Enclosure 1.

Preliminary Analysis of Relative Impact of Different Radionuclides Due to Drilling Intrusions Into the Repository

prepared by
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Preliminary estimates of potential doses following inadvertent drilling into a single canister emplaced in geologic repository located at a potential Yucca Mountain site are discussed below. The following information relates the releases of radionuclides (calculated by using the Nuclear Regulatory Commission's (NRC) computer code DRILLO2)) to lifetime doses, which were calculated by the Pacific Northwest Laboratory (PNL) computer code DITTY.

For this study, only two groups of persons were considered to be exposed: An individual member of the public located downwind in the region of greatest exposure at a distance of 5 kilometers from the drilling site, and the geologist who conducts the drilling and who is located several feet from the drilling operations. The geologist who inadvertently withdraws a contaminated core sample from a canister and subsequently examines it, would experience a large external exposure due to the Cs-137 (and its Ba daughter) and a possible internal exposure due to ingestion (not considered in this analysis for this person). The doses to the individual at 5 km are discussed below.

A number of assumptions were required in this study to calculate the doses to the individual located at 5 km with the DITTY computer code. The key assumptions were: (1) That all releases from the drilling were at ground level; (2) That only 4% of the releases to the biosphere became airborne and respirable, while the remainder of the cuttings, which were retained at the site of the drilling, did not become airborne; (3) That dispersion of all radionuclides into the atmosphere at Yucca Mountain can be estimated by a straight-line Gaussian plume model (the dispersion model used by DITTY); (4) That the dry deposition velocities for all radionuclides were identical (DITTY assumes 0.1 cm/sec for the non-gaseous nuclides in this study); (5) That all radionuclides were transported into only one of the sixteen 22.5 degree sectors that surround the drilling site (the sector west of the drilling site that produced the highest total lifetime exposure); (6) That transport by air into this sector occurred for only a fraction of a year (this fraction was calculated by DITTY from the joint wind speed and direction frequency data obtained from STAR listings for the Desert Rock Station in Nevada); and (7) That this person inhaled radionuclides from the plume passage and that he experienced both external exposure (air submersion, groundshine) and an intake by inhalation from re-suspended soil particles for 5,600 hours during a year.

For the drilling scenario, the entire release was assumed to occur in the year of drilling. At 100 years the releases in curies into the atmosphere that produced approximately 97% of the total dose over the 10,000-year period of dose calculation were:

Cs-137:	20.0
Np-237:	0.6
Pu-240:	1.3
Pu-239:	0.8
Am-241:	3.6

The major contributors to lifetime doses were identified by DITTY as Am-241, Pu-239, Pu-240 and NP-237. A total dose of 0.42 rems (effective dose equivalent) was calculated due to the sum of the doses from the nuclides Np, Pu, and Am during the equivalent 70-year calculational period yielding the largest individual dose. The effective lifetime dose for Cs-137 during this same period was 0.0012 rems. For this scenario (and all those studied), almost all of the dose was delivered along the atmospheric pathway by inhalation of the transuranic radionuclides. The ingestion pathways made only a minor contribution to the any of these doses.

Given the large inventory of Cs-137 in spent fuel when it was emplaced, it is appropriate to ask, "Why is dose from Cs-137 not a major contributor to the total dose for the individual located at 5 kilometers"? The inventory of Cs-137 in spent fuel that was present at the time of emplacement of the canister experiences rapid depletion. For example, at 100 years it is depleted by radioactive decay alone to around 10% of its initial value. Of this depleted inventory, only 4% of the cesium, like all other non-gaseous radionuclides, was assumed available for transport and subsequent inhalation. The committed dose from the inhalation of a single curie of intake of any of the transuranic nuclides is many orders of magnitude larger than the dose from the inhalation of 1 curie of cesium. This is because once the transuranic nuclides are inhaled and then transported to bone by the bloodstream, they remain there for the lifetime of the exposed individual (the TRU biological half-life is of the order of a 100 years, but for cesium the largest biological half-life is about 1/2 year). Thus, the dose from Cs-137 contributes only a small amount to the total lifetime dose due to inadvertent human intrusion into a geologic repository by exploratory drilling.

NOTE: The documentation for the DITTY dose assessment code was prepared by Napier, B. A. et al., "GENII: The Hanford Environmental Radiation Dosimetry Software System," Volumes 1, 2, and 3, Richland, Washington, Pacific Northwest Laboratory, PNL-6584, 1988. Pertinent documentation for DITTY will be made available upon request. The computer code DRILL02, which was used to calculate the releases, was developed by the NRC staff as part of its performance assessment studies. Details of this code will be available from NUREG-1464, "NRC Iterative Performance Assessment Phase 2: Development of Capabilities for Review of a Performance Assessment of a High-Level Waste Repository" when this report is published (publication expected in 1994).

Enclosure 2.

Response to Drs. Whipple and Budnitz

During the last meeting's presentation by Dr. Norman Eisenberg of my staff, Drs. Whipple and Budnitz questioned his contention that a repository less prone to releasing radionuclides under expected conditions, would have a greater potential for release of radionuclides under upset conditions, such as human intrusion. The point the committee members made seems to be valid, if the measure of performance is the risk. As the plume of radionuclides spreads in the geosphere the concentration per unit surface area decreases, but the probability of exhuming contaminated rock increases in exactly the same proportion, so the risk (the probability multiplied by the consequences) remains constant (this approximation neglects the details of the concentration gradients in the plume). Nevertheless, the consequences resulting from exhumation of a single borehole core will be less for a more dispersed plume (i.e. the plume resulting from an engineered barrier that fails earlier or more). Since some of the repository performance measures under discussion by the Committee are related more directly to consequences rather than risk, e.g. maximum individual dose, this coupling between consequences under expected conditions versus certain upset conditions is a factor the Committee may wish to consider.

ANALYSIS OF HUMAN INTRUSION: DRILLING MODELS FOR NRC'S ITERATIVE PERFORMANCE ASSESSMENT CAPABILITY

PRESENTED TO:

THE NATIONAL ACADEMY OF SCIENCES
COMMITTEE ON THE TECHNICAL BASES FOR YUCCA MOUNTAIN STANDARDS

PRESENTED BY:

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NOVEMBER 10, 1993

OVERVIEW

I. INTRODUCTION

II. PHASE 1 MODEL

III. PHASE 2 MODEL

IV. SUMMARY

WHY MODEL HUMAN INTRUSION BY DRILLING?

- REQUIRED TO GENERATE CCDF OF RELEASES PER EPA STANDARD

- SHOWS EFFECTS OF HUMAN INTRUSION

- SHOWS HOW WELL REPOSITORY RESISTS/ MITIGATES HUMAN INTRUSION

- EXPLORATORY DRILLING IS A POTENTIAL SCENARIO AT ANY SITE

MODELING OBJECTIVES

- PROBABILITY OF DRILLING (NOT THE FOCUS HERE)
  - (USED EPA GUIDANCE IN APPENDIX B OF 40 CFR PART 191)
- POTENTIAL CONSEQUENCES OF DRILLING:
  - DIRECT RELEASES TO ENVIRONMENT

    (MODELED IN PHASE 1 AND PHASE 2)

MODELING OBJECTIVES *(CONTINUED)*

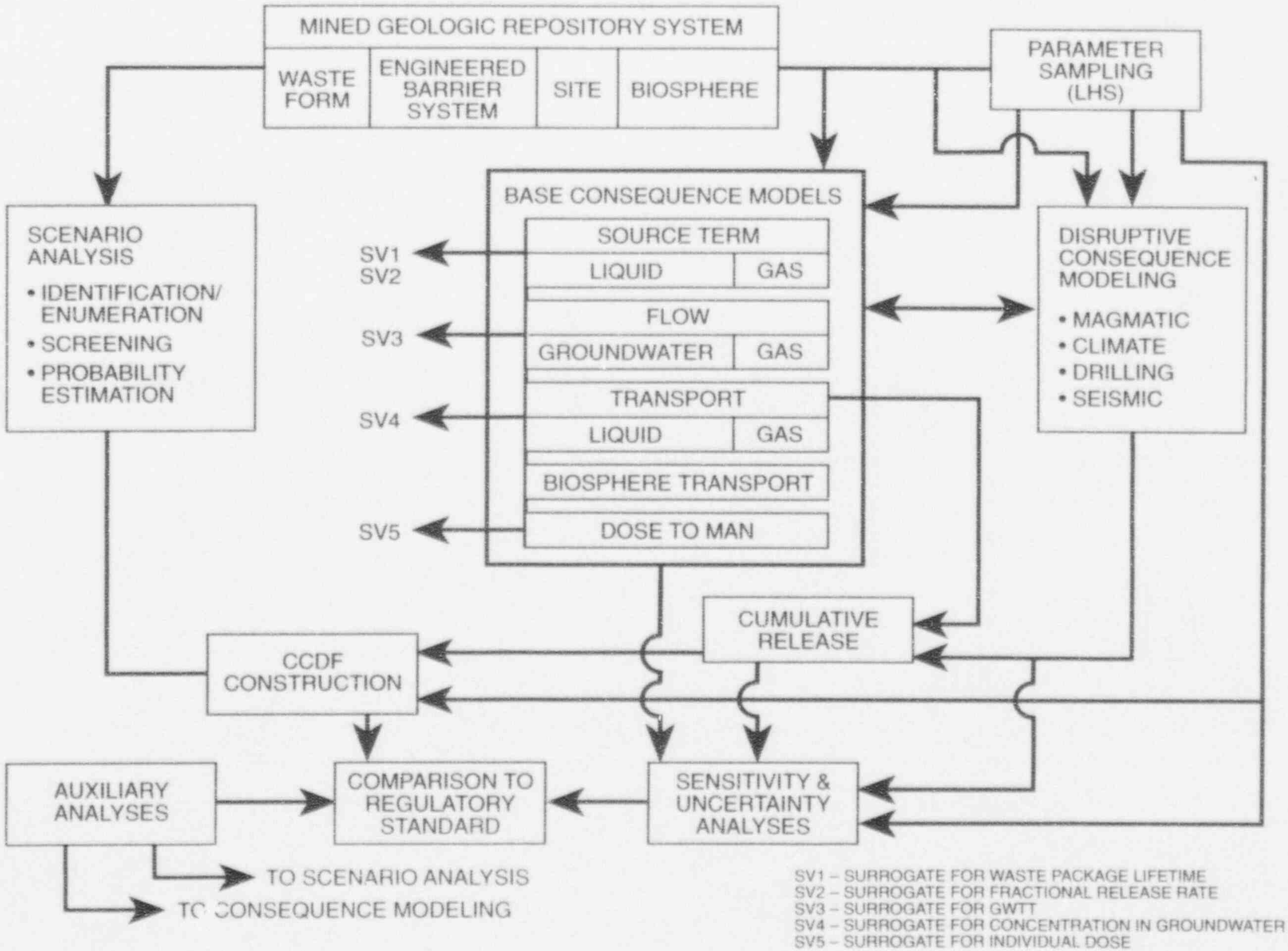
- DRILLING CAUSED FAILURE OF WASTE PACKAGE(S) AND/OR ENGINEERED BARRIER SYSTEM (EBS)

  (MODELED IN PHASE 2)

- EFFECTS OF DRILLING ON HYDROLOGIC FLOW AND RADIONUCLIDE TRANSPORT (LIQUID AND GAS PATHWAYS)

  (NOT YET MODELED)

PHASE 2 COMPONENTS OF TOTAL SYSTEM PERFORMANCE ASSESSMENT



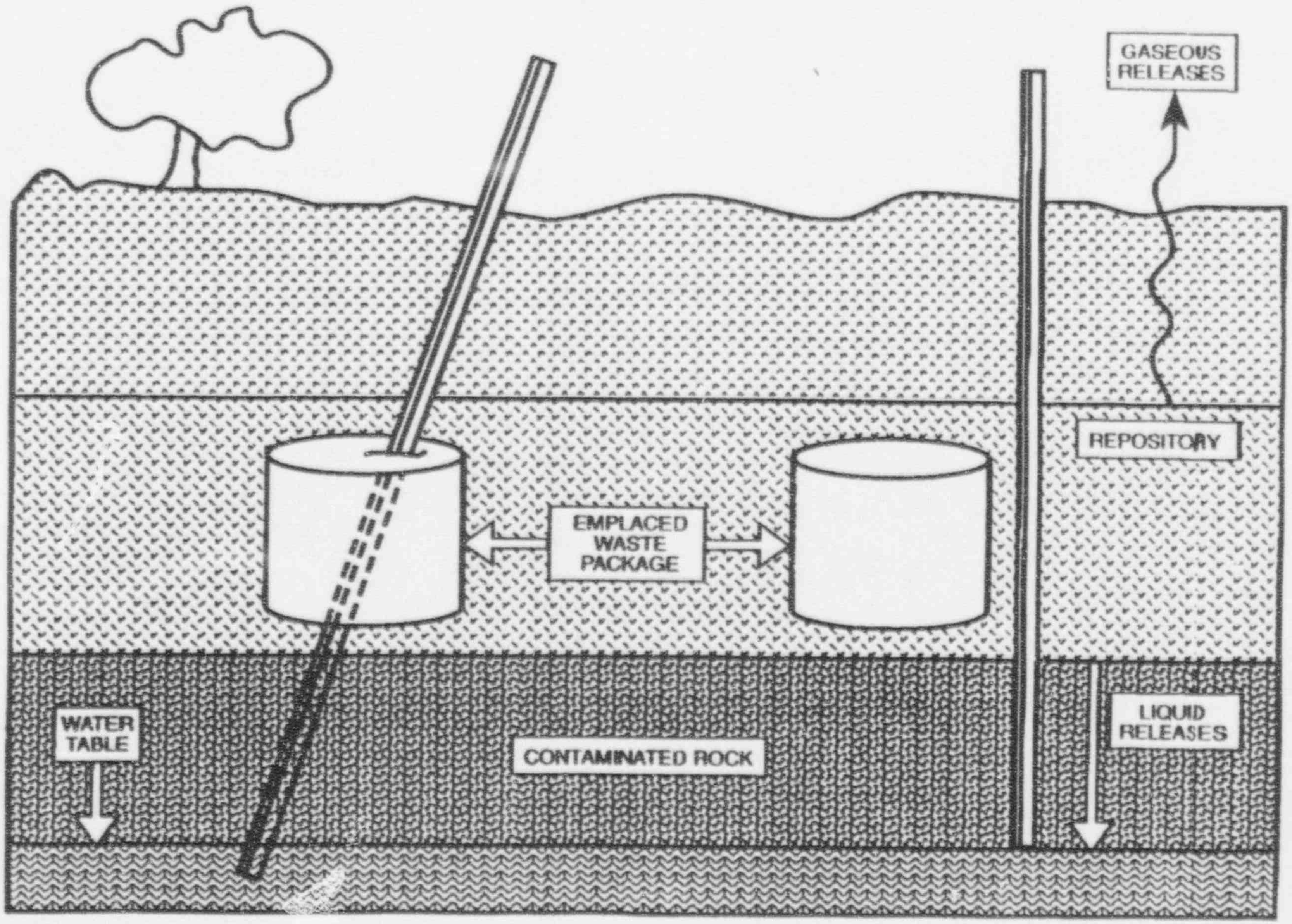
ASPECTS TO BE TREATED IN DRILLING CODE:

