 834 will require that the ALARA process, as applied to releases of radioactive materials causing radiation exposures to members of the public, consider:

- Maximum dose to members of the public;
- Collective dose to the population;
- Doses to workers;
- Applicable alternative processes, such as alternative decontamination levels and methods;
- Doses for each alternative;
- Cost for each alternative;
- Examination of the changes in cost among alternatives; and
- Social and environmental effects (positive and negative) and non-radiological risks associated with each alternative.

Inputs to the ALARA process for developing release limits should be structured to achieve the following:

1. There must be a reasonable expectation that the release of property containing concentrations of radionuclides at the release limits will not cause a dose to an exposed member of the public *from all sources* (including the released property and other sources) of more than 100 mrem in a year, which is the primary dose limit (Order DOE 5400.5, Sec. II.1.a).

2. To simplify evaluation of compliance with the primary dose limit, 10 CFR Part 834 will establish (consistent with existing Order DOE 5400.5 guidance) a presumption of compliance (i.e., a reasonable expectation) when it can be shown that an exposed member of the public could receive no more than 30 mrem in a year from DOE sources (e.g., released non-real property).

3. Items 1 and 2 notwithstanding, it is DOE's goal to establish release limits that will control exposures such that anticipated doses to members of the public are reduced to a few millirem in

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[1] For the purpose of this *Handbook*, release limits refers to authorized limits, supplemental limits, or both, depending on the context in which the guidance is applied.

a year or less above background [*Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material)*, DOE Assistant Secretary for Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41), p. 4, Nov. 17, 1995].

4. It is also DOE's policy to set release limits that will prevent releasing types and quantities of radioactive materials that could require licensing pursuant to NRC regulations. To insure against releases of DOE property that would otherwise be licensable, NRC personnel, or Agreement State representatives where appropriate, should be consulted during development of release limits. [*Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material)*, DOE Assistant Secretary for Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41), p. 5, Nov. 17, 1995].

E1.3 APPROACH

The ALARA process should be completed consistent with a site's public participation program requirements, and should be documented for each set of release limits needed (*see Handbook*, Step 3). However, the detail of the review conducted to satisfy ALARA process requirements should be commensurate with the complexity of the circumstances surrounding the proposed release, the potential for reducing dose by implementing different alternatives and the cost variations among alternatives.

E1.3-1 Defining Alternatives

To develop release limits for reuse or recycle of non-real property, the review should analyze alternatives involving not only release, but also disposal and storage of the property. Further, multiple alternatives involving release should be considered, as appropriate, to allow analysis of more than one option for release limits. For example, a situation might exist in which releasing tools and equipment for reuse appears desirable. If such tools and equipment contain residual radioactive material as fixed or removable surface contamination, several alternative surface release limits could be postulated (e.g., 5000 disintegrations per minute (dpm), 2000 dpm, 1000 dpm, and 100 dpm). The ALARA analysis in this situation would consider, among other things, the costs and benefits of implementing surface decontamination methods capable of achieving each release level postulated.[2]

[2] While it may be appropriate to decontaminate non-real property before releasing it to ensure that radiation exposures are acceptable and as low as reasonably achievable at the time of release, operational procedures should embody the ALARA concept in the field so that reasonable efforts are taken at all times during DOE's active use of the property to minimize the presence of removable contamination.

Some options for release limits may place ***restrictions*** on use of property ***after release***. In the case of non-real property, restrictions after release might be on first use of the property. For example, release limits for the release of crushed concrete might include a restriction requiring that the sales contract for the concrete specify that the concrete be used only for roadbed construction. Similarly, release limits for the release of scrap steel might include a restriction requiring that the sales contract specify that the steel be recycled only into rebar.

Restrictions After Release

Non-real property may be released from DOE control under release limits with or without restrictions. Unrestricted release limits place no conditions on future use or disposition of the property after it exits DOE control. Release limits that place restrictions on non-real property after its release, on the other hand, place specific conditions on who may receive the property, the form or condition of the property when released, or how the property can be managed after it leaves DOE control. Such conditions usually reduce radiation exposure to members of the public and must be enforceable or implementable.

Sometimes it may be appropriate for an alternative to combine disposal, storage and/or release. For example, property could be stored to allow decay to specified contamination levels prior to release.

The formulation of each alternative will be the foundation for subsequent dose and cost analyses. Therefore, the level of detail needed to sufficiently define an alternative will depend on the rigor with which dose and cost analyses must be performed, which, as is discussed below, depends on the magnitude of the expected differences in dose and cost among the alternatives.

IMPORTANT NOTE ABOUT SURFACE ACTIVITY RELEASE LIMITS

DOE requirements under Order DOE 5400.5 and 10 CFR Part 834 allow the use of the Surface Activity Guidelines (shown on Table 1) as authorized limits for residual radioactive material on surfaces of property intended for release. DOE requirements also provide for the development of authorized limits for specific applications. **In either case, ALARA process requirements apply**.*

If a DOE activity or contractor expects to use Table 1 values as authorized limits for releasing non-real property, both collective and individual doses should generally be low because the Table 1 values are consistent with NRC guidance ("Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source and Special Nuclear Material," NMSS Policy & Guidance Directive FC83-23, August 1983, and "Termination of Operating Licenses for Nuclear Reactors," Regulatory Guide 1.86, June 1974) and were first approved for DOE-wide use in 1984. The anticipation of low doses means that the ALARA process when Table 1 values will be the basis for authorized limits would typically need to include only qualitative, or at most semi-quantitative, dose calculations, rather than a full optimization study. The qualitative or semi-quantitative dose calculations should estimate or bound potential individual doses and collective doses to the public associated with the release or annual releases (if the authorized limit will be applied to operational releases of non-real property). The level of detail should be commensurate to the potential doses. Qualitative review will normally satisfy ALARA process requirements if projected collective doses are less than 10 person-rem and individual doses are less than 1 mrem in a year.

Doses estimates showing that projected doses are low should be included in documentation supporting Table 1 values as authorized limits. This may be important when the authorized limits are developed as part of a process for releasing non-real property on a regular basis over a long operational period.

***** While DOE has reviewed the surface contamination guidelines in Table 1 and determined that they are protective, the level of protection is not necessarily uniform. Hence, although qualitative, or at most semi-quantitative, review will satisfy ALARA process requirements, the level of detail should be commensurate with the potential maximum dose associated with the release. At Table 1 values, radionuclides such as Th-232, Ra-226 and natural uranium have the potential to cause maximum doses up to a few mrem/year, while I-129, Th-230 and Sr-90 have the potential to cause maximum doses of much less than 0.1 mrem/year. Based on this, release of property containing residual radioactive material at Table 1 values for the latter radionuclides justify very minimal ALARA review.

E1.3-2 Analyzing Alternatives

There are many uncertainties associated with making judgements in the analysis of alternatives conducted to satisfy ALARA process requirements. However, a detailed discussion of ALARA process requirements is beyond the scope of this *Handbook*. Therefore, it is critical that qualified professionals be responsible. It is also important that applicable ALARA guidance be consulted and followed (*see* "References," below) and that documentation discuss the uncertainties and conservatism in estimates. The following paragraphs briefly address how DOE and DOE contractor personnel should ascertain an appropriate level of complexity for analyses needed to satisfy ALARA process requirements when developing release limits for reuse or recycle of property containing residual radioactive material.

Scenarios

Dose Calculations

Verification that an alternative will comply with DOE's primary dose limit must be based on dose to the maximally exposed individual member of the public in each of two use scenarios for released property: (1) actual and likely use; and (2) worst plausible use. *Actual and likely use scenarios* for non-real property that will be released include reasonably anticipated future uses of the property, considering the history of use and proximity to residences, affected populations, or ecosystems, natural resources or unique areas of historic or cultural significance. *Actual and likely use scenarios* are those that have a fairly high probability of occurring. These represent expected uses of the property. As a general guide, scenarios included should be plausible, be unlikely to substantially underestimate the dose, and have a reasonable chance of occurring within at least the first 50 years after the property is released. Given these criteria, there may be more than one actual and likely use scenario. For example, if office furniture is released for reuse, but the expected useful life of the furniture is only 15 years, then the scenario of disposal also constitutes an actual and likely use scenario. Scenarios that are not expected to occur for at least 100 years after release of the property normally need not be considered as likely use scenarios.

The *worst plausible use scenario* for non-real property that will be released is any scenario deemed *credible*, even over the long term (e.g., beyond several hundred years). Dose to the maximally exposed individual member of the public calculated for the worst plausible use scenario may be acceptable even at a relatively large fraction of the primary dose limit, if the probability that the scenario will occur is relatively low. In cases where the probability that the worst plausible use scenario will occur is high, the dose to the maximally exposed individual member of the public will be considered acceptable only if it remains a small fraction of the primary dose limit. If the worst plausible use scenario has a high probability of occurrence within the first 50 years after release of the property, then the worst plausible use is also an actual and likely use.

Optimization Study

Unlike compliance verifications that must predict the dose to the maximally exposed individual under specified scenarios, only "average" or typical exposure assumptions should be made to predict potential collective doses to exposed populations for purposes of the optimization study needed to satisfy ALARA process requirements. Collective dose estimates should be "best estimates" rather than maximum estimates. This means that the doses are evaluated for a representative individual with average characteristics and located at an actual residence, rather than the maximum exposed hypothetical individual. In some cases, probablistic or stochastic dose assessments may be useful in making reasonable predictions of collective dose.

<u>Level of effort</u>

The review needed to satisfy ALARA process requirements in the case of proposals to release property containing residual radioactive material must optimize collective dose reductions by selecting, from among various alternatives, the one alternative that will result in the lowest practicable collective dose after taking into account cost and other non-radiological factors which may include social, environmental, technological and public safety factors. The effort expended to quantify the various factors (especially dose and cost) for the optimization study should be proportional to the potential benefits (i.e., the concept of a graded approach can be applied (*see Handbook*, Step 5)). Similarly, the effort expended to balance the various factors in the optimization study should be proportional to dose reductions that can be expected.

Cost Estimates

The following points provide guidance on the level of effort that should be expended during development of release limits to quantify doses and to balance the various factors in the optimization study.

- An effort should always be made to consider full life-cycle costs, including packaging, storage, transportation, management of secondary wastes, et cetera.

- Financial benefits should not be overlooked, including direct proceeds from sale of property for reuse or recycle and reduced costs of managing the property on-site.
- It is important to estimate the costs of all alternative using an equivalent scope (i.e., each alternative has a similar end point; for example, the point at which the property leaves DOE control and no further expenses regarding it will be incurred).
- The effort necessary to reduce uncertainties in cost estimates will depend on the sensitivity of the optimization study to costs.
- In any event, it is vital to use credible assumptions and thoroughly document all such assumptions.

Dose Calculations

In order for an alternative involving release of non-real property for reuse or recycle to be viable, doses to the public caused by releases of property postulated by the alternative must comply with the DOE primary dose limit and must be consistent with DOE goals and policies regarding release limits (*see* "Goals," above). Because the DOE primary dose limit (100 mrem/yr) applies to exposure from all sources and pathways, not just DOE sources, it could be complicated and expensive to demonstrate compliance. Therefore, DOE has simplified verification of compliance with the primary dose limit by establishing a presumption of compliance if doses to the public from DOE sources alone are estimated not to exceed 30 mrem in a year under actual and likely use scenarios (*see* above section entitled "*Scenarios*").

Often, a demonstration of consistency with dose limits and policy constraints can be made by conducting simplified, conservative dose evaluations. If such "screening" evaluations project dose to the maximally exposed individual member of the public from DOE sources to be a few mrem or less in a year (assuming an actual and likely use scenario) and collective dose from DOE sources to be less than 10 person-rem from annual releases (assuming an average or typical scenario), then the alternative is viable.

Further, as a rule of thumb, if the "screening" evaluations predict collective dose from annual DOE releases to be greater than 100 person-rem *or* dose to the maximally exposed individual from DOE sources to be on the order of 30 mrem in a year, then additional, more sophisticated, dose calculations probably should be made.

Doses projected by the "screening" evaluations can be used for the optimization study in some circumstances. This is not generally recommended, however, because "screening" evaluations are conservative. As such, they may in some caases, bias the results of the optimization study, thus foreclosing selection of the most protective alternative.[3]

[3] While this *Handbook* is not intended to address release of waste, a simple example of foreclosure of the most protective alternative could occur if "screening" evaluations were made using conservative estimations (i.e., over-estimates) of source terms for the purpose of assessing waste disposal alternatives. In such a case, the results could limit disposal to a specific option. If that option were only available at limited locations, storage and/or disposal would be forced, possibly at greater risk, to such locations.

As noted previously, authorized limits should be selected based on the ALARA process from among those alternatives that provide a reasonable expectation that public doses are less than 30 mrem in a year, assuming an actual and likely use scenario. Any alternative for which the projected dose to the maximally exposed individual member of the public from DOE sources exceeds 30 mrem in a year based on dose calculations for the actual and likely use scenario should be excluded from further consideration. Any alternative for which the projected dose to the maximally exposed individual member of the public exceeds the primary dose limit (100 mrem in a year) under any scenario *must* be excluded.

Optimization Study

If the differences among doses and costs associated with alternatives (i.e., different release limits) will most likely be small, a detailed balancing effort may not be warranted in the optimization study. In such cases, the choice of the optimal alternative may depend largely on non-radiological factors other than cost, which may include social, environmental, technological and public safety factors.

If the differences in doses among the alternatives will clearly be large, while the differences in costs will clearly be small, or vise-versa, the choice of the optimal alternative may be obvious, making detailed analysis unjustified.

A detailed balancing effort will probably be needed when the alternatives are likely to exhibit significant variations of dose, cost, or non-radiological factors other than cost.

If releases under postulated alternatives may result in individual doses that are a significant fraction of the primary dose limit (i.e., 30 mrem/year or more) or a collective dose in excess of 100 person-rem from annual releases, a rigorous analysis, including coordination with appropriate parties such as the local community, is expected in order to satisfy ALARA process requirements. (NOTE: As is indicated elsewhere in this *Handbook*, coordination with NRC and Agreement States is required under all circumstances.)

E1.3-3 Selection of Proposed Alternative

Selection of the proposed alternative for non-real property management should be based on the results of the ALARA optimization, including nonradiological factors. Some specific examples of nonradiological factors that could influence selection of the preferred alternative in the context of deriving authorized or supplemental limits for reuse or recycle of non-real property include:

- Environmental pollution consequences of reuse and recycle compared with recovering and processing raw materials and manufacturing new property;
- Waste minimization objectives;
- Environmental justice considerations (i.e., would the alternative result in disproportionately high and adverse human health or environmental effects on minority populations and low-income populations?);
- Transportation effects (e.g., increased truck traffic in local neighborhood to support reuse or recycle alternative);
- Nonradiological environmental permitting issues;
- Effects on ecological resources;
- Nonradiological worker hazards;

- Resource conservation objectives; and
- Public interest.

Not all factors on this list will be appropriate for every evaluation. Neither is the list intended to be exhaustive. Other specific factors may be appropriate in a particular situation. DOE and DOE contractor personnel who are conducting the ALARA process and proposing the preferred alternative must identify on a case-by-case basis the most appropriate nonradiological factors to be considered. One possible source of data concerning such factors are records associated with the site's public participation program.[4]

Whenever possible, if a quantitative optimization study is being conducted, the appropriate nonradiological factors should be quantified and analyzed as part of the study. However, many nonradiological factors may not be quantifiable. The optimization study should address such factors qualitatively. A possible methodology for incorporating nonradiological factors into a quantitative optimization study is described by *Decision Methodology for Fernald Scrap Metal Disposition Alternatives,* U.S. Department of Energy and Oak Ridge National Laboratory, Jan. 1996. Other references that may be helpful are listed in Section E1.4 below.

E1.3-4 Documenting Results

Because the ALARA process is often iterative and involves making extensive assumptions based on professional judgements, care must be taken to carefully document the decision process and assumptions. One element of the ALARA program which DOE activities are required to establish is a process for documenting ALARA decisions (see *Handbook*, Step 4). Therefore, when developing authorized and supplemental limits, the generic process for documenting ALARA decisions adopted by the responsible DOE Operations Office should be consulted, keeping in mind the information that must be included with each application for approval of authorized or supplemental limits (*see* Exhibits 2 and 3)

E1.4 REFERENCES

Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material), DOE Assistant Secretary for Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41), Nov. 17, 1995.

DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with DOE 5400.5 (Interim Guidance), DOE Assistant Secretary for Environment, Safety and Health, Office of Environmental Guidance (EH-23), Mar. 8, 1991.

DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with 10 CFR Part 834, DOE Assistant Secretary of Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41) (This document is under development; for information, contact EH-41).

Application of Best Available Technology for Radioactive Effluent Control, DOE Technical Standard (Draft), March 1997.

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[4] As a matter of policy, DOE recognizes that public participation must be a fundamental component of the Department's program operations, planning activities, and decision-making [Directive DOE P 1210.1 (July 29, 1994)]. As a result, each DOE site is responsible for developing its own public participation program and plans in consultation with stakeholders and with the concurrence of appropriate Headquarters program offices.

TABLE 1*
SURFACE ACTIVITY GUIDELINES
Allowable Total Residual Surface Activity (dpm/100 sq-cm)[1]

Radionuclides[2]	Average[3/4]	Maximum[4/5]	Removable[6]
Group 1 - Transuranics, I-125, I-129, Ac-227, Ra-226, Ra-228, Th-228, Th-230, Pa-231	100	300	20
Group 2 - Th-natural, Sr-90, I-126, I-131, I-133, Ra-223, Ra-224, U-232, Th-232	1000	3000	200
Group 3 - U-natural, U-235, U-238, and associated decay products, alpha emitters	5000	15000	1000
Group 4 - Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[7]	5000	15000	1000
Tritium (applicable to surface and subsurface)[8]	N/A	N/A	10000

* *Excerpt from Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material)*, DOE Assistant Secretary for Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41), Nov. 17, 1995.

NOTES:

[1] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by counts per minute measured by an appropriate detector for background, efficiency and geometric factors associated with the instrumentation.

[2] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[3] Measurements of average contamination should not be averaged over an area of more than 1 sq-m. For objects of smaller surface area, the average should be derived for each such object.

[4] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[5] The maximum contamination level applies to an area of not more than 100 sq-cm.

[6] The amount of removable material per 100 sq-cm of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 sq-cm is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

[7] This category of radionuclides includes mixed fission products, including the Sr-90 present in them. It does not apply to Sr-90 that has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

[8] Property recently exposed or decontaminated should have measurements (smears) at regular time intervals to ensure that there is not a build-up of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in Group 4 are not applicable to tritium. The Department has reviewed the analysis conducted by the DOE Tritium Surface Contamination Limits Committee ("Recommended Tritium Surface Contamination Release Guides," Feb. 1991), and has assessed potential doses associated with the release of property containing residual tritium. The Department recommends the use of the stated guideline as an interim value for removable tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure that nonremovable fractions and residual tritium in mass will not cause exposures that exceed DOE dose limits and constraints.

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EXHIBIT 2

APPLICATION FOR APPROVAL OF AUTHORIZED LIMITS
(Annotated Outline and Examples)

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EXHIBIT 2

APPLICATION FOR APPROVAL OF AUTHORIZED LIMITS
(Annotated Outline and Examples)

E2.1 INTRODUCTION

The annotated outline and examples provided in this exhibit are intended to help preparers avoid omissions of important information from their applications. The information discussed is either required by Order DOE 5400.5 and 10 CFR 834, or strongly recommended for inclusion. The structural organization, however, is only suggested.

The outline and examples should assist the preparer in documenting steps 1 through 5 of the *Handbook*. However, the level of detail presented in any particular application should be determined on a case-by-case basis using the concept of a graded approach (see *Handbook*, Step 5). In other words, the level of detail presented should be consistent with the complexity of the proposal and its potential to create risk to human health and the environment.

E2.2 ORGANIZATION OF THIS EXHIBIT

This exhibit presents an annotated outline followed by four sets of examples. The first two example sets consist of collections of excerpts from actual documents prepared, among other things, to support requests for approval of authorized limits. In each of these two example sets, the excerpts were chosen and are organized to illustrate how information described by the annotated outline has been presented in actual cases. Sometimes, the excerpts are not clear examples of a suggested outline section because the purpose of the document from which they came was only partially to support an application for approval of authorized limits. In such cases, the content of the excerpt may appear incomplete or fragmented in comparison with the description provided by the annotated outline. For some sections, the source documents contained none of the information described by the annotated outline. In such cases, the outline section title is given in the example set, along with a statement indicating that no excerpt was found to illustrate the section. In spite of these difficulties, the two sets of excerpts from actual documents should provide responsible DOE and DOE contractor personnel with a general idea for preparing their own applications. Following are citations for and brief descriptions of the two documents from which excerpts were taken:

1. *Environmental Assessment for the Recycling of Slightly Activated Copper Coil Windings from the 184 inch Cyclotron at Lawrence Berkeley Laboratory, Berkeley, California, (DOE/EA-0851) October 1993, U.S. Department of Energy.*

   The “Copper EA” was prepared for compliance with the National Environmental Policy Act (NEPA) and DOE Order 5400.5. The document supports the unrestricted release of about 140 tons of cyclotron coil windings and sale to local scrap metal dealers. The copper contains volumetric residual radioactivity (Co-60, up to 20 pCi/g, average 3 pCi/g) as a result of activation of impurities.

2. *Environmental Assessment, Proposed Sale of Radioactively Contaminated Nickel Ingots Located at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* (DOE/EA-0994) October 1995,

Science Applications International Corporation, Oak Ridge, Tennessee, for the U.S.DOE Oak Ridge Operations Office.

The "Nickel EA" was prepared to address NEPA considerations for a project that involved the decontamination and resale of radioactively contaminated (homogeneous, volumetric) nickel ingots. The resale value was estimated to be about $60,000,000. The scope of the project consisted of proprietary decontamination of 8500 - one metric ton ingots with average contamination levels of 0.049 Bq/g of total Uranium and 535 Bq/g of Technicium (Tc-99), followed by resale on the international scrap metal market.

The last two sets of examples presented in this exhibit were created as part of one hypothetical situation with two cases. The hypothetical situation involves decommissioning of a former uranium processing facility. Hypothetical Case 1 postulates that authorized limits are needed to release a category of material over time (i.e., desks) for reuse. Hypothetical Case 2 postulates that authorized limits are needed to release a particular quantity of recyclable steel. In each set of examples based on the hypothetical, sections of an application for approval of authorized limits have been created consistent with the facts of the hypothetical case. This approach is intended to provide additional vision to responsible DOE and DOE contractor personnel about how they might prepare their own applications.

It is expected that each proposal to release non-real property containing residual radioactive material for reuse or recycle will be unique. The sets of examples in this exhibit illustrate only a few approaches that could be taken to preparing the various sections of an application for approval of authorized limits.

E2.3 OVERVIEW OUTLINE FOR APPLICATION FOR APPROVAL OF AUTHORIZED LIMITS

Below is the basic outline for an application for approval of authorized limits. This outline is annotated in Section E2.4.

Application Summary
Glossary of Terms and Acronyms
1.0 Introduction
2.0 ALARA Process
- 2.1 Description of Alternatives
- 2.2 Analysis of Alternatives
  - 2.2.1 Radiological Assessment
  - 2.2.2 Economic Assessment
  - 2.2.3 Assessment of Other Factors
- 2.3 Selection of Proposed Alternative

3.0 Recommended Alternatives
- 3.1 Statement of Authorized Limit
- 3.2 Methods for demonstrating Compliance

4.0 Coordination Activities

E2.4 ANNOTATED OUTLINE FOR APPLICATION FOR APPROVAL OF AUTHORIZED LIMITS

Below is a detailed, annotated outline for an application for approval of authorized limits. The content of each section is described. Sections E2.5 through E2.8 provide application examples arranged according to this outline.

Application Summary

An Application Summary should be provided which states the applicability and need for the application and summarizes the analyses conducted. The proposed Authorized Limits and applicable restrictions should be stated.

Glossary of Terms and Acronyms

1.0 Introduction

The introduction should lay the foundation for understanding and provide clarity of scope, applicability, and objectives. Generally, this section should document the actions described by steps 1, 2, and 3 of the Handbook and should include the following information:

1. The purpose and need for the proposed authorized limits,

2. Background about the DOE site and the property proposed for release that would be helpful in understanding the scope and applicability of the proposed authorized limits,

3. A description of the property proposed for release. The description must include adequate definition of physical, chemical, and radiological attributes which may effect the manner in which the material may be handled, stored, treated, decontaminated, and dispositioned. Additionally, potential hazardous and radioactive constituents must be described to the extent necessary to assess pathways of exposure.

4. Other information as appropriate, which may effect analysis of exposures, cost, socioeconomic impacts, institutional issues, or other site specific considerations.

2.0 ALARA Process

2.1 Description of Alternatives

This section describes the viable alternatives evaluated in the optimization study conducted to satisfy ALARA process requirements. It begins the process of documenting step 4 of the *Handbook* (*see* Exhibit 1). Typically, at least three, but usually no more than five, viable alternatives should be identified. The level of detail needed to sufficiently define an alternative will depend on the rigor with which dose and cost analyses must be performed, which depends on the magnitude of the expected differences in dose and cost among the various alternatives.

In many cases, possible alternatives will be “screened” to provide a manageable number for analysis in the optimization study. In situations where some alternatives have been screened out of the optimization study, a brief discussion should be included describing how this screening was conducted.

Each alternative that is fully analyzed should be described to facilitate understanding of the optimization study. The description of each alternative should provide enough information so that reviewers of the application can unambiguously determine the facts and assumptions surrounding the alternative.

Each significant assumption affecting exposure, cost, or other factors should be clearly stated and where necessary justified. The “actual and likely use” and “worst plausible” scenario must be clearly stated for each alternative.

2.2 Analysis of Alternatives

2.2.1 Radiological Assessment

This section should describe the methodology, assumptions and results of radiological assessments for each alternative (see Exhibit 1). The description of results must discuss the ability of each alternative to comply with the DOE primary dose limit and must indicate potential collective dose to the exposed population.

Numerous methods exist for converting residual radioactivity levels to estimated radiation exposure. The following is a list of models, codes, and related documents that may be appropriate:

On-site Workers - external dose
- MICROSHIELD
- RESRAD BUILD
- RESRAD RECYCLE
- PNL-8724 (July 1995)

Internal dose (outside - air dispersal and stack releases)
- COMPLY
- CAP88PC
- GENII
- RESRAD RECYCLE
- PNL-8724 (July 1995)

Internal dose (inside buildings)
- RESRAD BUILD
- NRC NUREG-1500

Transportation
- RADTRAN
- RISKIND

Soils
- RESRAD
- MEPAS
- GENII
- NRC NUREG-1500

Recycling of Metals

- RESRAD RECYCLE
- PNL-8724 (July 1995)
- NRC NUREG-1500

The choice of appropriate method at each site should be made in consultation with qualified health physics and environmental professionals. The sets of examples which follow this annotated outline depict three methods. The most important criteria for selecting a method for a particular site are that the method be credible and believable and that the method be appropriate for the site.

Regardless of the method selected for converting residual radioactivity levels to estimated radiation exposure, all assumptions associated with receptors, pathways, source term, duration of exposure, and contaminant's dispersal and migration ability should be clearly documented and substantiated in this section of the application for approval of authorized limits (or in an appendix). Information that could assist in defining such assumptions for a site is available in the following guidance documents. However, care should be exercised in using these documents, as each has a specific scope and purpose.

- ICRP Report No. 26, Recommendations of the ICRP
- NUREG/CR 5512, Residual Radioactive Contamination From Decommissioning, Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent
- Draft NUREG-1500, Working Draft, U.S. Nuclear Regulatory Commission Regulatory Guide on Release Criteria for Decommissioning
- DOE/EH-0071, Internal Dose Conversion Factors for Calculation of Dose to the Public
- DOE/EH-0070, External Dose Conversion Factors for Calculation of Dose to the Public
- EPA 520/1-88-020, Limiting Values of Radionuclide Intake and Air Concentrations and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, Federal Guidance Report No. 11 (1988)
- EPA 402-R-93-081, External Exposure to Radionuclides in Air, Water, and Soil Exposure-to-Dose Coefficients for General Application, Federal Guidance Report No. 12 (September 1993)

2.2.2 Economic Assessment

This section should describe the methodology, assumptions and results of cost assessments for each alternative (*see* Exhibit 1). It is important to estimate costs for each alternative such that equivalency of scope is established. An example of equivalent scope is that each option concludes with a similar endpoint (e.g., the material is removed from the site and no additional expenses for care will be incurred). The description of results must discuss the cost of implementing the alternative. Potential effects of implementing the alternative should also be explained, along with estimates of the costs associated with such effects. For example, if decontamination activities required to implement an alternative will generate waste materials, estimates of the cost of properly managing such waste materials should be included. Every effort should be made to use full life cycle costs.

It is vital to use credible assumptions and document, for review, all significant cost assumptions.

2.2.3 Assessment of Other Factors

While cost and effective dose are the primary factors in selection of the optimal alternative, other factors must also be balanced in the optimization study. Identification of particular factors for assessment will be case specific, but may fall into one or more of the following general areas:

- *social factors*: impacts on local/national product market; employment; public acceptance; environmental justice considerations; transportation effects; and privatization of work.
- *environmental factors:* effects on ecological resources; waste generation rates; ease of management of resulting wastes; probable disposition of resulting wastes; and fate of residual radioactive material released.
- *technological factors*: promotion of emerging technology; technology transfer; robustness of technology; industrial safety of technology; and track record of technology.
- *policy and implementation factors:* consistency with waste minimization principles; promotion of resource conservation; consistency with final clean-up goals; adaptability to existing procedures and protocols; finality of the alternative; and environmental permitting issues.

2.3 Selection of Proposed Alternative

In this section, the results reported in Section 2.2 should be summarized. Regarding costs, this section should discuss the cost of each alternative relative to the cost of maintaining the status quo. The methodology of the optimization study should be provided, and an explanation given of how all factors were balanced to select a preferred alternative (i.e., the alternative that would reduce radiation exposures to levels that are as low as practicable, taking into account cost, social, environmental, technological, and policy factors). Finally, the preferred alternative should be identified.

3.0 Recommended Alternatives

3.1 Statement of Authorized Limit

This section should clearly and concisely set forth the proposed authorized limits, including the isotopes of concern, limits for each isotope of concern and any restrictions placed on the release. Limits for isotopes of concern may be expressed as any measurable quantity, such as activity (disintegrations per minute), activity per unit area, activity per unit mass, or direct count rate.

3.2 Methods for demonstrating Compliance

This section should discuss the measurement protocols and evaluation techniques proposed to determine compliance with the proposed authorized limits.

In most cases, existing site procedures will be used to demonstrate compliance with the authorized limits and any applicable restrictions. These may include operating procedures, QA procedures, and/or management oversight and inspections guidance. Wherever appropriate the specific procedures should be cited along with explanations of the scope of the citations. Major procedures should be provided with the application as appendices.

Where case specific plans are warranted (e.g., case specific sampling and analysis plans), these plans should be cited and included as the appendices.

Where restrictions are placed on the release of the material, evidence should be provided which demonstrates the controls that will be used to provide reasonable assurance that the restrictions will be implemented (*see* Exhibit 1).

4.0 Coordination Activities

This section should include information on activities which have been conducted to gain agreement with representatives of affected groups. Some items which could be provided in an appendix include:

- meeting agendas, attendee lists, and notes
- telephone contact reports
- letters from entities contacted

This section should document adherence to DOE's policy that, unless the transfer of radioactive material is to an NRC or Agreement State licensee and the material transferred will be covered by the scope of the license, NRC personnel or Agreement State representatives be consulted and agree that proposed release limits are not inconsistent with licensing requirements.

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E2.5 EXAMPLE APPLICATION FOR APPROVAL OF AUTHORIZED LIMITS

Using Excerpts from *Environmental Assessment for the Recycling of Slightly Activated Copper Coil Windings from the 184 inch Cyclotron at Lawrence Berkeley Laboratory*, Berkeley, California, (DOE/EA-0851) October 1993, U.S. Department of Energy

The example application for approval of authorized limits presented in this section is a collection of excerpts from the document cited above. The full document is NOT provided.

The excerpts have been selected and arranged to illustrate how information from the source document might have been presented in the format of the annotated outline provided in Section E2.4.