- RADIOACTIVE DECAY
- RADIONUCLIDE MIGRATION
- WASTE PACKAGE FAILURE FROM CAUSES OTHER THAN DRILLING
- DIRECT RELEASES

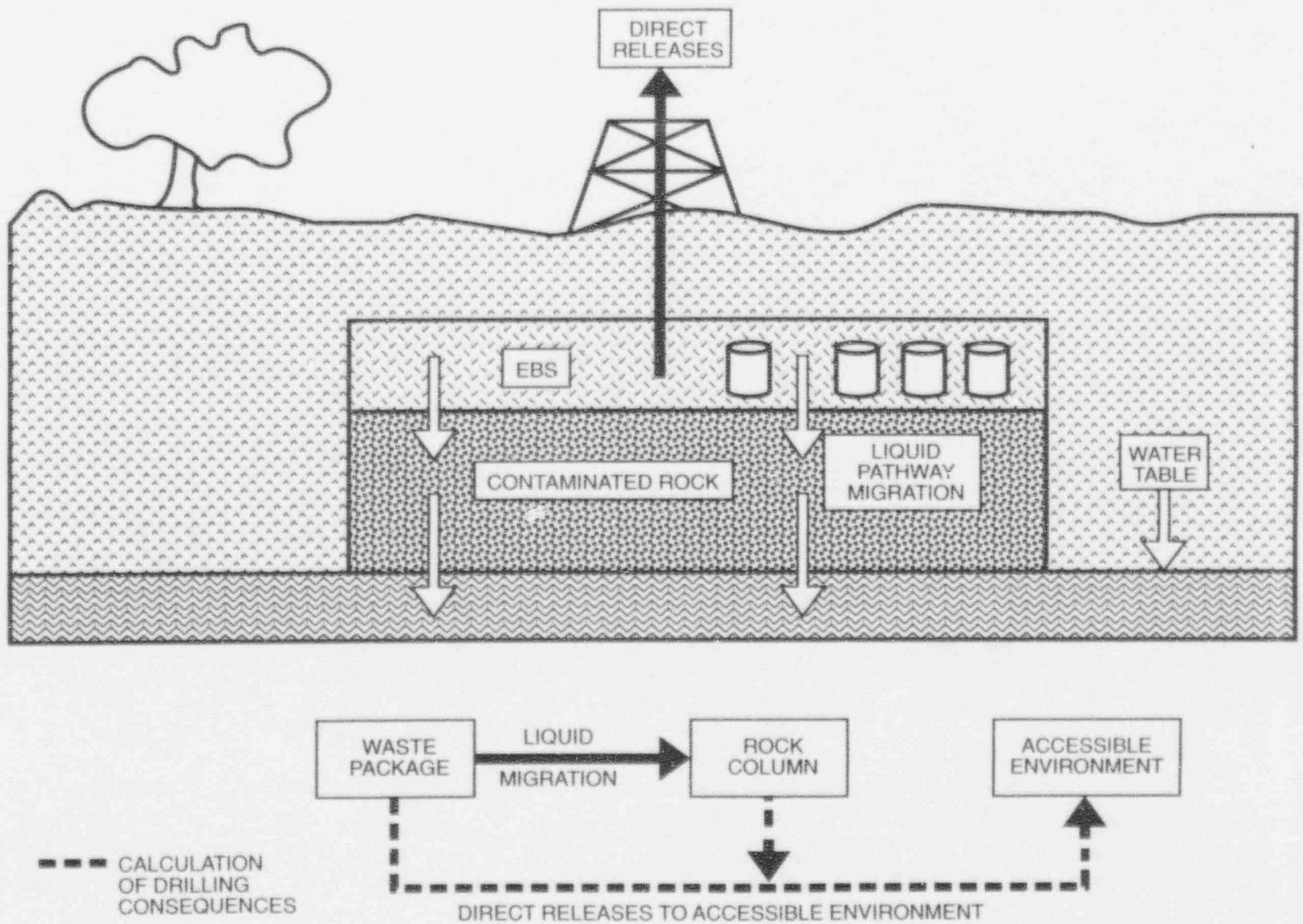
FACTORS NOT CONSIDERED IN EITHER MODEL

- SLANT DRILLING
- CHANGES IN LIQUID AND GAS FLOW DUE TO BOREHOLES
- WASTE DROPPED TO BASE OF BOREHOLE (SNL/DOE MODEL)
- EFFECT OF TOPOGRAPHY UPON DRILLING RATE
- ADDITION OF AND EFFECT OF DRILLING FLUID
- CONTAMINATED ROCK ABOVE REPOSITORY

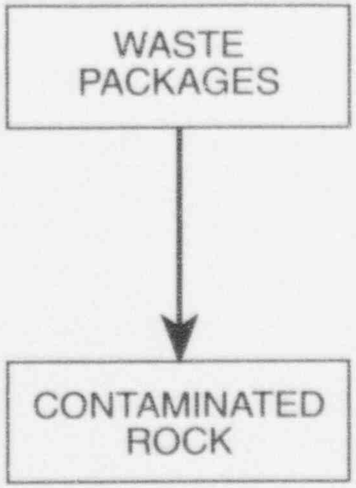
DRILLING SCENARIO

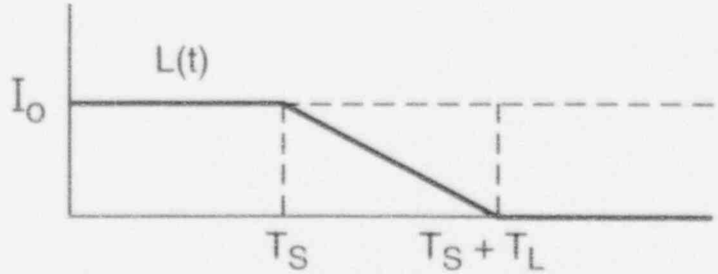


2 COMPARTMENT ANALYSIS

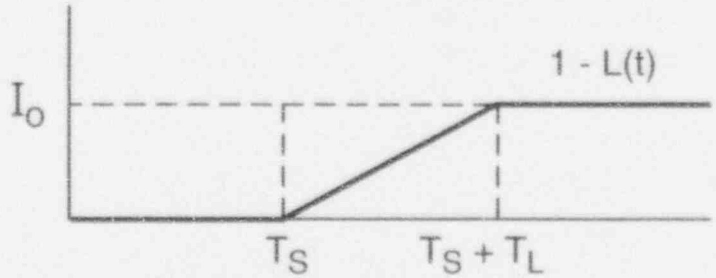


2 COMPARTMENT ANALYSIS





INVENTORY IN WASTE PACKAGES



INVENTORY IN CONTAMINATED ROCK

INVENTORY IN WASTE PACKAGE

$I_i(t) = D_i(t)\,L(t)$

INVENTORY IN CONTAMINATED ROCK

$I_i'(t) = D_i\,(1 - L(t))$

ASSUMED: UNIFORM CONCENTRATION OF RADIONUCLIDES WITHIN HOST ROCK

$D_i\,(t) \equiv$ DECAY OF RADIONUCLIDE i

$I_o \equiv$ INITIAL REPOSITORY INVENTORY

$T_L \equiv$ TIME OF LEACHING = (Io/R)

$T_S \equiv$ TIME THAT LEACHING STARTS (WASTE PACKAGE LIFETIME)

CONSEQUENCE CALCULATIONS

- POISSON PROCESS
  - POISSON DISTRIBUTION GIVES PROBABILITY ON n BOREHOLES, GIVEN DRILLING RATE AND TIME PERIOD
  - EXPECTED VALUE CONSEQUENCES CALCULATED
- AVERAGE CONSEQUENCES CALCULATED FOR WASTE & CONTAMINATED ROCK EXHUMATION
  - CONDITIONAL PROBABILITIES:
    - ROCK COLUMN = 1.0
    - WASTE PACKAGE = $\frac{\text{INTERCEPT AREA}}{\text{REPOSITORY AREA}}$

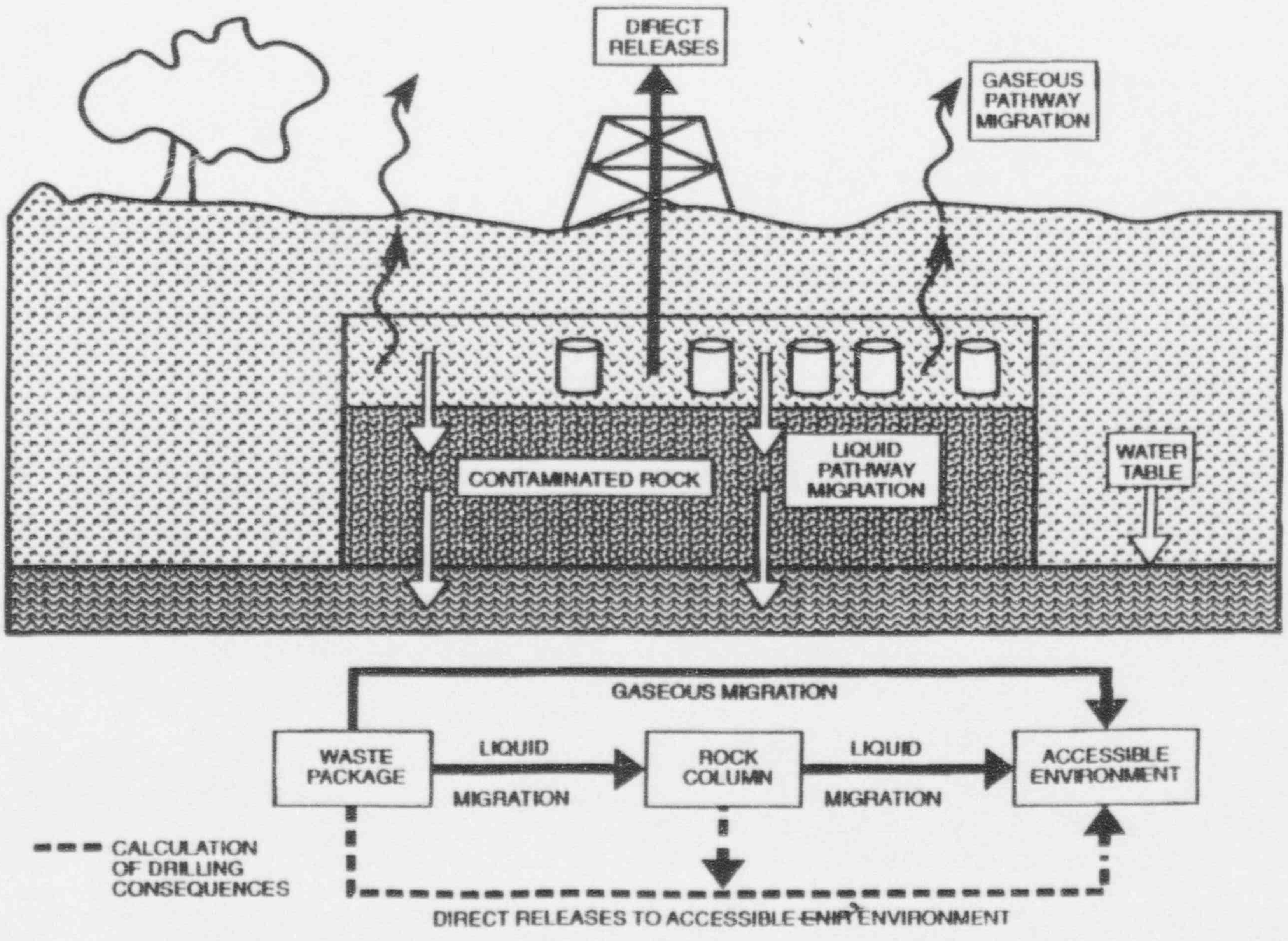
CONSEQUENCE CALCULATIONS *(CONTINUED)*

$$\text{EXPECTED VALUE} = P_{WP}\, C_{WP} + P_{RC}\, C_{RC}$$

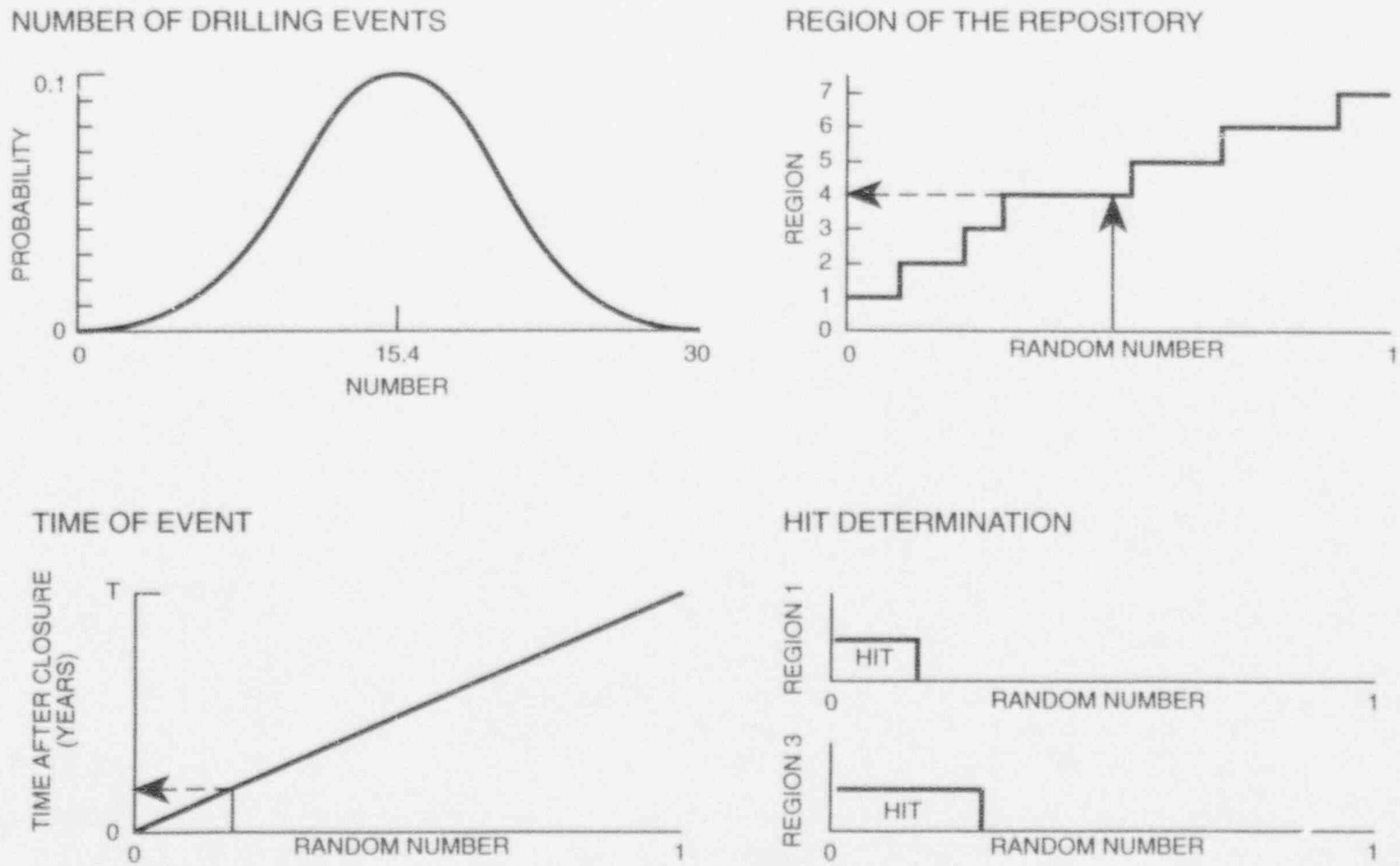
$$C_{WP} = I_{WP} \left[\frac{V_e}{V_{WP}} \right] \qquad C_{RC} = I_{RC} \left[\frac{A_e}{A_{RC}} \right]$$