Sometimes an excerpt may not be a very clear example of the application section it is used to illustrate because the purpose of the source document was only partially to support approval of authorized limits. Notwithstanding, the original text is presented without modification.

CONTENTS

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1.0 INTRODUCTION

[Introduction, Section 1.0, and Section 2.0 retyped from pages 1 and 2]

INTRODUCTION

This document is prepared for compliance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321-4347) and Department of Energy (DOE) Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE, 1990).

The proposed action is to recycle slightly activated copper that is currently stored in a warehouse leased by Lawrence Berkeley Laboratory (LBL) to a scrap metal dealer. Subsequent reutilization of the copper would be unrestricted. This document addresses the potential environmental effects of recycling and reutilizing the activated copper. In addition, the potential environmental effects of possible future uses by the dealer are addressed. Direct environmental effects from the proposed action are assessed, such as air emissions from reprocessing the activated copper, as well as indirect beneficial effects, such as averting air emissions that would result from mining and smelting an equivalent quantity of copper ore. Evaluation of the human health impacts of the proposed action focuses on the pertinent issues of radiological doses and protection of workers and the public.

Five alternatives to the proposed action are considered, and their associated potential impacts are addressed. The no-action alternative is the continued storage of the activated copper at the LBL warehouse. Two recycling alternatives are considered: recycling the activated copper at the Scientific Ecology Group (SEG) facility for re-use at a DOE facility and selling or giving the activated copper to a foreign government. In addition, two disposal alternatives evaluate the impacts attributable to disposing of the activated copper either at a local sanitary landfill or at the Hanford Low-Level Waste Burial Site.

The proposed project and alternatives include no new construction or development of new industry.

The options for disposition of the activated copper were evaluated for consistency with DOE's requirements for waste minimization (DOE Orders 5400.1 and 5820.2A). The proposed action is consistent with DOE's requirements to manage hazardous, radioactive, and mixed wastes in a manner that minimizes the generation of such wastes. DOE's Waste Reduction Policy Statement, issued June 27, 1990, directs that "waste reduction will be a prime consideration in research activities, process design, facility upgrade or modernization, new facility design, facility operations, and facility decontamination and decommissioning." This policy requires that all DOE program offices and field operations "institute a waste reduction policy to reduce the total amount of waste that is generated and disposed of by DOE operating facilities through waste minimization (source reduction and recycling) and waste treatment." Furthermore, DOE's Policy on Waste Minimization and Pollution Prevention (August 20, 1992) expresses a commitment to the "inclusion of cost-effective waste minimization and pollution prevention in all of its activities ...." LBL's own Waste Minimization Policy seeks to make environmentally-sound recycling an integral part of the philosophy and operations of LBL. Increased recycling is one means by which LBL intends to achieve the goal of overall reduction in the generation of hazardous, radioactive, and mixed waste streams (LBL, 1991).

1.0 BACKGROUND

The subject activated copper consists of approximately 140 metric tons (140,000 kg or 308,700 lbs) of cyclotron coil windings that were removed from the LBL 184-Inch Cyclotron when it was decommissioned in 1988. The copper became activated when it was used as electro-magnet coil windings for the 184-Inch Cyclotron. The coil windings are 4-inch-wide strips that are one-quarter-inch thick and typically 7 feet long. The coils are 99.99% copper (Appendix A). The activity ranges from 0 to 20 pCi/g with an average activity of 3 pCi/g. The California Department of Health Services (DHS)

1.0 INTRODUCTION

considers this copper to be non-radioactive material (DHS, 1992), see Appendix B.[1] A total of approximately 0.42 mCi of cobalt-60 is contained in the 140,000 kg of copper. The activated copper may also contain smaller amounts of other activation products, but these are minor with respect to resulting impacts. Cobalt-60 is the only isotope present which produces any meaningful external or internal dose rate. The second most prolific isotope in the activated copper is estimated to be nickel-53 at a current concentration of 1.5 pCi/g. However, it is a beta-emitter and thus produces no external dose hazard. The presence of nickel-63 in copper was estimated based on physical principles. No nickel-63 has been detected in the copper nor is detection of nickel-63 possible using normal analytic techniques. The dose equivalents from cobalt-60 and nickel 63 resulting from reprocessing for reuse and from disposal are calculated using the IMPACTS Code (NRC, 1984). It is not expected that, if the copper were recycled, it would be re-refined. The copper is 99.99% pure and would only be remelted and put in a new form. The cobalt-60 decays with a half-life of 5.26 years and will be undetectable using current analytical techniques in less than 50 years.

An environmental Assessment (EA) was prepared and a Finding of No Significant Impact (FONSI) was published for the LBL 1-2 GeV Synchrotron Radiation Source (DOE, 1988a). The 1-2 GeV synchrotron Source was installed in the place of the 184-Inch Cyclotron. The EA addressed decommissioning the 184-Inch Cyclotron and the reuse and disposal of the cyclotron’s 510 shielding blocks, which weighed 8,244 tons. Disposal of the activated copper coil windings was not specifically discussed in the EA. The EA addresses the shipping of the “radioactive” shielding blocks to the DOE Hanford site or reusing them within the DOE complex and the shipping of the “non-radioactive” blocks to a sanitary landfill. The EA provided definitions of “radioactive” and “non-radioactive” for the shielding blocks but did not define these terms for disposal of any of the other Cyclotron components. The EA defined radioactive blocks as those with a surface activity greater than 0.003 mR/hr above background or having in-depth activity greater than 25 pCi/g. All of the copper coil windings that exceeded 20 pCi/g (approximately 150 tons) have already been disposed of at Hanford. However, copper coils activated to 20 pCi/g or less remain in storage and are the subject of this EA. The characterization of the coil windings is presented in Appendix D.

2.0 PURPOSE AND NEED

The purpose and need for the action is to recycle, dispose of, or reuse the activated copper in a manner which is consistent with the intent of DOE’s Waste Reduction Policy Statement issued on June 27, 1990.

[1] Because the activity is induced (i.e., not naturally occurring) and because it occurs at such a low level, the copper is referred to as “slightly activated” for purposes of discussion within this document.

[Sections 3.0 through 3.6 retyped from pages 2 through 4]

3.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

The proposed action and five alternatives are considered. The proposed action is to transfer slightly activated copper that is currently stored in a warehouse to a scrap metal dealer. Subsequent reuse of the activated copper would be unrestricted. The no-action alternative is the continued storage of the activated copper at the LBL warehouse. Two recycling alternatives are considered: recycling the activated copper at the Scientific Ecology Group (SEG) facility for reuse at a DOE facility and selling or giving the activated copper to a foreign government. In addition, two disposal alternatives evaluate the impacts attributable to ultimate disposal of the activated copper either at a local sanitary landfill or at the Hanford Low-Level Waste Burial Site.

3.1 PROPOSED ACTION

The activated copper is currently stored at an LBL-leased warehouse (LBL Building 901) in Emeryville, California, located in Alameda County. The warehouse is located in an industrial area, providing 69,680 sq ft (gross) of indoor storage space and 86,500 sq ft of outdoor storage space (which is fenced). The activated copper is being stored in 32 wood crates located in the outdoor storage area.

The warehouse is located off a major urban thoroughfare with easy access to an interstate highway system. The scrap metal dealers who are expected to bid on the activated copper are located within 10 miles of the warehouse. The approximate geographic locations of the LBL warehouse, the Livermore landfill (see Section 3.5), the DOE Hanford radioactive waste site (see Section 3.6), and the SEG recycling facility (see Section 3.3) are depicted in Figure 1.

The proposed action would release the activated copper to the open market for beneficial and unrestricted reutilization. Once the activated copper is transferred t the scrap metal dealer and becomes available to the open market, it is likely that the activated copper would require reprocessing (i.e., remelting) before being incorporated into the end-use product. Whether this activated copper would be reprocessed with copper from other sources or would remain separate would be determined by the dealer or by a reprocessor who would purchase the copper from the scrap metal dealer.

Three scrap metal dealers located in Oakland, California, have been identified as potential buyers. The selected scrap metal dealer would transport the activated copper from the LBL-leased ware house to the dealer's facility using licensed common carriers and complying with approved LBL procedures for transport of the material.

The price paid for copper scrap metal fluctuates according to market demand for copper, but is currently around $0.80/lb (equivalent to a cost savings to DOE of $246,960 for 140 metric tons).

At least six domestic reprocessors of copper scrap metal have been identified (Bailey, 1992). These are located in the eastern, midwestern, and southwestern United States (U.S.). However, due to the foreign and domestic copper market, current industry practices for west-coast scrap metal dealers are to ship scrap metal directly to metal reprocessors in China or Taiwan (Jaye, 1992).

3.2 NO ACTION

The no-action alternative is the continued storage of the activated copper at the LBL-leased warehouse (LBL Building 901) in Emeryville, California (Figure 1). The warehouse is located in an industrial area, providing 69,680 sq ft (gross) of indoor storage space and 86,500 sq gt of outdoor, fenced storage space. The activated copper is being stored in 32 wood crates located in the outdoor storage area.

3.3 RECYCLE AT THE SEG FACILITY FOR REUSE AT A DOE FACILITY

This alternative would recycle the activated copper at the SEG facility for reuse at a DOE facility. SEG's Metal Processing Facility is a licensed and permitted radioactive scrap metal melting facility located in Oak Ridge, Tennessee (Figure 1). SEG processes radioactive scrap metals primarily into customized shielding blocks for use in DOE's high-energy physics programs. These programs, particle acceleration and beam projects, require very large amounts of high-density shielding. If recycled at the SEG facility, the activated copper windings would be melted together with other metals (mostly ferrous metals) to achieve a customized shielding block density and shape for use in a specific DOE experimental program. The furnace area of the Metal Processing Facility is provided with a hood and exhaust system which, during operation, collects and directs any potential airborne radioactivity to the HEPA-filtered heating, ventilation and air conditioning (HVAC) system (SEG, 1993).

3.4 SALE/GIFT TO A FOREIGN GOVERNMENT

This alternative would transfer ownership of the activated copper to a foreign government. The Institute of High Energy Physics in the People's Republic of China (PRC) has expressed interest in obtaining the activated copper for use in synchrotron accelerators.

The activated copper would be transported by truck to the Port of Oakland from its current storage location in Emeryville, California, using licensed common carriers and complying with approved LBL procedures for transport of the material. At the port, the activated copper would be transferred to a steamship carrier for transport to the end-use country. The activated copper would meet requirements for international shipping (Robillard, 1992) and would not require any special packaging for transport.

3.5 DISPOSAL AT A SANITARY LANDFILL

With this alternative, the activated copper would be buried as ordinary non-radioactive waste at an existing sanitary landfill. In a recent letter, the California DHS stated its position that it considers this copper non-radioactive material and can be recycled and ultimately disposed as such (see Appendix A). The State of California found that the risk to the health and safety of the public from the activated copper is acceptable under the practice of risk based regulation, meets the requirements of Title 17 Part 30104 of the California Code of Regulations, and is declared exempt from 10 CFR 61 licensed burial requirements. A permitted landfill has been identified in the Livermore, California, unincorporated area that would accept the activated copper (Figure 1). [footnote 2 omitted] The existing sanitary landfill would require additional testing of the activated copper [Waste Extraction Test (WET) to STLC criteria as described in State of California, Department of Health Services regulations Title 22 Part 66261d] to be certain that the copper is non-hazardous and meets the landfill acceptance criteria as specified in its operating permit (DTSC, 1993). Since no external dose equivalent rate is detectable from the activated copper (Bergsagel, 1992), it is expected to pass the standard radiation screening test at the landfill (400 counts/min above background) (Rindje, 1992). If the activated copper were to fail the STLC test, which is an extraction with a slightly acid citric salt solution, an application for exemption could be submitted to the State agency responsible for disposal of hazardous waste.

3.6 DISPOSAL AT A LOW-LEVEL WASTE BURIAL FACILITY

Under this alternative the activated copper would be disposed of as low-level radioactive waste at the DOE Hanford Low-Level Waste Burial Site in Richland, Washington. The activated copper would be transported by truck to Washington from its current storage location in Emery ville, California, using licensed common carriers complying with approved LBL procedures for transport of the material.

[Sections 5.0 and 5.1.1 retyped from pages 11 and 14 through 17]

5.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND ALTERNATIVES

This section addresses the potential environmental and human effects of the proposed action and the five alternatives. Direct impacts, as well as indirect impacts (such as averting air emissions from mining and refining an equivalent quantity of copper) are assessed. Table 2 presents a comparison of the impacts associated with the proposed action and the alternatives. Appendix C presents an evaluation of the proposed action and each alternative relative to the ALARA principle using $10,000 per person-rem (DOE, 1991).

5.1 PROPOSED ACTION

5.1.1 Human Health

The potential radiological effects of recycling the slightly activated copper are calculated based on the average activity of 3 pCi/g of cobalt-60 and 1.5 pCi/g of nickel-63 rather than the maximum of 20 pCi/g of cobalt-60 in the copper, because potential population effects will correspond to the average concentration and not the maximum. The processing and remelting of the activated copper is expected to distribute the contamination more evenly. The cobalt-60 exists in the copper at a ratio of 1 part cobalt-60 to $3x10^{14}$ parts copper. The nickel-63 exists in the copper at a ratio of 1 part nickel-63 to $4x10^{13}$ parts copper. No known refining process is capable of concentrating these contaminants at such extremely low concentrations. Any wastes produced from copper reprocessing would be expected to contain cobalt-60 and nickel-63 at the average concentrations in the copper itself. It is also probable that the subject activated copper would be mixed with copper which has not been activated, thus reducing its specific activity. Any dilution of the specific activity will have no effect on the cumulative population dose equivalent but will reduce the maximum individual dose equivalent. This probable dilution is not accounted for in this assessment.

Bounding radiological effects to the public from recycling the copper were calculated using the IMPACTS Code (NRC, 1984). It was assumed that the activated copper would be processed at only one facility (i.e., not multiple facilities). The IMPACTS Code assumes that 20% of the activated material will be disposed from reprocessing and that the copper and the extraneous material are contaminated at the same level. Although not necessarily applicable to the subject copper because of its purity, the code assumes that combustible extraneous material from reprocessing is incinerated and the ash, together with the glass and other materials, are disposed in a landfill. Thus, dose equivalents from incinerator airborne effluents and from the disposal in the landfill are included in the resultant calculated dose equivalents to the public. Conservative and default parameters were used as follows:

- The crated copper coils were postulated to have a gross weight of 150 metric tons and a total volume of 70 m^3, to allow for the empty space within the crates.

- Seven trips would be required to carry the copper to the disposal facility or to the recycler. The IMPACTS Code calculates the same transport worker and public dose equivalents irrespective of scenario. The Code calculates cumulative dose equivalents to the workers and the public, i.e., the same targets are assumed for each trip. The Code calculates only the maximum transport worker dose equivalent, the collective dose equivalent to all transport workers, and the collective dose equivalent to the general public along the transport route. No maximum individual transport dose equivalent to the public is calculated by IMPACTS, but it would be a small fraction of the public collective dose equivalent (i.e., a few μrem).

IMPACTS was used to estimate the dose equivalents from recycling the activated copper for use in home wiring and plumbing and the dose equivalents to transport workers, who truck the materials to the processing and disposal facilities.

5.1.1.1 Public

A total population impact to members of the public along the transport route was calculated to be $3x10^{-3}$ person-mrem, representing an additional population risk of $2x10^{9}$. The transport distance is an internal parameter in the IMPACTS Code. The fatal cancer risks calculated in this EA are based on the current International Commission of Radiological Protection (ICRP) fatal cancer health risks factor of $4x10^{-7}$ per mrem for workers and $5x10^{-7}$ per mrem for the general public (ICRP, 1991).

The IMPACTS Code assumes that the activated copper is used for home wiring or plumbing. The maximum individual dose equivalent to a member o the public was calculated to be $1x10^{-5}$ mrem/yr. The total population dose equivalent was calculated to be 0.5 person-mrem over a 30-y period. This corresponds to a maximum additional individual fatal cancer risk of $4x10^{-11}$and a total additional population fatal cancer risk of $3x10^{-7}$ from future use of the activated copper.

The IMPACTS Code also estimates public impacts from the recycling scenario due to airborne emissions as a collective dose equivalent of $3x10^{-11}$ mrem/y. This corresponds to a collective population risk of $2x10^{-17}$.

Although the IMPACTS Code provides a conservative, reasonable, and governmentally acceptable method to estimate the results of disposal and recycling of slightly contaminated waste materials, it has been previously postulated that the activated copper could be recycled for use in the alignment yoke magnets of video display terminals (VDTs) (Roberts, 1991).

The magnets are postulated to contain 100 g of copper at the maximum concentration of 20 pCi/g rather than the average of 3 pCi/gm because the maximum possible individual dose equivalent rather than a population dose equivalent will be estimated. The radiation from the magnet is postulated to be reduced by the surrounding, non-radioactive parts of the VDT which are estimated to be 10 cm in thickness, having an average density of 1.35 g/cm^3 and a mass absorption coefficient of 0.061 cm^2/g (Roberts, 1991). This results in a reduction of the dose equivalent rate by a factor of 0.44. No reduction in the dose equivalent rate from self-shielding is included. The VDT operator is estimated to be 1 m from the magnet 6 hr/d, 5 d/wk, and 48 wk/yr. This would result in a maximum personnel dose equivalent of $2x10^{-3}$ mrem in the first year. The associated maximum individual fatal cancer risk is $1x10^{-9}$. This dose equivalent and the associated risk are greater than that estimated by IMPACTS but represent a specialized utilization of the copper. It is not expected that the entire 140 metric tons (308,700 lbs) of activated copper would be used in such a manner, because this would correspond to the production of approximately 1.5 million magnets by a company in a year and the sale of these VDTs to businesses for a high level of daily use. Nor would VDTs be expected to have a 50-year useful life to result in a corresponding 50-y lifetime dose equivalent.

It has also been proposed that the activated copper could be used for jewelry, specifically copper bracelets. The probability of such a use can be estimated by examining the path that scrap copper follows through the recycling market and the quantities of copper produced and used in the U.S. The US produces approximately $1.6x10^{9}$ kg of new copper each year and recycles approximately $1.5x10^{9}$ kg per year of which $2.9x10^{9}$ kg is consumed domestically with the remainder exported (Lyman 1993). Scrap copper is processed by scrap metal dealers and sold to smelters. The smelters reprocess the scrap copper to purify and reshape it. The activated copper considered by then milled to produce ingots, sheet, and bar stock. These materials are sold to various manufacturers to produce products. The major uses of copper in the U.S. are for home wiring, plumbing and hardware, public utility equipment, electrical and electronic components, and automotive (Lyman 1993) The exact annual quantity of copper that is used for ornamental purposes, including jewelry, could not be estimated because marketing data are not kept for such small uses; however, it is thought that less than 0.1% would be used for ornamental purposes (Lyman 1993). For the purpose of this analysis it is estimated that less than 0.001% (31,000 kg) of the copper produced in the U.S. would be used to make bracelets.

There are approximately 4,000 jewelry manufacturers in the U.S. (Berryhill 1993) the vast majority of which are small operations that produce pieces from metals they recover from other pieces of jewelry. These small operations may purchase a pound or two of precious metal each year or may not even buy copper at all as there is little demand for copper jewelry. As jewelers do not obtain ingots, sheet, or bar stock from mills but buy small quantities of already finished product which they melt and recast, there is a negligible probability that the LBL activated copper would be used in this manner. The possibility exists, however, that there could be some specialty manufacturer in the U.S. that would purchase a large amount of copper ingot from a mill to recast as bracelets.

The probability of the LBL activated copper being used by such a manufacturer can be estimated by taking the product of the fraction of LBL activated copper to U.S. Copper production in a year and the fraction of copper, which may be made into bracelets ($1.4x10^{5}$ kg / $3.1x10^{9}$ kg x 0.00001), a maximum probability of $5x10^{10}$. This is more than three orders of magnitude less the criteria normally used in the NEPA process to identify credible events. This probability can be used to determine a use fraction of the LBL activated copper by taking the product of it and the mass of the copper ($5x10^{-10}$ x $1.4x10^{5}$ kg), $7x10^{-5}$ kg. This amount of copper could not be made into a bracelet as considered in this analysis. However, as small jewelers do obtain quantities on the order of 1 kg (2.2 lb), an estimate of the subject activated copper being used for such a purpose can be made.

A bracelet made of the activated copper could result in a dose to the skin of the wearer as well as a whole body dose. Assuming an average bracelet mass of 1 oz (28 g) and using the most activated copper (20 pCi/g) to determine a worst-case maximum individual dose equivalent, a bracelet 20 cm in circumference, 1 cm wide, and 0.16 cm thick was postulated. It was further assumed that the bracelet would be in contact with a specific square centimeter of skin no more than 4 hr/d and within 1 cm of the same square centimeter for 20 hr/d. A bracelet will move about the wrist and "spread" any exposure over an area larger than the size of the bracelet itself, so that these assumptions are considered conservative. The dose to the skin of the most exposed sq cm was calculated to be $1.4x10^{-5}$ rad/d. If the bracelet were worn 365 d/y, this would result in a maximum annual dose of approximately 5 mrad. The fatal cancer risk from such a dose is estimated, using the ICRP fatal skin cancer risk factor of $2x10^{-9}$ per mrad (ICRP, 1991), and weighting the exposed skin area versus the surface area of the skin of the whole body, a factor of 20 cm^2 / 16,000 cm^2 (ICRP 1974). A maximum individual risk of $1x10^{11}$ per year is estimated. The maximum lifetime dose from such a scenario is 38 mrad with an associated maximum lifetime individual risk of approximately $1x10^{-10}$.

The whole body dose equivalent associated with wearing such a bracelet 24 hr/d and 365 d/y was calculated, assuming that the bracelet was within an average of 2 ft of the whole body center-line for the entire time. This center-line dose equivalent rate is assumed to be representative of the whole body average dose equivalent rate. This is also a conservative assumption as the arm of an individual moves during the day or could be shielded by furniture resulting in a lower dose equivalent to the whole body. Using the factor of 1.3 mrem/hr/pCi at 1 m (DHEW, 1970), a maximum annual dose equivalent of $2x10^{-2}$ mrem was calculated.

The maximum individual lifetime dose equivalent from such a scenario is 0.15 mrem. This results in a maximum individual fatal cancer risk of $8x10^{-8}$. The risk from the exposure to the skin is negligible with respect to risk associated with the whole body dose equivalent. The possible lifetime collective dose equivalent to the public from use of 1 kg of copper in copper bracelets (36 bracelets) is then approximately 5.4 person-mrem, which results in an associated fatal cancer risk of $3x10^{-6}$.

To estimate the results of a manufacturer producing copper bracelets, the average specific activity of the copper (3 pCi/g) is used rather than the maximum specific activity of 20 pCi/g; any population effect will correspond only with the total activity and not with the maximum in any small portion, and the specific activity in any large quantity of copper going through the remelting process will be homogenized and diluted. The same assumptions of bracelet size and use are made as those for the maximum possible individual doses. Assuming an average bracelet mass of 1 oz (28 g), it is assumed that a maximum of approximately 100 kg (220 lbs) could be used for this purpose and be made into $3.6x10^{3}$ bracelets. The dose rate to the most exposed sq cm of skin is proportionately reduced (3 pCi/g / 20 pCi/g) to $2.1x10^{-3}$ mrad/d. If the bracelet is worn 365 d/y, this would result in a maximum annual dose rate of approximately 0.8 mrad/y. If each bracelet is worn for the lifetime of the wearer, this results in a lifetime dose of approximately 6 mrad to the skin. Weighting the exposed skin area versus the surface area of the skin of the whole body, a factor of 20 cm^2 / 16,000 cm^2 (ICRP, 1974) and applying the fatal skin cancer risk factor of $2x10^{-9}$ per mrad (ICRP, 1991), a maximum individual lifetime risk of $1.5x10^{11}$ is estimated. This would correspond to a maximum collective risk to the population of 3,600 bracelet wearers of $5x10^{-8}$.

The whole body dose equivalent associated with wearing the 3,600 bracelets is calculated using the average specific activity of 3 pCi/g rather than the maximum of 20 pCi/g. The bracelets are assumed to be worn 24 hr/d and 365 d/y and within an average of 2 ft of the whole body center-line for the entire time. This center-line dose rate is assumed to be representative of the whole body average dose rate. Again using the factor of 1.3 mrem/hr/pCi at 1 m (DHEW 1970), a proportionately reduced (3 pCi/g / 20 pCi/g) maximum annual dose equivalent of $3x10^{-3}$ mrem is calculated. If each bracelet is worn for the lifetime of the wearer, this results in a lifetime dose equivalent of 0.02 mrem. This results in a maximum collective dose equivalent of 72 person-mrem and a maximum collective fatal cancer risk to the population of 3,600 bracelet wearers of $4x10^{-5}$.

5.1.1.2 Worker

The IMPACTS Code calculated a maximum individual dose equivalent to a transport worker of $3x10^{-5}$ mrem and a total impact to transportation workers of $4x10^{-4}$ person-mrem. These correspond to fatal cancer risks of $1x10^{-11}$ and $2x10^{-10}$, respectively.

The maximum exposed worker in the metal reprocessing facility is postulated to be within 1 m of the coils for 40 hr and within 10 m of the activated copper for an additional 40 hr. Scrap metal is usually pre-processed manually or mechanically, such as by use of a hammer mill. The maximum resulting dose equivalent is calculated to be 0.04 mrem with an associated fatal cancer risk of $2x10^{-8}$.

The IMPACTS Code estimates worker impacts from reprocessing as a result of handling and emission to be a collective dose equivalent of $1x10^{-7}$ mrem/y. This corresponds to a collective work or fatal cancer risk of $4x10^{-14}$.

These direct risks are compared to an indirect reduction in risk to the LBL warehouse workers, should this option be exercised, of $4x10^{-8}$ and a reduction in risk to copper miners of $3.9x10^{-4}$, because the reuse of the activated copper will not require replacement of this resource on the world market by mining and processing virgin ore.

[Sections 5.2 through 5.6 are retyped from pp. 20 - 24]

5.2 NO ACTION

The no-action alternative is the continued storage of the activated copper at the LBL warehouse in Emeryville. The nearest residence to the Building 901 warehouse is located approximately 75 yards to the west. Based on the estimated external dose equivalent rate of 0.001 mrem/hr at 1 m. the dose equivalent rate at the nearest residence is calculated to be less than $2x10^{-7}$ mrem/hr. Postulating that the maximally exposed member of the public would be in the residence for 8,700 hr/y, a maximum dose equivalent of 0.002 mrem/y would result. The cobalt would decay with a maximum lifetime (50 years) dose equivalent is calculated to be 0.015 mrem. The individual lifetime total cancer risk associated with this dose equivalent is $8x10^{-9}$. Radiation exposure to the nearest resident from the activated copper is undetectable with current radiation detection instruments, being obscured by the natural background.

Workers in the Building 901 warehouse receive the natural radiation exposure described in Section 5.1.1.1. In addition, they receive some exposure from the activated copper. It is conservatively estimated that the maximally-exposed warehouse worker will spend 1 hr/month within 1 m of the crates while in the outdoor area and 10 hr/month within 10 m of the crates. While in the office and other areas of the warehouse, the maximally exposed worker will spend 1900 hr/y within 30 m of the crates. The estimated maximum dose equivalent rates calculated for these locations are $1x10^{-3}$ mrem/hr, $1x10^{-5}$ mrem/hr, and $1x10^{-6}$ mrem/hr (all of which are undetectable), respectively, neglecting the shielding provided by other stored materials and the warehouse structure. These dose equivalent rates may be compared to the natural background external dose equivalent rate of approximately 0.005 mrem/hr at the ware house (Bergsagel, 1992). Table 3 contains a summary of these dose rates and dose equivalents.

TABLE 3

RADIOLOGICAL SUMMARY OF THE NO-ACTION ALTERNATIVE

	Dose Equivalent Rate from Activated Copper (mrem/hr)	Dose Equivalent Rate from Activated Copper (mrem/y)	Maximum Lifetime Dose Equivalent from Activated Copper (mrem)
Residences Near the Warehouse	2×10^{-7}	0.002	0.015
Warehouse Workers	0.001 (at 1 m)	0.015	0.1

Based on the above assumptions, the maximum estimated total dose equivalent to a warehouse worker over a period of one year is 0.015 mrem. For purposes of comparison, the natural background dose equivalent rate is approximately 300 mrem/yr. Because cobalt-60 decays with a half-life of 5.26 years, the dose equivalent rate to a worker would decrease over time. Assuming a 50-year working lifetime, the total dose equivalent to a warehouse worker from the stored activated copper would be 0.1 mrem/lifetime. This corresponds to a lifetime fatal cancer risk of 4×10^{-8}.

The risk of fatal injury for copper mining is approximately 3.2 deaths per $1.2x10^{9}$ kg of refined copper produced (DOS, 1991). The fatal injury rusk associated with mining 140 metric tons (308,700) of copper is $3.9x10^{-4}$. This fatal injury risk is more than 1,000 times greater than the risk to LBL workers at the ware house from exposure to the radiation from the activated copper.

In addition, mines and facilities that process ores will have elevated dose equivalent rates from the naturally occurring uranium, thorium, and their daughter products in the earth and ores. These raise the external dose equivalent rate in such a facility and provide an additional source of radon gas, which is inhaled by the workers and produces an additional internal dose equivalent.

Dose equivalents to personnel in and around the ware house would be as follows: 0.015 mrem lifetime dose equivalent for residences nearest the warehouse and 0.1 mrem/lifetime dose equivalent for workers at the warehouse. The associated fatal cancer risks for these dose equivalents are $8x10^{-9}$ and $4x10^{-8}$, respectively. This alternative would avert the potential dose equivalents associated with transport: 0.003 person-mrem to public and 0.0004 person-mrem to the transport workers.

After 10 cobalt-60 half-lives, 53 years from the time of removal from the accelerator, less than 1/1000 of the original amount of cobalt-60 activity will remain in the activated copper. Essentially no dose equivalent would accrue after this time, and the activity in the activated copper would no longer be detectable using current analytical techniques.

[text omitted]

5.3 RECYCLE AT THE SEG FACILITY FOR REUSE AT A DOE FACILITY

Selection of this alternative would avert the potential maximum dose equivalent to the public of 0.5 person-rem over a 30-year period from future use of the activated copper (as calculated by the IMPACTS Code, which uses a 30-year period). The effects from transportation would be identical to the proposed action to the worker and to the public (0.003 person-mrem to public, 0.0004 person-mrem to workers transporting the material). The associated fatal cancer risks for these dose equivalents are $2x10^{-9}$ and $2x10^{-10}$, respectively. The potential dose equivalents to SEG workers from this alternative would be approximately equal to the effects to workers at a reprocessing facility in the proposed action, 0.04 mrem (as calculated in 5.1.1). The potential dose equivalents to DOE workers at the facility that accepted the SEG-formed shielding blocks containing the activated copper are expected to be less than the 0.1 mrem/lifetime (as calculated in 5.1.1 for workers at the LBL warehouse). The associated fatal cancer risks for these dose equivalents are $2x10^{-8}$ and $4x10^{-8}$, respectively

[text omitted]

5.4 SALE/GIFT TO A FOREIGN GOVERNMENT

The effects on workers and the public of transportation of the activated copper from the warehouse to the Port of Oakland would be identical to the proposed action (0.003 person-mrem to the public and 0.0004 person-mrem to the transport workers). The associated fatal cancer risks for these dose equivalents are $2x10^{-9}$ and $2x10^{-10}$, respectively. The activated copper is estimated to be shipped in 11 transport containers. No more than 4 dock workers are estimated to spend not more than 1 hr within 1 m of each of the transport containers in which the crates will be shipped. This would result in a maximum dose equivalent to dock workers of 0.44 person-mrem. The associated fatal cancer risks for this dose equivalent is $2x10^{-8}$. Although no special packaging requirements would be necessary, the 11 containers would most likely be stored on the ship in a configuration that would provide substantial shielding to shipboard workers. However, the effects of shielding are not taken into account. The shortest, great-circle distance from Oakland, California, to China (Hong Kong) is 6,900 mi. Transport vessels may or may not take the most direct route to a destination in order to take advantage of favorable currents. It is estimated that a transport vessel would travel at an average speed of 20 knots (23 mi/h) and require ~300 hr (12.5 days) to reach China. Bulk carriers typically have a crew of 12 to 26 members, and container ships typically have a crew of 12 to 23 members (Johnson, 1993). 49 CFR 176.708 specifies segregation distances for transport of radioactive material, which would apply to ocean shipment, but the copper does not meet the 49 CFR 173.403 definition of radioactive material (2 nCi/g); therefore, it would not require handling as radioactive material for the purposes of transport. Transport vessels are approximately 200 m in length. For the purposes of this EA, it is estimated that there will be 20 shipboard workers that would be within 100 m of the containers for a period of 12.5 days. The dose equivalent rate from the unshielded activated copper at 100 m is less than $2x10^{-7}$ mrem/hr. This would result in an individual dose equivalent for the trip of $6x10^{-5}$ mrem and a maximum collective dose equivalent of 0.001 person-mrem to the crew. The associated fatal cancer risks for these dose equivalents are $3x10^{-11}$ and $4x10^{-10}$, respectively.

[text omitted]

5.5 DISPOSAL AT A SANITARY LANDFILL

This alternative would avert the potential dose equivalent to the public from future use of the activated copper (maximum 0.5 person-mrem over a 30-year period as calculated in 5.1.1). Potential dose equivalents to the public from potential future residential use of the landfill was modeled using the IMPACTS Code. The IMPACTS code is described in NUREG/CR-3585 (NRC, 1984). The maximally-exposed individual is assumed to reside at the landfill site and to drink groundwater under the landfill. The dose equivalent for this maximally-exposed individual is calculated to be $3x10^{-6}$ mrem/yr. The associated fatal cancer risks for this dose equivalent is $2x10^{-12}$. The effects from transportation as calculated by IMPACTS would be identical to the proposed action to the worker and to the public (0.003 person-mrem to public; 0.0004 person-mrem to workers transporting the material). The associated fatal cancer risks for these dose equivalents are $2x10^{-9}$ and $2x10^{-10}$, respectively.

[text omitted]

5.6 DISPOSAL AT A LOW-LEVEL WASTE BURIAL FACILITY

This alternative entails burying the copper as low-level radioactive waste at the DOE Hanford Low-Level Waste Burial Site in Richland, Washington. This alternative would avert the potential dose equivalent to the public from future use of the copper (maximum 0.5 person-mrem over a 30-year period). The health effects from transportation would be identical to the proposed action to the worker and to the public (0.003 person-mrem to public; 0.0004 person-mrem to workers transporting the material). The associated fatal cancer risks for these dose equivalents are $2x10^{-9}$ and $2x10^{-10}$, respectively. The potential dose equivalents to member of the public after loss of administrative control of the Hanford Low-Level Waste Burial Site were not estimated but, due to the extended period of control which is assumed in such calculation (i.e., 100 years after closure), the associated dose equivalent would be extremely small in comparison to those estimated for disposal in a sanitary land fill, as determined above.

[text omitted]

[ALARA Considerations retyped from Appendix C]

ALARA CONSIDERATIONS

Federal requirements (DOE Orders and 10 CFR regulations) and national and international standards recommend that exposures to radiation be maintained as low as is reasonably achievable (ALARA). The ALARA philosophy and process is described in several recent standards issued by the International Commission on Radiological Protection (ICRP) (1982, 1989, & 1991), and these recommend that any practice involving radiation exposure be examined to determine (1) whether it is justified, i.e., whether it will result in a net benefit; (2) what practices are necessary to minimize the exposure; and (3) whether the resultant exposures will be within the regulatory limits. The ALARA principle is an approach to radiation protection to control or manage exposures to levels which are as low as economic and social considerations permit.

The activated copper addressed by this EA produces radiation exposures to the workers and the public. As the activated copper has already been produced by a "justified" activity (i.e., operation of the 184-Inch Cyclotron, which has produced a net benefit to society), and as all the possible alternatives will produce some exposure to either workers or the public (i.e., there is no option in which no exposure is possible), criterion (1) is met. All the dose equivalents estimated in the alternatives are below the regulatory limit of 100 mrem/y (DOE, 1990), thus criterion (3) is met. Optimization, criterion (2), is the only remaining consideration and is, essentially, complementary to the purpose of this EA to determine the optimum alternative for disposal of the copper. The dose equivalents associated with the proposed action and the various alternatives are estimated in Section 5 of this EA. This appendix presents an evaluation of the proposed action and each alternative relative to the ALARA principle.

The monetary equivalent value for a unit of collective dose can vary. Typical levels used are in a range for $1,000 per person-rem to $10,000 per person-rem, though values outside the range have also been considered. For application in the ALARA analysis that follows, $10,000 per person-rem (DOE, 1991) was used, recognizing that the use of $1,000 per person-rem makes no impact on the ALARA determination or the cost-benefit analyses. This is due to the fact that the potential individual and collective doses are insignificant to other factors. As a result, it was not considered reasonable to spend resources to better define the monetary equivalent per unit dose for this application.

Results of the ALARA evaluation are presented in the following table.

ALARA Considerations for the Proposed Action and the Alternatives

	Unrestricted Use (Proposed Action)	Storage (No Action)	Recycle at SEG	Sale/Gift to Foreign Government	Disposal at Hanford	Disposal at Sanitary Landfill
Monetary Equivalent	($720.00)	($1.15)	($1.40)	($0.47)	($0.03)	($0.03)
Savings/(Cost) 1993 Dollars	$246,960	($1,000/yr.) annual expenditure	($323,370) one-time expenditure	($30,000) one-time expenditure	($235,300) one-time expenditure	($4,245) one-time expenditure
Resultant Monetary Equivalent Saving/(Expenditure)	$246,960	($1,000/yr. for as many years as the copper remains in storage + $1)	($323,370)	($30,000)	($235,300)	($4,245)

The monetary equivalent of collective dose equivalents are estimated using the value of $10,000/person-rem. This value allows comparison between the "cost" of the radiation exposure and other cost and benefits.

[Sections 5.1.2 through 5.1.4 retyped from pp. 17 - 20]

5.1.2 Environment

Copper scrap metal recycling would produce wastes and air emissions, but would avoid the comparatively greater indirect environmental effects of producing an equivalent quantity of copper metal through mining (ore removal and transport), milling (crushing and grinding rock), and ore concentration (water flotation treatment) at the mine site. In addition, impacts from smelting would be avoided because upgrading copper ore concentrate requires a three-stage smelting process with resultant emissions to the air, particularly sulfur dioxide, generation of a variety of solid and liquid waste streams, and energy consumption.

Besides averting the environmental consequences associated with mining, milling, and refining copper ore, additional benefits of the proposed action would include:

(1) preserving valuable low-level radioactive waste burial space for material that is actually classified as radioactive waste;
(2) preserving valuable sanitary landfill space;
(3) releasing the currently-used storage space for future use, and
(4) complying with the Secretary of Energy's waste minimization and pollution prevention policy.

5.1.2.1 Air Quality

Reprocessing of copper scrap results in emissions to the air of particulate matter in various forms. Particulate emissions vary depending on furnace type, feed quality, extent of pretreatment, and size and shape of feed material. Particulate emissions are abated using baghouses, electrostatic precipitators (ESPs), or wet scrubbers. Particulate emissions from the reprocessing of 140 metric tons (308,700 lbs) of copper windings would be approximately 640 lbs (EPA, 1986) based on standard emission factors.

While the proposed action would result in particulate air emissions, the proposed action would have an overall beneficial effect on air emissions as a result of the indirect effect of averting emissions of particulates from mining and milling operations and averting emissions of particulates and nonparticulates (primarily sulfur dioxide) from copper smelting/refining operations. Particulate emissions, resulting from mining and milling copper ore to produce 140 metric tons of refined copper would be approximately 6,400 lbs (Sittig, 1975). Particulate emissions would also be produced during smelting/refining, resulting in an additional 84,000 lb of emissions, assuming that ESP (best-available) control technology is used. Copper refining results in the liberation of large quantities of sulfur dioxide from processing of ore concentrates containing as much as 35% sulfur (EPA, 1986). With recent improvements to smelter technology and the use of sulfuric acid plants to recover sulfur dioxide emissions, sulfur capture from copper smelters in the U.S. is about 95% of the input sulfur (Engineering and Mining Journal, 1990a). Sulfur dioxide emissions to the air resulting form copper smelting/refining operations to produce 140 metric tons of refined copper would equal 38,000 lb.

The total averted emissions due to the recycling of the subject activated copper are 90,000 lb of particulate emissions and 38,000 lb of sulfur dioxide emissions.

5.1.2.2 Water Quality

Water is not used directly in the reprocessing (i.e., recycling) of copper scrap metal. Wastewater, however, is produced indirectly from the cooling of furnaces, machinery and casting operations, and from boilers associated with power plants. Generally, such water is recirculated through cooling towers for reuse, and a small portion is discharged as blowdown (Sittig, 1975).

Blowdown typically contains slightly increased levels of copper, zinc, and particulates resulting from evaporation of clean water from the cooling towers. Any blowdown resulting from the proposed action would meet EPA standards.

The proposed action would have an overall, beneficial effect on water quality and consumption as a result of the indirect effect of averting affluents from copper mining and concentrating operations to replace the 140 metric tons (308,700 lbs) of copper. Grinding and waste flotation treatment are used at a mine to concentrate copper ores from 0.5% to 25% copper (EPA, 1986). Considerable quantities of dissolved copper as well as arsenic, iron, and lead are found in tailings pond effluents from mines and concentrating operations. Other sources of wastewater from mining, concentrating, and smelting copper ore that would be averted include:

- process wastes, including mine drainage, discarded leaching solutions, scrubber waste, smelter wastewater, and discarded electrolyte from refineries.
- waste-treatment wastes, including filter backwash, sludges from primary settling and ion-exchange regeneration solutions.
- indirect and direct cooling water from the cooling of furnaces, machinery, and casting operations.
- boiler and power plant wastes, including boiler blowdown and ash pit overflow.
- sanitary wastes (Sittig, 1975)

5.1.2.3 Energy Use

The proposed action to recycle the scrap activated copper material would have the indirect, beneficial effect of avoiding the energy costs associated with copper mining, milling, concentrating, and the several step smelting and refining process. There is a 90% energy savings from recycling scrap metal compared to refining new copper ore (Phelps, 1992). The actual energy savings would be considerably more than 90% if mining and milling energy costs were taken into account.[1]

5.1.2.4 Traffic

Approximately seven truck loads would be required to transport the activated copper from the warehouse to the selected scrap metal facility. Three potential scrap metal dealers are within 10 miles of the LBL warehouse.

It is not known to which U.S. reprocessing facility the copper would be shipped, or even if it would be reprocessed within the U.S. (see Section 3.1). Traffic impacts for this aspect of the proposed action are, therefore, not quantifiable. However, it is expected that the seven truck loads required for transporting the copper from the scrap metal dealer's facility to a reprocessing facility would have minimal impacts on the traffic conditions on any of the routes that might be followed.

5.1.2.5 Geology, Soils, Hydrology, Aesthetics

Eighty percent of the copper domestically mined comes from open pit mines in Arizona, Idaho, Montana, Nevada, New Mexico, and Utah with the remaining 20% from underground mines in Arizona, Michigan, New Mexico, and Oregon. Most open pit copper mines are extensive in size, covering several square miles of land area.

[1] In general, mining and milling costs are more than double the energy cost of the refining process in the U.S. (Metals and Minerals Yearbook, 1989).

Milling and concentrating operations on-site at the mines crush and grind the ore. Large quantities of water are required for concentrating the ore prior to transport to primary smelters. The spent material from this process is deposited in tailings ponds. Seepage from the tailings ponds into ground waster may occur depending on the type of underlying soil. Water quality of surface and ground water around tailings ponds must be monitored to determine the extent of seepage and compliance with operating permits (MacPhail, 1992).

The standard equipment used at a given mine includes several heavy duty drills and production loaders or conveyer systems. In addition, a fleet of bulldozers and graders are required to move ore and construct and maintain mine roads and slopes. An assortment of mining shovels and several hundred-ton capacity trucks are required to transport ore out of the mine (MacPhail, 1992). This equipment is primarily diesel-powered, which results in emissions of combustion by-products in addition to the fugitive particulate emissions from ore-moving activities.

Environmental effects of mining operations can be minimized by effective tailings dump development and reclamation. Dump surfaces must be prepared for cultivation including resloping and, in some cases, suitable top soil must be added to support revegetation. Acceptable surface waster drainage systems must be designed for these dump areas to keep acid drainage or nitrate leaching within acceptable bounds (MacPhail, 1992).

Since 1987 most smelters have adopted oxygen-enriched smelting furnaces. These furnaces generally require a lower-energy input than traditional smelting furnaces and provide a more concentrated sulfur dioxide gas stream, which allows for sulfuric acid production as a means of sulfur dioxide capture. In addition to environmental effects on air and water (see Sections 5.1.2.1 and 5.1.2.2), copper processing produces numerous liquid and solid waste streams, some of which are regulated as RCRA hazardous wastes. These waste streams include slag from primary copper processing, acid plant and scrubber blowdown, bleed electrolyte, calcium sulfate, and wastewater treatment plant sludge (Metals and Minerals Yearbook, 1989).

The proposed action would have the indirect benefits of averting the negative environmental effects to geology, soils, hydrology, and aesthetics associated with the mining, milling, smelting, and refining of virgin ore needed to produce an equivalent quantity of copper.

5.1.2.6 Natural Resources

The proposed action would have an indirect beneficial effect on natural resources in that 140 metric tons of high-purity copper would be recycled for future use.

5.1.2.7 Land Use

The proposed action would have a beneficial impact on land use in that it would preserve valuable landfill space.

5.1.2.8 Waste

It is assumed that the reprocessing of the copper under the proposed action would have impacts on waste generation similar to those that would be produced under the SEG alternative. For a discussion of potential impacts on waste generation of SEG, see Section 5.3.

Although the recycling of copper scrap metal would result in the generation of wastes, the proposed action would avert the comparatively greater generation of wastes associated with the mining (ore removal and transport), milling (crushing and grinding rock), and ore concentrating (water flotation treatment) for an equivalent quantity of copper metal. In addition, the variety of solid and liquid waste streams generated from the three-stage refining process would be avoided.

5.1.3 Accident Scenarios

No reasonable accident scenarios could be identified that resulted in greater radiological effects to workers or the public than the effects of the proposed action discussed in Section 5.1.1. Potential effects of accidents from the proposed action would be identical to those associated with transportation, reprocessing, or the end-use of non-activated copper. A traffic accident while transporting the activated copper would result in potential injuries and fatalities to the driver and occupants of other involved vehicles identical to an accident involving non-activated copper. Dose equivalents to members of the public and transport workers involved in an accident would be less than the limiting values estimated in 5.1.1. Similarly, accidents in smelters involving the activated copper would result in potential injuries and fatalities to the workers identic to those involving non-activated copper (i.e., burns or heavy object impacts). Dose equivalents to workers would be less than the limiting values estimated in 5.1.1. Accidents involving the end product of the activated copper (e.g., home wiring, electrical components, jewelry) would result in potential injuries to members of the public identical to those involving non-activated copper items (i.e.,, cuts, punctures, abrasions, impacts from heavy objects). The dose equivalents would be less than the limiting values estimated in 5.1.1.

5.1.4 Cumulative Impacts

The results of the environmental monitoring of LBL operations are documented, evaluated, and interpreted annually in the Annual Site Environmental Reports. The report for 1992 (LBL, 1993) indicates that the maximum individual dose equivalent to the public from LBL operations was 2.3 mrem and the maximum collective dose equivalent to the public within 80 km of LBL was 3.4 person-rem. The effect of any of the alternatives for disposition of the activated copper would have no detectable impact on either of these figures. No cumulative impacts were identified.

[Table 2 retyped from pages 12 and 13]

Table 2. COMPARISON OF THE PROPOSED ACTION AND ALTERNATIVES FOR RECYCLING OF ACTIVATED COPPER

	Unrestricted Use (Proposed Action)	Storage (No Action)	Recycle at SEG	Sale/Gift to Foreign Government	Disposal at Hanford	Disposal at Sanitary Landfill
Air Quality	Particulate emissions as a result of reprocessing the copper would be approximately 610 lbs. Indirect benefits of averting 90,000 lbs of particulate emissions attributable to the mining, milling, and refining of ore needed to produce an equivalent quantity of copper	Indirect impacts of 90,000 lb particulate emissions and 38,000 lb of sulfur dioxide emissions attributable to the mining, milling, and refining of ore needed to produce an equivalent quantity of copper	Negligible Impact	Impacts are unquantifiable but would likely be greater than those for the proposed action	Indirect impacts of 90,000 lb particulate emissions and 38,000 lb of sulfur dioxide emissions attributable to the mining, milling, and defining of ore needed to produce an equivalent quantity of copper	Indirect impacts of 90,000 lb particulate emissions and 38,000 lb of sulfur dioxide emissions attributable to the mining, milling, and refining of ore needed to produce an equivalent quantity of copper
Water Quality	An indirect, beneficial effect due to averting effluents produced from mining, milling, and refining of ore needed to produce an equivalent quantity of copper	Indirect impacts attributable to the mining, milling, and refining of ore needed to produce an equivalent quantity of copper	Similar to the potential effects associated with the proposed action	Similar to the potential effects associated with the proposed action	Indirect negative impacts attributable to the mining, milling, and refining of ore needed to produce an equivalent quantity of copper	Indirect negative impacts attributable to the mining, milling, and refining or ore needed to produce an equivalent quantity of copper
Energy Use	A >90% energy savings compared with mining, milling and refining copper ore	Indirect impacts of energy use attributable to the mining, milling, and refining of ore needed to produce an equivalent quantity of copper	A >90% energy savings compared with mining, milling, and refining copper ore	No Impacts	Indirect impacts on energy use attributable to the mining, milling, and refining of ore needed to produce an equivalent quantity of copper	Indirect impacts on energy use attributable to the mining, milling, and refining or ore needed to produce an equivalent quantity of copper
Traffic	Negligible Impact	No Impact	Negligible Impact	Negligible Impact	Negligible Impact	Negligible Impact
Geology, Soils, Hydrology, Aesthetics	An indirect, beneficial effect due to averting effluents produced from mining, milling, and refining of ore needed to produce an equivalent quantity of copper	Indirect impacts due to effects attributable to mining, milling, and refining of ore needed to produce an equivalent quantity of copper	An indirect, beneficial effect due to averting effluents produced from mining, milling, and refining of ore needed to produce an equivalent quantity of copper	Indirect, beneficial effects similar to proposed action	Indirect negative impacts attributable to the mining, milling, and refining or ore needed to produce an equivalent quantity of copper	Indirect negative impacts attributable to the mining, milling, and refining of ore needed to produce an equivalent quantity of copper
Natural Resources	An indirect, beneficial effect from the reuse of 140 metric tons of high-purity copper	Indirect impacts due to effects attributable to mining of ore needed to produce an equivalent quantity of copper	An indirect, beneficial effect from the reuse of 140 metric tons of high-purity copper	An indirect, beneficial effect from the reuse of 140 metric tons of high-purity copper	Indirect negative impact due to effects attributable to mining of ore needed to produce an equivalent quantity of copper	Indirect negative impact due to effects attributable to mining of ore needed to produce an equivalent quantity of copper
Land Use	Preserve valuable landfill space	No Impact	Preserve valuable landfill space	Preserve valuable landfill space	Disposal would use 0.058% of the available burial space	Disposal would use 0.008% of the available space at a local landfill

2.0 ALARA PROCESS
2.2.3 ASSESSMENT OF OTHER FACTORS

Table 2. (Cont'd.)

	Unrestricted Use (Proposed Action)	Storage (No Action)	Recycle at SEG	Sale/Gift to Foreign Government	Disposal at Hanford	Disposal at Sanitary Landfill
Waste	Direct impacts similar to those of the SEG Alternative. Indirect, Beneficial effects of averting waste generation associated with mining, milling, and refining ore needed to produce an equivalent quantity of copper.	No Impact	Would generate between four and eleven 55-gallon drums of waste. Indirect, beneficial effects of averting waste generation associated with mining, milling, and refining ore needed to produce an equivalent quantity of copper	No Impact	Negative impacts waste generation	Negative impacts waste generation
Maximum Lifetime Individual Worker Excess Fatal Cancer Risk (dose equivalent)	2×10^{8} (0.04 mrem)	4×10^{4} (0.1 mrem)	At SEG 2×10^{-8} (0.04 mrem) At end user 4×10^{-8} (0.1 mrem)	1×10^{-11}	1×10^{-11} (3×10^{-5} mrem)	1×10^{-11} (3×10^{-5} mrem)
Maximum Collective Transport Worker Excess Fatal Cancer Risk (dose equivalent)	2×10^{-10} (0.0004 person-mrem)	Averted	2×10^{-10} (0.0004 person-mrem)	Truck 2×10^{-10} (0.044 person-mrem) Dock Worker 2×10^{-8} (0.0004 person-mrem) Ship 4×10^{-10} (0.0001 person-mrem)	2×10^{-10} (0.0004 person-mrem)	2×10^{-10} (0.0004 person-mrem)
Maximum Lifetime Individual Public Excess Fatal Cancer Risk (dose equivalent)	8×10^{8} (0.15 mrem)	8×10^{9} (0.015 mrem)	Only transport dose equivalent is applicable	Only transport dose equivalent is applicable	2×10^{-12} (3×10^{4} mrem)	Only transport dose equivalent is applicable
Maximum Collective Public Excess Fatal Cancer Risk (dose equivalent)	4×10^{-5} (72 person-mrem)	Not Estimated	Only transport dose equivalent is applicable	Only transport dose equivalent is applicable	Only transport dose equivalent is applicable	Only transport dose equivalent is applicable
Maximum Collective Public Excess Fatal Cancer Risk from Transportation (dose equivalent)	2×10^{9} (0.04 person-mrem)	Averted	2×10^{-9} (0.04 person-mrem)	2×10^{-9} (0.04 person-mrem)	2×10^{-9} (0.04 person-mrem)	2×10^{-9} (0.04 person-mrem)

[Excerpts from Sections 5.2 through 5.6 retyped from pp. 20 - 25]

5.2 NO ACTION

[text omitted]

Selection of the no-action alternative would have minimal impacts to the existing environment as described in Section 4. However, the selection of this alternative would have an indirect, negative effect on natural resources in the 140 metric tons (308,700 lbs) of high purity copper would not be recycled at this time. Selection of this alternative would also not have the benefit of releasing the warehouse storage space for another use and would result in an estimated (1992) cost of $1,000 per year for storage of the 32 crates (G. Robillard, 1992). Although , after 53 years, the radioactivity in the copper would no longer be detectable with current techniques, it would still be radioactive with cobalt-60 at - 3 fCi/g [sic] and nickel-63 at - 1 pCi/g. Disposal of the copper as radioactive waste or release and recycling of the slightly activated material would still be necessary.

5.3 RECYCLE AT THE SEG FACILITY FOR REUSE AT DOE FACILITY

[text omitted]

Impacts to air quality from melting the activated copper at the SEG Metal Processing Facility would be negligible due to the system's design. Emissions resulting from the melting process are limited to particulates, which are abated using HEPA filters. The air exiting the Metal Processing facility is 10,000 times cleaner in particulate matter than the air entering the facility (SEG, 1993). There would be between four and eleven 55-gallon drums (or 6,000 to 15,000 lbs) of slag waste generated from reprocessing the copper. This is approximately 1 to 2% (by weight) of SEG's annual waste generation. The waste resulting from reprocessing the copper would be disposed of at an approved DOE disposal facility. Selection of this alternative would allow the reuse of a valuable natural resource thereby having the indirect, beneficial effect of averting the environmental consequences associated with mining and processing iron ore. However, since the activated copper would be used in an application which would typically be filled by ferrous materials, the selection of this alternative would have the indirect, negative effects associated with mining additional copper. The use of the slightly-activated copper in shielding blocks would avert the use of other virgin metals for block materials which would become contaminated and eventually require disposal as radioactive waste (SEG, 1991). The seven truck loads are not expected to impact the traffic along the interstate freeway system used to transport the copper from the warehouse to the SEG facility in Oak Ridge, Tennessee. In the immediate vicinity of the SEG facility, the seven shipments would contribute only a one-time slight increase to the six truck shipments that enter the SEG premises on an average daily basis during peak waste receiving periods.

The cost of this reuse alternative is $308,370 plus $15,000 for shipping to Oak Ridge, Tennessee, resulting in a total cost of $323, 370. While the reuse of the activated copper in a different form at another DOE facility may result in some savings, the absence of any immediate need for the copper at another facility renders calculation of any such savings at the present time speculative.

5.4 SALE/GIFT TO A FOREIGN GOVERNMENT

[text omitted]

This alternative would not avert exposure to the public from future reuse of the activated copper in the People's Republic of China (PRC) or other countries. However, this particular potential impact is outside the scope of this EA. Exposures in the PRC would be comparable to those estimated in Sections 5.1 or 5.3, depending on how the activated copper is used.

When considered on a global scale, the environmental impacts associated with this alternative are, in general, similar to those of the proposed action. Due to uncertainties in air emissions requirements and processes for abatement in foreign countries, the impact of this alternative on air emissions is unquantifiable. However, it would be likely that air emissions impacts related to this alternative would be treater than those for the proposed action (640 lbs of particulate emissions) due to less stringent emissions requirements in foreign countries. Also, some energy savings would be realized with this alternative, but they too are unquantifiable due to differences in technological processes in foreign countries. There would be indirect, beneficial effects similar to those for the proposed action on geology, soils, hydrology, aesthetics, and water quality due to averting the impacts attributable to the mining, milling, and refining of ore needed to product an equivalent quantity of copper. The impacts on land use and natural resources would be similar to that of the proposed action in that this alternative preserves valuable landfill space and has the indirect, beneficial effect of reusing 140 metric tons of high purity copper. The impacts on traffic, both land and sea, are anticipated to be negligible.

The costs for transporting the activated copper to the country having shown interest in receiving the activated copper (the PRC) is estimated to be $30,000. To the extent that the activated copper is sold at current scrap metal prices (see section 3.1) to an interested country rather than being the subject of a gift, LBL would receive a net gain of approximately $216,960.

5.5 DISPOSAL AT A SANITARY LANDFILL

[text omitted]

Permitted landfill space is scarce and is becoming more valuable as time goes on due to the cost of permitting such facilities. At the landfill's present capacity, the activated copper would occupy 0.0077% of the available space in the landfill. If the proposed 600 acres is permitted, the activated copper would occupy 0.00285% of the available space. Selection of this disposal alternative would have the direct, negative impact on land use of not preserving landfill space. In addition, selection of this alternative would not allow this valuable natural resource to be reused and would, therefore, have the indirect, negative impacts associated with mining, milling, and refining an equivalent amount of copper ore (e.g., air emissions and waste generation). The seven truck loads are not expected to impact the traffic along the interstate freeway route used to transport the copper from the warehouse to the sanitary landfill. In the immediate vicinity of the landfill, the seven shipments would contribute only a one-time slight increase to the 500 vehicles and trucks that enter the land fill premises on a daily basis. Selection of this alternative would release the warehouse space for reuse. In addition, selection of this alternative would be contrary to the Secretary of Energy's waste minimization policy in as much as a large amount of recyclable material would be disposed of as waste when risk-based analyses indicate no need to do so.

The cost of selecting this disposal alternative is estimated to be $4,465, which comprises the cost of transport to the landfill in Livermore ($1,820), the disposal fee ($2,425) and the fee for split sample WET test ($220) (Clayton Environmental, 1992). If the activated copper were classified as a RCRA waste using the STLC test, additional administrative costs would be incurred either to obtain an exemption or to dispose of the waste as hazardous in a permitted disposal facility. It is noted that copper metal is not a RCRA waste and is, therefore, not considered a hazardous material by the Federal government.

5.6 DISPOSAL AT A LOW-LEVEL WASTE BURIAL FACILITY

[text omitted]

At present, 295 acres are reserved at Hanford for the burial of low-level waste. The copper would occupy 0.017 acre (0.058%) of this land. Selection of this disposal alternative would have the direct, negative impact on land use of not preserving the Nation's valuable low-level waste landfill space. In addition, selection of this alternative would not allow this valuable natural resource to be reused and would, therefore, have the indirect \, negative impacts associated with mining, milling, and refining an equivalent amount of copper ore (e.g., air emissions and waste generation). The seven truck loads of copper would not impact the traffic along the route of interstate freeways that link the warehouse in Emeryville, California, to the Hanford Burial Site. Selection of this alternative would release the warehouse space for reuse. In addition, selection of this alternative would be contrary to the Secretary of Energy's waste minimization policy in as much as a large amount of recyclable material would be disposed of a waste when risk-based analyses indicate no need to do so.

Selection of this disposal alternative would result in a cost to LBL estimated to be $235,300. This cost is based on (1) transporting the copper from the storage facility in Emeryville, California, to the Hanford Site, which is estimated to be $6,208 (R. Roberts, 1992), and (2) burial of the copper at the Hanford Site, which is estimated to be $229,092 (N. Willis, 1992).

2.3 SELECTION OF PROPOSED ALTERNATIVE

[NOTE: The Copper EA presented both economic assessment and selection of proposed alternative in its Appendix A, "ALARA Considerations." Appendix A was reproduced as Section 2.2.3, above. Therefore, it is not also presented here.]

3.0 RECOMMENDED ALTERNATIVE

3.1 STATEMENT OF PROPOSED AUTHORIZED LIMITS

[NOTE: The Copper EA proposed the release of a specified quantity of slightly activated copper at its existing contamination levels (no decontamination). No specific proposal of authorized limits were stated.]

3.2 METHODS FOR DEMONSTRATING COMPLIANCE

[NOTE: The Copper EA reported the known existing radiological condition of the specific quantity of copper proposed for release. As mentioned above, no specific proposal of authorized limits was made. Also, no specific information was provided about demonstrating compliance with authorized limits.]

[Letter from the California Department of Health Services retyped from best available copy of Appendix B]

STATE OF CALIFORNIA HEALTH AND WELFARE AGENCY

DEPARTMENT OF HEALTH SERVICES
714/744 P STREET
SACRAMENTO, CA 95814

NOV 10 1989

US Department of Energy
San Francisco Operations Office
1333 Broadway
Oakland, CA 94612
Attn.: Mr. Joseph P. Juettan, Director
Environmental and Operational Safety Division

Subject: Exemption for Activated Copper

Dear Mr. Juettan,

This letter is in response to your request for exemption from 10 CFR 61 radioactive waste disposal requirements pursuant to Title 17 of the California Code of Regulations (CCR) Section 30104 in communications dated 2 October 1989.

Background

The material under consideration is approximately 140 metric tons of copper cyclotron coil windings from the dismantled 184 inch cyclotron at Lawrence Berkeley Laboratory (LBL). The form of this copper is 1/4" x 4" strips typically 7 feet long. These strips are currently in storage at LBL in Berkeley, CA.

The copper was activated to a degree from bombardment with neutrons and other high energy particles. This resulted in the internal production of radionuclides, primarily Cobalt 60. Due to the nature of the operations of this particular machine, almost all of the activation products have decayed prior to this time. Your plan for the copper, as stated in your letter of 2 October 1989, is recycling through a local smelter.

The copper strips have been sampled and analyzed for radionuclide content by LBL and the results transmitted to us. Additional samples of this material have been obtained for confirmation and analysis has been performed by the California Department of Health Services' (DHS) Sanitation and Radiation Laboratory. Results from the State lab confirm data received from Lawrence Berkeley Laboratory.

Measurement and screening procedures developed at LBL provide adequate assurance that no materials with concentrations in excess of 20 picoCuries per gram (pCi/g) will be released. Since the concentration of radionuclides in the copper ranges from a maximum of 20 pCi/g to none, with the majority of the material under consideration having no detectable activity, the average concentration of the material to be released will be less than picoCuries per gram. As a conservative measure, all calculations have been made for a concentration of 20 pCi/g.

Analysis

A computer code (IMPACTS/BRC) developed for the Nuclear Regulatory Commission (NRC) was used both DHS and Department of Energy, San Francisco Operations Office (DOE-SFOO) technical staff to determine estimates of the impact upon the public from disposal of waste containing very low levels of radioactive materials. We acknowledge that this code is not directly applicable for the recycling of activated materials, but feel that it retains some usefulness as a yardstick for comparison purposes. In addition, the eventual fate of most of this material is likely to be disposal in a public landfill after its utility has diminished.