A = CROSS-SECTIONAL AREA
C = AVERAGE CONSEQUENCES OF REMOVING RADIONUCLIDES FROM THE COMPARTMENT
I = INVENTORY OF RADIONUCLIDES IN THE COMPARTMENT
V = VOLUME
P = CONDITIONAL PROBABILITY OF DRILLING INTO THE COMPARTMENT
$_e$ = BOREHOLE (EXCAVATED)
$_{RC}$ = ROCK COLUMN (SAME AREAL EXTENT AS REPOSITORY)
$_{WP}$ = WASTE PACKAGE

3 COMPARTMENT ANALYSIS



SAMPLED DRILLING EVENTS



PHASE 2 DRILLING CONSEQUENCE ANALYSIS

$$\frac{dI_i}{dt} = -\lambda_i I_i + \lambda_{i-1} I_{i-1} + M_i(t)$$

I_i = INVENTORY OF NUCLIDE i IN THE GIVEN COMPARTMENT

λ_i = DECAY CONSTANT FOR NUCLIDE i

$M_i(t)$ = RATE OF MASS INJECTION OR REMOVAL OF NUCLIDE i IN THE COMPARTMENT

FOR BATEMAN SOLUTION:

$$M_i(t) = 0 \qquad I_i(t=0) = I_{0i}$$

TO USE BATEMAN SOLUTION, ASSUME:

$$M_i(t) = \sum_{j=0}^{J} \delta(t-t_j)\, \Delta t_j F_{ij}$$

$\delta(t-t_j)$ = DIRAC DELTA FUNCTION

Δt_j = LENGTH OF TIME INTERVAL

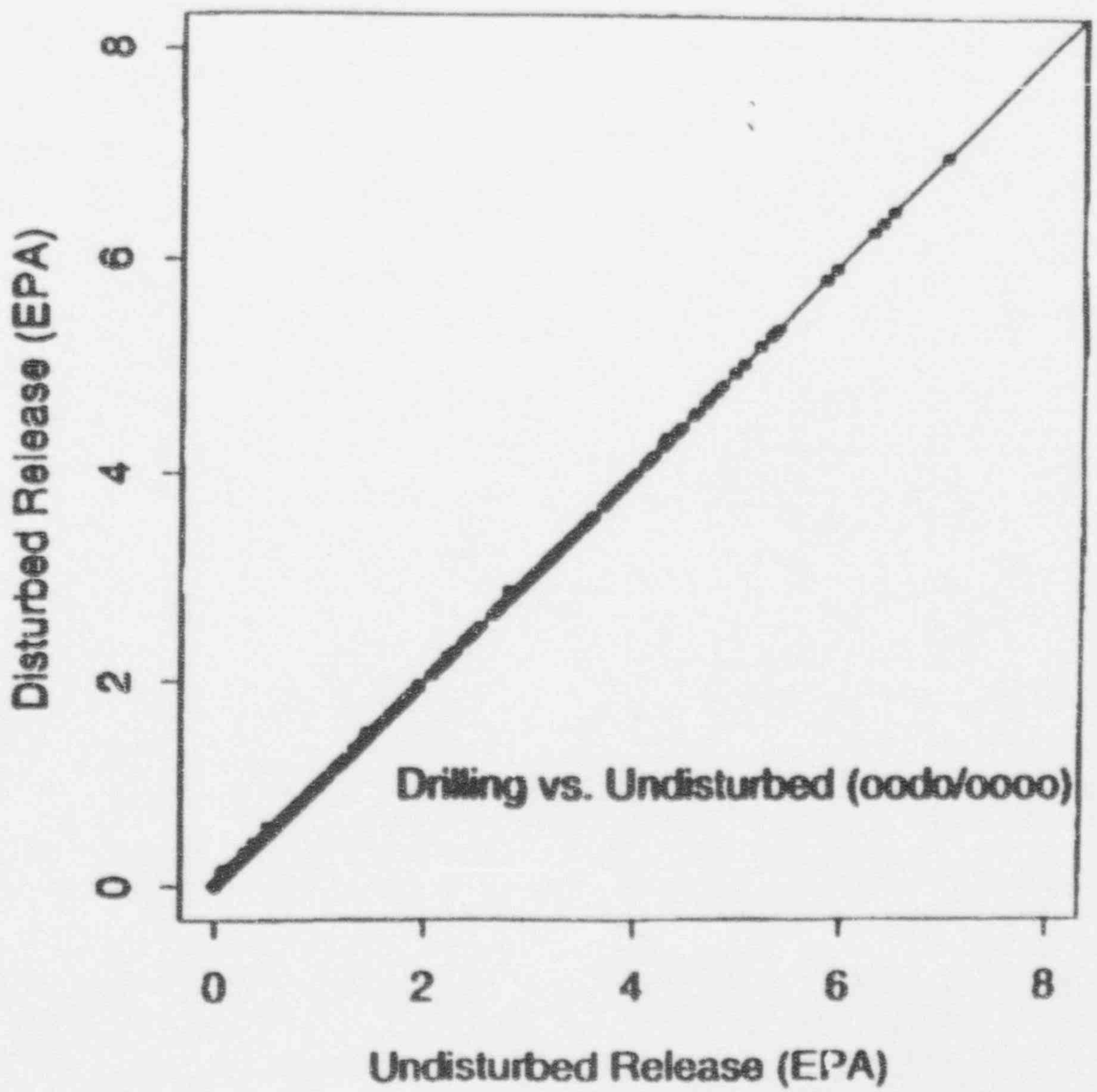
PHASE 2 DRILLING CONSEQUENCE ANALYSIS *(CONTINUED)*

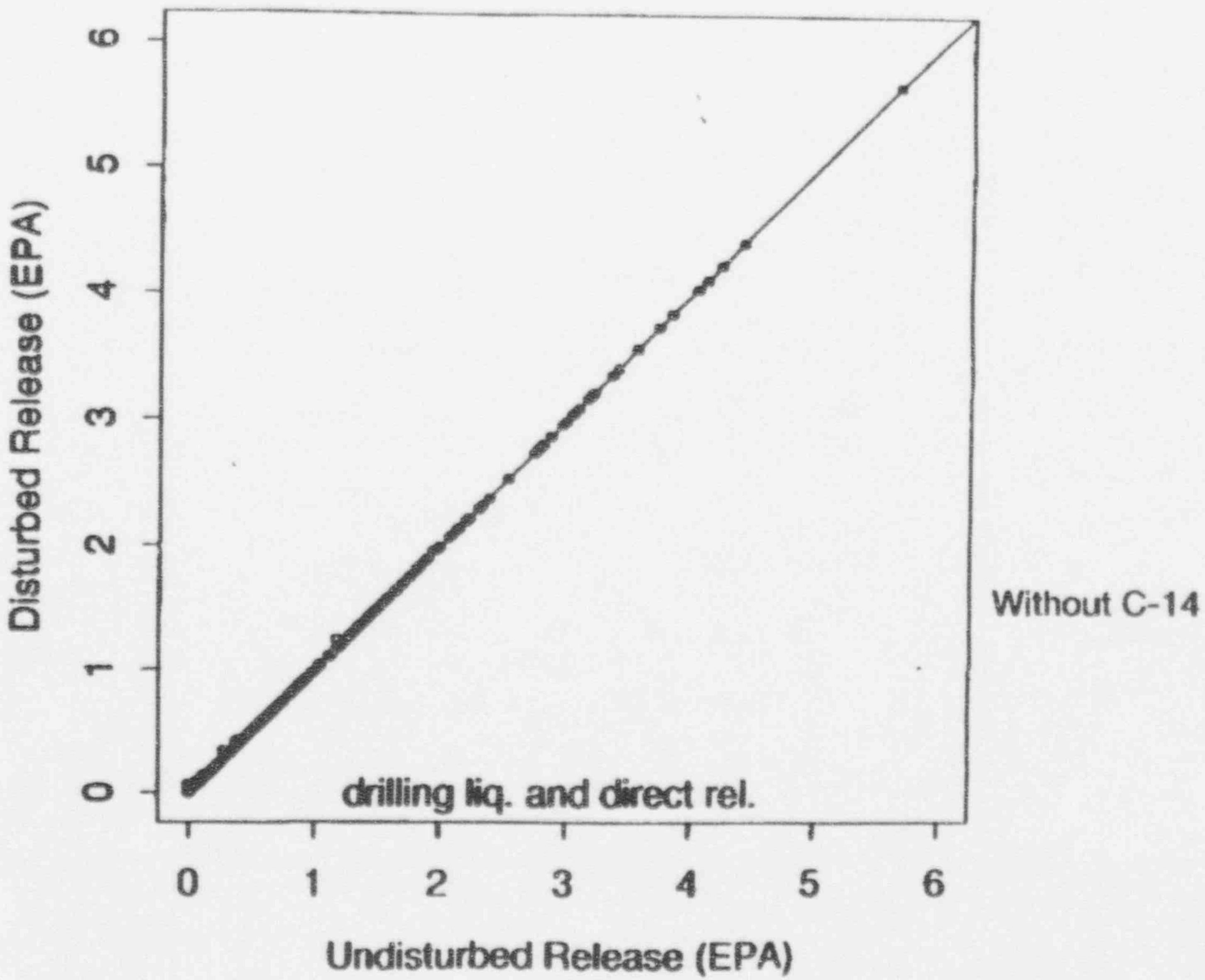
F_{ij}^{WP} = - POINT ESTIMATE OF THE RELEASE OF RADIONUCLIDE i AT TIME j TO THE GEOSPHERE

F_{ij}^{RC} = + POINT ESTIMATE OF THE RELEASE OF RADIONUCLIDE i AT TIME j FROM THE WASTE PACKAGE - POINT ESTIMATE OF THE RELEASE OF RADIONUCLIDE i AT TIME j TO THE ACCESSIBLE ENVIRONMENT

$$C_{HIT} = I_{WP} \left[\frac{A_e}{A_{WP}} \right] + I_{RC} \left[\frac{A_e}{A_{WP}} \right]$$

$$C_{MISS} = I_{RC} \left[\frac{A_e}{A_{RC}} \right]$$


Drilling vs. Undisturbed (oodo/oooo)
Disturbed Release (EPA)
Undisturbed Release (EPA)
0
2
4
6
8



Disturbed Release (EPA)
0
1
2
3
4
5
6
drilling liq. and direct rel.
Undisturbed Release (EPA)
Without C-14

Preliminary Calculations
Subject to Further Review

HUMAN INTRUSION SCENARIOS: DOSES TO MEMBER OF THE PUBLIC

ASSUME:

---HUMAN INTRUSION RESULTS IN A HIT ON A CANISTER AND THE RELEASE OF RADIONUCLIDES DIRECTLY TO THE SURFACE ABOVE THE REPOSITORY

---4% OF MATERIAL BROUGHT TO SURFACE BECOMES AIRBORNE & RESPIRABLE

---MEMBER OF PUBLIC DOWNWIND AT 5 KILOMETERS FOR 5550 HOURS PER YEAR

---THE PLUME DEPOSITS RADIONUCLIDES ON CROPS SUBSEQUENTLY INGESTED BY FARM ANIMALS AND HUMANS (CONTAMINATED MILK, BEEF, VEGTABLES)

HIGHEST LIFETIME EFFECTIVE DOSE FOLLOWING HIT:

HIT AT:	DOSE AT:	REMS/70YRS:	R=SUM Q/L
100 YRS	140 YRS	4.2E-01	2.97E-02
500	560	4.7E-01	2.25E-02
1,000	1,050	2.5E-01	2.18E-02
10,080	>10,080	<3E-06	1.89E-02

NOTE: AM-241, PU-239, PU-240, NP-237 ARE MAJOR CONTRIBUTORS TO DOSE.

CONTRIBUTION FROM C-14 IS NEGLIGIBLE AT ALL TIMES SHOWN.

OVERVIEW OF MODEL DIFFERENCES BETWEEN PHASE 1 AND PHASE 2:

	PHASE 1	PHASE 2
COMPARTMENTS	2	3
MIGRATION PATHWAY(S)	LIQUID ONLY	LIQUID AND GASEOUS
DECREASE IN ROCK COLUMN INVENTORY	DECAY ONLY	DECAY AND MIGRATION TO ACCESSIBLE ENVIRONMENT
METHOD OF CONSEQUENCE DETERMINATION	AVERAGE	SAMPLED
MODEL SOPHISTICATION	RUDIMENTARY	SIMPLE
NUMBER OF AREAL REGIONS USED	1	7
INVENTORY MODELING	DECAY ONLY	DECAY & DAUGHTER PRODUCTION
DRILLING FAILURE OF CANISTERS	NO	YES
CONSEQUENCES (CUMULATIVE RELEASE)	SMALL	SMALLER

PROBLEM AREAS:

- DISCRETIZATION IN TIME AND SPACE
- APPROPRIATE LEVEL OF DETAIL
- PROBABILITIES MAY BE INFLUENCED BY SAMPLED VARIABLES
- INTEGRATION WITH OTHER SCENARIOS
- MANAGING CONCURRENT EVENTS
- VARIABILITY IN CHARACTERISTICS AND SCOPE OF HUMAN INTRUSIVE EVENTS (e.g., TYPE OF DRILLING, MINING, INJECTION)

LESSONS LEARNED

- SIGNIFICANT UNCERTAINTY IN PREDICTING HUMAN ACTIVITY:
  - FULL RANGE OF POTENTIAL ACTIVITIES CAN NOT BE MODELED
  - MODELS MAY FOCUS ONLY UPON ASPECTS EASILY MODELED

LESSONS LEARNED *(CONTINUED)*

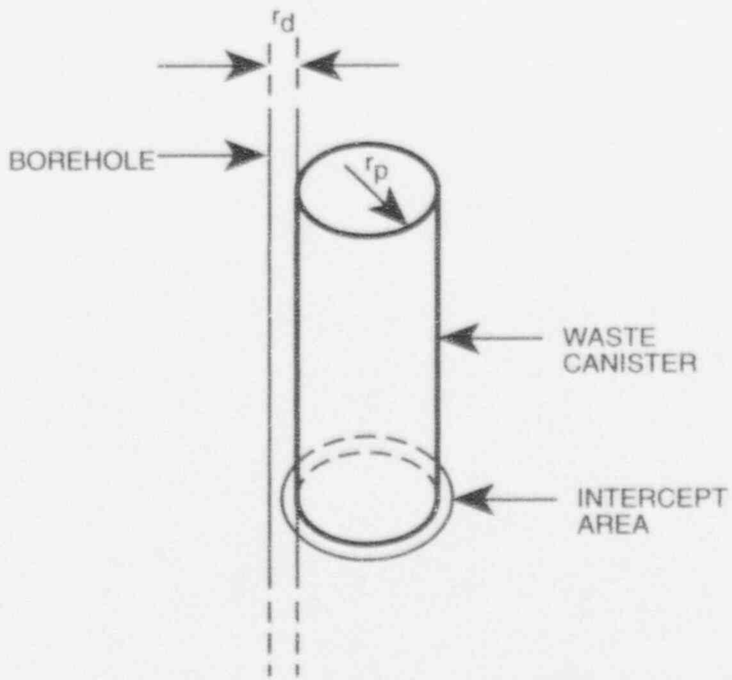
- COUPLING OF BASE PERFORMANCE AND DISRUPTED PERFORMANCE:

  - A REPOSITORY BETTER AT RETAINING RADIONUCLIDES FOR UNDISTURBED CONDITIONS WILL BE VULNERABLE TO DISRUPTIVE EVENTS.