4.0 COORDINATION ACTIVITIES

NOV 10 1989

By use of the IMPACTS code, it was determined by the Department of Energy that the largest dose to an individual would be 2.4 millirem to a metal worker, and that an intruder to the site (after loss of administrative control of the site) would receive a maximum of 0.142 millirem per year. The other impacts calculated by this code were less than these values. The suppositions which were utilized by DOE in making the dose assessment were examined and found to be both reasonable and in keeping with current professional practice. These calculations have been verified by independent code runs by DHS technical staff.

Since, as noted above, the fate of this material is not immediate burial, additional calculations were conducted to estimate the potential dose resulting from recycling the copper. These calculations included estimations of dose for possible dispersement as an aerosol during the resmelting process, and potential dose to the public as a mass of copper contained in various consumer products. The results of these calculations showed a very low potential for a measurable dose. One of these calculations has been included as an example of the scenarios which have been examined.

A simulation was run on the Microshield (tm) code for the radiologic dose resulting from a hypothetical 100 gram spheric copper source containing 20 pCi/g of Cobalt 60 at a reference meter distance. This particular geometry was chosen to represent the alignment yoke magnet of a cathode ray tube (CRT), a plausible source of potential high copper concentration near a human environment. The dose rate was calculated to be 2.715 E (sic) milliRem per hour. If we assume that an individual would spend (sic) hours a day near a CRT 5 days per week, 50 weeks per year, this would result in a yearly whole body equivalent (WBE) dose of 5. E-1 MilliRem (sic) per year. Conservative assumptions in this calculation include 1. Rejection of shielding considerations for the mechanism surrounding the CRT, 2. Using the highest concentration of radionuclide vs an average, 3. Using a high "occupancy" factor for dose calculations.

Health Effects

Current scientific evidence places risk from radiation exposure to be approximately 6.0 E-4 health effects per REM of exposure. The calculated dose which would result from the recycling of the material would constitute a risk of approximately 3.24 E-9. Health risks in the range of 1.0 E-5 have been previously accepted by Federal regulatory agencies. If we would extrapolate exposure to the public from this entire mass (1.2 million 100 gram spheres), we could calculate a total increased health risk of 0.0041 health effects from this recycling. This value should be compared with 0.16 health effects caused by radiation exposure from all NRC licensed activities and the 57,600 health effects caused by natural background radiation exposure.

Summary

We have calculated that the risk to the health and safety of the public from the recycling of activated copper from Lawrence Berkeley Laboratories is acceptable under the practice of risk based regulations.

We have determined that his waste meets the requirements of Title 17 part 30104 and is declared to be exempt from 10 CFR 61 licensed burial requirements. This material may be disposed of as ordinary non-radioactive waste or recycled at your option.

If you should have any questions concerning this matter, please contact Mr. David Speed at (916) 739-4207.

Sincerely,

(Original signed by Chief,
Environmental Management Branch)

cc: James Haley, Deputy Dept. Head, EH&S - LBL

E2.6 EXAMPLE APPLICATION FOR APPROVAL OF AUTHORIZED LIMITS

Using Excerpts from *Environmental Assessment, Proposed Sale of Radioactively Contaminated Nickel Ingots Located at the Paducah Gaseous Diffusion Plant Paducah, Kentucky,* (DOE/EA-0994) October 1995
Science Applications International Corporation
Oak Ridge, Tennessee,
for the U.S. DOE Oak Ridge Operations Office

The example application for approval of authorized limits presented in this section is a collection of excerpts from the document cited above. The full document is NOT provided.

The excerpts have been selected and arranged to illustrate how information from the source document might have been presented in the format of the annotated outline provided in Section E2.4.

Sometimes an excerpt may not be a very clear example of the application section it is used to illustrate because the purpose of the source document was only partially to support approval of authorized limits. Notwithstanding, the original text is presented without modification.

CONTENTS

[Executive Summary retyped from pages xi and xii]

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) proposes to sell 8,500 radioactively contaminated nickel ingots (9,350 short tons*), currently in open storage at the Paducah Gaseous Diffusion Plant (PGDP), to Scientific Ecology Group, Inc. (SEG) for decontamination* and resale on the international market. SEG would take ownership of the ingots when they are loaded for transport by truck to its facility in Oak Ridge, Tennessee. SEG would receive approximately 200 short tons per month over approximately 48 months (an average of 180 ingots per month.)

The nickel decontamination process specified in SEG's technical proposal is considered the best available technology and has been demonstrated in prototype at SEG. The resultant metal for resale would have contamination levels between 0.3 and 20 Becquerel per gram (Bq/g). The health hazards associated with release of the decontaminated nickel are minimal. The activity concentration of the end product would be further reduced when the nickel is combined with other metals to make stainless steel.

Low-level radioactive waste from the SEG decontamination process, estimated to be approximately 382 m^3 (12,730 ft^3), would be shipped to a licensed commercial or DOE disposal facility. If the waste were packaged in 0.23 m^3- (7.5 ft^3-) capacity drums, approximately 1,500 to 1,900 drums would be transported over the 48-month contract period.

Several alternatives to the proposed action were considered and carried through evaluation of impacts:

Alternative 2--Reprocessing for Unrestricted Release by DOE
Alternative 3--Improved Storage of the Ingots at PGDP
Alternative 4--Direct Disposal of the Ingots
Alternative 5--No Action (Continued Open Storage at PGDP)

Two alternatives were identified and eliminated from further consideration. Internal reuse of the nickel within DOE was considered speculative because no near-term uses were identified. Release of the nickel by DOE for unrestricted use without reprocessing was not considered reasonable because the level of contaminants in nickel presents too high a risk for public use. Additional characterization would be expensive. The nickel is sufficiently characterized for Alternative 1 and 2 because the decontamination process includes quality assurance steps to ensure that the nickel sold for public use would have contaminant levels below 20 Bq/g.

Minimal impacts to biota, natural resources, and humans are projected under all the alternatives based on the evaluation of socioeconomics, environmental justice issues, air and water quality, soils, and ecological receptors (including threatened and endangered species and wetlands). No floodplains or wetlands would be affected by the proposed action or alternatives.

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*Terms defined in the Glossary are marked with an asterisk at their first occurrence in the text.

Transportation risk as a result of accidents would be very low for alternatives involving transport. Based on risk calculations, $\leq$0.057 casualties would be expected. Release of contamination during a transportation accident would not occur because the nickel ingots are massive and not readily sheared or splintered, and the decontamination waste would be solid and packaged for transport.

Radiological impacts to human health and safety for both workers and the public would be within limits established by DOE and U.S. Nuclear Regulatory Commission requirements as implemented by Tennessee's State Regulations for Protection Against Radiation. Health and safety procedures followed at SEG would minimize exposure to workers. The public would not be exposed to radiation during transport of either the ingots or the decontamination waste because the beta radiation emitted by the primary contaminants is of low energy (0.101 MeV) and would be absorbed by clothing. transport containers, or the nickel itself. Use of stainless steel industrial products using the decontaminated nickel would result in little exposure to the population (a collective effective dose equivalent of 1.5 person-mrem). Unrestricted public use of the decontaminated nickel in the United States would result in low doses (collective effective dose equivalent of 42 person-mrem.). Both end use scenarios would contribute effectively zero excess fatal cancers in the affected populations.

DOE's policy of keeping radiation exposures to the public, the environment, and workers as low as reasonably achievable has been specifically addressed in evaluating the alternatives and is discussed in Appendix A. The analysis presented in Appendix A indicates the proposed action would result in a net benefit, would minimize exposures related to the action, and would prevent exposures exceeding applicable limits. The net economic benefit to DOE would be approximately $7.9 million. Details of the cost/benefit analysis are provided in Appendix A.

1.0 INTRODUCTION

[Sections 1.1 through 1.3 retyped from pages 1, 4, and 5]

1. INTRODUCTION

1.1 PURPOSE AND NEED

The U.S. Department of Energy (DOE) is proposing to sell surplus, radioactively contaminated nickel currently stored at its Paducah Gaseous Diffusion Plant (PGDP), Paducah, Kentucky, to Scientific Ecology Group, Inc. (SEG), Oak Ridge, Tennessee, for processing to reducer the concentration of radionuclides in the nickel. The decontaminated* nickel would ultimately be resold by SEG in the international market.

The purpose of this action is to remove a nonessential asset from storage while at the same time achieving financial gain. Selling the nickel would remove it from open storage, where its radionuclide and metals content are potential environmental hazards, and would provide DOE with funds to process other scrap materials. In addition to the financial gain it provides, the proposed action would make additional space available at PGDP for other activities and eliminate maintenance and surveillance costs from the nickel storage area.

1.2 BACKGROUND

Approximately 8,500 radioactively contaminated nickel ingots* [2,200 lb or 1 metric ton each] are stored at PGDP (Fig. 1), which is operated by Lockheed Martin Energy Systems (Energy Systems) under contract to DOE. The nickel was originally in shapes/forms that were “classified” for national defense reasons. In 1981-1985 the nickel was melted and cast into ingots to remove its “classified” status. During processing, surface radioactivity was distributed throughout the ingots. After recasting, the ingots were double- and triple-stacked aboveground and uncovered in an area referred to as the C-746-H4 Nickel Ingot Storage Pad (Storage Pad in this environmental assessment*), a restricted-access, fenced area of approximately 0.56 ha (1.4 acres) (Fig.2).

During the recasting process, samples were taken from 30 ingots. Results of the sample analyses are given in Appendix E. Analyses indicated the following concentrations of radionuclides:

	Average (Bq/g)	Maximum (Bq/g)
Total Uranium	0.049	0.280
Technetium-99	535.	2650.

Neptunium-237 (^{237}Np) was detected in only five samples: the average and maximum concentrations were 0.021 and 0.031 Bq/g, respectively. One sample had a plutonium-239 (^{239}Pu) concentration of 0.011 Bq/g (Williams 1986).

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*Terms defined in the glossary are marked with an asterisk at their first occurrence in the text.

The ingots are not regulated under the Resource Conservation and Recovery Act because they are intended for recycle and a demonstrated recycling option exists (40 *CFR* 261.6 and Tennessee Hazardous Waste Management Regulations 1200-1-11). Secondary wastes resulting from treating the ingots are addressed in Sect. 2.1. The radioactive contaminants are regulated under applicable federal and state regulations, either by the U.S. Nuclear Regulatory Commission or an agreement state. The U.S. Nuclear Regulatory Commission requirements as implemented by Tennessee's State Regulations for Protection Against Radiation would apply to any domestic commercial facility or organization external to DOE. DOE regulates source, by--product, and special nuclear materials at its facilities through DOE Orders pursuant to the Atomic Energy Act.

Personnel exposures from current storage practices are in compliance with the limits of DOE Order 5480.11 and 10 *CFR* 835 for occupationally exposed individuals and DOE Order 5400.5 for members of the general public.

DOE has investigated the feasibility of decontaminating the stored nickel. Three companies, including SEG, were awarded contracts in 1986 by the DOE Oak Ridge Operations Office to demonstrate processes to decontaminate the nickel (as well as some other metals). None of the companies was able to decontaminate the nickel (with respect to ^{99}Tc) within the time and funding constrains of the original contract. In a pilot program of their own funding, SEG subsequently demonstrated success in removing ^{99}Tc from the nickel using a processing option not available to them during the earlier demonstration phase. DOE requested proposals in 1988 for decontamination and disposition of the nickel, and SEG was the only company to submit a proposal. SEG would use an electrode contamination process, which is considered the best available technology for removing higher levels of ^{99}Tc from volumetrically contaminated nickel (EPA 1994). DOE and SEG have maintained good faith negotiations on their proposal since its submittal in 1989. DOE proposes to sell the nickel to SEG for decontamination and resale by SEG to an international buyer.

1.3 SCOPE OF THE ANALYSIS

This environmental assessment evaluates the potential impacts from the proposed action and alternatives to the proposed action. Many of the activities evaluated are beyond DOE regulatory authority because they would be performed by SEG, a corporation licensed and monitored by the State of Tennessee. However, DOE's contract with SEG would specify adherence to the terms of SEG's technical proposal to decontaminate the nickel. In its proposal, SEG assures compliance with DOE notices and regulations on radiation protection (for example, DOE Orders 5400.5, 5480.6, and 5480.15, and 10 *CFR* 835) and all applicable federal, state, local, and foreign regulations. Thus, to provide for a comprehensive analysis, SEG activities are evaluated in this environmental assessment.

PGDP has been added to the U.S. Environmental Protection Agency's (EPA's) National Priorities List; the site will be evaluated for remediation options under the Comprehensive Environmental Response, Compensation, and Liability Act through an interagency agreement currently under negotiation with the EPA and the State of Kentucky*. Site characterization, and if necessary, remedial action in the Storage Pad area would be addressed in separate environmental documentation.

For the no-action alternative, no changes in land use, air quality, and archeological/cultural resources would occur; these issued are thus not considered in the analysis of impacts in Sect. 4.

1.0 INTRODUCTION

It is the policy of DOE to keep radiation exposures as low as reasonably achievable (ALARA) below applicable dose limits. DOE notices and regulations specifically require the application of the ALARA process for radiation protection of workers and the public and the environment. DOE (1991) provides interim guidance on the procedures for applying the ALARA process for compliance with DOE 5400.5. The guidance states that ". . . DOE Orders and regulations recognize that ALARA decisions require consideration of a broad range of technical and social considerations and recommend that the bases for ALARA judgements be documented." Appendix A specifically addresses ALARA considerations, and these are identified throughout the text of this analysis as well.

DOE is committed to the complete assessment and full disclosure of the environmental consequences of its actions. If significant environmental impacts are found to be associated with the proposed sale to SEG, an environmental impact statement will be prepared; if not, DOE will issue a Finding of No Significant Impact" and proceed with the proposed action.

2.0 ALARA PROCESS
2.1 DESCRIPTION OF ALTERNATIVES

[Sections 2.1 through 2.6 retyped from pages 7, 10, 11, and 12]

2. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 ALTERNATIVE 1 -- PROPOSED ACTION

The proposed action would be comprised of these activities:

- handling, packaging, and loading the ingots at PGDP;
- transport from PGDP to SEG;
- constructing new buildings at SEG;
- decontaminating the nickel at SEG;
- managing process emissions, effluents, and wastes at SEG;
- transport of decontamination waste to a licensed commercial or DOE disposal facility;
- loading and shipping decontaminated nickel to the buyer; and
- end use of the decontaminated but residually radioactive, nickel.

DOE proposes to sell its inventory of radioactively contaminated nickel ingots stored at the Storage Pad at PGDP through a sole source contract with SEG, a wholly owned subsidiary of the Westinghouse Electric Corporation. The sale of the decontaminated nickel ingots would be in accordance with SEG's operating license and applicable requirements.

The current proposal is for SEG to resell the decontaminated nickel to a Spanish company for use in making stainless steel products for industrial use. A metals broker in the United States would assist SEG with international transfer requirements and negotiations with the Spanish buyer. Spanish regulations allow the acceptance of recycled scrap metal with low activity levels (up to 74 Bq/g); however, the decontaminated nickel would have residual levels far less than the regulations allow (between 0.3 and 20 Bq/g). Combining the nickel with other metals to make stainless steel would further reduce the activity of the end product. There would be restrictions on end use in Spain; the nickel could not be used to make personal items such as cookware, toys, earrings, or domestic tools as these are prohibited uses regulated by the Nuclear Security Council of the Spanish government.

SEG would take delivery of approximately 200 short tons* per month over a 48-month time period (approximately 180 ingots per month). The nickel ingots would be sold "as is" and SEG would be responsible for transportation in accordance with applicable Department of Transportation requirements defined in 49 *CFR*. SEG would load the nickel ingots into Department of Transportation-approved steel trucks for delivery to its facility located in Oak Ridge, Tennessee (Figs. 3 and 4). Once loaded, the nickel ingots would become the property and responsibility of SEG. If SEG acts as the shipper, SEG would take ownership of the nickel upon release from PGDP. Prior to receipt of the nickel, SEG would construct three new buildings [1.150 m^2 (12,80 ft^2) total] in currently developed areas at the SEG Bear Creek Road site to house the facilities for the nickel processing and decontamination.

The SEG electrolytic decontamination process, the details of which are proprietary, was demonstrated in prototype at SEG and is diagramed in simplified form in Fig. 5. The use of electrolytic decontamination would eliminate high chemical consumption, minimize waste generation, and produce high-quality nickel. A license for the decontamination process would be regulated from the Division of Radiological Health, Tennessee Department of Environment and Conservation, prior to operation.

2.0 ALARA PROCESS
2.1 DESCRIPTION OF ALTERNATIVES

SEG's processing of the nickel would begin with characterization of the nickel for initial quality assurance. The ingots would be melted and cast into pellets followed by dissolution of the nickel in either a sulfate or chloride electrolyte. Decontamination of the dissolved nickel electrolyte then would be performed using ion exchange resins, followed by the plating of decontaminated nickel as cathodic plates. After processing by SEG, the nickel would still be slightly radioactively contaminated, with the total contamination being in the range of 0.3 to 20 Bq/g (a 96 percent or greater reduction in contamination). The radioisotope remaining would be principally ^{99}Tc, with trace or undetectable quantities of low-enriched uranium, ^{239}Pu, and ^{237}Np. Final quality assurance/quality control analysis of the nickel plates would be performed prior to shipping to ensure that plated nickel is $\leq$ 20 Bq/g. The cathodes would then be transported by truck to a port on the Gulf or Atlantic seaboard assumed in this analysis to be Savannah, Georgia and shipped to Spain.

The spent ion exchange resins containing the contaminants from the nickel processing would be neutralized, dewatered, and further treated, as necessary, to render the waste nonhazardous. The waste would then be solid as defined by the U.S. Nuclear Regulatory Commission in 10 *CFR* 61. All waste treatment would be conducted according to the terms of SEG's license from the State of Tennessee Division of Radiological Health which includes provisions for treatment of hazardous secondary waste to achieve a nonhazardous waste form. Approximately 382 m^3 (12, 730 ft^3) of nonhazardous, low-level, radioactively contaminated waste would be produced. DOE would assume responsibility for disposition of the decontamination waste. The containerized waste [about 1,500 to 1,900 drums, each with a 0.23 m^3 (7.5 ft^3) capacity] would be transported in trucks by SEG or its agent to a licensed commercial or DOE disposal facility. For the purpose of this analysis, the commercial facility is assumed to be Envirocare, Inc. (Clive, Utah), and the DOE disposal facility to be the Hanford Site, located near Richland, Washington.

2.2 ALTERNATIVE 2--REPROCESSING FOR UNRESTRICTED RELEASE BY DOE

This alternative would involve decontamination of the nickel by SEG, return of the decontaminated metal to DOE, and release of the nickel by DOE for unrestricted use in the United States. This alternative differs from the proposed action only in the end use scenarios: use of the nickel would not be restricted as it would be in Spain because the United States has not established use restrictions or acceptance standards for residually contaminated metals. DOE could release the decontaminated nickel through the procedure described in Sect. II. (6) of DOE Order 5400.5. Radiation Protection of the Public and the Environment. Release of the decontaminated nickel would require demonstration of minimal health risk, approval of the Assistant Secretary of DOE, and agreement by the appropriate State agency that the nickel does not warrant regulation as a radioactive material. The nickel is assumed to be used in a range of products similar to the actual uses of nickel in the United States. These scenarios are described in detail in Sect. 4 of this environmental assessment.

2.3 ALTERNATIVE 3--IMPROVED STORAGE

The improved storage alternative would involve storing the nickel ingots indefinitely in a specially designed and engineered structure to prevent the potential release of radioactive contamination to the environment. For this analysis, the structure is assumed to be a 1,107 m^2 (12,000 ft^2) metal building on a concrete slab. The action within this alternative would include the physical removal of the ingots to a staging area, construction of the storage structure, and placement of the ingots in the new structure.

2.4 ALTERNATIVE 4--DIRECT DISPOSAL

In the direct disposal* alternative, the radioactively contaminated nickel ingots would be disposed of as low-level radioactive waste. Under current U.S. Nuclear Regulatory Commission regulations (10 *CFR* 61) and DOE Order 5820.2A, this type of waste may be disposed of in near-surface disposal facilities, including engineered shallow land trenches or other suitable disposal facilities. Site activities would include physical removal of the ingots, transportation, and disposal at a permanent waste disposal facility. for the purpose of this analysis, the commercial disposal facility is assumed to be Envirocare, Inc. (Clive, Utah), and the DOE facility to be the Hanford site located near Richland, Washington.

2.5 ALTERNATIVE 5-- NO-ACTION

Under the no-action alternative, DOE would continue the open, above-ground storage of the nickel ingots at the Storage Pad. Routine monitoring of the ingots and occasional grounds maintenance would continue. The nominal cost of maintaining the Storage Pad is incorporated into PGDP’s overall environmental radiological, monitoring, and waste management activities.

2.6 ALTERNATIVES CONSIDERED AND REJECTED FROM FURTHER CONSIDERATION

2.6.1 Release for Unrestricted Use Without Reprocessing

This alternative would involve DOE release of the nickel ingots in their current form to the commercial nickel market in the United States. To consider this a reasonable option, more extensive characterization of the contamination in the ingots would be required, which is an expensive activity estimated to cost more than $1 million. The sampling that has already been done is sufficient to characterize the contaminants prior to decontamination, but not for direct release for public use because the level of contaminants in the nickel presents too high a risk without reprocessing. The decontamination process considered in this environmental assessment involves testing contaminant levels at several steps in the process and testing the final product prior to release, thus the contaminant level is assured of being below a preestablished benchmark (20 Bq/g). The release without reprocessing alternative is not considered reasonable and is not considered further.

2.6.2 Internal Recycle

The internal recycle of the nickel ingots would involve the reuse of the material within DOE facilities and/or programs. However, DOE currently has no internal uses for the nickel and hypothetical future uses have implementability constraints (e.g., use of the nickel in making stainless steel containers for storage/disposal would require special production facilities that do not exist). Because no near-term internal uses have been identified, the internal recycle alternative is considered speculative and will not be considered further in this assessment.

[Excerpts from Section 4.1.8 retyped from pages 29 - 32]

4.1.8 Human Health and Safety

4.1.8.1 Occupational worker

[text omitted]

Radiological Exposure --SEG Workers

In addition to the nonradiological risks associated with nickel processing, workers would be exposed to contaminated materials throughout the action. The principal mode of radiation exposure would be internal exposures from inhalation and ingestion of airborne contamination resulting from processing operations. The bulk of the radionuclide contamination in the nickel ingots is ^{99}Tc, a low-energy beta emitter. As discussed in Sect. 4.1.7, ^{99}Tc would not present an external irradiation hazard. Surface exposure measurements of the ingots indicate that at 0.6 cm (0.25 in.), external radiation levels are very low, below detection (Energy Systems 1994).

The constraining scenario (i.e., highest exposure) in the decontamination process has been identified as the sectioning of ingots for initial feedstock preparation. Dose was estimated using a cutting scenario, which is a conservative representation of the pelletization process currently planned by SEG. Assuming an air concentration of 1×10^{-3} g/cm^3 and the same contaminant concentration as in the ingots, a full-time worker is estimated to receive an exposure of 0.00036 mrem/year. In this case, the worker is assumed to wear a respirator with a particulate filtration efficiency of 0.99. Assuming that the full-time worker stayed on the same job for the 4 years of nickel processing, the total exposure would be 0.0014 mrem, which corresponds to a potential lifetime fatal cancer risk of 7×10^{-10}. For an estimated four workers to complete this task, the collective exposure would be 0.006 person-mrem and the excess fatal cancers about 0.000000003, effectively zero. For comparison, about 1 in 3 Americans will develop cancer from all sources, and it is estimated that 60 percent of all cancers are fatal (American Cancer Society 1992); this translates to a baseline risk of about 0.2 fatal cancers in the general population, or 1 in 5. Thus, the excess risk of cancer for workers processing nickel is many times less than the existing risk of cancer for the general population having no exposure to the nickel processing.

Actual exposures would be maintained as low as reasonably achievable through application of SEG’s Radiation Protection Program, which is regulated by the State of Tennessee Department of Environment and Conservation, Division of Radiological Health. The specific regulations for “Standards for Protection Against Radiation” are provided in the Tennessee Regulations SPAR Chapter 1200-2-5.

SEG maintains a written Radiation Protection Program designed to comply with applicable regulations as well as to prevent employees and the general public from unnecessary or inadvertent exposures to radiation. In addition to regulatory and access controls, SEG has incorporated several engineering features, such as ventilation systems, shielding, remote handling equipment, area monitoring, and waste collection and processing systems, to reduce personnel exposure to radiation and radioactive material. SEG’s ALARA program requires a detailed health physics review for each task performed under a Radiation Work Permit.

Occupational exposures are monitored at SEG through use of personal dosimetry, health physics surveys, and bioassay programs. Employees routinely involved in melting radioactively contaminated scrap metal at this facility have annual monitored exposures of less than 250 mrem/year from all processes conducted at the facility. Radionuclide concentrations in the nickel ingots are not significantly different from or greater than radionuclide contamination in scrap metal currently smelted at SEG. Because decontamination of nickel ingots at this facility would be by electrorefining, air borne emissions would be significantly lower and would not be expected to produce annual exposures to workers in excess of currently measured exposures. The average annual exposure at SEG is well below Tennessee's State Regulations for Protection Against Radiation exposure limits for all radionuclides assayed (Davis 1993).

Radiological Exposure--Smelter Workers

Under the proposed action, the nickel would be reused following the decontamination process. The most plausible scenario of nickel application is smelting with iron into nickel steel (which is corrosion resistant) in a commercial smelter. In general practice, about a 15 percent nickel content is typical for the allow (Sibley 1985). Thus, for a nickel inventory of 9,350 tons, a total of 62, 330 tons of nickel steel is expected as product, which would bring the average level of ^{99}Tc in the product steel to 1.8 Bq/g. The constraining scenario for this process has been identified as the caster worker. The assumptions follow the International Atomic Energy Agency (IAEA) 111 Report (IAEA 1992), where the workers are subject to the inhalation and inadvertent ingestion pathways. The smelting process is assumed to take place in a commercial smelter; because smelter workers are not considered to be radiation workers, no protection such as respirators is assumed. The potential dose to a full-time worker is estimated to be 0.01 mrem/year. Assuming that a worker stays on the same job for 4 years of processing, the total dose would be 0.04 mrem, which translates into a lifetime fatal cancer risk of 2×10^{-4}. The estimated population dose for workers would be about 0.3 person-mrem over 4 years of processing which is about 0.00000002 excess fatal cancers in the affected population, effectively zero. As explained in Sect. 4.1.8.1, this excess risk to workers processing nickel is many times less than the risk of cancer in the general population, who are not exposed to the nickel.

4.1.8.2 Public exposure

Members of the general public would not be exposed to external radiation during transport of the nickel ingots, the decontamination waste, or the decontaminated nickel cathodes, as described in Sect. 4.1.7.

Radiological Exposure from Processing at SEG

The radiological exposure to the public resulting from routine decontamination operations at SEG is limited by the remote location of the facility, which is approximately 1 mile to the east of the nearest residence, and by use of HEPA filtration systems to prevent the release of material to the air. Emissions from SEG are regulated according to Tennessee's State Regulations for Protection Against Radiation. The regulatory limit for effective dose equivalent to a member of the public is 10 mrem/year (40 *CFR* 16.102). for calendar year 1993, SEG's radionuclide emissions were calculated to result in a whole body dose to the nearest receptor of 5.8×10^{-2} mrem/year, or less than 1 percent of the standard (SEG 1994). Decontamination of nickel ingots at the SEG facility would not be likely to affect this estimate because electrorefining processes would not release airborne radioactive contaminants.

Radiological Exposure in Spain

The current proposal is for SEG to resell the decontaminated metal to a Spanish company for use in making stainless steel products for industrial use. As discussed above, the smelted steel product from the subject contaminated nickel would contain as estimated ^{99}Tc concentration of 1.8 Bq/g. Because Spanish regulations do not allow the production of personal items such as cookware, toys, earrings, or domestic tools from recycled metal, the likely end uses of such steel products are industrial equipment and machinery. Also, because such steel is quite resistant to corrosion, it is highly unlikely that ^{99}Tc in the steel could become dispersed or available for human intake, either by inhalation or ingestion, through the normal use of such end products under ambient environmental conditions. Thus, on the basis of these considerations and the fact that external exposure is also an unlikely route of exposure, no radiological impacts are expected to result from implementation of this alternative.

The impact of atmospheric releases of the public from a smelter in Spain producing stainless steel is estimated to be 9 x 10^{-4} mrem/year. The population dose from such releases is estimated to be 0.3 person-mrem/year for a populated urban environment. Over 4 years of processing the collective population dose would be 1.2 person mrem., which corresponds to 0.0000006 excess fatal cancers in the affected population, effectively zero.

Radiological impacts for the proposed action and alternatives are summarized in Table 4. Appendix A provides discussion of the proposed action relative to DOE's ALARA policy.

Table 4. Estimated radiological impacts by alternatives for the disposition of contaminated nickel ingots

Impact Group	Alternative 1 Proposed Action	Alternative 2 Release by DOE	Alternative 3 Improved Storage	Alternative 4 Direct Disposal	Alternative 5 No Action
Maximum lifetime individual, worker					
Excess fatal cancer risk	7×10^{10}	7×10^{10}	None	Not estimated	None
Dose equivalent	0.0014 mrem	0.0014 mrem	--	--	--
Collective, worker					
Excess fatal cancers	0.00000002	0.00000002	None	Not estimated	None
Dose equivalent	0.04 person-mrem	0.04 person-mrem	--	--	
Collective, transport worker					
Excess fatal cancer risk	None	None	None	None	None
Dose equivalent	--	--	--	--	--
Maximum lifetime individual, public					
Excess fatal cancer risk	2×10^{8}	2×10^{8}	None	5×10^{7}	None
Dose equivalent	0.04 mrem	0.04 mrem	--	1 mrem	--
Collective, public					
Excess fatal cancers	0.0000008	0.00002	None	Not estimated	None
Dose equivalent	1.5 person-mrem	43.5 person-mrem	--	--	--
Collective from transportation, public					
Excess fatal cancers	None	None	None	None	None
Dose equivalent	--	--	--	--	--

[Section 4.1.1 retyped from page 19]

4.1.1. Socioeconomics

Sale and removal of the nickel ingots would not cause any socioeconomic* impacts within the Paducah area; no jobs would be eliminated or created at PGDP because other scrap metal is stored at the same location and would continue to be managed. Material loading would be handled by existing SEG personnel.

The construction and operation of the decontamination facility by SEG would result in the additional employment of an estimated 20 persons. Employment of these persons could continue after the nickel from DOE was processed based on the expected use of the facility for other decontamination projects (Waldrup 1993). The number of persons moving into the Oak Ridge area, if any, would represent a very small percentage of the total living within a 80-km (50-mile) radius of the proposed facility (Sect. 3.2.1). Implementation of the proposed action would have minimal impacts on local social services because of the locations of the facility. Six municipalities, representing three counties, are located within 16 km (10 miles) of the proposed facility (Sect. 3.2.1). The minor impacts to social services that would be generated would be shared among these nine local government entities.

Sale of the decontaminated nickel would not affect the price or availability of nickel on the international market because the amount to be sold is a small percentage of the average annual world production of nickel. For each of the 4 years of the proposed action, the amount sold would be 2.6 percent of the average annual world production of nickel (U.S. Bureau of Census 1994).

The gross value of the ingots is $50.9 M, based on the current market value of nickel ($3.25/lb). Cost to decontaminate the nickel is approximately $43 M. The net economic gain would be $7.9 M.

[Sections 4.1.2 through 4.1.7 retyped from pages 19 - 24]

4.1.2 Land Use and Archaeological/Cultural Resources

No changes in land use would occur for this alternative. Construction of additional buildings on the SEG property would be consistent with its industrial setting. The proposed action would not cause changes in land use at PGDP. The Storage Pad at PGDP might be remediated at some later time but would remain in government use within the PGDP complex. Archaeological or cultural resources at PGDP would not be affected by the proposed action because no soil would be disturbed. New construction at SEG would occur in a currently developed area (a parking lot).

4.1.3 Geology and Soils

Neither the soils nor the geology at PGDP would be affected under the proposed action because the ground would not be disturbed. At SEG, soils would be disturbed during construction of the new buildings [1.189.1 m^2 (12,800 ft^2)]. The soil present on the site is highly susceptible to accelerated erosion, thus stringent erosion control measures would be necessary to prevent erosion following disturbance. Appropriate use of silt fences and berms and rapid revegetation of open areas would mitigate the potential for soil loss. The geology of the SEG location would not be affected.

4.1.4 Water Quality

No impacts to groundwater or surface water would occur at PGDP during the removal of the nickel ingots. No impacts to groundwater would be expected to occur from the construction of the nickel processing buildings at the SEG Oak Ridge site. Best management practices, such as diversion ditches and silt fences, would be used to reduce impacts to the surface water quality of Grassy Creek. An increase in surface runoff would be expected after construction was completed because of the additional low-permeability surfaces (buildings and parking areas) that would be added to the site. SEG has a stormwater collection system at the Bear Creek facility that facilitates sediment precipitation and velocity reduction of stormwater prior to discharge into Grassy Creek. SEG is permitted by the Tennessee Department of Environment and Conservation to discharge stormwater into Grassy Creek in accordance with the requirements set forth in Rule 1200-4-10.04 (Tennessee Code Annotated Sect. 69-3-101. et seq.). Appendix B lists parameter reporting levels.

Negative impacts to surface water quality would not be expected from the decontamination process because process chemicals would be recycled for reuse, no organic effluents would result from the processing, no floor drains would be present in the bermed process or storage areas, and on underground tanks would be used (Hipsher 1994). The residual waste would be dewatered prior to shipment to the Envirocare, Inc. facility, thus, the potential for leakage is negligible. The liquid from dewatering would be incinerated or solidified (Norris 1995).

4.1.5 Air Quality

Pollution would be produced from the exhaust of loading equipment and the trucks used for transportation of the nickel ingots from PGDP to the SEG Oak Ridge site and the decontaminated nickel to a seaport. The quantities of emissions generated would be small and would be expected to have a negligible effect on local or regional air quality. The average cancer fatality induced by vehicle exhaust emission is 2.1×10^{-9} facilities per shipment mile (Saricks and Kvitek 1994); for the proposed action, the total excess cancer fatalities would be 0.0014, which is essentially zero.

Construction of the nickel processing buildings at the SEG Oak Ridge site would also temporarily produce small amounts of fugitive dust and internal combustion engine emissions but not in quantities expected to adversely affect air quality. A construction permit from the Division of Air Pollution Control, Tennessee Department of Environment and Conservation would be required prior to the start of construction.

Standard engineering controls would be used during the decontamination process to prevent evaporative losses; fumes from acid dissolutions and other processes that cause the generation of hydrogen gas would be collected and diluted. Air quality would be monitored to check the effectiveness of the engineering controls. Stack effluent would be filtered through a high-efficiency particulate air (HEPA) filter system. SEG's stack emissions are controlled by State Regulations for Protection Against Radiation and conditions of the license issued by the Division of Radiological Health, Tennessee Department of Environment and Conservation. SEG has not yet applied for a permit for the proposed nickel decontamination facility, so there is not a specific emission limit for the process. However, the permit would require compliance with the state regulations, which prohibits release of radionuclides to the ambient air in amounts that would cause a member of the public to receive in any year an effective dose equivalent or greater than 10 mrem/year. For nonradioactive contaminants, the majority of sources of emissions at SEG have a particulate emission limit set by the State of Tennessee at 0.01 lb/hr of general particulate (Cole 1995). Monitoring would be performed in the stack and at the HEPA filters to verify the efficiency of the engineering controls and to ensure compliance with all air quality regulations and permitted emission levels.

4.1.6 Ecological Resources

The proposed action would have no impacts on ecological resources int he PGDP area. The storage area would be used for another DOE function after the ingots were removed; therefore, it would not revert to natural habitat. Because the contamination within the ingots is not known to act as a source of contamination to the environment, no known benefits to local biotic systems would result from removal of the ingots. Individual organisms (e.g., insects and reptiles) that might be exposed to the contaminated ingots by living around them could benefit from removal of the ingots.

The construction of the nickel processing facility would not result in the loss of habitat at the SEG Oak Ridge site. The new processing buildings would be constructed on disturbed land (a parking lot). Federally or state-listed threatened or endangered species are not expected to be adversely affected because construction associated with the proposed action would occur in currently developed areas.

4.1.7. Transportation

Total accidents and casualties (injuries and facilities) were estimated for shipments of ingots by truck between PGDP and SEG, shipment of the decontaminated nickel between SEG and a seaport at Savannah, Georgia, and transportation of processing waste by truck or rail from SEG to Envirocare, Inc. (Clive, Utah) or the Hanford Site. Fatalities during transportation of processing waste by truck from SEG to a storage facility at the K-25 Site were also estimated. Packaging of the ingots, processing waste, and decontaminated nickel would meet the requirements of Department of Transportation regulations specified at 49 *CFR*. "Total vehicle miles of travel" is used as a measure of accident exposure for each destination. Accident rate data are combined with measures of accident exposure to determine the accident potential associated with transporting the material. The potential for contamination to spread during an accident is negligible because the low-level radiation in the nickel is distributed throughout massive, solid ingots and cannot spill like a liquid or become airborne like a dust. The processing waste would be spent ion exchange resins that would be dewatered and further treated as necessary by SEG to render the waste solid and nonhazardous to satisfy 10 *CFR* 61, Licensing Requirements for Land Disposal of Radioactive Waste. Thus, release during an accident in not considered further in this assessment.

External radiation hazard during transportation of the ingots to SEG, the processing waste to a disposal facility, and the decontaminated nickel to Spain is not considered a plausible pathway because the principal contaminant in the material is ^{99}Tc, which emits relatively weak beta particles [0.101 megaelectron-volt (MeV)] during radioactive decay of ^{99}Tc to a stable isotope (Ruthenium-99) (U.S. Department of Health, Education, and Welfare 1970). Although exhaustive measurements have also revealed a very weak gamma emission (Knolls Atomic Power Laboratory 1984), from the radiation protection point of view this emission is considered nonexistent (e.g., International Commission on Radiological Protection 1983; EPA 1993). The range of beta particles in dry air is about 30 cm/MeV (Brady and Holum 1988); thus, the beta particles emitted by ^{99}Tc would travel approximately 9 cm (3.5 in.) in dry air. Beta particles are easily blocked by clothing worn by a potential receptor or any objects between the source and receptor. Even upon close body contact with the source, such beta particles can barely penetrate the outer layer of skin to cause any significant radiological risk. Thus, the impact of ^{99}Tc via the external pathway is practically nonexistent, and no further evaluation of the risk from external exposure is considered in this environmental assessment.

4.1.7.1 Transport of Ingots

For the purpose of this analysis, it is assumed that a total of 20 ingots would be packaged and loaded at PGDP onto a 14-m (45-ft) flatbed trailer, creating a total payload of 18,144 kg (44,000 lbs) for each shipment to SEG. This shipment weight, when added to the weight of the tractor and semi-trailer, would result in a total weight well within the required maximum legal weight limit of 36,288 kg (80,000 lb) for tractor and semi-trailer transport. Using these assumptions, 425 shipments would be required to transport this material by truck. Approximately nine shipments would be made per month to provide the ingots in the 200-ton allotments to be specified in the proposed contract. The route of transport would be State Route 64 to I-24, to I-265, to I-40, to State Route 58, to Powerhouse Road and Bear Creek Road. The distance for each highway class to be traveled and the associated accident and casualty rates are shown in Table 1. A shipper’s license issued by the Division of Radiological health, Tennessee Department of Environment and Conservation, would be obtained prior to shipment.

Based on a total exposure of 0.1284 million vehicle miles of travel and casualty rates per highway class, as shown in Table 1 (Office of Technology Assessment 1988), it would be expected that a total of 0.038 casualties (effectively zero) could occur during shipment of this material by truck.

4.1.7.2 Transport of decontamination waste

Transport of the decontamination waste to Envirocare, Inc. or the Hanford Site would be by rail and would be performed by SEG or its agent. Transport would first involve truck shipments between SEG and the K-25 Site rail loading facility. It is assumed that 30 drums would be moved in an enclosed truck or container for each trip. To transport the 1,500 to 1,900 drums of waste, 57 truck trips would be required. The distance from SEG to the K-25 Site is 8 km (5 miles) [16 km (10 miles) round-trip] on rural minor arteries or nonpublic roads within the K-25 Site, thus, 912 km (570 miles) would be traveled. Applying the accident rates in Table 1 for rural minor arterial results in an estimated 0.0006 total number and 0.0003 casualty accidents (Table 2), which is effectively zero.

Table 1. Accident and casualty rates for highways to be traveled during transport of nickel ingots

Route	Miles Per Trip	Highway Class	Accident Rate[a]	Casualty Rate[a]	Total VMT[b] (Millions)	Total Accidents	Casualty Accidents
SR 64	3	Rural Minor Artery	0.97	0.48	0.0013	0.0012	0.0006
I-24	126	Rural Interstate	0.77	0.27	0.0536	0.0412	0.0145
I-265[c]	15	Urban Interstate	2.79	0.55	0.0064	0.0178	0.0035
I-40	143	Rural Interstate	0.77	0.27	0.0608	0.0468	0.0164
SR 58	10	Rural Minor Artery	0.97	0.48	0.0043	0.0041	0.0020
Powerhouse Rd. to Bear Creek Rd	5	Rural Minor Artery	0.97	0.48	0.0021	0.0021	0.0010
TOTAL	302				0.1284	0.1133	0.0381

[a] Accident and casualty rates are per million vehicle miles traveled. Rates are from Office of Technology Assessment 1988.
[b] Vehicle miles traveled.
[c] The routing from I-24 on the north side of Nashville, Tennessee, to I-40 on the east side of Nashville involves the transfer to/from three different interstates (I-65, I-265, and I-24) in the span of approximately 10 miles.

The rail distance between the K-25 Site and Envirocare, Inc. was determined to be 3.267 km (2.030 miles) (Fig. 6). It is assumed that 80 drums of waste can fit into a single box car and that five or six boxcars would be shipped at a time, resulting in a total of 4 shipments [or 13.068 km (8,120 miles)]. The total rail accident rate is assumed to be 11.88 accidents per million miles traveled (NRC 1985). This results in an estimated total number of rail accidents of 0.0965. Based on a fatality accident rate of 0.045 per million miles traveled (Cashwell et al. 1989), the estimated number of fatality accidents is 0.0004 (Table 2).

The rail distance between the K-25 Site and the Hanford Site was determined to be 4.215 km (2,619 miles) (Fig. 7). Multiplying the miles traveled times the rail accident ate of 11.88 accidents per million miles traveled results in an estimated 0.1245 total rail accidents. Based on the rail fatality accident rate of 0.045 per million miles traveled, the estimated number of rail fatality accidents is 0.0005 (Table 2).

Risk from radiological causes are exceedingly small. Because there are no gamma emitters identified in the decontamination waste, no routine exposures are anticipated from the shipment. The radiological accident risks were assessed using the RADTRAN 4 code (Neuhauser and Knipe 1994) using the accident release data developed by the Nuclear Regulatory Commission (NRC 1977). The estimated radiological risk is 0.01 person-mrem for the entire waste shipment, which corresponds to 5×10^{-9} latent cancer fatalities.

4.1.7.3 Transport of decontaminated nickel to a seaport

The decontaminated nickel would be transported either by truck or rail to a seaport on the eastern coast of the United States, assumed in this analysis to be Savannah, Georgia, for shipment to Spain. For the purpose of this analysis, truck transport is considered. Accident risk for rail transport, given as estimated casualties, would be similar to but lower than truck transport casualties.

The nickel would be transported from SEG in 20-ton lots and 10 shipments per month for 4 years. To transport 2400 tons of decontaminated nickel each year, 120 truck shipments would be required annually for a 4-year total of 480 shipments. The distance to Savannah from SEG is approximately 458 miles. The majority of the distance traveled would be on rural interstate highways. The estimated total number of accidents is 0.2347 and the estimated number of casualty accidents is 0.0684 (Table 3).

[Tables 2 and 3 and Figures 6 and 7 omitted]

[Section 4.1.9 retyped from pages 32 and 34]

4.1.9 Environmental Justice

Executive Order 12898 requires federal agencies to achieve environmental justice "to the greatest extend practicable" by identifying and addressing "disproportionately high and adverse human health or environmental effects of its . . .activities on minority population and low-income populations . . ."

Census data on areas near SEG have been examined to identify any low-income or minority population that could be affected by the proposed action. The census tracts for the city of Oak Ridge are shown in Fig. 8. The population distribution by race in these census tracts is shown in Table 5.

In census tract 201, 36.8 percent of the population is black; in the other census tracts, the black population ranges from 1.4 to 6.5 percent of the total. The other non-white and Hispanic population are less than 6 percent in each census tract, and no tract has a substantially larger percentage of these populations. With these data, tract 201 is identified as the community with the highest percentage of minority households. The 1989 household income by census tract is shown in Table 6. The 1994 Federal Poverty Guideline on income levels by size of family unit for all states (except Alaska, Hawaii, and the District of Columbia) is shown in Table 7 (59 Federal Register 6277).

Although the 1994 Federal Poverty Guideline defines a low-income *household*, there is no guidance available yet on what would comprise a low-income *community*; that is, what percentage of the total households in the community have incomes in the poverty range. Another concern in identifying a low-income community is the availability of data. For the census tracts near SEG, no data on household income by household size are available. As shown in Table 6, the available data, which are from a report prepared by the city of Oak Ridge, list households by income level and census tract but without information on household size. Therefore, this analysis uses two reference points for considering whether low-income communities are located near SEG.

First, the analysis uses the Federal Poverty Guideline income level of $14,800 for a family of four; this is very close to the $14,999 break point used in the available data, as shown in Table 6. Second, the analysis uses the State of Tennessee median household income level of $24,807, which is based on 1990 census data; this is very close to the $24, 999 break point used in the available data, as shown in Table 6.

In track 201, 55 percent of the households have incomes less than $24, 999 and 34 percent have incomes less that $14,999. In tract 205, 58 percent of the households have incomes less that $24,999, and 40 percent have incomes less than $14,999. In other tracts, more than 50 percent of the households have incomes greater than the Tennessee median income. Also, less than 30 percent of the households in the other tracts have incomes of less than $14,999. Based on these data, tracts 201 and 205 are identified as having the highest percentage of low-income or minority households in areas near SEG.

As discussed in Sect. 4.1.8.2 and summarized in Table 4 of this environmental assessment, potential dose and risk to members of the public would be very low. Although tracts 201 and 205 do have a higher percentage of low-income and minority households in the vicinity of SEG, there are no significant environmental impacts or human health risks. Therefore, this analysis does not indicate disproportionate effects on low-income and minority populations.

[Tables 4 is presented on page E2-49, Tables 5, 6, and 7 and Figure 8 omitted]

[Section 4.6 retyped from pages 43 and 44]

4.6 POTENTIAL CUMULATIVE IMPACTS

Cumulative impacts are the effects on the environment that could result from the incremental impacts of the proposed action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts could result from individually minor, but collectively significant, actions taking place over a period of time (40 *CFR* 1508.7).

Evaluating cumulative effects requires bounding the analysis in space and time and defining the resources considered most at risk. Identifying the resources most at risk helps to determine appropriate spatial and temporal boundaries. Based on the alternatives considered in this environmental assessment, water quality, air quality, and human health and safety are the only entities potentially at risk from additive effects.

For the purpose of this analysis, spatial bounding is considered in three tiers: the site of the action; local area; and the region. The sites considered are SEG, PGDP, and the K-25 Site. The local area is defined as the Oak Ridge Reservation (for actions at SEG and K-25 Site) or the Paducah Reservation for actions at PGDP. The region is defined as the southeastern United States. Regional effects are expected only when site-specific and local effects are identified.

The time span considered in this evaluation of cumulative effects is 5 years. Local planning documents used to identify actions with potential additive effects typically project 5 years in the future. Ecological resources, which are usually less well protected by regulations than human health, are not expected to be affected by the alternatives in this environmental assessment, so limiting the evaluation to 5 years is reasonable.

4.6.1 Water Quality

Some adverse impacts to the surface water quality of Grassy Creek and Big Bayou Creek could occur during construction of buildings at SEG and PGDP, although erosion, runoff, and stormwater controls would be expected to minimize the impact. None of the area on the Oak Ridge Reservation in the Grassy Creek watershed is currently proposed for use by DOE (DOE 1993d); thus, it is unlikely that other construction projects in the watershed would contribute sediment load during building construction at SEG.

4.6.2 Air Quality

Fugitive dust and equipment emissions would occur during construction of the nickel processing buildings at SEG or the new storage building at PGDP. Other construction projects or activities requiring heavy equipment could add to these emissions. However, no construction projects are planned by DOE for the nearby area on the Oak Ridge Reservation; therefore, no cumulative impacts to air quality resulting from fugitive dust or equipment emissions would be expected for the SEG area. SEG would be adding another source of air emissions by constructing and operating the nickel decontamination facility. These emissions would be additive to other SEG emissions and other local sources. SEG is in an area of attainment of ambient air quality criteria and the new emissions are small relative to permit limits and are not expected to result in cumulative exceedance of any air quality parameter over the next 5 years.

4.6.3 Human Health and Safety

Occupational radiation exposures would be small. Releases of radioactive contaminants to the environment during processing would be small; SEG expects to maintain emissions at less than 10 percent of permitted levels, as they do for their other processes at the Bear Creek Road facility. Long-term , but extremely low-level, radiation doses to the public would result from implementation of Alternatives 1 and 2. These doses would be an insignificant fraction (1/10,000 th) of the dose from natural background radiation. The resultant impacts would be indistinguishable in the exposed population. Therefore, no measurable long-term impacts would be expected.

[Appendix A retyped from pages A-3 - A-5]

Appendix A

ALARA Considerations

Federal requirements (DOE Orders and 10 *CFR* regulations) and national and international standards recommend that exposures to radiation be maintained as low as reasonably achievable (ALARA). The ALARA philosophy and process id described in several recent standards issued by the International Commission on Radiological Protection (ICRP) (1982, 1989, & 1991), and these recommend that any practice involving radiation exposure by examined to determine (1) whether it is justified, i.e., whether it will result in a net benefit; (2) how to minimize exposure by optimizing cost and dose reduction and (3) whether the resultant exposures will be within the regulatory limits. The ALARA principle is the mechanism by which recommendations are made to achieve criterion (2).

The radioactively contaminated nickel addressed by this environmental assessment was produced by a “justified” activity (i.e., uranium enrichment activities, which have produced a net benefit to society), so criterion (1) is met. All the dose equivalents estimated in the alternatives are well below the regulatory limit of 100 mrem/year (DOE 1991), thus criterions (3) is met. Optimization of radiation protection, i.e., the ALARA determination, criterion (2), is the only remaining consideration and is essentially complementary to the purpose of the environmental assessment, which is to determine the best alternative for disposition of the nickel. The dose equivalents associated with the proposed action and the alternatives are estimated in Sect. 4 of this environmental assessment. This appendix presents an evaluation of the proposed action and each alternative relative to the ALARA principle.

The monetary equivalent value for a unit of collective dose can vary. Typical values assigned range from $1,000 per person-rem to $10,000 per person-rem, though values outside the range have also been considered. For application in the ALARA analysis that follows, $10,000 per person-rem (DOE 1991) was used, recognizing that the use of $1,000 per person-rem makes no impact on the ALARA determination or the cost-benefit analyses. This is due to the fact that the potential individual and collective doses to the public from the alternatives are so low that the monetary equivalent cost of the doses is insignificant to other factors. As a result, it was not considered reasonable to spend resources to better define the monetary equivalent per unit dose for this application.

A summary of the costs and benefits of the alternatives is presented in Table A.1. Additional benefits of Alternatives 1 and 2 would include:

- Environmental consequences, e.g, air emissions, water quality, energy use, and traffic associated with the mining and processing of nickel ore to produce an equivalent quantity of nickel would be averted;
- Valuable, and expensive, low-level radioactive waste burial space for material that is actually classified as radioactive waste would be preserved;
- Compliance with the DOE waste minimization and pollution prevention policy would be achieved; and
- Nickel, a valuable resource, would be preserved.

DISCUSSION AND CONCLUSIONS

Optimization means determining the alternative which has the minimum total cost. This infers maximizing the benefit. The total cost, in such studies, includes the monetary equivalent for collective dose and any other considerations to the extent they can be quantified in terms of a cost equivalent. The relative insignificance of the collective dose for the alternatives considered in this environmental assessment eliminates health as a significant factor in deciding on a course of action. Clearly the proposed decontamination and recycle options are preferred from ALARA considerations, not only on the basis of cost considerations, but also in consideration of the other "additional benefits" listed above. In this case, both the individual and collective doses to the public and to workers are too small to be a consideration for selecting any of the options.

Table A.1. Costs and benefits of the proposed action and alternatives

	Alternative 1 Proposed Action	Alternative 2 Reprocessing for Unrestricted Release	Alternative 3 Improved Storage	Alternative 4 Direct Disposal	Alternative 5 No Action
Collective dose (person-mrem)	1.5	10	0[a]	Not estimated	0[a]
Monetary equivalent of collective dose[b]	($15)	($100)	0[a]	No monetary equivalent available[c]	0[a]
Benefit/(cost) of alternative (1995 dollars)	$7.9 M[d]	$7.9 M	($188,412) one time expenditure ($4,860) annual expenditure	($1.708 M)[e] one time expenditure	($6,110) annual expenditure
Resultant monetary equivalent savings (expenditures)	$7.9 M minus $15	$7.9 M minus $100	($188,412) + $4,860/year for as long as the nickel remains in storage)	($1.708 M)	($6,110/year for as long as the nickel remains in storage)

[a] No plausible exposure pathways exist for this alternative. Inhalation or ingestion of contaminants would not occur and external exposure is effectively zero (see Sect. 4.1.7).

[b] The monetary equivalent of collective dose equivalent is calculated using the value of $10,000 per person-rem. This value allows comparison between the "cost" of the radiation exposure and other costs and benefits.

[c] No estimate of collective dose is available. See Sect. 4.4.2 of text for explanation.

[d] This is the value of the nickel after decontamination cost ($43 M) has been considered. This value does not include DOE's cost of transporting ($180,000) and disposing ($204,000) of residual waste. The $43 million includes SEG's cost of loading/unloading and transport of the nickel ingots. The price of nickel has fluctuated over the last several years between $2.50 and $4.25/lb. Because the nickel is not virgin metal, its reprocessed value is discounted from the market price. Based on an inventory of 9,350 short tons and a discounted price of $2.72/lb from the market price of $4.18/lb (the value in September 1995), the gross value of the nickel is $50.9 million. For this analysis, the discount is assumed to be 35%; however, the actual discount will be negotiated in finalizing the sales contract with the vendor.

[e] This is the cost of transporting and disposing of the ingots in a licensed disposal facility.

3.0 RECOMMENDED ALTERNATIVE

3.1 Statement of Proposed Authorized Limits

[NOTE: The Nickel EA proposed the release of a specified quantity of radioactively contaminated nickel ingots at existing contamination levels (no decontamination). No specific proposal of authorized limits were stated.]

3.2 Methods for Demonstrating Compliance

[NOTE: The Nickel EA reported the known existing radiological condition of the specific quantity of nickel proposed for release. As mentioned above, no specific proposal of authorized limits was made. Also, no specific information was provided about demonstrating compliance with authorized limits.]

[Sections 5.1 and 5.2 retyped from pages 45 and 46]

5. PERMIT AND REGULATORY REQUIREMENTS

The radioactive contaminants in the contaminated nickel would be regulated under the Atomic Energy Act by the U.S. Nuclear Regulatory Commission in Title 10 of *the CFR* if the material were released to an organization external to DOE. The secondary Waste from processing the nickel may initially have hazardous characteristics; however, SEG's radioactive materials license from the state of Tennessee allows treatment of such wastes to render them nonhazardous. Therefore, the requirements of the Resource Conservation and Recovery Act are not applicable.

5.1 EXPORT TO SPAIN

Any radioactivity remaining after processing of the scrap nickel would be principally ^{99}Tc, with trace or undetectable quantities of low-enriched uranium, ^{239}Pu, and ^{237}Np. The export of these quantities to most countries is allowed under a general license under the authority of the U.S. Nuclear Regulatory Commission of 10 *CFR* 110, Export and Import of Nuclear Equipment and Material. The relevant General license requirements are listed in Table 8:

Table 8. Allowable radioactive isotopes and quantities for export or import established in 10 *CFR* 110

Export/Import Constituents	Allowable Export/Import Quantities
Low-enriched uranium	Residual contamination (< 17.5 ppm)
Pu	1 g or less per individual shipment, 100 g or less per year per country not listed 10 *CFR* 110.28 or 110.29
By-product material (e.g., ^{99}Tc)	All except for ^{3}H, ^{210}Po, ^{237}Np, and ^{241}Am

No specific export license would be required if the contamination in the nickel to be exported were within the general license limits listed in Table 8. It should also be noted that the average concentrations of ^{237}Np and ^{239}Pu should remain below 0.1 and 10 Bq/g, respectively, in order to be in compliance with the shipment limits established in 10 *CFR* 110.

In consultation, the U.S. Nuclear Regulatory Commission has informed SEG that the general licenses do not relieve SEG from complying with any other statutes, regulations, rules, orders, or guidelines applicable to the material and its future use (NRC 1993).

The regulatory limit for allowable activity in recycled scrap metal in Spain is 74 Bq/g or less for alpha-, beta-, and gamma-emitting radionuclides. Article 39 of the Spanish Regulations for Nuclear and Radioactive Facilities established that facilities that use nickel or fabricate steel from nickel are exempt from the requirement to maintain a radioactive materials license. On January 1, 1993, Regulations for Sanitary Protection Against Ionizing Radiation, Appendix V, Section 6 went into effect and codified the same exemption for contaminated nickel with the following exception (unreferenced translation):

The use of contaminated nickel or steel for the fabrication of toys and personal accessories (e.g., earrings) is prohibited.

Contaminated nickel is prohibited in the fabrication of prostheses, sanitary products (e.g., toilet paper), domestic tools (e.g., kitchen utensils, pans, etc.), and construction material, unless the use of the nickel or steel in the fabrication of those products can be justified to the Spanish Nuclear Safety Council.

According to the Sanitary Protection regulation, the importation of contaminated nickel is not restricted; however, the destination and use of the final product must be considered.

The U.S. Nuclear Regulatory Commission has recommended that DOE notify the Department of State to formally notify Spain of the proposed sale of the nickel. DOE has complied with this recommendation (see Appendix F).

The transport of radioactive materials in the United States must meet Department of Transportation requirements for shipping radioactive materials in accordance with 49 *CFR*. Department of Transportation exemptions for scrap loads are available, but must be requested by contacting the appropriate state radiation control office.

5.2 DOMESTIC RELEASE

Alternative 2 considered in this environmental assessment involves decontamination of the nickel by SEG, return of the nickel to DOE, and release of the processed nickel to DOE, and release of the processed nickel for unrestricted use as described in DOE Order 5400.5, Section II.5c(6). This section of the Order states that although no generic guidance is currently available for release of volumetrically contaminated material for unrestricted use, such materials may be released if "criteria and survey techniques are approved by EH-1." This refers to the need for approval from the Assistant Secretary for Environment, Safety, and Health for release of such material to any organization or entity not licensed by the U.S. Nuclear Regulatory Commission.

4.0 COORDINATION ACTIVITIES

[Section 7 . retyped from page 53]

7. PERSONS AND AGENCIES CONSULTED

Kentucky Heritage Council
The State Historic Preservation Office
300 Washington Street
Frankfort, Kentucky 40601

Nuclear Security Council
Sor Angelea de la Curz, 3
28020 Madrid
Spain

Dewey Large
Walter Hipsher
Catherine Waldrup
Scientific Ecology Group
P.O. Box 2530
1560 Bear Creek Road
Oak Ridge, Tennessee 37831-2530

U.S. Department of the Interior
Fish and Wildlife Service
446 Neal Street
Cookeville, Tennessee 38501

U.S. Nuclear Regulatory Commission
Exports, Security, and Safety Cooperation
Office of International Programs
Washington, D.C. 20551-001

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E2.7 EXAMPLE OF APPLICATION FOR APPROVAL OF AUTHORIZED LIMITS
Using Hypothetical Situation, Case 1
Re-use of Office Furniture (desks)

CONTENTS

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1.0 INTRODUCTION

1.1 PURPOSE AND NEED

The purpose of this report is to request approval of authorized limits in accordance with 10 CFR Part 834, "Radiation Protection of the Public and Environment." The authorized limits requested will apply to potentially contaminated U.S. Department of Energy (DOE) property to be released for reuse or recycle. The report provides the rationale and justification for the recommended authorized limits, explains how compliance with DOE release requirements will be demonstrated, and shows that the recommended limits are protective and as low as reasonably achievable (ALARA).

Authorized limits covered by this application are needed to support the planned decommissioning of a DOE uranium processing facility. One goal of decommissioning is the removal of all buildings and equipment from the site. To accomplish this goal, it would be desirable to release non-real property for reuse or recycle, provided that human health and the environment are protected. Such a release requires DOE approval of release limits. As this application indicates, the release limits recommended for approval are expected to result in individual doses of less than a few millirem in a year and collective doses of less than 10 person-rem in a year. The recommended limits were selected based on an evaluation of several viable management options or "alternatives."

1.2 BACKGROUND

A DOE uranium enrichment facility has been inactive for the past several years, and plans are underway for the implementation of decommissioning. The decommissioning activities include dismantlement of all process buildings, including the process equipment and systems. Differing levels of contamination control were experienced throughout the operational period of the facility. It is anticipated that decommissioning will produce a substantial amount of reusable and recyclable materials in the next five years. Among the reusable materials are furniture, equipment, hand tools, etc. Two major categories of materials are being considered for recycling: process systems and structural material (including ancillary equipment). These materials consist of various types of metal and will originate from the radiologically controlled area. Much of the material will originate from contamination areas, and some will come from high-contamination areas and high radiation areas.

1.0 INTRODUCTION

1.3 PROPERTY DESCRIPTION

1.3.1 Physical Attributes

It is estimated that a total of 1,500 office desks will be considered for release as a result of decommissioning over the projected five-year period. In any given year, the released quantity will not exceed 500 desks. As a conservative measure, these annual figures are to be used for deriving the authorized release limits. The desks are typically constructed of light-gauge metal, coated with baked enamel surfaces, and are 3 ft by 5 ft by 2.5 ft, weighing about 100 lb. There is little rust or damage to the desks. The desks were primarily used for typical office activities; however, some may have been used as working surfaces and storage for non-office applications (e.g., sample preparation and counting).

1.3.2 Contaminants

The administrative areas where the office desks were located have been surveyed routinely for the last few years, and the desks' external surfaces were normally surveyed during these evaluations. The surveys consisted of direct beta-gamma scans and collection of smears, which were counted for gross alpha and beta-gamma activity. The areas, including desks, were maintained to levels below the limits for all radionuclides imposed by 10 CFR Part 835, "Occupational Radiation Protection."

Given the focus of the operations at the plant in general, it is known that the contaminants of concern are Tc-99, U-234, U-235, U-238, Pu-239, and Np-237. Records from operations confirm the primacy of these radionuclides, and excerpts from past operating contamination surveys are included in the attachments to this document. The activity on desks was found to be limited to surfaces. The radiological profile for the property is shown in Table 1.

1.0 INTRODUCTION

Table 1: Radiological Profile of the Property

Item	Characteristic of Contaminants	Radionuclide	Contamination Level	
			Average, dpm/100 cm^2 (Bq/cm^2)	Removable, dpm/100 cm^2 (Bq/cm^2)
Office desks	External surface	Tc-99	12,000 (2.0)	10,000 (1.7)
		U-234	10,000 (1.7)	8,000 (1.3)
		U-235	300 (0.05)	200 (0.03)
		U-238	100 (0.017)	80 (0.013)

Initial surveillance indicated an average level of contamination of 12,000, 10,000, 300, 100 dpm/100 cm^2 for Tc-99, U-234, U-235, and U-238, respectively, on the surfaces of the desks, as shown in Table 1. Trace amounts of Pu-239 and Np-237 were also present. A swipe test was done to find the removable contamination. Removable contamination is also listed in Table 1. No excessive levels of radiation were found in other parts of the desks, including the internals and drawers. All debris in the drawers has been cleaned out. All 1,500 desks are in excellent condition and are prime for reuse.