  - A REPOSITORY LESS ABLE TO RETAIN RADIONUCLIDES FOR UNDISTURBED CONDITIONS WILL BE MORE IMMUNE TO DISRUPTIVE EVENTS.

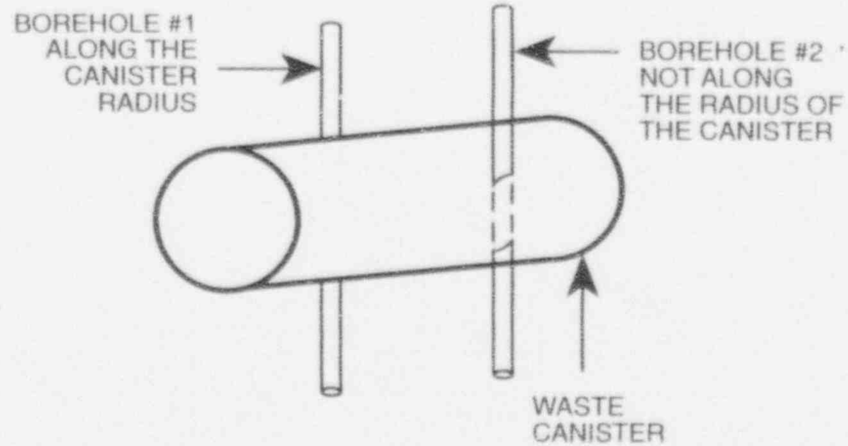
VERTICAL EMPLACEMENT

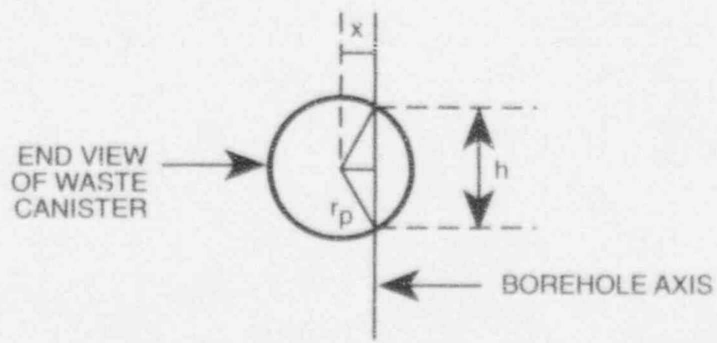
$$V_e^v = \pi r_d^2 L$$



HORIZONTAL EMPLACEMENT

$$V_e^h = \frac{r_p (\pi r_d^2)}{2}$$





V_e^h = VOLUME OF WASTE EXCAVATED FROM A HORIZONTALLY EMPLACED WASTE PACKAGE

V_e^v = VOLUME OF WASTE EXCAVATED FROM A VERTICALLY EMPLACED WASTE PACKAGE

r_p = RADIUS OF THE WASTE PACKAGE

r_d = RADIUS OF THE BOREHOLE

L = LENGTH OF THE WASTE PACKAGE

RADIONUCLIDE MIGRATION

WASTE PACKAGE

▼

EBS

▼

GEOSPHERE

▼

BIOSPHERE

WASTE PACKAGE, EBS, GEOSPHERE } REPOSITORY

GEOSPHERE, BIOSPHERE } ACCESSIBLE ENVIRONMENT

Preliminary Calculations
Subject to Further Review

HUMAN INTRUSION SCENARIOS: EXTERNAL DOSES DUE TO CANISTER HIT

ASSUME:

---RELEASE FROM CORE SAMPLE (1.5 METERS LONG AND O.D.= 0.1 METER)

---DAMP CORE SAMPLE - NO AIRBORNE DUST - NO INHALATION

---NO INGESTION OF CORE SAMPLE MATERIAL (UNREALISTIC?)

---CORE SAMPLE IS UNSHIELDED (BOTH BETA AND GAMMA DOSE CALCULATED)

---CONSIDER ONLY EXTERNAL EXPOSURE TO GEOLOGIST THAT HANDLES SAMPLE

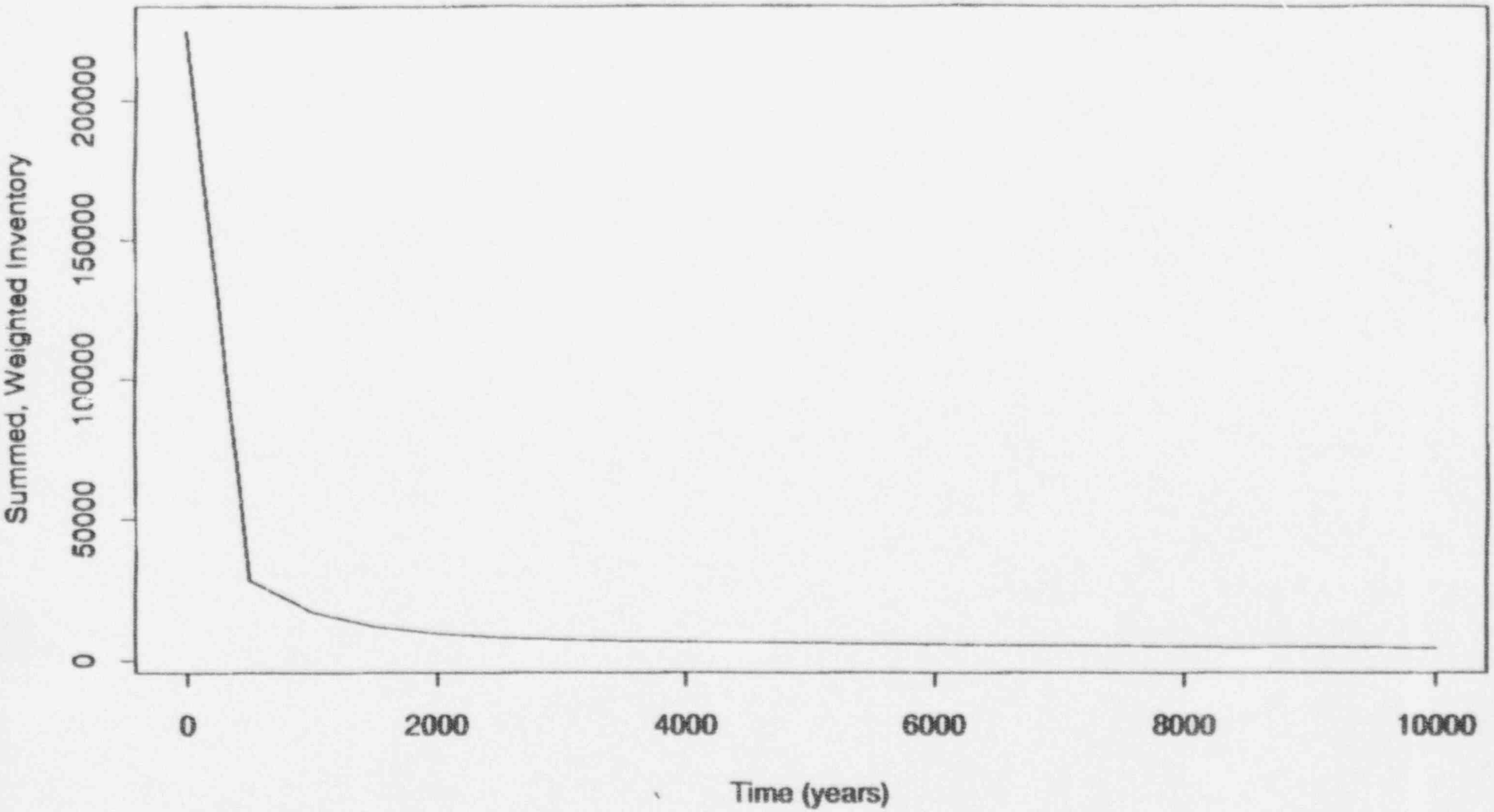
---ALL OPERATIONS CONDUCTED AT ARM'S LENGTH (2 FEET)

---EXPOSURE FOR ONE HOUR (TO DECOUPLE SAMPLE, LOG IN, STUDY, STORE)

---EXTREMITY DOSES NOT CONSIDERED, ONLY WHOLE BODY DOSE

---DOSE BASED ON INVENTORY OF PARENT AND DAUGHTERS AT TIMES SHOWN

DOSE AT:	REMS/HOUR:	R=SUM Q/L	CONTRIBUTING NUCLIDES:
100 YRS	60.7	2.19E-04	99.7% CS-137
10,000 YRS	0.3	1.40E-04	94.5% NP-237; 5.5% NB-94



Repository inventory as a function of time, assuming no release, only decay and produ..on. Measured in units of R = sum(Qi(t)/Li).

POLICY ISSUE
(Information)

November 26, 1993

SECY-93-322

FOR: The Commissioners

FROM: James M. Taylor
Executive Director for Operations

SUBJECT: INSTITUTIONAL CONTROLS USED TO PROTECT WASTE DISPOSAL SITES FROM INADVERTENT INTRUSION

PURPOSE:

To provide the Commission with information on, and examples of, passive and active institutional controls that have been used to protect waste disposal sites from inadvertent intrusion.

SUMMARY:

In this paper, the staff examines and reports on institutional controls used by the U.S. Nuclear Regulatory Commission, the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Energy (DOE) to protect against inadvertent intrusion into waste disposal sites. As defined in this paper, active institutional controls to protect against inadvertent intrusion are deliberate human actions carried out at the site to restrict access and use of the site; they are primarily security measures such as visual surveillance. Passive institutional controls are man-made controls that do not require any deliberate human action at the site after they have been put in place, and are taken primarily to provide control over access and future use of the site. They include: land-use controls, such as restrictive land covenants; records of the site; identifying markers and monuments; government land ownership; and man-made barriers to limit access to the site.

NOTE: TO BE MADE PUBLICLY AVAILABLE IN 10 WORKING DAYS FROM THE DATE OF THIS PAPER

Contact: Ronald B. Uleck, NMSS
504-2595

The types of controls used in NRC, EPA, and DOE programs are similar, except that EPA does not usually require government ownership of the site, as NRC and most Agreement States do in their regulations.

BACKGROUND:

On May 26, 1993, the Commission was briefed by the NRC staff on its risk harmonization efforts with EPA. (Supporting documentation is provided in SECY-93-134, "Status of Risk Harmonization with the Environmental Protection Agency under the 1992 Memorandum of Understanding.") In that briefing, questions were identified about NRC's and EPA's use of institutional controls to protect against inadvertent intrusion, namely: Is inadvertent intrusion explicitly considered in the regulations? What are the agencies' regulatory requirements regarding institutional controls to prevent intrusion? What are the distinctions between "active" and "passive" institutional controls? Have the agencies employed a consistent approach to use of institutional controls?

The Commission subsequently requested the staff, in a Staff Requirements Memorandum (SRM) dated June 16, 1993, to provide further information on institutional controls used to protect sites against inadvertent intrusion. The staff's response, which follows, is based on a review of NRC, EPA, and DOE programs.

DISCUSSION:

The staff has organized this paper in a format which allows meaningful comparisons among institutional controls employed in different programs. The paper contains the following in the sequence shown:

- Key terms related to institutional controls for protection against inadvertent intrusion are defined. The programs covered in this paper do not always use the same terms, or even explicitly address the concepts associated with institutional controls to protect against inadvertent intrusion. Thus, a defined terminology is needed to compare institutional controls among different programs.

- The different approaches that could be employed to prevent or reduce the potential for inadvertent intrusion for long time periods are identified and described. Using institutional controls is one of these approaches.

- Examples are then provided of active and passive institutional controls that are now being used to protect against inadvertent intrusion.

- An overview is provided of the regulatory requirements for institutional controls to protect against inadvertent intrusion for specific EPA, NRC, and DOE programs.

- Staff observations are provided that highlight the major points that have been derived from this review.

- Enclosure 1 is a table summarizing, for each program, institutional controls and other regulatory provisions relevant to inadvertent intrusion, including performance objectives to protect the intruder, siting criteria, facility design features, and waste characteristics and form.
- Enclosure 2 gives a brief description of each program, focusing especially on institutional controls for protection against inadvertent intrusion.

Definitions:

To assist in providing common understanding of the various terms used in the different waste disposal programs, the staff has identified key terms and defined them broadly below. These definitions were used in reviewing each of the programs examined in this paper. The definitions used in this paper are generally consistent with requirements in current regulations, but are not intended to replace terms used in current regulations or applied in practice in specific programs.

As used in this paper:

"Inadvertent intrusion" means the action(s) taken by a person who might unknowingly enter and occupy a site and engage in normal activities, such as agriculture, dwelling construction and occupancy in which the person might be unknowingly exposed to radiation, hazardous chemicals, or other waste materials. Intrusion may be permanent, such as in a lifetime residence; temporary, such as for transient recreational activities; or for exploitation of natural resources. Intrusion may or may not involve physical disturbance of the site or the waste.

"Institutional controls" mean the actions taken by an "institution" for management and control of a site after closure. It includes activities such as: physical security; surveillance; environmental monitoring; access control; site utilization; maintenance operations; site marking and preservation of records; government land ownership; and other activities, as determined by the responsible regulatory authority. Certain of these activities are related to protection against human intrusion and habitation of the site, whereas others are directed at maintenance and monitoring to ensure proper control of disposal systems. This paper addresses only those institutional controls whose primary functions are to protect the sites from inadvertent intrusion. The definitions for active and passive institutional controls below, therefore, are limited to actions taken to protect against inadvertent intrusion.

"Institution" means a public or private organization, establishment, agency, society, or other entity engaged in or directed to a particular objective.

"Active institutional controls" mean deliberate human actions physically carried out at the site to restrict access to and use of the site. Active institutional controls involve some form of human activity, to ensure continued restriction of access and use of the site. Active controls can be ongoing, such as security surveillance, or may be limited to infrequent activity, such as a one-time repair of a fence.

"Passive institutional controls" mean man-made controls, such as a permanent monument or restrictive land covenant, that do not require or directly involve any deliberate human action at the site after they have been put in place. Passive controls are undertaken primarily to provide control over access and future use of the waste disposal site. It is expected that certain passive institutional controls, such as restrictive land covenants, will survive long after active institutional controls have ended.

In practice, there may not always be a clear delineation between active and passive controls. For example, some barriers (e.g., fences, a passive control) require periodic maintenance (an active control) to ensure their continued effectiveness. The effectiveness of restrictive land covenants (a passive control) relies upon actions of institutions that record and control land use. Nevertheless, the staff believes the above definitions are useful for describing the essential differences between the two types of institutional controls.

Approaches to Protection against Inadvertent Intrusion:

Different approaches can be undertaken to prevent inadvertent intrusion onto sites. The use of institutional controls is one of several. In this section, the staff identifies and briefly describes these approaches to help place in perspective the use of institutional controls and their contribution to the overall objective of protecting sites against inadvertent intrusion. The comparison of different programs presented later in this paper also includes each of these approaches.

The principal approaches used for protection against inadvertent intrusion are the following:

- Establishing a specific regulatory provision or a performance objective requiring the site operator to take specific actions to protect the inadvertent intruder. Although not a control per se, an explicit regulatory provision can provide additional assurance that an intruder is protected. For example, 10 CFR 61.42 requires that the design, operation, and closure of a land disposal facility must insure protection of any individual inadvertently intruding into the site at any time after active institutional controls over the disposal site are removed.