2.0 ALARA PROCESS

2.1 DESCRIPTION OF ALTERNATIVES

Numerous alternatives were considered for the release of the desks. A two-step process was used to evaluate alternatives with screening evaluations as the first step to limit the number of alternatives given full analysis. The screening criteria applied in the first step to evaluate the viability of alternatives included

- Regulatory constraints
- Technical viability
- Technical ability to perform adequate dose and risk estimates
- Consistency with program goals and objectives
- Estimated cost
- Availability of technologies and maturity of technologies

Because the majority of the contamination is removable, it is feasible to perform a simple decontamination followed by comprehensive surface monitoring, using standard hand-held gross alpha and beta-gamma instruments, and smear surveys prior to releasing the desks for future use as office furniture. More elaborate, aggressive methods of decontamination, such as the abrasive decontamination method, were not considered because they would likely damage the desks and therefore destroy any potential for reuse. Reuse of the desks is intended to be unrestricted following sale and transfer of the property. A "no action" alternative is not credible because it conflicts with the decommissioning goal of removing all buildings and equipment from the site.

Based on the above-mentioned criteria and considerations, the following alternatives were found viable and were analyzed for the development of authorized limits:

1. No decontamination and sale "as is" with no restrictions.

2. Decontamination to twice the Table 1 removable activity limits* (2,000 dpm/100 cm^2 removable activity) and sale "as is" with no restrictions.

3. Decontamination to the Table 1 removable activity limits* (1,000 dpm/100 cm^2 removable activity) and sale "as is" with no restrictions.

4. Decontamination to 50% of the Table 1 removable activity limits (500 dpm/100 cm^2 removable activity) and sale "as is" with no restrictions.

5. Decontamination to 20% of the Table 1 removable activity limits (200 dpm/100 cm^2 removable activity) and sale "as is" with no restrictions.

6. Burial as low-level waste (LLW).

* "Table 1 limits" refer to DOE's Surface Activity Limits as defined by *Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material),* DOE Assistant Secretary for Environment, Safety, and Health, Office of Environmental Policy and Assistance (EH-41), 1996.

2.0 ALARA PROCESS

The actual and likely use scenario for purposes of evaluating the dose to the maximally exposed individual for alternatives 1 through 5 is the use of the desks in a normal office environment. The anticipated life expectancy of the desks is 20 years, at which time the desks are expected to be dispositioned as either scrap metal for recycling or disposed of in a sanitary landfill. Given the quantity of desks being released and reasonable expectations of useful life, the likely use scenario would also be considered as the worst plausible scenario. This is due to the inherent life expectancy and ultimate recycling or disposal conditions.

2.2 ANALYSIS OF ALTERNATIVES

2.2.1 Radiological Assessment

Doses have been calculated for workers and members of the public for the alternatives considered). For each exposed group, both maximally exposed individual and collective population doses are calculated. In the calculations, realistic scenarios and parameters were used.

Each desk is assumed to be occupied by one office worker who would maintain a work schedule of eight hours per day (2,000 hours per year). The steel desk is also assumed to have a 20-year reusable life span. It is assumed that only the desktop is contaminated. Exposure pathways are mainly direct external exposure. To a lesser extent, inhalation by resuspension of surface contaminants and inadvertent ingestion of removable contaminants may occur. Methods available for dose calculations include the RESRAD-RECYCLE code and other approaches established in previous studies (Nieves et al. 1995**).** RESRAD-RECYCLE has been chosen for use in the sample case. The RESRAD-RECYCLE computer code is a pathway analysis tool designed to calculate potential radiation doses and risks resulting from the recycling of radioactive scrap metal and the reuse of surface-contaminated material and equipment (Nabelssi et al. 1996). Some key parameters of this scenario are given in Table 2.

Table 2: Key Parameters for Surface Dose Calculations

Source Geometry	Source Area (cm^2)	Source Concentration[a] (dpm/100 cm^2)	Exposure Duration (h/yr)	Distance (⊥ and ∥) (cm)	Life Span (yr)	Shielding Thickness (cm)
Half circle	14,000	Tc-99--12,000 U-234--10,000 U-235--300 U-238--100	2,000	15, 0	20	none

[a] Source concentrations for alternatives 2, 3, 4, and 5 for Tc-99 and U-234 are 4,000, 3,000, 2,500, and 2,200 dpm/100 cm^2, respectively. It is assumed that U-235 and U-238 concentrations change as the U-234 concentration changes (ratio of all uranium removable fractions will change in the same manner; therefore, the U-235 concentrations for alternatives 2, 3, 4, and 5 would be 150, 125, 112.5, and 105 dpm/100 cm^2, respectively, and the U-238 concentrations would be 40, 28, 25, and 22 dpm/100 cm^2, respectively.)

Following reusable life, the desks are assumed to become scrap metal, some of which would enter the general scrap metal pool for future recycling, and some may be destined for municipal landfills. Because of the anticipated large dilutions associated with future recycling or landfill disposal, potential exposures to individuals are likely to be negligible compared with the reuse scenario. Table 3 gives the estimated radiological impact for each alternative considered.

Maximum lifetime individual dose equivalent is calculated by multiplying the first annual dose equivalent (with the product life in years) by the average decay factor over the product life. Collective doses are calculated by multiplying the total number of desks by the individual dose equivalent and a correction factor for average use. The average use correction factor is assumed to be 0.75 (i.e., all the workers or the members of the public may not be using the desks for 2,000 hours, on the average desks are used for 1,500 hours. Because the worker is a member of the public, worker and public doses are the same.

The impacts on human health from burial of the office desks were calculated by using the RESRAD computer code (Yu et al. 1993). Each desk weighs about 100 lb, and it is assumed that 1% of the steel is eroded and uniformly dispersed in the soil. The total steel eroded would be 1,500 lb (680,400 g), which represents 2, 1.7, 0.05, and 0.017 Bq/cm^2 for Tc-99, U-234, U-235, and U-238, respectively. By using the surface-to-volume conversion factor of 0.78 ft^2/lb (1.6 cm^2/g), the total activity released would be 2,200,000, 1,800,000, 54,000, and 18,000 Bq (5.8×10^7, 4.9×10^7, 1.5×10^6, and 4.9×10^5 pCi) for Tc-99, U-234, U-235, and U-238, respectively. It is assumed that this activity is mixed with the top 1 m of soil in a 1,000-m^2 area. By using a soil density of 1.6 g/cm^3, the soil activity levels would be 0.037, 0.031, 0.00095, and 0.0003 pCi/g for Tc-99, U-234, U-235, and U-238, respectively. For these dose calculations, all default RESRAD parameters (Yu et al. 1993) were used. Only the maximum individual dose was calculated. Maximum total dose of 0.053 mrem/yr will occur some time in the future because of groundwater ingestion for the maximally exposed individual. It is assumed that the public water supply is not contaminated.

Table 3: Estimated radiological impacts by alternatives for the disposition of office desk

Impact Group	Alternative 1: No Action (No Decontamination)	Alternative 2: Decontamination to 200% of Removable Limit	Alternative 3: Decontamination to 100% of Removable Limit	Alternative 4: Decontamination to 50% of Removable Limit	Alternative 5: Decontamination to 20% of Removable Limit	Alternative 6: LLW Burial
Maximum lifetime individual, worker[a]						
Excess fatal cancer risk dose equivalent (mrem)	0.50	0.22	0.17	0.15	0.13	not applicable[b]
Collective, worker[c]						
Excess fatal cancers dose equivalent (person-rem)	0.56	0.25	0.20	0.17	0.15	not applicable
Maximum lifetime individual, public[d]						
Excess fatal cancer risk dose equivalent (mrem)	0.50	0.22	0.17	0.15	0.13	2.7[e]
Collective, public						
Excess fatal cancers dose equivalent (person-rem)	0.56	0.25	0.20	0.17	0.15	0.3[f]

[a] Maximum lifetime individual worker dose is calculated by multiplying the yearly dose by life span of 20 years.

[b] Maximum lifetime individual worker and collective worker doses for LLW Burial alternative are not calculated because the workers are assumed to be radiation workers.

[c] Collective worker dose is calculated by multiplying the maximum lifetime individual dose by the number of total released desks and a correction factor for average use. The average use correction factor is assumed to be 0.75.

[d] Public dose is the same as the worker dose because the worker is a member of the general public in the case of unrestricted release of the property.

[e] Maximum lifetime individual public dose for LLW Burial alternative is calculated by multiplying the maximally exposed individual yearly dose by 50 (i.e., the maximally exposed individual would be exposed to the maximum dose for 50 years).

[f] Collective public dose for the LLW Burial alternative is calculated from the transport of waste. Risk factor of 7.3×10^{-9}/shipment-mile for external exposure was taken from "Assessment of Risks and Costs Associated with Transportation of U.S. Department of Energy Radioactively Contaminated Carbon Steel" (Chen, S.Y. et al., ANL/EAD/TM-62, September 1996). In the calculation it is assumed that 30 shipments travel a total distance of 30,000 miles. For the public it is assumed that the municipal water supply is used which is not contaminated.

2.2.2 Economic Assessment

Table 4 provides a summary of the total costs and elements of costs associated with each of the alternatives considered. Equivalency of scope is established in that all alternatives conclude with a similar end point (i.e., disposition of all desks and the associated waste and source term). The cost estimates presented were balanced with exposure estimates and other considerations to select the optimal alternative.

Below is a list of general assumptions used for all scenarios, followed by specific assumptions for each alternative in estimating the costs presented in Table 4.

GENERAL ASSUMPTIONS

1. The desk size is 3 ft x 5 ft x 2.5 ft and 100 lb.
2. The surface-to-mass ratio is 0.78 ft^2/lb.
3 The survey rate is 3 in./s or 75 ft^2/h.
4. The shipment payload is 40,000 lb.
5. Drums weigh 50 lb, have a usable volume of 7 ft^3, and cost $50 per drum.
6. The sale price of a desk is $20 per desk.
7. The professional labor rate is $50/h (burdened).
8. The craft and technician labor rate is $40/h (burdened).
9. Bulk containers weigh 6,000 lb, have usable volume of 1,200 ft^3, and cost $6,000 per container.
10. The bulk-container packaging efficiency is 80%.
11. A shipment of bulk containers consists of two containers.
12. Shipment costs are $3,500 per shipment.
13. Sample and analysis: four events per drum shipment (~100 drums).
14. Sample and analysis costs are $2,000 per event.
15. Quality Assurance (QA) is based on 10% of survey costs.
16. Burial cost is $27/$ft^3$ (external volume) (i.e., 7.4 ft^3 per drum or 1,350 ft^3 per bulk container).
17. The drum packaging cost is $100 per drum.

Specific Assumptions

Alternative 1: No Decontamination and Unrestricted Release

1. Survey and QA are required to verify expected levels of contamination.
2. No decontamination is done.
3. No wastes are generated.
4. Interactions with regulators and stakeholders will require 200 hours of professional time.

Alternative 2: Decontamination (Twice the Table 1 Removable Limit) and Unrestricted Release

1. The decontamination method is dry vacuuming.
2. The decontamination rate is 15 minutes per desk.
3. Waste generation from decontamination is one vacuum bag (1 ft^3) per 100 desks.
4. The waste is placed into drums at 50 lb/ft^3.
5. Two hundred hours of added professional labor is required for external interactions.

Alternative 3: Decontamination (Table 1 Removable Limit) and Unrestricted Release

1. The decontamination method is dry vacuuming.
2. The decontamination rate is 30 minutes per desk.
3. Waste generation from decontamination is one vacuum bag (1 ft^3) per 50 desks.
4. The waste is placed into drums at 50 lb/ft^3.

Alternative 4: Decontamination and Unrestricted Release (50% of the Table 1 Removable Limit)

1. The decontamination method is dry vacuuming and Masilin cloth wiping ($0.50 per/cloth).
2. The vacuuming decontamination rate is 30 minutes per desk.
3. Waste generation from vacuuming decontamination is one vacuum bag (l ft^3) per 50 desks.
4. The waste is placed into drums at 50 lb/ft^3.
5. The Masilin decontamination rate is 30 minutes per desk.
6. Waste generation from Masilin decontamination is one cloth (0.2 lb) per 50 ft^2.

Alternative 5: Decontamination and Unrestricted Release (20% of the Table 1 Removable Limit)

1. The decontamination method is dry vacuuming followed by high-pressure water wash.
2. The dry decontamination rate is 30 minutes per desk.
3. The wet decontamination rate is 15 minutes per desk.
4. Waste generation from dry decontamination is one vacuum bag per 50 desks.
5. The amount of water waste is trivial and is sent to on-site treatment.
6. Waste is placed into drums at 50 lb/ft^3.

Alternative 6: Burial as LLW

1. No decontamination — burial.
2. The volume of a desk is 37.5 ft^3.
3. The packaging rate is one bulk container per four hours.
4. Waste characterization consists of documentation at four hours per shipment.
5. No size reduction activities are done.

Table 4: Cost ($) Evaluation of Different Alternatives for the Release of Office Desks

		1: No Decontamination	2: Decontamination to 200% of Table 1 Removable Limit	3: Decontamination to Table 1 Removable Limit	4: Decontamination to 50% of Table 1 Removable Limit	5: Decontamination to 20% of Table 1 Removable Limit	6: LLW Disposal
Regulatory interface		10,000.00	10,000.00				not applicable
Decontamination			15,000.00	not applicable 30,000.00	not applicable 61,170.00	not applicable 45,000.00	not applicable
Survey and Measurement		not applicable 62,400.00	62,400.00	62,400.00	93,600.00	93,600.00	not applicable
QA		6,240.00	6,240.00	6,240.00	9,360.00	9,360.00	not applicable
Waste	Package		188.00	380.00	951.00	380.00	363,000.00
	Characterization	not applicable	200.00	400.00	507.00	400.00	6,000.00
	Transportation	not applicable	90.00	175.00	222.00	175.00	105,000.00
	Burial	not applicable	500.00	1,000.00	1,429.00	1,000.00	2,150,000.00
End use		not applicable (30,000.00)	(30,000.00)	(30,000.00)	(30,000.00)	(30,000.00)	0.00
TOTAL		48,640.00	64,618.00	70,595.00	137,239.00	119,915.00	2,624,000.00

2.2.3 Assessment of Other Factors

Six alternatives were evaluated for the disposition of 1,500 desks. One alternative involved unrestricted release of the desks for reuse at their present levels of contamination (i.e., no decontamination). Four alternatives involved surface decontamination followed by unrestricted release for reuse. One alternative involved disposal of the desks as LLW. Table 5 summarizes the status of the alternatives relative to pertinent factors other than dose and cost. For the purposes of this summary, the four alternatives involving surface decontamination are grouped together because very little distinction was apparent among them with respect to any of the factors considered.

Table 5: Status Summary of Other Factors Considered

Factor	No Decontamination	Surface Decontamination	LLW Disposal
Impact on product markets	Insignificant	Insignificant	None
Public acceptance	Significant objection expected	Objection may vary with level of decontamination	No project-specific objection expected
Consistency with waste minimization principles	No LLW generated; no decontamination wastes generated; nonradiological solid waste generation deferred.	Small LLW volume generated (from decontamination) compared with volume of desks; amount of decontamination waste varies with level of decontamination; nonradiological solid waste generation deferred.	LLW volume generated equal to volume of desks; no decontamination wastes generated; no nonradiological solid waste generated.
Consistency with DOE policy	Not fully consistent with goal to take reasonable steps to minimize releases of removable contamination	Consistent	Not consistent with DOE Policy on waste minimization
Marketability of desks	Questionable	Good	Not applicable
Regulatory approvals	May require state review	May require state review	Meets DOE requirements

Because significant public objection is expected to the release of desks with no decontamination and because the marketability of such desks is expected to be questionable, the option of sale for reuse without decontamination (alternative 1) may not be viable, regardless of dose and cost considerations. Also, since state regulatory review may be required prior to releasing decontaminated desks under any of alternatives 2 through 5, the preferences of the responsible regulatory agency may influence the choice among the four alternatives involving decontamination. Otherwise, the decontamination alternatives appear approximately equivalent with respect to factors other than dose and cost. Of all of the alternatives, alternative 6 generates the most LLW requiring disposal but otherwise seems little different from alternatives 2 through 5 when only factors other than dose and cost are considered.

2.3 SELECTION OF PROPOSED ALTERNATIVE

Table 6 summarizes the dose and cost information for all six alternatives.

Table 6: Dose and Cost Summary for Office Desks

Alternative	Maximum Public Individual Dose (mrem/yr)	Collective Public and Workers Dose[a] for 1-yr Release (person-rem)	Collective Public and Workers[b] Dose (person-rem)	Cost ($)	Cost per person-rem Reduction (No Decontamination Baseline) ($/person-rem)
1: no decontamination	0.025	0.19	0.56	48,640	na[c]
2: decontamination to 200% removable limit	0.011	0.083	0.25	64,618	38,000
3: decontamination to 100% removable limit	0.0085	0.064	0.20	70,595	45,000
4: decontamination to 50% removable limit	0.0074	0.056	0.17	137,239	167,000
5: decontamination to 20% removable limit	0.0067	0.050	0.15	119,915	130,000
6: LLW disposal	0.05	0.1	0.3	2,624,000	na

[a] For 500 desks with 20-year useful life.
[b] Total cumulative dose for a three-year release.
[c] Not applicable.

As was discussed in Section 2.2.3, the alternative of selling the desks “as is” without decontamination (alternative 1) appears not to be viable based on factors other than dose and cost. Therefore, it was eliminated from further consideration, even though its cost estimate was low compared with other alternatives and, like the other alternatives, its dose estimate for the maximally exposed individual was well below DOE’s stated goal of controlling releases such that exposures to members of the public will not exceed a few millirem in a year.

The following conclusions can be reached based on the information provided in Table 6 for the remaining five alternatives:

1. Doses estimated for the maximally exposed individuals are lower than 1 mrem in a year for all alternatives, and collective doses for all alternatives are lower than 1 person-rem. Such doses are well below DOE's stated goal of controlling releases such that exposures to members of the public will not exceed a few millirem in a year.

2. Estimated costs for alternatives 4, 5, and 6 were significantly higher than estimated costs for alternatives 2 and 3.

Based on these conclusions, alternatives 2 and 3 are preferred over alternatives 4, 5, and 6. However, there is no clear cost or dose distinction between alternatives 2 and 3. Therefore, the choice between these alternatives was based on other factors. As indicated in Section 2.2.3, the possible need for state regulatory approval was the only other factor with potential to distinguish among the alternatives involving decontamination prior to release. Therefore, through communications with the responsible state regulatory agency, it was determined that alternative 3 (i.e., decontamination to 1,000 dpm/100 cm^2 removable activity) was preferred over alternative 2.

3.0 RECOMMENDATION OF PROPOSED ALTERNATIVE

3.1 STATEMENT OF PROPOSED AUTHORIZED LIMITS

As discussed in Section 2.0, the optimization study performed to meet ALARA process requirements concluded that, of the six alternatives considered, alternative 3 was preferred for managing surface-contaminated desks from the uranium processing facility as part of decommissioning. Therefore, consistent with the choice of alternative 3, the surface activity guidelines in Table 1 are proposed as authorized limits for Tc-99, U-234, U-235, and U-238 on desks. In addition, while the use of released desks will be unrestricted, the number of desks released will be restricted to 500 per year.

3.2 METHODS TO DEMONSTRATE COMPLIANCE

3.2.1 Management

All activities associated with the release of the subject property will be conducted under the cognizance of John Doe, Manager, Uranium Processing Facility Waste Management Division.

3.2.2 Procedures and Protocol

The following standard operating procedures for the site (copies in Appendix XX) provide the basis for the major activities associated with implementing the authorized limits:

SSOP-HP01	Selecting portable radiation and contamination survey instruments
SSOP-HP02	Conducting and reporting radiation and contamination surveys
SSOP-WM01	Packaging, transporting, and disposal of LLW
SSOP-WM02	Management of excess government property
SSOP-QA01	Conducting radiation and contamination survey verification surveillance
SSOP-QA02	Conducting QA audits

3.2.3 Record Keeping

To demonstrate compliance with the authorized limits and restrictions, the following records will be entered into the public record maintained in a manner consistent with the site's public participation plan:

Application for Approval of Authorized Limits. This document provides (1) a description of property to be released from DOE control; (2) a description of the radiological history of the property to be released; (3) a statement of authorized limits and all applicable restrictions; and (4) an optimization study that meets the requirements of the ALARA process and supports approval of authorized limits.

3.0 RECOMMENDATION OF PROPOSED ALTERNATIVE

Final Project Report. This document will provide (1) all final clearance survey results (including instruments used, date of the survey, and surveyor's name); (2) the quantity and disposition of all waste resulting from the project; (3) the quantity of material released (including release dates); (4) the identity of the initial recipient of all released desks, with evidence that such a recipient was informed of the radiological status of the desks and the availability of documentation regarding that status; and (5) all QA inspection and verification reports.

4.0 COORDINATION ACTIVITIES

4.1 COORDINATION WITH THE U.S. NUCLEAR REGULATORY COMMISSION AND THE AGREEMENT STATE

Appendix XX contains copies correspondence and records of meetings with the U.S. Nuclear Regulatory Commission (NRC) and the responsible State regulatory agency, indicating their agreement that the proposed authorized limits (i.e., Table 1 surface activity guidelines, for Tc-99, U-234, U-235, and U-238) are not inconsistent with licensing requirements for radioactive materials.

4.2 COORDINATION WITH OTHER APPROPRIATE PARTIES

NOTE: An actual application for approval of authorized limits would include site-specific information concerning activities such as stakeholder meetings, general public meetings, contacts with potential purchasers, contacts with other regulatory agencies, etc. Because such information is particularly site-specific, no hypothetical example is included.

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E2.8 EXAMPLE APPLICATION FOR APPROVAL OF AUTHORIZED LIMITS
Using Hypothetical Situation, Case 2
Recycling of Structural Steel

CONTENTS

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1.0 INTRODUCTION

1.1 PURPOSE AND NEED

The purpose of this report is to request approval of authorized limits in accordance with 10 CFR Part 834, "Radiation Protection of the Public and Environment." The authorized limits requested will apply to potentially contaminated DOE property to be released for reuse or recycle. The report provides the rationale and justification for the recommended authorized limits, explains how compliance with DOE release requirements will be demonstrated and shows that the recommended limits are protective and as low as reasonably achievable.

Authorized limits covered by this application are needed to support the planned decommissioning of a DOE uranium processing facility. One goal of decommissioning is the removal of all buildings and equipment from the site. To accomplish this goal, it would be desirable to release non-real property for reuse or recycle, provided that human health and the environment are protected. Such a release requires DOE approval of release limits. As this application indicates, the release limits recommended for approval are expected to result in individual doses of less than a few millirem in a year and collective doses of less than 10 person-rem in a year. The recommended limits were selected based on an evaluation of several viable management options or "alternatives."

1.2 BACKGROUND

A DOE uranium enrichment facility has been inactive for the past several years, and plans are underway for the implementation of decommissioning. The decommissioning activities include dismantlement of all process buildings, including the process equipment and systems. Differing levels of contamination control were experienced throughout the operational period of the facility. It is anticipated that decommissioning will produce a substantial amount of reusable and recyclable materials in the next five years. Among the reusable materials are furniture, equipment, hand tools, etc. Two major categories of materials are being considered for recycling: process systems and structural material (including ancillary equipment). These materials consist of various types of metal and will originate from the radiologically controlled area. Much of the material will originate from contamination areas, and some will come from high-contamination areas and high radiation areas.

1.3 PROPERTY DESCRIPTION

It is estimated that a total of 40,000 tons of steel will be generated over the five-year decommissioning period, with the majority (32,000 tons) exhibiting only surface contamination. At the point of generation, recyclable steel will be surveyed and sorted into piles of surface-contaminated and volume-contaminated metal. The surface-contaminated steel is expected to consist typically of carbon steel from structural components, which have little potential for reuse but are good candidates for recycling. The authorized limits for which this application requests approval would apply only to surface-contaminated steel.

1.0 INTRODUCTION

1.3.1 Physical Attributes

The authorized limits requested by this application would apply to recyclable steel expected to have the following physical attributes:

- Typically consists of structural members and support system metal (0.115 ft^2/lb).
- All material is common carbon steel, with nonferrous metals and stainless steel having been segregated at the point of generation.
- All accessible external surfaces have been painted many times throughout the life of the plant.
- Some paint may be lead-based.
- Small areas of surface rust and oxidation are visible on most surfaces.
- All components that are potentially subject to regulation under the Resource Conservation and Recovery Act (RCRA) as hazardous have been removed (e.g., mercury switches).

1.3.2 Contaminants

All material released under the proposed release limits is expected to have been contaminated as a result of deposition of airborne radioactivity, spills, or buildup from spreading of low levels of contamination. Therefore, contamination is expected to be surficial and either loosely adhered or fixed via oxidation or applied paint. Based on the nature of operations at the uranium processing plant, the contaminants are expected to consist of Tc-99, U-234, U-235, U-238, and Pu-239 (Chen et al. 1996). Table 1 provides the existing radiological profile based on preliminary surveys and measurements.

Table 1: Radiological Profile of the Property

Item	Characteristics of Contaminants	Radionuclide	Contamination Level[a] dpm/100 cm^2 (Bq/cm^2)
Structural	Surface	Tc-99	275,000 (46)
		U-234	215,000 (36)
		U-235	7,000 (1.2)
		U-238	2,500 (0.4)
		Pu-239	50 (0.01)

[a] Average activity.

2.0 ALARA PROCESS

2.1 DESCRIPTION OF ALTERNATIVES

Because the recyclable steel is contaminated only on its surface with loosely adhered or fixed contaminants and because maintaining the structural integrity of the material is not important, aggressive decontamination methods such as chemical treatment or abrasive decontamination were identified as reasonable techniques for reducing contamination levels. Simple decontamination methods such as vacuum cleaning, moist cloth wiping, and low-pressure steam cleaning were not considered because they are only effective for removing loose contamination, and they tend to be labor intensive. The following alternatives were found, through initial screening, to be viable and were analyzed in the optimization study required by the ALARA process for the development of authorized limits.

- Alternative 1: Unrestricted Release. Recyclable steel would be sold as scrap metal without restrictions or prior decontamination, provided that contamination levels do not exceed existing levels (shown in Table 1, above).

- Alternative 2: Unrestricted Release after Melt Refining. Recyclable steel would be melt-refined and cast into ingots for sale without restrictions as scrap metal.

- Alternative 3: Unrestricted Release after Abrasive Decontamination - Recyclable steel would be surface-decontaminated by using abrasive decontamination techniques and would be sold without restrictions as scrap metal.

- Alternative 4: Release for Designated Use after Melt Refining. Recyclable steel would be melt-refined and cast into ingots for sale as scrap metal, with the restriction that the ingots be remelted only for use as rebar.

- Alternative 5: Release for Designated Use after Abrasive Decontamination. Recyclable steel would be surface-decontaminated by using abrasive decontamination techniques for sale as scrap metal, with the restriction that the scrap metal be remelted only for use as rebar.

- Alternative 6: Sent to LLW Site for Burial. Recyclable steel would undergo size reduction, packaging, and disposal as low-level radioactive waste at an off-site DOE disposal facility.

Two potential alternatives involving chemical decontamination prior to release (restricted release following chemical decontamination or unrestricted release following chemical decontamination) were eliminated by initial screening because their costs were noticeably higher than the costs of other alternatives, while the amount of contamination removed was essentially the same as abrasive decontamination. Also, there were no other remarkable factors favoring chemical decontamination over abrasive decontamination.

2.0 ALARA PROCESS

Each alternative considered in the optimization study would involve some or all of the general materials-handling steps listed below.

- Prepare project plans.
- Prepare material.
  - Perform initial surveys and sorting.
  - Perform size reduction for loading.
- Package into reusable transport container.
- Transport to vendor.
- Process.
- Sample and analyze products.
- Package and characterize waste.
- Transport waste.
- Bury waste as LLW.
- Release product.
  - Sell to scrap broker.
  - Load and transport to minimill.
  - Grade scrap.
  - Size scrap.
  - Prepare scrap charge.
  - Charge furnace and melt.
  - Slagging operations.
  - Analyze and adjust metallurgical chemistry.
  - Cast (continuous).
  - Remove baghouse dust and recycle.
  - Scarfing.
  - Product sale and use.

The following sections describe specific assumptions for each alternative, based on the general steps involved in carrying out the alternative. An overarching assumption is that all activities, regardless of alternative, will be conducted in compliance with applicable DOE and/or NRC (or authorized state) regulations.

2.0 ALARA PROCESS

2.1.1 Alternative 1: Unrestricted Release

The following are specific assumptions used to conduct dose and cost analyses for alternative 1.

- A total of 32,000 tons of surface-contaminated steel will be processed, with no more than 10,000 tons being processed in any one year.
- Metal is stockpiled for pickup by the purchaser.
- Structural steel will be melt-refined with a yield of 95% or 30,000 tons.
- Partitioning factors at the minimill furnace are (1) Tc-99 -- 10% to metal phase, 10% to slag phase, and 100% to baghouse; and (2) U-234, U-235, U-238, and Pu-239 -- 2% to baghouse, 1% to metal phase, and 97% to slag (in some cases because of uncertainties partitioning factors could add to more than 100%).
- All waste generated at the minimill (after release, no restrictions) will be managed in accordance with typical mill practices: slag (200 lb/ton melted) is recycled into the process or sold; baghouse dust (28 lb/ton melted) is recycled for zinc content, and residuals are managed in accordance with applicable requirements of the RCRA; mill scale (100 lb/ton cast) is recycled into the process or sold to concrete manufacturers.
- The minimill yield is 90% for product-grade metal; home and prompt scrap (runaround) are internally recycled.

The actual and likely scenario for alternative 1 is that the released material will be mixed and melted with other sources of scrap at a minimill and cast into structural products.

The worst plausible scenario for alternative 1 differs from the actual and likely use scenario in that batch processing could occur such that the released material is not diluted at the minimill with scrap metal from other sources. However, in order to maintain proper steel chemistry in its output, the minimill will add alloys to the furnace, even if batch processing occurs. Therefore, product steel will never consist of more than 80% released material.

2.1.2 Alternative 2: Unrestricted Release after Melt Refining

The following are specific assumptions used to conduct dose and cost analyses for alternative 2. In this alternative, the melt refining is considered as a decontamination process in that most of the radioactive content is collected in the slag and disposed of as LLW. As a result, the ingots contain much less radioactivity than the original scrap metal.

- A total of 32,000 tons of surface-contaminated recyclable steel will be processed, with no more than 10,000 tons being processed in any one year.
- Structural steel will be sized to less than 15-ft sections, packaged into reusable containers, and transported to the vendor (NRC nuclear material licensee).
- Melt refining yields 95% (weight of the input, or approximately 30,000 tons (ingots) for 32,000 tons of input.

- Partitioning factors at both the electrorefining furnace and the minimill furnace are: (1) Tc-99--10% to metal phase, 10% to slag phase, and 100% to baghouse; and (2) U-234, U-235, U-238, and Pu-239--2% to baghouse, 1% to metal phase, and 97% to slag.
- All waste generated (slag, 200 lb/ton melted; and dust, 28 lb/ton melted) in the melt--refining operations will be managed as LLW. It is not listed as a hazardous waste under RCRA, and its generation will be managed so that it does not exhibit a hazardous characteristic.
- Melt refining produces ingots that will be sold with no restrictions as scrap metal.
- The ingots will be remelted at a minimill.
- All waste generated at the minimill (after release, no restrictions) will be managed in accordance with typical mill practices: slag (200 lb/ton melted) is recycled into the process or sold; baghouse dust (28 lb/ton melted) is recycled for zinc content, and residuals are managed in accordance with applicable requirements of the RCRA; mill scale (100 lb/ton cast) is recycled into the process or sold to concrete manufacturers.
- The minimill yield is 90% for product-grade metal; home and prompt scrap (runaround) are internally recycled.

The actual and likely scenario for alternative 2 is that the melt-refined ingots will be mixed and melted with other sources of scrap at a minimill and fabricated into structural products.

The worst plausible scenario differs from the actual and likely use scenario in that batch processing could occur such that the melt-refined ingots are not diluted with other sources of scrap metal at the minimill. However, in order to maintain proper steel chemistry, the minimill will add alloys, even if such batch processing occurs. Therefore, any industrial products produced will never contain more than 80% material from melt-refined ingots.

2.1.3 Alternative 3: Unrestricted Release after Abrasive Decontamination

Alternative 3 involves surface decontamination using the abrasive decontamination technique prior to unrestricted sale as scrap metal when the surface-contaminated steel has small surface-to-mass ratios. Decontamination to meet the Table 1 surface activity guidelines is assumed for material that can be economically surface-surveyed. For light-gauge material and material with inaccessible contamination, the mass contamination equivalents of Table 1 limits are assumed to be met.

The actual and likely scenario for alternative 3 is that released decontaminated steel will be mixed and melted with scrap metal from other sources at a minimill and fabricated into industrial products. If the decontaminated steel is sold to a single typical minimill, the dilution factor is assumed to be 100 to 1 (i.e., in 1,000,000 tons of minimill product annually, 10,000 tons of decontaminated steel would be dispersed uniformly and released annually).

The worst plausible scenario for alternative 3 differs from the actual and likely use scenario in that batch processing could occur such that the released material is not diluted at the minimill with scrap metal from other sources. However, in order to maintain proper steel chemistry in its output, the minimill will add alloys to the furnace, even if batch processing occurs. Therefore, product steel will never consist of more than 80% released material.

2.1.4 Alternative 4: Release for Designated Use after Melt Refining

Specific assumptions for alternative 4 are identical to the specific assumptions listed in section 2.1.2 for alternative 2, except that sale of the melt-refined ingots will be restricted to a mini-mill that agrees to mix and melt the ingots with scrap metal from other sources to produce only steel rebar. It is assumed that no more than 10,000 tons of ingots will be released annually and that the minimill will uniformly disperse such ingots to produce 1 million tons of rebar.

The worst plausible exposure scenario for alternative 4 is the same as the actual and likely use scenario because it is assumed that the restrictions on sale of the ingots to the minimill will always be observed (i.e., the ingots will only be used to produce rebar).

2.1.5 Alternative 5: Release for Designated Use after Abrasive Decontamination

The specific assumptions made for alternative 5 are essentially the same as those mentioned for alternative 3, with the primary difference being that releases of recyclable steel that has been decontaminated using the abrasive decontamination technique will be restricted to a minimill that agrees to mix and melt the decontaminated steel with scrap metal from other sources to produce only steel rebar. It is assumed that no more than 10,000 tons of decontaminated steel will be released annually and that the minimill will uniformly disperse such steel throughout its scrap supply to produce 1 million tons of rebar.

The worst plausible exposure scenario for alternative 5 is the same as the actual and likely use scenario because it is assumed that the restrictions on sale of the decontaminated steel to the minimill will always be observed (i.e., the decontaminated steel will only be used to produce rebar).

2.1.6 Alternative 6: Burial as Low-Level Waste at a DOE Disposal Facility

This alternative assumes the burial of all scrap metal and no release activities. Burial is assumed to be at a remote site having rigid waste acceptance criteria. The following are activities assumed to be necessary for implementing alternative 6:

- Procure single-use containers.
- Perform size reduction and packaging (30 lb/ft^3).
- Seal and certify containers.
- Load onto transport vehicles.
- Perform necessary paperwork and QA checks.
- Transportation and burial.

No actual and likely or worst plausible scenarios are identified because no material would be released.

2.2 ANALYSIS OF ALTERNATIVES

2.2.1 Radiological Assessment

The surface-contaminated recyclable steel generated during decommissioning of the uranium processing facility is assumed to have a surface-to-mass ratio of 0.115 ft^2/lb. Based on this conversion factor, average activity in the structural steel scrap would be (1) Tc-99--10.8 Bq/g; (2) U-234--8.4 Bq/g; (3) U-235--0.27 Bq/g; (4) U-238--0.10 Bq/g; and (5) Pu-239--0.002 Bq/g.

For modeling purposes, the recycling process is divided into the following steps: initial transportation of released steel (i.e., decontaminated scrap or melt-refined ingots), melting and processing of released steel, fabrication of end products, distribution of end products, and use of end products by the public. All steps may not be required for every alternative. However, all alternatives (except disposal) assume that released steel will be melted and processed after release.

In this assessment, it is assumed that public radiological exposure begins at the time when the recyclable steel is released from DOE's radiological controls (i.e., doses are calculated only for the general public, including workers associated with transport and melting, as well as users of end products). For alternative 1 (unrestricted release), the point of release from DOE control occurs when the recyclable steel is sold. For alternatives 3 (unrestricted release after abrasive decontamination) and 5 (release for restricted use after abrasive decontamination), the point of release from DOE control occurs after decontamination of the recyclable steel is completed and it is sold. For alternatives 2 (unrestricted release after melt refining) and 4 (release for restricted use after melt refining), the point of release from DOE control occurs after melt refining is completed and the ingots are sold. For alternative 6 (LLW burial), the recyclable steel is assumed to remain within DOE control at all times.

Two general types of exposure scenarios are considered: (1) worker scenarios to evaluate the dose and risk to people involved in the processing of recycled materials and (2) end-product scenarios to evaluate dose and risk to people using or otherwise being exposed to products made from recycled radioactive materials. For a detailed discussion of these scenarios and the parameters used in the modeling, see the report by Nabelssi et al. (1996).

For the metal recycled, 90% is assumed to be available for manufacturing purposes, and 10% is assumed to go into slag. The end-use scenarios have been postulated based on steel use in a distribution of industries (see Table 2). The following consumer product scenarios are considered: (1) parking lot (slag), (2) room/office, (3) automobile, (4) appliance, (5) office furniture, (6) home furniture, and (7) frying pan. For a throughput of 100 tons of scrap steel, some key parameters and assumptions to model end-use products are shown in Table 3.

Table 2: Mass Distribution of Metal among Representative Consumer Products

Representative Consumer Product	Mass Distribution (% of total)
Room/office	38
Automobile	30
Appliance	8
Office furniture	8
Home furniture	8
Frying pan	8

Source: U.S. Bureau of Mines (1985), after normalization.

Table 3: Typical Parameters Used to Model End-Use Products for a Throughput of 100 Tons

Recycle Step	Scenario	Source Geometry	Density (g/cm^3)	Thickness (cm)	Radius [a] (cm)	Distance from Source (cm)	Occupancy Time (h)	Number of Individuals [b]
Consumer products	Parking lot	1 full cylinder	2.70	10	3,400	100	62	1,000
	Room/office	4 half cylinders	7.86	0.2	300	100, 250, 250, 400	2,000	380
	Automobile	4 full cylinders	7.86	0.1	150	50	730	800
	Appliance	1 half cylinder	7.86	0.1	92	100	730	4,300
	Office furniture	1 half cylinder	7.86	0.1	103	15	2,000	7,000
	Home furniture	1 half cylinder	7.86	0.1	110	15	3,650	6,000
	Frying pan	1 full cylinder	7.86	0.4	15	30	180	41,000
Public products	Pavement	1 full cylinder	2.70	10	3,400	100	0.0074 [c]	8,200,000
	Public building [d]	4 half cylinders	7.86	0.5	300	100, 250, 250, 400	2,000	164
	Bridge	2 half cylinders	7.86	1.2	1,800	100,400	0.002 [c]	8,200,000

[a] Modeled in RESRAD-RECYCLE computer code as the equivalent circular area.
[b] Does not include mass distribution among various industries. If the throughput is changed, the number of exposed individuals will change accordingly.
[c] For individual dose calculations, exposure durations of 6 h and 1 h are applied for pavement and bridge scenarios, respectively.
[d] Shielded by 15 cm of concrete.

Doses have been calculated for workers and members of the public for the release of 32,000 tons (total) of structural steel in the context of each recycle alternative (alternatives 1 through 5) (see Table 4). For each exposed group, both maximally exposed individuals and collective population doses were calculated. In the calculations, realistic scenarios and parameters were used.

The impacts on human health from disposal (alternative 6) of the surface-contaminated recyclable steel as LLW were calculated by using the RESRAD code (Yu et al. 1993). It is assumed that 1% of the steel is eroded and is mixed with the top 1 m of soil in a 10,000-m^2 area. The total activity released (Tc-99--9.3 x 10^{10} pCi; U-234--7.3 x 10^{10} pCi; U-235--2.3 x 10^9 pCi; U-238--8.5 x 10^8 pCi; and Pu-239--1.7 x 10^7 pCi) is mixed with 1.6 x 10^{10} g of soil; this mixing would result in the following activity concentrations in the soil: Tc-99--5.8 pCi/g; U-234--4.5 pCi/g; U-235--0.15 pCi/g; U-238--0.05 pCi/g; and Pu-239--0.001 pCi/g. For the dose calculations the other parameters are the RESRAD defaults (Yu et al. 1993). Maximum total dose of 9.8 mrem/yr will occur some time in the future because of groundwater ingestion for the maximally exposed individual. It is assumed that the public water supply is not contaminated.

2.2.1.1 Radiological Assessment References

Nieves, L., et al., 1995, *Evaluation of Radioactive Scrap Metal Recycling*, ANL/EAD/TM-50, Argonne National Laboratory, Argonne, Ill., Dec.

Nabelssi, B.K., et al., 1996, *RESRAD-RECYCLE: A Computer Model for Analyzing the Radiological Doses Resulting from the Recycling of Scrap Metal and the Reuse of Surface-Contaminated Material and Equipment*, Draft Report, Argonne National Laboratory, Argonne, Ill.

Yu, C., et al., 1993, *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0*, Draft, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, Ill., Sept.

U.S. Bureau of Mines, 1985, *Mineral Facts and Problems*, Bulletin 675, Washington, D.C.

Chen, S.Y., et al., 1996, *Assessment of Risks and Costs Associated with the Transportation of U.S. Department of Energy Radioactively Contaminated Carbon Steel*, ANL/EAD/TM-62, Argonne National Laboratory, Argonne, Ill., Sept.

Table 4: Estimated Radiological Impacts by Alternatives for the Recycle of Surface-Contaminated Structural Steel

Impact Group	Alternative 1: Unrestricted Release without Decontamination	Alternative 2: Unrestricted Release[a] after Melt Refining	Alternative 3: Unrestricted Release after Abrasive Decontamination[b]	Alternative 4: Release for Designated Use after Melt Refining [c]	Alternative 5: Release for Designated Use after Abrasive Decontamination[c]	Alternative 6: LLW Disposal
Maximum lifetime individual, worker Excess fatal cancer risk dose equivalent (mrem)	3.0 (slag worker)	3.0×10^{-2} (slag worker)	3.0×10^{-2} (slag worker)	3.0×10^{-4} (slag worker)	3.0×10^{-4} (slag worker)	Not applicable[d]
Collective, worker Excess fatal cancers dose equivalent (person-rem)	4.2×10^{-2}	4.0×10^{-4}	4.0×10^{-4}	4.0×10^{-4}	4.0×10^{-4}	Not applicable
Collective, transport worker Excess fatal cancers dose equivalent (person-rem)	5.0×10^{-5}	5.0×10^{-7}	5.0×10^{-7}	5.0×10^{-9}	5.0×10^{-9}	Not applicable
Maximum lifetime individual, public Excess fatal cancer risk dose equivalent (mrem)	4.0×10^{-3} mrem (parking lot)	4.0×10^{-5}	4.0×10^{-5}	1.0×10^{-7}	1.0×10^{-7}	490[e]
Collective, public Excess fatal cancers dose equivalent (person-rem)	2.4×10^{1}	2.4×10^{-1}	2.4×10^{-1}	2.0×10^{-4}	2.0×10^{-4}	15[f]

a For this alternative, worker doses are calculated after the material has been melt-refined (i.e., is formed into ingots and sold without restrictions). Doses decrease by a factor of 100 compared with Alternative 1 because, for most radionuclides, only 1% of the radioactivity is partitioned to the ingots in the melt-refining process.

b Doses are 100 times less than for alternative 1 because activity has been decreased 100-fold by abrasive decontamination.

c For alternatives 4 and 5, which involve restricted release, maximum lifetime individual worker dose is 100 times less than for alternatives 2 and 3 respectively, because dilution of 100 times will result from the restrictions. Worker collective dose, however, is the same for both restricted and unrestricted release because the total activity handled over the life of decommissioning remains the same. Public lifetime and collective doses for alternatives 4 and 5 assume the use of rebar made from release of steel in occupied buildings.

d Maximum lifetime individual worker and collective worker doses for the LLW disposal alternative are not calculated because the workers are assumed to be radiation workers.

e Maximum lifetime individual public dose for LLW disposal alternative is calculated by multiplying the maximally exposed individual yearly dose by 50 (i.e., the maximally exposed individual would be exposed to the maximum dose for 50 years).

f Collective public dose for the LLW disposal alternative is calculated from the transport of wastes. Risk factor of 7.3×10^{-9}/shipment-mile for external exposure was taken from "Assessment of Risks and Costs Associated with Transportation of U.S. Department of Energy Radioactively Contaminated Carbon Steel" (Chen, S.Y. et al., ANL/EAD/TM-62, September 1996). In the calculation it is assumed that 1,500 shipments travel a total distance of 1,500,000 miles. For the public it is assumed that the municipal water supply is used which is not contaminated.

2.2.2 Economic Assessment

This section reports the costs estimated for the alternatives considered. The estimated costs will be weighed against the collective doses assessed in the above sections. The following general assumptions are made for cost-estimating purposes, with specific assumptions subsequently described. It should be recognized that cost estimates are based on realistic assumptions from vendor information, previous DOE contracts, and considerations for economies of scale. However, potential variations would exist based on site-specific information. For instance, disposal estimates (currently based on the assumption of the Nevada Test Site as the disposal site) are likely to increase, whereas for estimates recycle option tend to be more stable and vary more toward lower cost.

GENERAL ASSUMPTIONS

1. Decontamination and processing services (including release surveys) are contracted with a licensed vendor.
2. Waste treatment, packaging, and disposal are performed by maintenance and operations personnel.
3. The survey rate is 3 in./s or 75 ft^2/h.
4. The shipment payload is 40,000 lb.
5. Drums weigh 50 lb, have a usable volume of 7 ft^3, and cost $50 per drum.
6. The surface-to-mass ratio is 0.115 ft^2/lb.
7. The professional labor rate is $60/h (burdened).
8. The craft and technician labor rates are $50/h and $40/h (burdened), respectively.
9. Bulk containers weigh 6,000 lb, have a usable volume of 1,200 ft^3, and cost $6,000 per container.
10. The bulk-container packaging efficiency is 80%.
11. A shipment of bulk containers consists of two containers.
12. The shipment cost is $3,500 per shipment.
13. Sample and analysis: four events per drum shipment (~100 drums).
14. Sample and analysis costs are $1,000 per event.
15. Quality Assurance is based on 10% of survey costs.
16. Burial cost is $27/$ft^3$ (external volume) (i.e., 7.4 ft^3 per drum or 1,350 ft^3 per bulk container).
17. The drum packaging cost is $100 per drum.
18. All waste generated is assumed to be LLW that is RCRA nonhazardous.
19. The package density of radioactive scrap metal is 30 lb/ft^3.
20. The package density of debris and consumables is 60 lb/ft^3.
21. The package density of solidified (treated) waste is 90 lb/ft^3.
22. Stabilization additives are added at a 6/4 ratio.
23. All radioactive scrap metal is painted and has a coating thickness of 6 mils.

Table 5 provides a summary of the total costs and elements of costs associated with each alternative considered.

2.0 ALARA PROCESS

Specific Assumptions

Alternative 1: Unrestricted Release (without Decontamination)

1. All metal is size-reduced for handling and surveying.
2. Surveys and QA are required to verify expected levels of contamination.
3. No decontamination is performed before release.
4. No decontamination wastes are generated.
5. Metal is stockpiled for pickup by the purchaser.

Alternative 2: Unrestricted Release after Melt Refining

1. All radioactive scrap metal (RSM) is melt-refined by a vendor for $0.85/lb.
2. Slag generation is 10% of the input charged material (RSM + flux).
3. Baghouse losses are 0.1% of the input charged material.
4. Scrap steel ingots have a value of $80 per ton.
5. Scale losses are 1% of cast metal.

Alternative 3: Unrestricted Release after Abrasive Decontamination

1. All RSM is grit-blasted by a vendor for $0.70/lb
2. The use of abrasive media is minimized with internal recycling, and media are used at a rate of 12 lb/ton of RSM.
3. Decontamination effectiveness for a single evolution has a dilution factor (DF) of 100.
4. One decontamination evolution is conducted with a rejection rate of 5%.
5. Rejected metal is buried as LLW.

Alternative 4: Release for Designated Use after Melt Refining

1. All RSM is melt-refined by a vendor for $0.85/lb.
2. Slag generation is 10% of the input charged material (RSM + Flux).
3. Baghouse losses are 0.1% of the input charged material.
4. Scrap steel ingots have a value of $80 per ton.
5. Scale losses are 1% of cast metal.
6. Scrap value is discounted 25% due to restrictions.

Alternative 5: Release for Designated Use after Abrasive Decontamination

1. All RSM is grit-blasted by a vendor for $0.70/lb.
2. The use of abrasive media use is minimized with internal recycling, and media are used at a rate of 12 lb/ton of RSM.
3. Decontamination effectiveness for a single evolution has a DF of 100.
4. One decontamination evolution is conducted with a rejection rate of 5%.
5. Rejected metal is buried as LLW.
6. The scrap value is discounted 25% due to restrictions.

Alternative 6: Disposal as LLW

1. The RSM is densified to 35 lb/ft^3.
2. The RSM is packaged into bulk containers.
3. The U.S. Department of Transportation restricts shipments by weight to one container per shipment.

Table 5: Cost Estimate[a] Summary ($) Contamination

Element	Alternative 1: **No Decontamination;** No Restrictions	Alternative 2 : **Melt Refine**; No Restrictions	Alternative 3: **Abrasive Decontamination;** No Restrictions	Alternative 4: **Melt-Refine** Restrictions	Alternative 5: **Abrasive Decontamination;** Restrictions	Alternative 6: **LLW Disposal**
Labor	2,887,000	1,807,000	4,106,000	1,807,000	4,106,000	3,698,000
Equipment	589,000	144,000	210,000	144,000	210,000	1,045,000
Other direct costs	0	1,151,000	6,319,000	1,151,000	6,319,000	10,667,000
Contracts	0	54,400,000	44,755,000	54,400,000	44,755,000	Not applicable
Disposal	0	4,718,000	8,720,000	4,718,000	8,720,000	61,440,000
Subtotal	3,476,000	62,220,000	64,110,000	62,220,000	64,110,000	77,996,000
Resale	(2,560,000)	(2,400,000)	(2,421,000)	(1,791,000)	(1,816,000)	Not applicable
TOTAL	**916,000**	**59,820,000**	**61,689,000**	**60,429,000**	**62,294,000**	**77,996,000**
	$0.014/lb	**$0.935/lb**	**$0.964/lb**	**$0.944/lb**	**$0.973/lb**	**$1.219/lb**

[a] The cost estimates are based on realistic assumptions from vendor information, previous DOE contracts, and considerations for economies of scale. Examination of the results indicates that only a few variables drive the cost analysis: contract service costs, burial rates, and packaging density.

Sensitivity analysis was performed on these significant assumptions. The following are the ranges that were analyzed and considered to have credibility:

Melt Cost Range	\$0.65/lb - \$1.05/lb	(base, \$0.85/lb)
Grit Blasting	\$0.60/lb - \$0.90/lb	(base, \$0.70/lb)
Disposal Rates	\$10/ft^3 - \$45/ft^3	(base, \$27/ft^3)
Packaging Density	20 lb/ft^3 - 40 lb/ft^3	(base, 30 lb/ft^3)

The high, low, and base estimates for the cost of each alternative, except alternative 1 (unrestricted release with no decontamination), are presented in Table 6. Alternative 1 is not shown because the uncertainties of the labor and equipment costs (i.e., the only elements contributing to the total cost of alternative 1) are low. Therefore, the uncertainty in the total cost estimate for alternative 1 is low in comparison with the uncertainties of the other alternatives.

Table 6: High, Low, and Base Cost Estimates

Alternative	Low	Base	High
2: Unrestricted release after melt refining	$47,020,000	$59,820,000	$72,620,000
3: Unrestricted release after abrasive decontamination	$55,296,000	$61,689,000	$74,477,000
4: Release for designated use after melt refining	$47,629,000	$60,429,000	$73,229,000
5: Release for designated use after abrasive decontamination	$55,901,000	$62,294,000	$75,082,000
6: LLW disposal	$30,171,000	$77,996,000	$142,197,000

The following observations can be made about the sensitivity of the total cost for alternatives 2 through 6 shown in Table 5:

1. The disposal cost has the largest effect on the total cost of an alternative. The disposal cost is also the least certain of the elements estimated. Therefore, it contributes to wide-ranging cost estimates for all alternatives.

2. Density assumptions have a significant effect on disposal costs. The DOE complex wide experience indicates that lower packaging density (and therefore higher cost) is normal, which is counterintuitive.

3. Contract service cost can also vary. However, credible data are available that limit the range of potential variations, thereby increasing the certainty of the estimates. While DOE contract services to date have involved relatively low volumes of radioactive scrap metal, it is expected that in the future, economies of scale will push costs toward the lower end of the uncertainty range.

In conclusion, the sensitivity analysis supports the assumptions used in making the cost estimates summarized in Table 5. The uncertainty in the estimates of the disposal element may cause total costs to be higher than expected in some cases.

2.2.3 Assessment of Other Factors

Six alternatives were evaluated for the release of 32,000 tons of recyclable steel. Alternatives 1, 2, and 3 place no restrictions on use after release. Alternatives 4 and 5 restrict use after release to the production of rebar. Alternative 6 involves size reduction and disposal as LLW. Table 7 summarizes the status of the alternatives relative to pertinent factors other than dose and cost.

Table 7: Status Summary of Other Factors Considered

Factor	Alternative 1: Unrestricted Release; No Decontamination	Alternative 2: Unrestricted Release after Melt Refining	Alternative 3: Unrestricted Release after Abrasive Decontamination	Alternative 4: Release for Designated Use after Melt Refining	Alternative 5: Release for Designated Use after Abrasive Decontamination	Alternative 6: LLW Disposal
Impact on product markets	Insignificant addition to volume of steel products manufactured in U.S.			Insignificant addition to volume of steel rebar manufactured in U.S.		Not applicable
Public acceptance	Significant objection expected	Minimal objection expected as a result of public involvement program				Some objection expected
Consistency with waste minimization principles	No waste requiring disposal	About 2,500 tons of waste requiring disposal as LLW	About 5,000 tons of waste requiring disposal as LLW	About 2,500 tons of waste requiring disposal as LLW	About 5,000 tons of waste requiring disposal as LLW	32,000 tons of waste requiring disposal as LLW
Marketability of released metal	Questionable	Good				Not applicable
Resource conservation	Conserves energy and mineral resources and reduces pollution associated with mining and processing virgin ores					No conservation
Regulatory Approvals	Coordination with NRC/ state regarding radioactive release	Coordination with NRC/state regarding radioactive release	Coordination with NRC/state regarding radioactive release; may require state review of waste management activities	Coordination with NRC/state regarding radioactive release	Coordination with NRC/state regarding radioactive release; may require state review of waste management activities	Meets DOE requirements

Because significant public objection is expected to the release of recyclable steel that has not been decontaminated (alternative 1) and because the marketability of such steel (both as scrap and as end-use product) may be questionable as a result, the option of unrestricted release without decontamination may not be viable, regardless of dose and cost comparisons. Alternatives 2 through 5 are not significantly different from each other regarding other factors. However, alternatives 2 and 4 (melt-refining alternatives) may be slightly preferred over alternatives 3 and 5 for two reasons. First, melt refining generates less LLW requiring disposal than does abrasive decontamination. Second, waste management activities associated with abrasive decontamination may require project-specific review by the responsible state agency.

Based solely on factors other than dose and cost, alternative 6 (LLW disposal) is less desirable than any of alternatives 2 through 5 because it would result in the largest volume of LLW requiring disposal and because it would not promote conservation of energy and natural resources (as recycling does).

2.3 SELECTION OF THE PROPOSED ALTERNATIVE

Table 8 summarizes doses and costs for all alternatives.

Table 8: Dose and Cost Summary for Structural Steel

Alternative	Maximum Public Individual Dose (mrem/yr)	Collective Public and Workers Dose for 1-yr Release (person-rem)	Collective Public and Workers Dose for Project (person-rem)	Cost ($)	Cost per person-rem Reduced (No Decontamination Baseline) ($/person-rem)
Alternative 1: Unrestricted release	3.0	8	24	916,000	Not applicable
Alternative 2: Unrestricted Release after melt refining	0.03	0.08	0.24	59,820,000	2,500,000
Alternative 3: Unrestricted release after abrasive decontamination	0.03	0.08	0.24	61,689,000	2,600,000
Alternative 4: Release for designated use after melt refining	0.0003	0.0002	0.0006	60,429,000	2,500,000
Alternative 5: Release for designated use after abrasive decontamination	0.0003	0.0002	0.0006	62,294,000	2,600,000
Alternative 6: LLW burial	9.8	5	15	77,996,000	Not applicable

As was discussed in Section 2.2.3, the alternative of releasing recyclable steel without decontamination appears not to be viable based on factors other than dose and cost. In addition, the maximally exposed individual member of the public would be expected to receive a dose of 3 mrem in one year if this alternative were implemented. While this dose is consistent with DOE’s goal that members of the public receive no more than a few millirem in a year above background from DOE releases, it still is significantly higher than all other alternatives. Therefore, Alternative 1 was eliminated from further consideration, even though its cost estimate was relatively low.

The following conclusions can be reached based on the information provided on Table 8 for the remaining alternatives 2 through 6.

1. The dose estimated for the maximally exposed individual member of the public for alternative 6 far exceeds the doses projected for the maximally exposed individual members of the public for alternatives 2 through 5. At 5 mrem/ 1-yr, alternative 6 also exceeds DOE's goal that exposures to members of the public from DOE activities not exceed a few millirem in a year.

2. The estimated cost of implementing alternative 6 is discernibly higher than the estimated cost of implementing any of alternatives 2 through 5.

3. The estimated dose for the maximally exposed individual member of the public for any of alternatives 2 through 5 is well below 1 mrem in a year, which meets DOE's goal for keeping the public dose to less than a few millirem in a year from DOE releases. Additionally, the estimated collective doses to workers and the public over the life of the project are lower than 1 person-rem.

4. Estimated costs of implementing alternatives 2 through 5 are not distinguishable, given the uncertainties of the estimates shown in Table 6.

Based on these conclusions, alternative 6 (LLW disposal) was eliminated because of its higher projected dose and cost relative to the other alternatives.

The remaining alternatives 2 through 5 could not be differentiated based on estimated implementation costs. However, the estimated maximum public individual doses for alternatives 4 and 5, which are equal to each other, are a factor of 100 lower (due to restrictions limiting the end-use product to rebar) than those estimated for alternatives 2 and 3. Therefore, without factors other than dose and cost that would outweigh the dose differential, alternatives 4 and 5 were chosen as preferred over alternatives 2 and 3.

As noted in Section 2.2.3, melt refining generates less LLW requiring disposal than does abrasive decontamination. Also, waste management activities associated with abrasive decontamination may require project-specific review by the responsible state agency. Therefore, alternative 4 (release for designated use after melt refining) was considered to be a slightly more desirable alternative than alternative 5 (release for designated use after abrasive decontamination).

3.0 RECOMMENDATION OF PROPOSED ALTERNATIVE

3.1 STATEMENT OF PROPOSED AUTHORIZED LIMITS

As discussed in Section 2.0, the optimization study performed to meet ALARA process requirements concluded that, of the six alternatives considered, alternative 4 (release for designated use after melt refining) was preferred for managing surface-contaminated recyclable steel from the uranium processing facility as part of decommissioning. Therefore, consistent with the choice of alternative 4, the following release limits are proposed:

1. Total surface activity on recyclable steel entering the melt-refining process will be limited as shown in Table 9:

Table 9: Limits on Total Surface Activity of Recycle Steel

Radionuclide	Surface Activity Levels, dpm/100 cm^2 (Bq/cm^2)
Tc-99	275,000 (46)
U-234	215,000 (36)
U-235	7,000 (1.2)
U-238	2,500(0.4)
Pu-239	50(0.01)

2. No more than 10,000 tons of melt-refined ingots shall be sold annually.

3. Sales of melt-refined ingots shall be restricted to scrap metal purchasers who can ensure that the ingots will be mixed and melted with scrap from other sources to produce only rebar.

3.2 METHODS TO DEMONSTRATE COMPLIANCE

3.2.1 Management

All activities associated with the release of the subject property will be conducted under the cognizance of John Doe, Manager, Uranium Processing Facility Waste Management Division.

The manager named above will also be responsible for scheduling all material transfers in a manner that complies with calendar-year quantity release restrictions.

3.2.2 Procedures and Protocol

The following standard operating procedures for the site (copies in Appendix XX) provide the basis for the major activities associated with implementing the authorized limits:

SSOP-HP01	Selecting portable radiation and contamination survey instruments
SSOP-HP02	Conducting and reporting radiation and contamination surveys
SSOP-WM01	Packaging, transporting, and disposal of LLW
SSOP-WM02	Management of excess Government property
SSOP-QA01	Conducting radiation and contamination survey verification surveillance
SSOP-QA02	Conducting QA audits

3.2.3 Record Keeping

To demonstrate compliance with the authorized limits and restrictions, the following records will be entered into the public record in a manner consistent with the site public participation plan.

Application for Approval of Authorized Limits. This document provides (1) a description of the property to be released from DOE control; (2) a description of the radiological history of the property to be released; (3) a statement of authorized limits and all applicable restrictions; and (4) an optimization study that meets the requirements of the ALARA process and supports the approval of authorized limits.

Final Project Report. This document will provide (1) all final clearance survey results (including instruments used, date of the survey, and surveyor's name); (2) the quantity and disposition of all waste resulting from the project; (3) the quantity of material released (including release dates); (4) the identity of the initial recipient of all released recyclable steel, with evidence that such a recipient was informed of the radiological status of the metal and the availability of documentation regarding that status; and (5) all QA inspection and verification reports.

4.0 COORDINATION ACTIVITIES

4.1 COORDINATION WITH NUCLEAR REGULATORY COMMISSION AND THE AGREEMENT STATE

Appendix XX contains copies of correspondence and a record of meetings with the NRC and the responsible state regulatory agency, indicating their agreement that the proposed authorized limits are not inconsistent with licensing requirements for radioactive materials.

4.2 COORDINATION WITH OTHER APPROPRIATE PARTIES

NOTE: An actual application for approval of authorized limits would include site-specific information concerning activities such as stakeholder meetings, general public meetings, contacts with potential purchasers, contacts with other regulatory agencies, etc. Because such information is particularly site-specific, no hypothetical example is included.

EXHIBIT 3

APPLICATION FOR
APPROVAL OF SUPPLEMENTAL LIMITS
(Annotated Sample Table of Contents)

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EXHIBIT 3
APPLICATION FOR APPROVAL OF SUPPLEMENTAL LIMITS
(Annotated Sample Table of Contents)

A Word About the Sample Table of Contents

The annotated Table of Contents provided here is intended as a tool to help preparers avoid omissions of important information from their applications for supplemental limits. The information discussed is either required by Order DOE 5400.5 and 10 CFR Part 834, or stongly recommended for inclusion. The structural organization presented is only as a suggestion. Also, the level of detail provided in any particular application should be determined using a graded approach (*see Handbook* Step 5). In other words, the level of detail for analyses and information presented should be consistent with the complexity of the proposal and its potential to create risk to human health and the environment.

Application Summary

The Application Summary should:

- Briefly explain the circumstances surrounding the request for supplemental limits, including reasons that existing authorized limits are not appropriate;
- Indicate the proposed concentration levels and any restrictions, that together comprise the supplemental limits for which approval is sought;
- Summarize the broad scope of the process for the release of common material from various DOE activities at the site; and
- Identify any unusual site-specific issues that have affected the nature of the existing authorized limits and/or the supplemental limits proposed.

Table of Contents

Glossary of Terms and Acronyms

1 Introduction

The Introduction should include information on:

- Description of the property proposed for release **(*see Handbook*, Step 1)**;
- The purpose of and need for the proposed supplemental limits;
- Description of existing authorized limits and brief statement of reasons they are not appropriate;
- Background about the DOE activity and the property proposed for release that would be helpful in understanding the scope and applicability of the proposed supplemental limits; and
- Other subjects, as appropriate.