- Siting in a location where the likelihood of intrusion is lower than for other possible locations. Sites located in sparsely populated areas or areas where there are no known natural resources that could be exploited at a later time have a lower likelihood of intrusion than sites with known resource potential.

- Incorporating design features so that human intrusion into the waste disposal system is difficult or impossible. Fences around the perimeters of the sites are often used, as are multi-layered covers or concrete covers over disposal trenches. Soil or a geologic formation between the waste and the earth's surface, or thick concrete vaults can be employed. For all of these features, the functions of the barriers are to make intrusion difficult.

- Specifying the characteristics of the hazardous materials. Limits can be placed on the concentrations of materials, for example, so that if intrusion occurs, the hazard would be bounded, or for sites where the hazard decreases over time, the absence of a significant hazard would be ensured.

- Employing long-term institutional controls that restrict human access to the sites, warn humans about the hazards posed by the waste materials, and maintain physical barriers.

Institutional Controls Used to Protect Against Inadvertent Intrusion:

The staff reviewed the use of institutional controls for several different programs. Programs regulated by NRC and addressed in this paper include: low-level radioactive waste (LLW), high-level radioactive waste (HLW), uranium mill tailings, (covered under the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA)), and decommissioning. Programs regulated by EPA include: hazardous waste management and municipal solid waste management covered under the Resource Conservation and Recovery Act (RCRA); Superfund sites covered under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA); and the Waste Isolation Pilot Project (WIPP). The DOE LLW disposal program was also reviewed. In its review of the regulations and current and planned sites, the staff identified active and passive institutional controls used to protect against inadvertent intrusion. Examples of active and passive institutional controls to protect against inadvertent intrusion are given below. These examples are drawn from both current regulations and historical applications.

Examples of Active Institutional Controls
Used to Protect Against Inadvertent Intrusion

- Security to limit access to the site, including visual surveillance or guards, coordination with local law enforcement agencies to enforce against trespassing, and monitoring of the site to ensure that the site is used only for permitted uses.

- Maintenance of a security fence and other barriers to limit access.

Examples of Passive Institutional Controls
Used to Protect Against Inadvertent Intrusion

- Records deposited with government agencies, including: as-built drawings of the facility; all disposal data; a plat or land survey; and other records prepared by the developer-operator that may have a bearing on protection against inadvertent intrusion.
- Engraved stone monuments and signs, both onsite and offsite, warning of the hazard of the site.
- Intervisible monuments (that is, visible from one to the other) providing vertical and horizontal data on site locations. These are typically referenced to U.S. Geological Survey control stations and are intended to provide definitive, recorded data on site location.
- State or Federal land ownership of the site after closure, including subsurface rights and interests (government ownership and control of use is expected to survive long into the future).
- Restrictive land covenants attached to the deed of the property (site). (For additional information on restrictive covenants and equitable servitudes, easements, zoning, government ownership, trusteeship, deed notices, restrictions on water use and other site conditions, and cooperative agreements, see: Memorandum from D. Michaels, Office of the General Counsel (OGC), to F. Cameron, OGC, August 27, 1993, on "Alternative Mechanisms for Land Use Restrictions.")
- Land-use control through zoning ordinances, community master plans, and special use/area plans.
- Fencing and other physical barriers.

In addition to the controls listed above, which are undertaken specifically to protect against inadvertent intrusion, institutional controls designed for other purposes may also indirectly provide protection. For example, the human presence required to perform environmental monitoring and maintenance operations will, itself, limit to some extent the likelihood of inadvertent and unauthorized activities at the site. Further, actions taken to maintain site integrity, such as maintenance of disposal unit covers, will make it more difficult to intrude into the waste.

An overview of the Federal agency regulatory requirements for the use of institutional controls to protect against inadvertent intrusion, for each program reviewed for this paper, is provided below. Statutory requirements are noted, where applicable.

NRC - LLW Disposal: Active controls are required for up to 100 years, including control of access to the site. Passive controls include Federal or

State ownership of the site, site markers, and restrictions on future land use.

NRC - HLW Disposal: Certain passive institutional controls are required to restrict access and to reduce the risk of human intrusion; active institutional controls are not required over long time periods. Passive controls include DOE land ownership, permanent monuments, records, and water rights. The Energy Policy Act of 1992 requires continued DOE oversight of the Yucca Mountain site, but does not specify a time period for such oversight. The Act further directs NRC to assume, consistent with National Academy of Science findings, that following repository closure, DOE oversight along with engineered barriers will be effective.

NRC - Uranium Mill Tailings Disposal: Active controls for inadvertent intrusion are not required. Passive controls mandated by UMTRCA include Federal or State ownership and custody of the disposal site. Other passive controls include control over public use of groundwater.

NRC - Decommissioning: Normally, no measures for protection against inadvertent intrusion are required or allowed for decommissioning, since, under current NRC regulations, the objective is to remove radioactivity to levels acceptable for unrestricted use of the site. However, under the proposed enhanced participatory rulemaking on residual radioactivity criteria, alternatives to unrestricted use are being considered.

EPA - Hazardous Waste Management: Active controls, such as security measures to control access to the site, are typically required for 30 years, but can be extended or shortened by EPA if necessary, depending on the specific conditions of the site. Passive controls are required, and are primarily land-use restrictions and records of the facility.

EPA - Municipal Solid Waste Landfill: Controls are similar to those used in hazardous waste management. Active controls, such as security measures to control access to the site, are typically required for 30 years. Passive controls are required, and are primarily land-use restrictions and records of the facility.

EPA - Superfund: The National Contingency Plan, required by CERCLA, is sufficiently general to allow the use of a wide variety of institutional controls, on a site-specific basis, to implement remedies that eliminate, reduce, or control risks to human health and the environment. Institutional controls may be required during initial remedial/feasibility investigations and during implementation of short-term and long-term remedies to limit exposure to or contain the wastes. If a remedial action results in hazardous contaminants remaining on site above unrestricted use levels, institutional controls would likely be required. Active controls, such as site security measures, may be required for 30 years or more; passive controls may include Government ownership of the site and perpetual oversight by responsible parties.

EPA - WIPP: The use of active controls is encouraged, and such controls are to be maintained as long as possible, but are not to be relied on for more than 100 years in performance assessments. Passive controls are required and include Federal ownership of the site, permanent markers, and extensive records. The WIPP Land Withdrawal Act of 1992 provides for DOE jurisdiction and certain land-use restrictions over the withdrawn lands.

DOE - LLW Disposal: Requirements are similar to those for NRC LLW disposal. Active site security controls are required for up to 100 years. Passive controls are required and include permanent identification markers, records, and DOE ownership and oversight.

A more detailed summary of the regulatory requirements in each program, to protect against inadvertent intrusion, is given in Enclosure 1. The regulatory requirements include the following areas: performance objectives for the inadvertent intruder; siting; facility design; waste characteristics and form; and institutional controls. The institutional controls in the table represent the major types of controls applicable to the different programs. The duration (number of years) required, or the maximum number of years for which credit can be taken in performance assessment, is shown for both active and passive institutional controls. For active institutional controls, the major control is site access control (this is the only one shown in the table). It includes all security measures to limit access to the site, including visual surveillance, coordination with law enforcement agencies, monitoring and control of permitted uses, and maintenance of fences and other barriers. For passive institutional controls, the types of controls shown are: site access control, such as fences; government ownership requirements of the site; records, such as, as-built drawings of the facility, waste data, and plats and land surveys; site identification measures, such as monuments and signs; and site land-use controls, such as restrictive land covenants, zoning ordinances, and community master plans.

OBSERVATIONS:

Based on staff's review of the Federal regulations and case-specific practices for the programs covered in this paper, the staff offers the following observations concerning institutional controls and their use to protect against inadvertent intrusion.

- Federal regulations for all waste disposal programs reviewed for this paper require institutional controls for protection against inadvertent intrusion. (For sites that are remediated to allow release for unrestricted use, there are typically no requirements or allowances for institutional controls after closure, and termination of the license if applicable, assuming that such sites would not present a public health and safety hazard. This includes NRC-licensed decommissioning sites and EPA-regulated hazardous waste management and Superfund sites which have been remediated to allow unrestricted use.)

- The use of specific controls for protection against inadvertent intrusion, both in the Federal regulations and in practice, is affected by the characteristics of the hazardous materials and technology used at each site. For example, both HLW and RCRA hazardous wastes may remain hazardous for thousands of years. For HLW, the strategy of deep geologic disposal at a suitable site - where inadvertent intrusion would be difficult - is intended to reduce the necessity for and reliance upon active institutional controls. For hazardous waste disposal facilities, where waste may be disposed of near the surface of the earth and more easily disturbed, there are requirements for both active and passive controls of the disposal site, to prevent intrusion and disturbance of the waste.

- NRC waste disposal programs use similar institutional control strategies to protect sites against inadvertent intrusion. There are some programmatic differences, however. All require government ownership and similar passive controls that are expected to be available into the indefinite future. Similar active controls, to protect against inadvertent intrusion, are also required, except in the uranium mill tailings program, which relies only on design and construction of barriers to prevent intrusion. The duration that active institutional controls are required to be implemented differs from one program to another. These differences are, in part, influenced by the accessibility of the waste. In the LLW program, the active institutional control period is 100 years after closure. In the HLW program, there is no explicit limit on the duration of active institutional control. However, the provision for termination of a repository license indicates that long-term reliance on active institutional controls is not anticipated. The staff identified no differences in NRC programs that are not explainable and justifiable.

- Although there are similarities, EPA and NRC programs sometimes differ in their approaches to inadvertent intrusion. NRC specifies that the State or Federal government own the land on which waste is disposed. EPA hazardous waste, municipal waste, and Superfund programs do not typically require government ownership. EPA generally specifies a certain time period for active controls, as does NRC, but places stronger emphasis on its discretion to lengthen or shorten the 30-year control period specified in the regulations, depending on the conditions at a particular site. The 30-year post-closure period may not be sufficient for some sites containing hazardous materials that do not significantly degrade with time.

- There appears to be a growing trend towards requiring longer periods of institutional control, but there remains no consensus on the length of time that these controls can be relied on. The longer periods of active institutional controls can be used as an additional measure of protection above that required to protect public health and safety (i.e., be a margin of safety) or as an essential feature in providing adequate protection of public health and safety. For example, in the

HLW program, while the Energy Policy Act of 1992 requires DOE to maintain continued oversight of the Yucca Mountain site, it also directs the National Academy of Sciences (NAS) to evaluate whether a system for post-closure oversight, based upon active institutional controls, can be developed to prevent certain unreasonable risks. In the LLW program, some States have specified active institutional controls for longer than 100 years. At this time, Part 61 precludes the reliance on these controls for more than 100 years in assessing facility performance. In the decommissioning program, a frequent comment from the public in the recent workshops on the "Enhanced Participatory Rulemaking for Decommissioning" was the desirability of allowing greater reliance on longer-term active controls.

- NRC and EPA regulatory programs both provide flexibility that can be applied to measures to prevent inadvertent intrusion. NRC's recent decision to accept Utah's exemption to State ownership by its LLW licensee, Envirocare, reflects a willingness to consider alternative approaches to land ownership in addition to those provided for in the NRC requirements. In the RCRA and Superfund programs, EPA has substantial discretion, and permittees and responsible parties have flexibility to specify particular types of institutional controls on a case-specific basis.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objection. The descriptions of the EPA and DOE programs that appear in the enclosure have been coordinated with, and reviewed by, the staffs of those agencies.

James M. Taylor
Executive Director
for Operations

Enclosures:
Summary of Regulatory Requirements
Descriptions of Federal Programs

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SUMMARY OF REGULATORY REQUIREMENTS THAT CONTRIBUTE TO PROTECTION AGAINST INADVERTENT INTRUSION

Regulatory Requirements[1]	Agency/Program								
	NRC LLW	NRC[2] HLW	NRC TAILINGS	NRC[3] DECOM	EPA HAZ	EPA MUNICIPAL	EPA CERCLA	EPA[4] WIPP	DOE LLW
Performance Objectives[5]	Yes	No	No	No	No	No	Yes	No	Yes
Siting	Yes	Yes	Yes/No[7]	No	Yes	Yes	No	Yes	Yes
Facility Design	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Waste Characteristics/Form	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Active Inst Ctrls	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Duration (yr)	100	NS	No	--	30+[9]	30+[9]	30+[9]	Yes[10]	100
Site Access Control	Yes	Yes	No	--	Yes	Yes	Yes	Yes[6]	Yes
Passive Inst Ctrls	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Duration (yr)	NS	NS	Perpetual[8]	--	NS	NS	Perpetual	NS	NS
Site Access Control	Yes	Yes[6]	No	--	Yes	Yes	Yes	Yes	Yes
Gov't Ownership Req'd	State/Fed	Fed	State/Fed	--	No	No	Maybe	Fed	Fed
Records	Yes	Yes	Yes	--	Yes	Yes	Yes	Yes	Yes
Site Identification	Yes	Yes	Yes	--	Yes	Yes	Yes	Yes	Yes
Site Land-Use Control	Yes	Yes	Yes	--	Yes	Yes	Yes	Yes	Yes

[1] The regulatory requirements shown in this table reflect the concepts embodied in the actual Federal regulations, as interpreted by staff for the purposes of this paper. Any particular regulation may or may not, however, contain the terminology used in this table. A "Yes" or other descriptive term in the table means that the requirement is included in the regulation, in some form, for that type of waste disposal; a "No" means that the requirement is not included or addressed. "NS" for the duration requirement means that the time period is not specified.

[2] Entries reflect current NRC regulations, and do not reflect future amendments to conform the regulations to generally applicable environmental protection standards that will be promulgated by EPA.

[3] In NRC's regulations, "decommission" means to remove a facility safely from service and reduce residual radioactivity to a level for unrestricted use and termination of license. At termination of license, therefore, there will be no administrative or other controls on the site.

[4] The EPA standards apply to disposal of spent nuclear fuel, high-level, and transuranic wastes (40 CFR Part 191). EPA has oversight responsibility over the Waste Isolation Pilot Plant (WIPP), which also involves regulations beyond 40 CFR Part 191. EPA has not established criteria for its certification of compliance with 40 CFR Part 191.

[5] Performance objectives are requirements in the regulations that specifically address the concept of protecting the inadvertent intruder.

[6] Ownership and control requirements apply to the controlled area, from which certain incompatible activities will be restricted following permanent closure. For HLW disposal, NRC requires additional controls, including water rights as needed outside the controlled area, to prevent adverse human actions.

[7] There are siting criteria for new active sites and, to some extent, for existing active sites; but there are no siting criteria for inactive sites.

[8] Duration is limited to 100 years for restoration of contaminated aquifers at inactive sites. EPA standards stipulate that the institutional controls must be effective over the entire period of time that they would be in use, and that the controls proposed must have a high probability of protecting human health and the environment and must receive NRC concurrence.

[9] The active control period may be extended if it is determined that continued active controls are necessary to ensure protection of public health and safety and the environment.

[10] Active institutional controls are to be maintained as long as possible. A maximum duration of 100 years is allowed for use in performance assessments.

Enclosure 1

TABLE OF CONTENTS

DESCRIPTIONS OF FEDERAL PROGRAMS

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FORMAT FOR PROGRAM DESCRIPTIONS

Descriptions of the programs in this enclosure are organized in the following format:

PROGRAM TYPE:

Name of program.

PROJECT DESCRIPTION:

A brief description of the nature of a typical project covered under the regulatory program.

REGULATORY FRAMEWORK:

The primary statutes and regulations governing the licensing or permitting of site-specific projects; agency responsibilities; emphasis on those regulations related to protection of sites against inadvertent intrusion.

LICENSING OR PERMITTING HISTORY:

A brief history of licensing/permitting of projects to date, including projects currently in the licensing/permitting process.

INTRUDER PROTECTION MEASURES:

Summary of active institutional controls, passive institutional controls, and site and design features used to protect sites against inadvertent intrusion.

REGULATORY AND INDUSTRY TRENDS:

Discussion of new projects, future trends, effectiveness of institutional controls, and new challenges for regulators and licensees.

PROGRAMS REGULATED BY THE U.S. NUCLEAR REGULATORY COMMISSION

PROGRAM TYPE: LOW-LEVEL RADIOACTIVE WASTE DISPOSAL

PROJECT DESCRIPTION

A low-level radioactive waste (LLW) disposal facility is a facility designed to isolate LLW from the biosphere inhabited by people. An LLW disposal facility licensed under 10 CFR Part 61 consists of the land, buildings, and equipment required for the disposal of LLW containing source, special nuclear, or byproduct material that is suitable for disposal on or into the subsurface of the land. All existing and closed LLW disposal facilities, except the Envirocare facility, were licensed before Part 61 and use shallow land burial designs. Facility designs being considered for new LLW disposal facilities, to be licensed under Part 61 or compatible Agreement State regulations, include shallow land burial with engineered enhancements, earth-mounded concrete bunkers, below-ground concrete canisters, above-ground vaults, and mined cavities.

[Note: NRC regulations allow licensees to dispose of radioactive wastes on their own property. Before 1981, 10 CFR 20.304 permitted licensees to make disposals limited to specifically given nuclide quantities and under specific conditions without prior approval. On January 29, 1981, 10 CFR 20.304 was revoked, because the NRC believed it inappropriate to continue generic authorization of these burials without licensees first notifying NRC about the location of the burial, concentrations of radionuclides, and the form of packaging. Licensees can still make disposals under 10 CFR 20.302; however, it requires an evaluation of proposed burials by the NRC or an Agreement State. These sites may be reassessed at the time the facility is decommissioned. Onsite disposals under these regulations are not covered in this paper.]

REGULATORY FRAMEWORK

The regulatory framework established by the Nuclear Regulatory Commission in 10 CFR Part 61 (promulgated in 1982) covers all phases of land disposal of LLW, from site suitability through facility design, licensing, operations, closure, and postclosure active and passive institutional control. Under the Low-Level Radioactive Waste Policy Act of 1980 and the Low-Level Radioactive Waste Policy Amendments Act of 1985, States are responsible for the disposal of commercial LLW generated within their respective States. The licensing agency for non-Agreement States is NRC; for Agreement States, it is the responsible State agency.

Part 61 contains provisions intended both to reduce the likelihood of human intrusion into a land disposal facility, and to limit the radiological impacts of inadvertent intrusion into a facility, should it occur. Thus, Part 61 contains site suitability criteria to avoid sites with known natural resources that could lead to human intrusion, and requirements for intruder barriers designed to prevent intrusion into Class C waste for 500 years. Part 61 also requires a period of active institutional control to physically control access to the disposal site, after closure. It also requires measures such as government land ownership, markers, records, and deed restrictions designed to preserve knowledge of the existence of the radioactive waste disposal facility and its content. Part 61 also contains provisions to limit radiation exposures to the inadvertent intruder, in the form of a performance objective for protection of the inadvertent intruder, and a waste classification system that limits the concentration of radioactive materials to which the intruder could be exposed.

The principal section of Part 61 that establishes institutional control requirements is 10 CFR 61.59. Section 61.59(a) includes land ownership requirements and 10 CFR 61.59(b) prescribes institutional control requirements for LLW land disposal facilities, namely: control of access, environmental monitoring, surveillance, minor custodial care, and administration of funds to cover the costs for these controls.

The following sections of Part 61 provide additional specification of institutional control requirements to protect against inadvertent intrusion:

61.7(b)(3) - Institutional controls are to ensure against inadvertent intrusion or improper use of the site after operations.

61.7(b)(5) - Disposal of Class C waste, including use of intruder barriers, to be designed for 500 years.

61.17(b)(4) - Institutional control program for control of access to site is required for up to 100 years.

61.23(c) - Proposed facility, including the institutional control period, must be adequate to meet the inadvertent intruder protection requirement of the performance objective in 10 CFR 61.42.

61.23(g) - The proposed institutional control period must be long enough to ensure the findings of 10 CFR 61.23(b)-(e) and 61.59.

61.55 - Determination of waste classification must consider hazard over time, including institutional controls and intruder protection.

LICENSING HISTORY

Six commercially operated LLW disposal facilities have been licensed and operated in the United States. These facilities were licensed before Part 61 in the following locations: Beatty, Nevada; Maxey Flats, Kentucky; West Valley, New York; Richland, Washington; Barnwell, South Carolina; and Sheffield, Illinois. The Richland and Barnwell facilities continue to operate as disposal facilities for LLW, whereas the other four sites have closed.

Following the legislative directives discussed above, States and regional compacts currently have 11 new facilities in various stages of planning and licensing. All new facilities would be licensed under Part 61 or compatible Agreement State regulations. In addition, Envirocare of Utah, Inc., has applied to NRC for a license to construct and operate a facility to receive, store, and dispose of uranium and thorium byproduct material at a site located near Clive, Utah, and has a license issued by the State of Utah to accept high volume, low activity low-level waste.

INTRUDER PROTECTION MEASURES

Protection against inadvertent intrusion is accomplished in several interrelated ways. Measures to protect against inadvertent intrusion, listed in the previous section, include requirements for site suitability, disposal site design, facility operation and disposal site closure, waste classification and characterization, and institutional controls.

Site and Design Features

Site and design features have been used to offer protection against inadvertent intrusion for both existing and planned LLW disposal facilities. Site features include: location in areas where the potential for human intrusion would appear to be low, such as areas where population growth will not affect the site; a buffer zone of land between the disposal area and the site boundary; and limited potential for future exploitation of natural resources in and around the site. Design features include all those engineered facilities that provide structural barriers to human intrusion. These could include waste disposed of below existing grade, and covered with soil or other backfill; waste placed in concrete vaults; engineered, multi-layered covers over the waste-containing trenches or vaults; and security fences around the disposal area. The regulations also specify a maximum concentration of radionuclides for all wastes, so that at the end of 500 years (the design life of intruder barriers for Class C waste) remaining radioactivity will be at a level that does not pose an unacceptable hazard to an inadvertent intruder.

Active Institutional Controls

These types of controls are usually performed by the custodial agency responsible for long-term care after site closure. The control specifically directed to protection against inadvertent intrusion is physical security, to limit site access. Other active controls, such as periodic inspection of the site, maintenance of disposal unit covers, revegetation of the disposal area, and maintenance of the security fence also indirectly provide protection. The possibility of using active controls longer than 100 years is proposed for some of the new LLW disposal facilities, although Part 61 provides that institutional controls cannot be relied upon for more than 100 years. For example: a minimum of 100 years of active controls is proposed for new facilities in California and Nebraska; the license application for a new facility in Illinois contained a 300-year active institutional control period; and Pennsylvania LLW regulations state that long-term care will be provided for the hazardous life of the waste, with active controls conducted for a **minimum** of 100 years.

Passive Institutional Controls

Typically, the primary passive controls will be: (1) the legacy of records of the facility and (2) various land-use controls of the site. Records include: as-built drawings of the disposal facility; all waste disposal data; and a formal plat or land survey. Land-use controls include government ownership of the land, restrictive covenants, and land-use zoning. Other controls include: engraved stone monuments at each trench/vault location; and intervisible monuments, providing vertical and horizontal locations referenced to U.S. Geological Survey control stations. These passive controls, typically put in place at the inception of or during the active institutional control period, are designed and expected to survive long into the future.

REGULATORY AND INDUSTRY TRENDS

Some of the planned LLW disposal facilities incorporate substantial design features, such as engineered structural barriers around the disposal units, and active institutional controls, such as enhanced maintenance operations, that afford greater protection against human intrusion into the waste. Some of the proposed LLW disposal projects also expect to use active institutional controls for periods longer than 100 years after closure. Further, the State of Utah (an Agreement State) recently used an exemption provision in its compatible LLW regulations to allow its licensee, Envirocare, to own the site. NRC's decision to accept Utah's exemption reflects a willingness to consider alternative approaches to land ownership in addition to those provided for in NRC requirements.

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PROGRAM TYPE: HIGH-LEVEL RADIOACTIVE WASTE DISPOSAL

PROJECT DESCRIPTION

A geologic repository for the permanent disposal of commercial spent nuclear fuel and high-level radioactive waste can be visualized as a large underground excavation with a complex of tunnels occupying roughly 2,000 acres, at a depth between 1,000 and 4,000 feet. To handle the waste received for disposal, surface facilities would be developed that will occupy about 400 acres. The repository is expected to be operational for about 25 to 30 years. After the repository is closed and sealed, waste isolation will be achieved by a system of multiple barriers, both natural and engineered, that will act together to contain and isolate the waste, as required by regulations. The natural barriers include the geologic, hydrologic, and geochemical features and conditions of the site. The engineered barriers consist of the waste package and the underground facility. The waste package includes the waste form, the waste disposal container, and materials placed over and around the containers. The underground facility consists of underground openings and backfill materials, not associated with the waste package, that are used to further limit ground-water circulation around the waste packages and to impede the subsequent transport of radionuclides into the environment.

REGULATORY FRAMEWORK

The Commission has licensing and related regulatory authority over geologic repositories for high-level radioactive waste, pursuant to the Energy Reorganization Act of 1974, as amended. The Commission has implemented this authority by promulgating 10 CFR Part 60. In general, the regulations mandate the establishment of certain passive institutional controls, but do not require the maintenance of active institutional controls over long periods of time.

NRC regulations must not be inconsistent with generally applicable environmental standards promulgated by the U.S. Environmental Protection Agency (EPA), including such standards as may be promulgated by EPA (following completion of a study by the National Academy of Sciences (NAS)), pursuant to the provisions of the Energy Policy Act of 1992. That statute directs the Commission to assume, to the extent consistent with the findings and recommendations of the NAS that, after repository closure, the inclusion of engineered barriers and the U.S. Department of Energy (DOE) post-closure oversight of the Yucca Mountain site will be sufficient to: (1) prevent any activity at the site that poses an unreasonable risk of breaching the repository's engineered or geological barriers; and (2) prevent any increase in the exposure of individual members of the public to radiation beyond allowable limits.

The Commission first addressed issues concerning human intrusion, as they relate to a geologic repository, in an advance notice of proposed rulemaking published in 1980 (45 FR 31393, May 13, 1980). These statements by the Commission stress that it is important to avoid sites, that would invite intrusion and, further, to rely upon deep geologic repositories, since it is not possible to completely engineer against human intrusion. At the time that the technical criteria for high-level waste repositories were proposed (40 FR 35280, July 8, 1981), the Commission elaborated on this concept and required additional institutional controls, to reduce the likelihood of inadvertent intrusion. The Commission adopted the position that everything that is reasonable would be done to discourage intrusion into the repository. This is to be accomplished by directing site selection toward locations with little resource value and that hold no apparent attraction for future societies. The site selection criteria are then supplemented by reliable documentation of the existence of the repository, its location, and the nature of the wastes emplaced within the repository. The site would also be identified with the most permanent markers practical.

After receiving public comments on human intrusion as well as on other matters, the Commission adopted its final regulations (48 FR 28194, June 21, 1983). The discussion accompanying these regulations includes comments on how the required institutional controls would be used in the evaluation of possible intrusive events. These passive control measures are expected to significantly reduce the likelihood of inadvertent intrusion into a geologic repository. It was also indicated that some intrusion, however limited it may be upon the repository, cannot be ruled out, and that some provision should be made to allow consideration of intrusion, should the passive measures fail. The final rule incorporates a definition of "unanticipated processes and events" that are reviewable in a licensing proceeding. The assumptions required by the rule include: (1) the required monuments are assumed to be sufficiently permanent to serve their intended purpose; (2) the value of potential resources to future generations can be adequately assessed at this time; (3) some functioning institutions exist that understand the nature of radioactivity and appreciate its hazards; (4) relevant records are preserved and are accessible for several hundred years after permanent closure; and (5) if institutions exist that can cause intrusion at depth, then institutions will exist that will be able to assess the risk and to take remedial action at the same level of technical competence required to initiate the events or processes concerned.

The following provisions, in the Part 60 regulations, address matters of institutional controls and human intrusion:

60.2 - contains a definition of "unanticipated processes and events" that limits the nature of human intrusion that is to be considered in a licensing review. The definition addresses the survivability of monuments, records, social organization, and technical knowledge, as well as the current ability to assess future resource valuations.

60.21 - requires DOE to include, in its license application, information concerning natural resources, land use controls, and monuments, as well as an evaluation of the performance of the repository that assumes the occurrence of unanticipated processes and events (which might include human intrusion).

60.43 - allows appropriate conditions to be placed on the license application by the Commission.

60.51 - requires DOE to submit an application to amend the license prior to permanent closure, and to include, among other things, a detailed description of measures to be employed to regulate or prevent activities that could impair waste isolation and to ensure preservation of relevant information, for the use of future generations.

60.112 - establishes an overall system performance objective that includes conformity with EPA standards, with respect to anticipated and unanticipated processes and events (which might include human intrusion).

60.121 - establishes requirements for the ownership of the geologic repository operations area and the controlled area and for appropriate additional controls outside the controlled area to prevent adverse human actions that could significantly reduce the repository's ability to achieve isolation of the waste.

60.122 - lists favorable conditions and potentially adverse conditions to be considered in evaluating whether the performance objectives relating to isolation of the waste have been met. The potentially adverse conditions include the presence of materials that may have resource value as well as evidence of past mining or drilling.

LICENSING HISTORY

No HLW disposal facilities have been licensed by the NRC to date.

INTRUDER PROTECTION MEASURES

The regulations and the statements of consideration for licensing a HLW disposal facility indicate the measures that are to be taken in siting, constructing, and operating the repository. During the operational phase of the repository, 10 CFR Part 20 regulations will be applicable to the facility. After closure, it is foreseen that monuments, land ownership, restrictions on land use and access to the site, the acquisition of water rights, and the preservation of records will deter or mitigate the effects of human intrusion. Certain assumptions described in the regulations are to be applied when determining that processes and events are sufficiently credible for consideration in the license application. The statements of consideration accompanying the final rulemaking include a discussion of assumptions related to institutional controls, their permanence, and the potential for remedial action.

REGULATORY AND INDUSTRY TRENDS

There are no high-level waste repositories that have been licensed, to date, under Part 60. Consequently, there has not been any prior application of institutional controls, under the NRC HLW regulations. The historic NRC approach to reliance on institutional controls, pertaining to HLW disposal, was outlined during the Part 60 rulemaking (1980-1983). In 1992, passage of the Energy Policy Act of 1992 and the upcoming promulgation of EPA standards under this Act has renewed interest in human intrusion and the persistence and effectiveness of institutional controls to prevent or mitigate the consequences of such intrusion.