2 Justification of Need

This section should include information that adequately documents justification for the decision to seek supplemental limits (*see Handbook*, Step 2). If supplemental limits involving restrictions on future use of the property released will be considered among the management alternatives, this section should clearly show that existing authorized or supplemental limits are not appropriate, or cannot reasonably be achieved and that restrictions on use of the property are necessary. In all cases, the supplemental limits sought must be shown to be protective.

3 ALARA Process

This chapter of the application documents the ALARA process used to develop supplemental release limits (*see Handbook*, Step 4).

3.1 Description of Alternatives

This section should describe the viable alternatives evaluated in the optimization study conducted to satisfy ALARA process requirements. It begins the process of documenting step 4 of the *Handbook* (*see* Exhibit 1). Typically, at least three viable alternatives should be identified. The level of detail needed to sufficiently define an alternative will depend on the rigor with which dose and cost analyses must be performed, which depends on the magnitude of the expected differences in dose and cost among the various alternatives.

In many cases, possible alternatives will be "screened" to provide a manageable number for analysis in the optimization study. In situations where some alternatives have been screened out of the optimization study, a brief discussion should be included describing how this screening was conducted. In all cases, alternatives retained for analysis must be protective. In some cases, proposed supplemental limits may be more protective than existing authorized or supplemental limits. This may occur when, for a particular use or item of property the existing authorized or supplemental limits have been determined to not be sufficiently protective.

Each alternative that is fully analyzed should be described to facilitate understanding of the optimization study. The description of each alternative should provide enough information so that reviewers of the application can unambiguously determine the facts and assumptions surrounding the alternative.

Each significant assumption affecting exposure, cost, or other factors should be clearly stated and where necessary justified. The "actual and likely use" and "worst plausible" scenario must be clearly stated for each alternative.

3.2 Analysis of Alternatives

3.2.1 Radiological Assessment

This section should describe the methodology, assumptions and results of radiological assessments for each alternative (*see* Exhibit 1, “Deriving Release Limits”). The description of results must discuss the ability of each alternative to comply with the DOE primary dose limit and must indicate potential collective dose to the exposed population. Preparers of the application may choose from a number of guidance documents and computer codes for making the dose calculations that will be reported in this section (*see* Exhibit 2, “Annotated Outline for Application for Approval of Authorized Limits”).

3.2.2 Economic Assessment

This section should describe the methodology, assumptions and results of cost assessments for each alternative (*see* Exhibit 1, “Deriving Release Limits”). It is important to estimate costs for each alternative such that equivalency of scope is established. An example of equivalent scope is that each option concludes with a similar endpoint (e.g., the material is removed from the site and no additional expenses for care will be incurred). The description of results must discuss the cost of implementing each alternative. Potential effects of implementing each alternative should also be explained, along with estimates of the costs associated with such effects. For example, if decontamination activities required to implement an alternative will generate waste materials, estimates of the cost of properly managing such waste materials should be included. Every effort should be made to use full life cycle costs. It is vital to use credible assumptions and document, for review, all such assumptions.

3.2.3 Assessment of Other Factors

While cost and effective dose are the primary factors in selection of the optimal alternative, other factors must also be balanced in the optimization study. Identification of particular factors for assessment will be case specific, but may fall into one or more of the following general areas:

- *social factors*: impacts on local/national product market; employment; public acceptance; environmental justice considerations; transportation effects; and privatization of work.

- *environmental factors:* effects on ecological resources; waste generation rates; ease of management of resulting wastes; probable disposition of resulting wastes; and fate of residual radioactive material released.

- *technological factors*: promotion of emerging technology; technology transfer; robustness of technology; industrial safety of technology; and track record of technology.

- *policy and implementation factors:* consistency with waste minimization principles; promotion of resource conservation; consistency with final clean-up goals; adaptability to existing procedures and protocols; finality of the alternative; and environmental permitting issues.

3.3 Selection of Proposed Alternative

This section should describe the methodology and results of the optimization study conducted to select a preferred alternative (*see* Exhibit 1, "Deriving Release Limits"). In this section, the results reported in Section 3.2 should be summarized and balanced for each alternative. The preferred alternative should be identified (i.e., the alternative that would reduce radiation exposures to levels that are as low as practicable, taking into account economic, social, environmental, technological and policy factors). This section must clearly show that the preferred alternative for supplemental limits is protective.

4 Recommendation of Proposed Alternative

4.1 Statement of Proposed Authorized Limits

This section should clearly and concisely set forth the proposed supplemental limits, including the isotopes of concern, concentration limits for each isotope of concern and any restrictions on release.

4.2 Methods for Demonstrating Compliance

This section should discuss the measurement protocols and evaluation techniques proposed to determine compliance with the proposed supplemental limits. If the proposed supplemental limits include restrictions on future use of released property, enforceability of the restrictions must be demonstrated.

5 Coordination Activities

5.1 Coordination with NRC and Agreement State (if any)

This section should discuss how adherence to DOE's policy that NRC personnel or Agreement State representatives be consulted and agree that proposed release limits are not inconsistent with licensing requirements.

5.2 Coordination with Other Appropriate Parties

This section should discuss coordination, if any, that has been initiated with local communities or other stakeholders.

Appendices

EXHIBIT 4

DOE APPROVAL OF AUTHORIZED AND SUPPLEMENTAL LIMITS

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EXHIBIT 4
SEQUENCE FOR OBTAINING DOE APPROVAL OF AUTHORIZED AND SUPPLEMENTAL LIMITS

An application for approval of authorized or supplemental limits must be submitted to the DOE Operations Office having direct responsibility for oversight of the activity proposing the release. Such DOE Operations Offices have primary responsibility for review and approval of release limits. An aspect of such responsibility includes involving other DOE organizations in the approval process.

Until 10 CFR Part 834 is promulgated, the sequence whereby the responsible DOE Operations Office will involve other DOE organizations in approval of release limits remains as required by Order DOE 5400.5. After promulgation of 10 CFR Part 834, some details of the sequence will change. Both sequences are presented below for ease of reference.

DOE APPROVAL OF AUTHORIZED LIMITS AND MEASUREMENT PROTOCOLS FOR RELEASE UNDER ORDER DOE 5400.5

[excerpt from *Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material)*, DOE Assistant Secretary for Environment, Safety and Health, Office of Environmental Policy and Assistance (EH-41), pp. 5 - 6 (November 17, 1995)]

While application, implementation and approval of authorized limits for property subject to surface contamination (consistent with guidelines described below) are the responsibility of DOE field and program elements, DOE 5400.5 requires EH-1 approval of authorized limits for residual radioactive material in mass or volume. However, authorized limits and survey protocols for residual radioactive material in mass or volume or surface contamination limits in lieu of Table 1 may be derived and approved by DOE field office managers without EH-1 written approval if:

1) The applicable criteria [for releasing DOE property for disposal, or for reuse or recycle] are appropriately addressed;

2) Based on a realistic but reasonably conservative assessment of potential doses, it is demonstrated to the satisfaction of the responsible field office manager, that:

   - The release or releases of the subject material will not cause a maximum individual dose to a member of the public in excess of 1 mrem in a year or a collective dose of more than 10 person-rem in a year;

   - A procedure is in place to maintain records of the releases consistent with DOE 5400.5 requirements and that survey or measurement results are reported consistent with the data reporting guidelines in the DOE November 1992 radiological survey guidance[1] and DOE/EH-173T; and

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1 The radiological survey guidance has been updated. See *Environmental Implementation Guide for Radiological Survey Procedures*, U.S. Department of Energy, Assistant Secretary for Environment, Safety and Health, Office of Policy and Assistance (Draft Report for Comment, February 1997).

3) A copy of the authorized limits, measurement/survey protocols and procedures, supporting documentation, including a statement that the ALARA process requirements have been achieved, and appropriate material documenting any necessary coordination with the state(s) or NRC are provided to the Office of Environment, EH-4, at least 40 working days prior to the authorized limits becoming effective.

   - EH-4 will provide written notification to the field office of the receipt of the material, and

   - notify the field, if the authorized limits or supporting material are not acceptable, within 20 days of receipt, otherwise the authorized limits (including any conditions or limitations set forth by the approving DOE field elements) may be considered approved without written EH-1 approval.

Field office elements may request technical assistance in the review or development of such authorized limits; however, such assistance should be requested as early as possible in the process but at least 90 working days before the desired implementation date for the authorized limits. Nothing in this guidance should be construed to override or replace the need for field elements to coordinate or consult with DOE program offices having jurisdiction over actions or portions of the actions covered by the authorized limits. Authorized limits for residual radioactive material in mass or volume that do not meet the field approval criteria stated above must be approved by EH-1. It is recommended that the DOE elements responsible for requesting EH approval, coordinate the analyses with EH-412, the Air, Water and Radiation Division prior to submitting the request to EH-1.

DOE APPROVAL OF AUTHORIZED AND SUPPLEMENTAL LIMITS FOR RELEASE UNDER 10 CFR PART 834

FIELD DOCUMENTATION

- After approving authorized or supplemental limits, the responsible DOE Operations Office will transmit two copies of the final documentation, as approved, to DOE Headquarters. One copy of the documentation should be sent to the Headquarters lead program office, and the other, a correspondence copy, should be sent to EH-4. Documents should be sent at least 60 days prior to the anticipated date of implementation. The 60-day period begins upon confirmation of receipt of the documentation by the Headquarters lead program office.

HEADQUARTERS LEAD PROGRAM RESPONSIBILITIES

- The Headquarters lead program office will provide the responsible DOE Operations Office with verification that the application was received.

- If decisions made at a responsible Operations Office potentially pose concerns for the program complex wide, then the Headquarters lead program office must respond to the Operations Office within the 60-day period and inform EH-4 and any other potentially interested Headquarters program offices as appropriate.

- If no concerns are identified, the responsible DOE Operations Office may implement the authorized release limits on or after 60 days from the receipt confirmation date.

- If concerns are identified, the DOE Headquarters lead program office will notify the responsible DOE Operations Office of the need to delay implementation and the actions required before implementation of the release limits can occur.

OFFICE OF THE ASSISTANT SECRETARY FOR ENVIRONMENT, SAFETY AND HEALTH RESPONSIBILITIES

- EH will only be responsible for compiling and maintaining a database of all documents received from DOE Operations Offices.

- EH will provide technical assistance to the responsible DOE Operations Office and to any Headquarters program office upon receiving a timely request.

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EXHIBIT 5

EXCERPT FROM

DRAFT ENVIRONMENTAL IMPLEMENTATION GUIDE FOR RADIOLOGICAL SURVEY PROCEDURES
(February 1997)

(Section 4.6, "Survey of Equipment and Small Items")

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This Document Contains Only Selected Excerpts That Have Been Retyped.

DOE-

DRAFT

Environmental Implementation Guide for Radiological Survey Procedures

Office of Environmental Policy and Assistance
Assistant Secretary for Environment, Safety, and Health
U.S. Department of Energy
Washington, D.C. 20581

Draft Report for Comment
February 1997

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4.6 SURVEY OF EQUIPMENT AND SMALL ITEMS

Surveys for release or characterization of non-real property (equipment or other small objects and materials, and personal items) are conducted using a process similar to that used for lands and structures. Such surveys may be conducted (1) to release non-real property during decontamination and decommissioning projects or where remedial measures are being implemented, or (2) as part of a facility's normal operations. Figure 4.4 diagrams a general process for conducting these surveys and determining if the subject properties are acceptable for release.

The first step is to characterize the use of the item or equipment. If there is adequate process knowledge to certify that the item(s) or equipment was never subject to radiological contamination,* the material may be released without radiological survey. Property that may contain residual radioactive material or has been decontaminated must be surveyed before release to verify that residual radioactive material concentrations on surfaces or in the material are less than the authorized limits and comply with the ALARA process requirements. The detail and scope of the survey should be proportional to the potential for contamination. The limits should be applied and release approved on the basis of the following conditions.

a) Prior to release, property should be surveyed to ensure that the limits and ALARA objectives have been achieved.

b) Survey techniques and instruments are appropriate for detecting the specific limits.

- Direct measurements and swipes/samples should be taken so that applicable release criteria are evaluated.
- Samples should be taken if the property may be contaminated in volume.

c) Surveys, analysis, and evaluations shall be conducted by qualified personnel.

As Fig. 4.4 indicates, the process allows flexibility with regard to authorized limit development. In those cases where there are a significant number of items or pieces of equipment to be released and some above background levels of residual radioactive material are likely to be

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*"Property shall be considered to be potentially contaminated if it has been used or stored in areas that could contain unconfined radioactive material or that are exposed to beams or particles capable of causing activation (neutrons, protons, etc.)," Order DOE 5400.5, February 8, 1990. It is noted that items stored out of the radiation control area are not considered subject to activation due to the relatively low intensity of the beams permitted in uncontrolled areas.

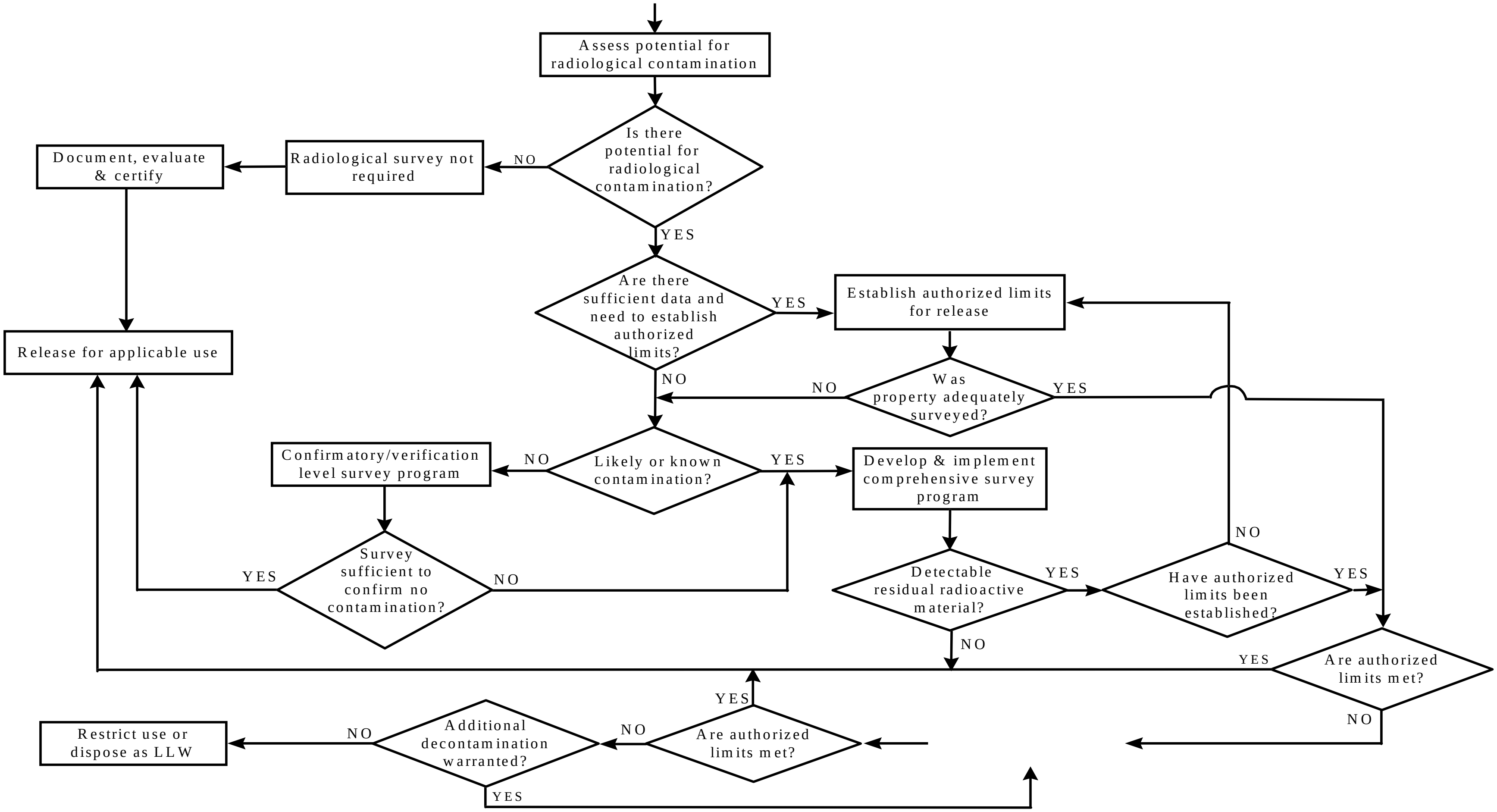

Fig. 4.4 General process for surveys for release or characterization of non-real property

encountered, authorized limits (consistent with the ALARA process) should be established prior to the survey. This will permit the development of a more specific survey plan or protocol and more efficient surveys. However, the establishment of such limits may require considerable effort (to complete the ALARA analysis) or may require more information than is available with regard to radionuclide mix and distribution. Therefore, if it is expected or there is reasonable expectation the items(s) is not contaminated, establishment of authorized limits may be deferred until such time as it is clear they are required. If surveys are conducted prior to development of authorized limits, any detectable residual radioactive material will necessitate the development of authorized limits. Figure 4.5 provides more specific information for the survey process when it has been determined that the property cannot be released on the basis of process knowledge. At this point in the process the property can be categorized as either:

Category 1 - contaminated, previously contaminated, or highly suspect, requiring comprehensive or full survey (similar to the characterization or final release survey (similar to the characterization or final release survey for lands and structures), or

Category 2 - possibly contaminated with no direct evidence of contamination, requiring at least a confirmatory/verification-type survey.

Property known to be contaminated or believed contaminated, or property that has been decontaminated should receive comprehensive surveys before release. Property or equipment previously decontaminated for which radiological data are incomplete, or not completely adequate, also qualified for Category 1 treatment. All surfaces should be scanned, smear-sampled, and a sufficient number of static counts completed to ensure that the property meets the applicable release criteria. In most cases, scans for hot spots should cover nearly 100% of the accessible surfaces and systematic static measurements should be completed. Systematic measurements should be proportional to the size of the items being surveyed and should be no less frequent than one per square meter of surface. However, static measurement frequency may vary depending on the detection limits of the scanning. If the scanning sensitivities are good (activities of less than 50% of the authorized release limit), static measurements may be less frequent and may be performed only for confirmatory/verification measurements. However, if the sensitivity for scanning is significantly above the release limits [e.g., 3 times the limit for average activity) a statistically valid number of static measurements must be made [see DOE/CH-8901 (DOE 1989a]. In addition, difficult-to-access areas that are subject to contamination should be surveyed to obtain a representative estimate of residual radioactivity. This may require disassembling significant portions of the equipment. In some cases, a less comprehensive survey may be permitted if property-specific conditions are such that selected scanning, static measurements or samples/swipes of specific portions of the equipment, item, or property provide confidence that the unsurveyed portions of the item of interest are not contaminated. For example, if measurements of representative lengths of ducting or pipes, and measurements in traps or at elbows demonstrate no levels of radiation above the limits, concentrations of radionuclides in fluids contained in the pipes or equipment are not indicative of contamination, the property

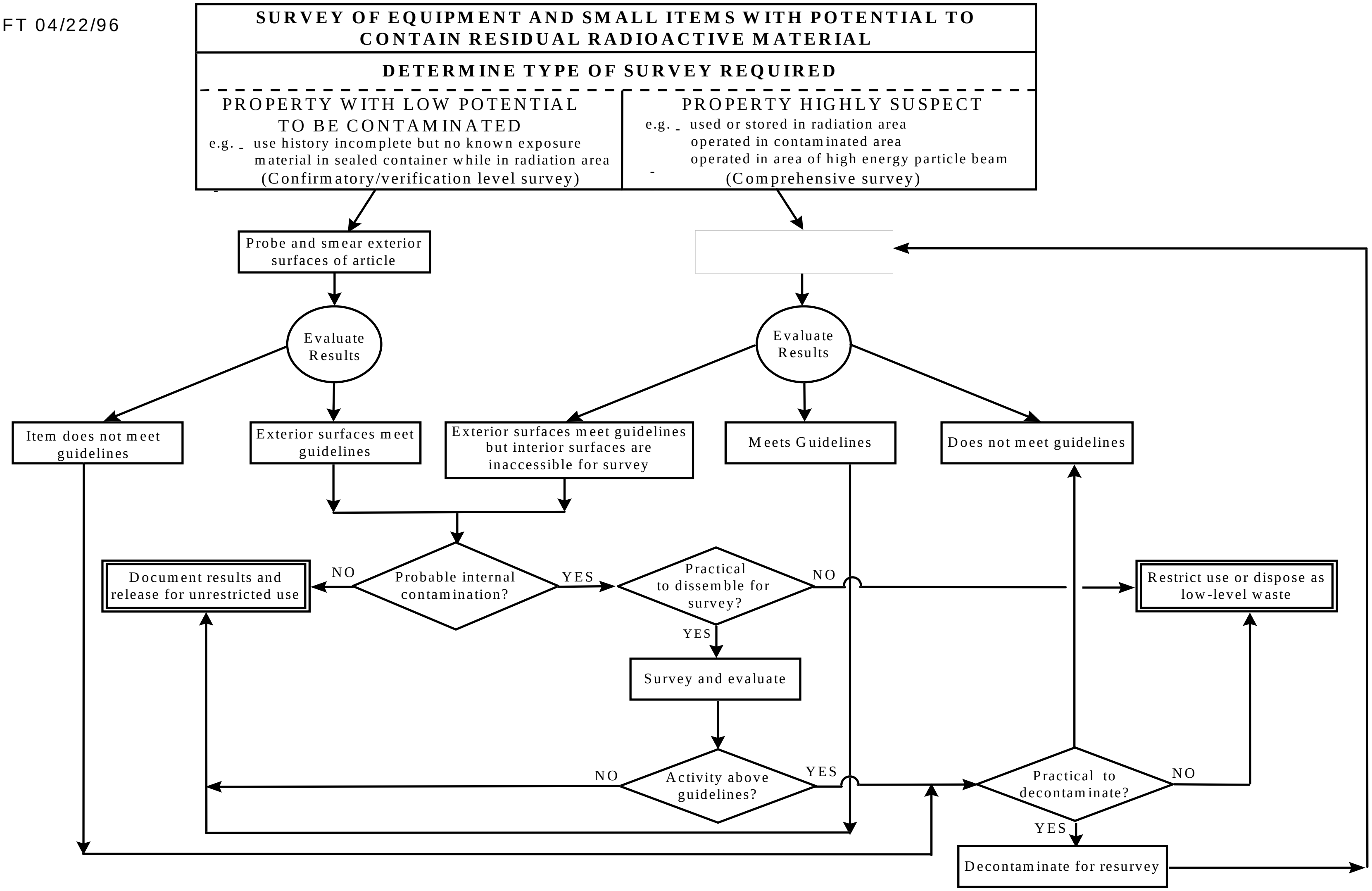

Fig. 4.5 Example survey procedure flow for survey of equipment & small items.

may be released without surveying 100% of the material. When this representative sampling/survey approach is applied, the survey leader should select, for survey/sampling, those areas or portions of the item(s) being evaluated for release that are most likely to be contaminated. Data collected using the representative sample/survey approach should be analyzed to show that there is a 95% significant confidence that the areas sampled are within guidelines. However, the "representative sampling/survey" approach should only be used when there is significant benefit from doing so, or when a full survey is not physically possible. A full survey is recommended when the subject property is highly suspect, known to be contaminated or potentially contaminated, and easily accessible.

The second category described above covers items or equipment where there is low potential for contamination (contamination is possible but unlikely). These items may have been stored, used, or handled in an area that may have subjected them to contamination but the potential for such contamination is low based on process knowledge; however, there is insufficient information to certify that they meet release requirements. In such situations it is not reasonable to require 100% survey of all surfaces. Instead, an approach similar to a confirmatory/verification survey should be used. Items(s) should be surveyed to produce a statistically representative set of measurements that can be used to support process knowledge information or any previous survey data. If these surveys identify contamination, the items should be re-categorized and surveyed consistent with Category 1 items. Examples of property that may warrant Category 2 surveys include:

- Items(s) not exposed to radioactive material in quantities great enough to cause contamination in excess of guidelines.

- Item(s) previously decontaminated for which radiological data are incomplete, or not completely adequate.

- Items(s) for which there is no reason to suspect contamination but there is a significant gap in use history, and they reasonably may have been used in an area that could subject them to contamination.

Scanning should cover as much of the accessible surface of the items(s) as possible. Similarly, static measurements should be done on a statistical basis (some fraction of large items or complete surveys of random samples of some number of small items if the release involves many like items). The need for spot checking areas very difficult to access should be determined on the basis of use history. It is generally recommended that at least some confirmatory/verification measurements be taken in accessible areas. For example, representative samples of fluids in pumps or engines and representative measurements at the opening of input and exhaust ports should be made. However, unless these spot checks indicate contamination, disassembly should be required for a Category 2 items.

- Special Surface Survey Techniques for Small Items

The determination of average levels of residual radioactive material on surfaces may require relatively long counting times to demonstrate that the authorized limits have been met. For instance, it is not possible to detect 100 dpm/100 cm^2 of Pu-239 with most typical survey problems during a scan-type survey. Therefore, static measurements must be performed. One acceptable approach is to make several static measurements at several representative locations over the surface and average them. Depending on the instrumentation, background, and so forth, counting times form 1 to 3 min may be needed to ensure that 100 dpm/100 cm^2 is detected. However, an alternative approach that covers more surface area is to slowly scan the surface with the survey meter in the integrating mode over the required 1-3-min time period. This procedure will provide an acceptable average. Averaging for the integrated scan approach should be limited to areas of about 1 m^2 or less.

EXHIBIT 6

EXCERPT FROM

DRAFT ENVIRONMENTAL IMPLEMENTATION GUIDE FOR RADIOLOGICAL SURVEY PROCEDURES
(February 1997)

(Section 8.2, "Data Reporting")

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This Document Contains Only Selected
Excerpts That Have Been Retyped.

DOE-

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Environmental Implementation Guide for Radiological Survey Procedures

Office of Environmental Policy and Assistance
Assistant Secretary for Environment, Safety, and Health
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8. DATA REPORTING AND MANAGEMENT

8.1 FIELD DATA

Records must be legible, thorough, and unambiguous. Data are recorded in indelible ink, signed, and dated. Enough data must be collected to enable an independent evaluation of the site status. Changes are made by striking through the item to be changed with a single line, entering the corrected information, and initialing and dating the change. Where practical, survey data should be recorded on standardized forms. Other information, for which forms are not appropriate, is recorded in a bound logbook. All data and supporting information, necessary to substantiate the survey findings, should be considered permanent legal records and, as such, should be protected from damage or loss and retained for a time period appropriate for such records.

8.2 DATA REPORTING

Documentation for survey reports should provide a complete and unambiguous record of the radiological status of the site/facility relative to the requirements of the particular survey type conducted. See Sect. 3.1 for a discussion of the different types of surveys and the extent of data required to satisfy the aim of the investigation. In addition, sufficient information and data should be provided to enable an independent re-creation and evaluation at some future data of both the survey activities and the derived results.

The content and form of the report will be dictated largely by the type of survey and the resulting data requirements. The report should provide a synopsis of the historical information detailing specifics concerning former processing activities as listed in Sect. 2. This would include locations of activities, radionuclides involved, release points, and information regarding past and/or present buildings and other structures. The location and type of facility, and a description of the physical characteristics of the site should be given. Among relevant details are ownership history, current activities on the site, and topographical data and geographical/geological data that may have been, or may now be, a factor in the extent or distribution of contamination. Data sources will include information from any previous surveys, the survey field data sheets and maps, lab analysis results, photographs, QA documentation, chain-of-custody forms, and the document identified during the review as described in Sect. 2.

Much of the information for a particular report will likely be available from other sources and may only require a summation or reference in the report. Such sources may include documentation detailing previously conducted surveys, decommissioning and survey design and work plans, and the various information required as part of the accountability program (i.e., lab reports, survey data, QA documentation, chain-of-custody forms, etc.)

The general approach used for the survey procedures and the reasons for adopting that approach should be described along with the types of measurements and samples taken and the methods for procuring them. Background levels and concentrations should be selected for comparison with survey results, and the rationale for the selection of that data should be provided. See Sect 4.4 for a complete discussion of background baseline material.

Tables and figures relating survey findings should be supported by detailed discussion in the text of the report. All relevant data should be provided in a clear and concise manner. Figures may include layouts of surveyed areas upon which measurement and sample results may be superimposed. The survey results should be compared to the applicable guidelines and any problem areas specifically addressed. The statistical design, analysis, and test methods should be identified and results of the tests included and interpreted.

A generic report format used for any of the types of radiological surveys discussed in Sect. 1 is provided below.

RADIOLOGICAL SURVEY REPORT FORMAT

I. Abstract

This section should be a brief, executive-type summary of survey results. It should include a brief statement about exposure evaluation results.

II. Introduction

This section should include:

a. purpose of the survey;
b. when the survey was conducted and by whom;
c. a brief history of the site, or if it is a vicinity property, a history of the associated candidate site (include process history if appropriate—use only published or documented information); and
d. a description of property [include area maps, site-scaled drawings and photographs (using care not to divulge site location or ownership if appropriate—use codes for all references to site location as needed)].
e. references to related studies.

III. Survey Methods

This section should include a simple listing of the types of measurements and samples taken. The appendices or documents that describe the survey plan for the site and those that detail the survey instrumentation and sample analysis methods employed should be referenced. A brief description of the survey techniques and instrumentation should be included.

Include a synopsis of any special activities conducted to allow access for surveying, and identify and justify, if necessary, areas not surveyed. Discuss special problems or conditions affecting the conduct of the survey.

The organization and arrangement of the reported data is, at least partly, dictated by the unique characteristics of the site/facility and may require explanation. Any special nomenclature arbitrarily assigned to areas, structures, or materials for the purpose of identification of locations and measurements should be defined.

IV. Survey Results

Subsections should discuss results for each measurement type. Text should summarize data in terms of range and average levels observed. Appropriate figures and detailed data tables should be referenced. For on-site measurement results, comparisons to guidelines and/or normal background levels should be mentioned in this section. In addition, specific requirements for each section are provided as follows.

a. Background Radiation Levels

Reference or present a brief description of areas and results included in background determinations. If applicable, state values and locations of background levels found on site.

b. Indoor Survey Results

This section should describe the results of all measurements, and include a detailed discussion of any residual contamination discovered. Results of the radiological survey should be compared to background and guideline values. The following parameters, where applicable, should be detailed, and appropriate documentation in the form of tables and/or figures prepared to substantiate the findings:

1. measurements of external radiation levels,
2. sampling results [dust, paint chips, structural material, tap water (if supply is a private well), drain residues, etc., including results of indirectly measured concentrations of radioactive materials (i.e., smear analyses),
3. radon and radon daughter measurements, thoron and thoron daughter measurements,
4. air monitoring results,
5. subsurface investigations:
   - reference to appended hole-logging graphs.

c. Outdoor Survey Results

All outdoor data should be discussed in this section and any residual contamination described. Results should be compared to background and guideline values. The following parameters should be detailed and appropriate documentation in the form of tables and/or figures prepared to substantiate the findings:

1. measurements of external radiation levels,
2. surface soil sampling results,

3. subsurface soil investigations,
   - reference to appended hole-logging graphs,
4. measurements of potentially transferable contamination where suspected (e.g., residues, collected debris around or in effluent systems such as roof vents, sumps, sewers, etc.
5. other samples;
   - water as appropriate, e.g., surface water, core-hole water, vegetation, drain residues, collected debris around or in effluent systems such as roof vents, sumps, sewers, etc.

V. Significance of Findings

The introductory paragraph of this section should state that, based on the results of the survey, the following information can be derived.

a. Extent of Continuation - Discuss the areal extent of contamination (or conversely, it's absence) indoors and outdoors. The location(s) of measurements and/or samples exceeding applicable guidelines should be outlined. A discussion of the area(s) involved and an estimate of the extent of contamination in each area should be detailed.

b. Evaluation of Radiation Exposures - Summarize the bases for evaluation, assumptions used, and preliminary calculated estimate of the increased risk, if any, to individuals on site.

VI. References

VII. Appendices

Appendices should detail any additional information (such as auger-hole logging graphs) not appropriately addressed elsewhere in the document.

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