The current regulations that govern the disposal of HLW mandate that certain passive institutional controls - such as establishing reliable documentation of the site, and the marking of the site - be provided, while not requiring the maintenance of active institutional controls. This position is consistent with the Commission's stated belief that the use of passive institutional controls will significantly reduce the risk of human intrusion. The Commission has pointed to historical evidence that there is continuity in the information transfer across generations, even in the presence of significant disruptive events such as war, as an indication of the persistence of passive controls. The location of the repository deep underground means that a significant level of effort would be required to intrude upon the repository and severely limit the potential for casual intrusion. The Commission has made the assumption that the technical ability required to intrude into the repository would coexist with institutions that could identify the risk and mitigate the consequences of an intrusion.

The NRC suspended the conforming rulemaking on Part 60 after the 1985 EPA HLW disposal standards were remanded by the courts in 1987. The Nuclear Waste Policy Act of 1982 directs that NRC regulations must not be inconsistent with generally applicable environmental regulations promulgated by the Environmental Protection Agency. The Energy Policy Act of 1992 directs NRC to revise its requirements and technical criteria to be consistent with EPA's following the completion of the required study by NAS. The Energy Policy Act of 1992 also directs the Commission to assume, consistent with the findings and recommendations of the NAS, that after repository closure, the inclusion of engineered barriers and DOE oversight will be sufficient to: (1) prevent any activity at the site that poses an unreasonable risk of breaching the repository's engineered barriers or geologic barriers; and (2) prevent any increase in the exposure of individual members of the public to radiation beyond allowable limits.

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PROGRAM TYPE: URANIUM MILL TAILINGS DISPOSAL

PROJECT DESCRIPTION

Uranium mill tailings are generated as byproduct wastes in the milling of uranium-bearing ore to extract source material (in the form of yellow cake). Such tailings have been generated in the United States at now "inactive" mills that were operated to provide uranium for national defense, as well as "active" mills regulated by NRC or the Agreement States and operated mainly to provide uranium to the commercial nuclear power industry.

Mill tailings pose a potential radiation health hazard to the public. The most critical hazardous constituent in the tailings is radium-226 and its daughter products. Because of the long half lives of several uranium daughters and the presence of heavy metals, the mill tailings are potentially hazardous for thousands of years.

In accordance with the existing regulations, uranium mill tailings must be stabilized for 1000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. Stabilization and safe isolation of the tailings, in disposal sites, are functions of the site and engineering design, with the overriding consideration given to site characteristics.

REGULATORY FRAMEWORK

The Atomic Energy Act of 1954, as amended, provided authority for ownership, custody and control of byproduct materials, including mill tailings. The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) requires stabilization, disposal, and control of mill tailings in a safe and environmentally sound manner, under two titles: Title I program, for inactive (abandoned) sites, and Title II program, for active sites.

Title I of UMTRCA provides a joint Federal-State funded program for remedial action at 24 inactive commercial uranium mill sites, at which all or substantially all of the uranium was produced for sale to any Federal agency, prior to January 1, 1971. DOE will own the radioactive materials in perpetuity and will be subject to a general NRC license. Under Title I, DOE is assigned the responsibility of selecting and completing remedial action at inactive sites. EPA is assigned the responsibility of establishing the environmental standards that DOE implements in its remedial action. NRC is assigned the responsibilities of evaluating and concurring that DOE's proposed remedial actions meet the EPA standards, and licensing DOE for long-term care of the disposal sites.

Title II of UMTRCA applies to mill tailings from commercial uranium mills that were under license by NRC or Agreement States, after the Act was enacted in 1978. Title II legislation authorized NRC to control, and EPA to establish applicable standards for radiological and non-radiological hazards, with ultimate State or Federal ownership subject to NRC license.

Standards for environmental protection at uranium and thorium mills were promulgated by EPA pursuant to UMTRCA. The standards were issued separately for the Title I and Title II sites. Standards for Title I sites were issued on January 5, 1983, as Subparts A, B, and C of 40 CFR Part 192. But based on a court decision, that part of the Title I standards pertaining to groundwater protection was reissued by EPA (Proposed Rule dated September 24, 1987). The Final Rule for the Title I groundwater standards has not been issued. The Proposed Rule has been, and will continue to be, used in the implementation of the Title I program, until the Final Rule is promulgated by EPA.

Standards for Title II sites were published on October 7, 1983, as Subparts D and E to 40 CFR Part 192. NRC established regulations that are generally consistent with the EPA standards for regulating the Title II licensees. NRC's final regulations, conforming Appendix A of 10 CFR Part 40 to EPA's Part 192, Subparts D and E requirements for protection from radiological and non-radiological hazards and long-term stabilization of Title II tailings sites, were issued on October 16, 1985. EPA's groundwater protection standards for Title II sites were incorporated into NRC's regulations in Appendix A to Part 40, on November 13, 1987.

The regulations for mill tailings distinguish between remedial action involving the stabilization and isolation of tailings (i.e., site or surface remediation) and remedial action to clean up contaminated groundwater (groundwater remediation). Institutional controls may be applied at these sites for isolation and control of tailings (both Title I and Title II sites) and/or for groundwater restoration (Title I sites only).

Institutional controls to protect against inadvertent intrusion are not explicitly identified or designated in the regulations for surface remediation of either Title I or Title II tailings sites. However, there are provisions in the EPA standards and NRC regulations that contribute directly and indirectly to intruder prevention and protection. These mainly include: (1) transfer of ownership and control of the site and, if possible subsurface rights, to a government agency (usually DOE) for long-term custody; and (2) periodic site inspection and surveillance, monitoring, and, if necessary, maintenance by the custodian government agency, during the post-closure period. The inspections and surveillances are not considered to be controls to protect against inadvertent intrusion, as defined in this paper, since their primary purpose is to inspect the integrity of the site and its barriers. The EPA standards also include design provisions in the Proposed Rule for Title I sites.

The NRC regulations include the following provisions for institutional controls:

10 CFR 40.27: General license and license provisions for custody and long-term care of residual radioactive material disposal sites (Title I sites).

10 CFR 40.28: General license for custody and long-term care of uranium or thorium byproduct materials disposal sites (Title II sites).

Appendix A to 10 CFR Part 40 (Title II Sites):

Criteria 9 & 10: Financial surety arrangements to cover projected costs of decontamination, decommissioning, and surveillance.

Criterion 11: Site transfer to the Federal or State government, which may also include obtaining subsurface rights/interests, and if such rights cannot be secured, proper notification in the local land public records, indicating that land is used for disposal of radioactive materials and subject to NRC's license prohibiting the disruption and disturbance of the tailings.

Criterion 12: Long-term site surveillance is required to confirm site integrity and to determine the need, if any, for maintenance and/or monitoring. At a minimum, annual site inspections must be conducted by the custodian Government agency, to confirm the site integrity and to determine the need, if any, for maintenance or monitoring. Results of the inspections must be reported to NRC, and NRC may require more frequent site inspections, if necessary.

The EPA standards for Title I explicitly identify institutional controls as measures that may be considered in groundwater remediation (40 CFR192.12(c)(4)(ii)). According to EPA, institutional control of public use of groundwater may be used, along with adequate monitoring, to justify passive restoration of contaminated aquifers, provided that: (1) passive restoration through natural flushing can be accomplished within a period of less than 100 years; (2) groundwater is not now and is not projected to be used for a community water supply within this period; and (3) the institutional controls will effectively protect public health during the restoration period. The proposed regulations also indicate that institutional controls may also be a useful mechanism for situations where active groundwater restoration to completely achieve the standards is impracticable, environmentally damaging, or excessively costly (Proposed Rule for Title I standards pertaining to groundwater protection, September 24, 1987; 52 FR 36004).

The EPA standards stipulate that the institutional controls employed in support of groundwater restoration must be effective over the entire period of time that they would be in use. The standards state that in all cases where DOE proposes to use institutional controls in groundwater restoration, the measures must have a high probability of protecting human health and the environment and must receive NRC concurrence.

LICENSING HISTORY

To date, institutional controls have not been physically implemented at any Title I sites, for either site (surface) or groundwater restoration. This is because, to date, only one Title I site has been transferred to DOE (only recently, in September 1993) under the general license provided in 10 CFR40.27. A groundwater restoration program has not yet been implemented at any of the Title I sites. However, DOE does maintain a custodial role at Title I sites, to prevent misuse and dispersement of the mill tailings during the ongoing site remediation, before the general license becomes effective. Furthermore, the long-term surveillance plans prepared by DOE in support of its remedial action plans and long-term actions for individual Title I sites include arrangements to establish local law enforcement contacts that report to DOE if intrusion is noted. In addition, the existing groundwater contamination from abandoned processing sites is monitored by DOE and the participating States and tribes, to prevent the use of contaminated groundwater, which, in some cases, involves furnishing alternate water supplies to affected users.

Controls are presently implemented as provisions in the general license for possession, storage, custody, and/or long-term care and surveillance of uranium/thorium byproduct materials for Title II sites that are currently licensed by NRC. These include about 30 sites located in the States of Arizona, New Mexico, Nebraska, South Dakota, Utah, and Wyoming. In addition, the Uranium Recovery Field Office (URFO) has imposed deed restrictions to preclude the use of groundwater, and restrictions on the State Engineer to prevent construction of new wells at two uranium solution mines licensed by NRC in Wyoming, because of groundwater contamination at these sites.

INTRUDER PROTECTION MEASURES

Site and Design Features

Siting and site selection are required by the regulations for Title II sites (Criteria 1, 2, and 3 of Appendix A to Part 40), but they are not explicitly addressed in the regulations for Title I sites. However, by requiring that the tailings are to be stabilized and isolated for up to 1000 years, or at least 200 years without active maintenance, NRC regulations for Title II sites and EPA standards for both Title I and Title II sites require site evaluation to demonstrate that this objective will be achieved at specific sites.

In addition, the regulations for both Title I and Title II sites include requirements for proper engineering design and design features for isolation and stabilization of tailings, which contribute to intruder protection/ prevention.

Institutional Controls

Under EPA and NRC regulations and practice, the following institutional control provisions apply to surface remediation of mill tailings disposal sites: land ownership; records control; and deed and land-use restrictions.

Specific institutional controls applicable to contaminated groundwater, cited by EPA, include use restrictions enforceable by permanent Government entities, or measures with a high degree of permanence, such as Federal or State ownership of the land containing the contaminated water. The EPA regulations indicate that in some instances, a combination of institutional controls may have to be used at the same time, to provide adequate protection, such as placing a deed restriction on the property, to prevent use of contaminated groundwater, and providing an alternate water source of drinking water. The EPA regulations also identify some institutional control measures that would not be adequate in this case, including health advisories, signs, posts, admonitions, or any other similar measures that require voluntary cooperation of private parties.

It is noted that neither the EPA nor NRC regulations for uranium mill tailings offer definitions of, or specific criteria to distinguish between, active and passive institutional controls. In addition, institutional controls practiced by DOE and URFO, to date, at uranium mill tailings sites do not make this distinction.

REGULATORY AND INDUSTRY TRENDS

No significant trends were noted by the staff.

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PROGRAM TYPE: DECOMMISSIONING SITES

PROJECT DESCRIPTION

Decommissioning sites involve both reactor and materials licensees, and include buildings, equipment, and land where licensed activities have taken place. Levels of contamination and the nuclides involved vary widely, depending on the licensed activities, any accidents or nonroutine events that may have occurred during operations, and the level of housekeeping employed by the licensee. In some cases, onsite disposals under 10 CFR 20.302 or 20.304 have occurred.

REGULATORY FRAMEWORK

The regulatory framework for decommissioning is established in 10 CFR Parts 30, 40, 50, 70, and 72, depending on the licensed activities. In these regulations, promulgated in 1988, decommission is defined as "to remove (as a facility) safely from service and reduce residual radioactivity to a level <u>for unrestricted use</u> and termination of license" (emphasis added). This definition, in effect, means that only the radioactivity exceeding the NRC limits for unrestricted use must be removed and no further institutional or administrative controls are required to be placed on the site following license termination. In other words, after decommissioning (for unrestricted use) is complete, and the facility license is terminated, the general public would be allowed use of the facility without radiation protection controls. In special cases, licensees may request and may be granted exemptions to the unrestricted use requirement. These exemptions could be granted after NRC review of the case-specific factors proposed by the licensee.

Additional specific requirements are provided below:

1. Decommissioning definition:

   Byproduct material licenses - 10 CFR 30.4
   Source material licenses - 10 CFR 40.4
   Reactor licenses - 10 CFR 50.2
   Special nuclear material licenses - 10 CFR 70.4
   Independent storage of spent fuel licenses - 10 CFR 72.3

2. Termination procedures:

   Byproduct material licenses - 10 CFR 30.36
   Source material licenses - 10 CFR 40.42
   Reactor licenses - 10 CFR 50.82
   Special nuclear material licenses - 10 CFR 70.38
   Independent storage of spent fuel licenses - 10 CFR 72.54

3. Decommissioning financial assurance:

   Byproduct material licenses - 10 CFR 30.35
   Source material licenses - 10 CFR 40.36
   Reactor licenses - 10 CFR 50.75
   Special nuclear material licenses - 10 CFR 70.25
   Independent storage of spent fuel licenses - 10 CFR 72.30

In 1981 NRC published a draft Branch Technical Position on "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations." Under two disposal options, that include institutional controls, this position allowed the disposal of certain concentrations of uranium and thorium, if sites were zoned for industrial use, and when recorded title documents are amended to place specific covenants into deeds restricting activities that could take place on the property. The two options, allowing the use of these restrictions, are currently not being applied since the regulations defining decommissioning, that were promulgated in 1988, allow license termination only when radioactivity is removed to levels acceptable for unrestricted release.

LICENSING HISTORY

Materials and reactor licenses for commercial uses of nuclear materials have been granted by NRC and its predecessor, the U.S. Atomic Energy Commission, since the 1950's. On the order of 30,000 licenses have been terminated since that time.

INTRUDER PROTECTION MEASURES

Normally, no intruder protection measures are required or allowed for decommissioning (or site closure) since the objective is to remove radioactivity to levels acceptable for unrestricted use. (Note that the regulations require that appropriate security plans, to protect public health and safety, be in place during the decommissioning.) Only in a limited number of special cases have deed restrictions been required, to minimize the probability that intruders will have direct access to residual contamination at the site. The cases where deed restrictions have been required are being identified or are under review by the staff, to ensure that there are no public health and safety problems at these sites; these cases include NRC licensees who disposed of licensed material onsite under the provision of 10 CFR 20.304.

REGULATORY AND INDUSTRY TRENDS

NRC, in its Site Decommissioning Management Plan, identified several sites containing large quantities of thorium contamination. Because of the extremely large costs of disposing of the thorium contamination at a licensed LLW disposal site, the licensees of these thorium-laden sites are investigating options that include administrative controls, such as deed restrictions. One licensee requested a license amendment to dispose of thorium-contaminated slag at a hazardous waste disposal site, incorporating specific deed restrictions to prevent future site occupation. These regulatory options are currently being evaluated by NRC staff (see SECY 93-179).

PROGRAMS REGULATED BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY

PROGRAM TYPE: HAZARDOUS WASTE MANAGEMENT

PROJECT DESCRIPTION

Hazardous waste management facilities treat, store, and dispose of hazardous solid wastes that pose a substantial hazard to human health or the environment. Wastes are classified as hazardous under the Resource Conservation and Recovery Act (RCRA) if they exhibit one or more of the following characteristics: ignitability, corrosivity, reactivity, or toxicity. The Environmental Protection Agency (EPA) regulations for hazardous waste management facilities include requirements for design, operation, emergency procedures, recordkeeping, release limits, financial assurance, closure and post-closure activities, monitoring, and other facility conditions to ensure protection of public health and the environment. EPA has specific regulations for container storage sites, tank systems, surface impoundments, waste piles, land treatment facilities, landfills, incinerators, drip pads, and miscellaneous units. EPA has several thousands of these treatment, storage, and disposal facilities (TSDFs) on record.

REGULATORY FRAMEWORK

Each type of TSDF facility is subject to both general and site-specific closure requirements. Owner/operators of hazardous waste management facilities are required to:

a. Close the facility in such a way that: (1) minimizes the need for further maintenance of the facility; (2) controls, minimizes or eliminates the post-closure escape of hazardous materials and; (3) is in compliance with all closure requirements.

b. Submit a closure, and in some cases a contingent closure plan. For permitted facilities, this plan is submitted as part of the RCRA permit application. For facilities with interim status,[1] the closure plan is maintained onsite and submitted to EPA at time of closure. The plan must include: a description of how each unit at the facility will be closed, to ensure compliance with the performance standard outlined above; an estimate of the amount and an inventory of the hazardous material in each unit; the procedures that will be used to remove,

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[1] Section 3005 (a) of RCRA prohibits treatment, storage, or disposal of hazardous waste without a RCRA permit after November 19, 1980. Interim status allows facilities in existence on November 19, 1980, to continue operation until EPA has completed evaluation of the facility's permit application. Facilities that become subject to regulation under RCRA after November 19, 1980, may also qualify for interim status. In addition, 40 CFR Part 265 also contains requirements for thermal treatment facilities, facilities that treat hazardous waste by chemical, physical or biological means, and underground injection facilities.

treat, store and dispose of the hazardous waste in the unit, including soil, equipment, and structures; a description of the activities that will be employed during the closure and post-closure periods, to ensure that the environment is protected (groundwater monitoring, leachate collection, etc.); a schedule for closure, and, in some cases, an estimated date for completion of final closure. Financial assurance for closure and post closure care is required, but not included in the closure or post-closure plan.

EPA allows hazardous waste management facilities to be closed with the "waste in place" or the facilities may be "clean closed." Clean closure involves the removal of hazardous waste constituents down to acceptable screening and action levels for residual contamination. EPA is currently developing these levels for hazardous constituents. If a facility is clean closed, all waste and contaminated material is removed from the site. Facilities that are clean closed do not require post-closure care plans. Closure and post-closure plans are required for facilities where waste is left onsite after cessation of operations.

The closure period begins with the last shipment of hazardous waste. Within 90 days after receiving the last shipment of waste the owner/operator must remove, treat, or dispose of the all waste on-site. Within 180 days of the last waste shipment the owner/operator must complete the decontamination or removal of remaining structures, equipment, soil, etc. on-site. These times may be extended by the EPA Regional Administrator.

EPA's requirements for the closure of hazardous waste management facilities under RCRA are codified in 40 CFR Part 264, Subparts G - X, for permitted facilities and 40 CFR Part 265, Subparts G - X, for facilities with interim status. Subpart G (40 CFR 264.110 - 264.120) deals with the general closure requirements for all types of hazardous waste management facilities. Unit-specific requirements for the closure of permitted facilities are summarized below. Unit-specific requirements for interim status facilities, at Part 265, generally follow the Part 264 section designations.

40 CFR 264.140 - 264.178, Subpart H - Financial Requirements
40 CFR 264.178, Subpart I - Container Storage
40 CFR 264.197, Subpart J - Tank Systems
40 CFR 264.228, Subpart K - Surface Impoundments
40 CFR 264.258, Subpart L - Waste Piles
40 CFR 264.280, Subpart M - Land Treatment Facilities
40 CFR 264.310, Subpart N - Landfills
40 CFR 264.351, Subpart O - Incinerators
40 CFR 264.575, Subpart W - Drip Pads
40 CFR 264.603, Subpart X - Miscellaneous Units

Closure requirements for incinerators and container storage areas require the removal of all contaminated material. All contaminated material at surface impoundments must be removed, or the surface impoundment must be covered with a cap similar to that required for landfills (see below). In addition, the owner/operator must maintain the cap and those systems required to monitor the facility for releases to the environment. For waste piles, drip pads, and tank systems, the owner/operator must remove all contaminated material or close the facility, in accordance with the criteria for landfills (see below). Land treatment facilities are required to install and maintain a protective vegetative cover, maintain the land treatment facility operating systems (i.e., pH control, run-on/run-off control, etc.) and prohibit food-chain crops from being grown on the facility. Closure for interim status facilities is identical to fully permitted facilities. Closure requirements, at Part 265, for thermal treatment facilities and facilities that treat waste by chemical, physical, or biological means are the same as those for incinerators - that is, all contaminated material must be removed.

At final closure of landfills, or cells within landfills, the owner/operator must install a cover designed to minimize long-term migration of liquids through the landfill, function with minimum maintenance, promote drainage, minimize erosion, accommodate settling and subsidence, and have a permeability less than or equal to the bottom liner or natural subsoils present. The owner/operator must, for the duration of the post-closure period, continue to maintain and operate all monitoring systems at the facility, prevent run-on and run-off at the cell or site, and protect the markers used to delineate waste cells.

In addition, the EPA Regional Administrator, at partial and final closure, may require the continuation of any of the requirements of 40 CFR264.14 (active site security requirements) during part or all of the post-closure period, when the hazardous wastes may remain exposed after completion of partial or final closure and pose a hazard to human health.

Within 60 days of completion of the closure period (240 days from the last waste shipment), the owner/operator must inform the EPA Regional Administrator that the site has been closed. The owner/operator must also provide the local zoning authority with a survey plat showing the location of the disposal units at the site. This plat must include a note stating the owner's obligation to restrict disturbance of the site during the post-closure period. In addition, the owner/operator must record, in the land deed, that the property was used to manage hazardous waste, and that its use is restricted; include a survey plat of the site and a record of the waste disposed of at the site; and provide the EPA Regional Administrator with a certification that these activities have been performed.

The post-closure period begins at the completion of the closure period and continues for 30 years. During the post-closure period, the owner must perform environmental monitoring and reporting, maintain the monitoring equipment, and comply with other requirements of the facility post-closure plan. The EPA Regional Administrator may lengthen or shorten the post-closure period. Post-closure use of the land is contingent upon the requirements outlined in the post-closure plan, but in general, the use may not disturb the waste or any of the components of the disposal unit (cover, monitoring equipment, etc.). At the end of the post-closure period, the owner is required to submit, to the EPA Regional Administrator, a certification that the post-closure period has ended.

EPA closure requirements outlined above are the general requirements for all hazardous waste management facilities. Closure requirements for each type of facility may vary (for example, containers and tanks require removal of the waste, whereas landfills require disposal in place) but, in general, all facilities must meet these general requirements.

When the post-closure period ends, the site may be used for those activities identified in the post-closure plan. If, at some time after the post-closure period ends, conditions at the site do not conform to the conditions specified in the post-closure plan and present a problem for health and safety (for example, hazardous wastes were leaking), the site could become subject to regulation under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA or Superfund). If the site became subject to action under CERCLA, remediation of the site would have to meet any legally applicable or relevant and appropriate requirements (ARARs), standards, criteria, or limitations under Federal statutes (including RCRA), or more stringent State environmental laws.

PERMITTING HISTORY

In May 1991, the Government Accounting Office reported on the progress in closing and issuing post-closure plans for RCRA facilities. The report indicates that of the 4615 facilities that store, treat or dispose of hazardous waste, 2282 (1128 land disposal facilities, 39 incinerators, and 1115 treatment/storage facilities) decided to close because they are unwilling or unable to meet RCRA operational requirements. (The report also indicates that EPA believes that these facilities may present some of the worst environmental remediation problems in the United States, and, as of the report date, 22 had been transferred to the CERCLA program.) As of February 1991, only 337 of the 1128 land disposal facilities that are in the process of closing had actually closed, and only 105 had received post-closure permits (the majority of these facilities had decided to close in 1985). EPA indicated that the limited progress in completing closure and post-closure care permits was because EPA has concentrated its efforts on permitting those facilities that wish to continue operations. This is in response to a 1984 legislative mandate to issue permits to land disposal facilities by November 1988, to incinerators by November 1989 and to treatment and storage facilities by November 1992. In that few, if any, facilities have reached the end of the post-closure period, little information is available on the progress or effectiveness of post-closure care programs.

INTRUDER PROTECTION MEASURES

EPA's requirements for the closure of RCRA hazardous waste management facilities do not specifically address ensuring against inadvertent intrusion. However, discussions with EPA staff indicate that intrusion protection is considered when reviewing closure and post-closure permits. In general, EPA uses both passive and active measures, to ensure that hazardous waste in disposal units is not disturbed.

Active Institutional Controls

The EPA Regional Administrator may incorporate additional requirements, such as for design and site security measures (an active control to limit intrusion), if it is determined that these additional requirements are needed to protect the public.

Passive Institutional Controls

The primary passive controls for the facility will be the legacy of records prepared by the owner/operator, in accordance with the requirements of 40 CFR 264.119 et al. These records include deed notices stating that the facility was used to manage hazardous wastes and that its subsequent use is restricted, survey plats; and records of the location, type, and quantity of hazardous waste disposed of in the unit.

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PROGRAM TYPE: MUNICIPAL SOLID WASTE LANDFILL

PROJECT DESCRIPTION

Municipal solid waste landfills (MSWLFs) receive and dispose of the normal residential and commercial solid waste generated within a community; hazardous wastes and other wastes covered by separate regulations are generally excluded. MSWLFs may be publicly or privately owned; use of a site as a landfill must be permanently recorded on the deed to the property. They are subject to siting and design criteria; monitoring of air and ground-water quality is required; and environmental remediation must be undertaken when needed. Post-closure maintenance, monitoring, and remedial action are required for 30 years; this period may be shortened or extended by a responsible official, if he determines that the changes protect human health and the environment. Closed landfill sites are often converted to other compatible uses; current regulations neither prohibit nor discourage this practice.

REGULATORY FRAMEWORK

EPA regulates land disposal of solid wastes under Chapter I, Subchapter I - SOLID WASTES - of Chapter 40 of the U.S. Code of Federal Regulations, particularly Parts 241, 256, 257 and 258 (Part 258 becomes partially effective October 9, 1993 and completely effective April 9, 1994). These parts implement the Solid Waste Disposal Act of 1965, the Resource Recovery Act of 1970, RCRA, and the Hazardous and Solid Waste Amendments Act of 1984, and subsequent amendments.

Between 1965 and 1993, the approach of the Federal Government to regulation of MSWLFs has evolved from the provision of guidance on preferred landfill management techniques, mandatory for Federal facilities only, to mandating sharply drawn prescriptive procedures generally applicable except for specific exemptions. The regulations have had successive objectives: the control of rats and other vectors of disease at open dumps; control of air pollution from burning dumps; improvement of aesthetics; and ultimately, groundwater protection. As the regulations were being developed, there has been continuing recognition that landfill sites would be privately as well as publicly owned, that title transfers would take place, and that post-closure use of disposal sites would be acceptable, if the wastes were not disturbed, except under supervision, and there would be no resulting increase in the potential threat to human health and the environment.

The institutional controls employed by EPA consist of requiring post-closure care for the nominal period of 30 years, and of requiring notations on the deeds to properties used as landfills. Parties responsible for harm to human health and the environment may be required to carry out remediation under the provisions of CERCLA. EPA's reliance on continued monitoring and on deed restrictions suggests that EPA is satisfied that these institutional controls will be effective in meeting the statutory requirement to protect human health and the environment.

Specific regulations are discussed below.

40 CFR Part 241 - "Guidelines for the Land Disposal of Solid Wastes"

This regulation, promulgated in 1974, offers recommended procedures for the operation of a sanitary landfill. They are mandatory for Federal agencies, advisory for all others. They specify that plans should describe the projected use of the completed land disposal site, that the integrity of the final cover not be disturbed by agricultural cultivation activities, and that construction of major structures on a completed land disposal site is not recommended. Further, upon completion of the site, a detailed description, including a plat, should be recorded with the area's land recording authority. The description should include general types and locations of wastes, depth of fill, and other information of interest to potential landowners.

40 CFR Part 256 - "Guidelines for Development and Implementation of State Solid Waste Management Plans"

This regulation, promulgated in 1979, requires the States to develop and implement Solid Waste Management Plans. These plans are required to include permit procedures to ensure that future use of property used for solid waste disposal will be compatible with that use. The permit procedures are expected to require identification of future land use or the inclusion of a stipulation, in the property deed, that notifies future purchasers of precautions necessitated by the use of the property as a solid waste disposal facility.

40 CFR Part 257 - "Criteria for Classification of Solid Waste Disposal Facilities and Practices"

This regulation was also first promulgated in 1979, was then amended in 1981, and was further amended in 1991. It established criteria for use under RCRA in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment. Its only provision directly affecting possible future users concerned the effects of applying cadmium in solid wastes to within 1 meter (3 feet) of the surface of land used for the production of food-chain crops and requires a stipulation, in the land record or property deed, to state that the property has received solid waste at high cadmium application rates, and that food-chain crops should not be grown, because of a possible health hazard. Until 1991, MSWLF units were covered by Part 257; at that time, a new regulation, 40 CFR Part 258, containing extensive prescriptive requirements for such facilities, was promulgated, to become effective in 1993 (see the discussion of Part 258, below).

40 CFR Part 258 - "Criteria for Municipal Solid Waste Landfills" (Effective October 9, 1993, except for Subpart G - "Financial Assurance Criteria," effective April 9, 1994)

As noted, this regulation was promulgated in 1991, and prescribes, in great detail, the siting, operational practices, environmental monitoring, remediation, and financial assurances to be applied at a MSWLF. For closure, this regulation requires that a notation be placed on the deed in perpetuity, to notify potential purchasers that the land has been used as a landfill facility and that its use is thereby restricted. Moreover, after closure, the owner or operator must provide post-closure care for 30 years. The care must consist of maintaining the final cover, maintaining and operating the leachate collection and gas monitoring systems, and monitoring the ground water. The length of the monitoring period may be decreased or increased at the discretion of the regulating agency. Post-closure use of the property must be reported in the closure plan and may not disturb the final cover, liner, or any components of the containment or monitoring systems.

PERMITTING HISTORY

As the regulatory citations show, requirements for post-closure control of MSWLF units have been steadily evolving with passage of successively more prescriptive legislation. In 1965, the Federal Government had not yet exerted authority over solid wastes; in its guidelines, it could only encourage good operating practices and good record-keeping and discourage some agricultural activity and construction on a completed landfill site. Even now, although the control period may be extended as far beyond 30 years as a regulatory agency believes wise, the only activities restricted on a site are those that will adversely affect the landfill or the monitoring systems, and notations on the property deed are considered a primary enforcement tool.

In practice, the potential for future beneficial use of a landfill site after closure has often been offered as an inducement for initial community acceptance of the landfill. In fulfillment of these inducements, golf courses (Baltimore County, MD), amphitheaters (Virginia Beach, VA), and sports complexes (Meadowlands, NJ), for example, have indeed been provided on or near closed landfills.

In pursuit of these policies and practices, it is recognized that institutional control must be considered to be ongoing and that under such circumstances, unknowing intrusions into the filled waste would be unlikely.

INTRUDER PROTECTION MEASURES

Protection against inadvertent intrusion is provided by regulations that require access control, protection of the cover and the waste from disturbance, and placement, on the deed, of a notation that the site has been used as a MSWLF, and that unauthorized disturbance is prohibited.

REGULATORY AND INDUSTRY TRENDS

There are presently no clear indicators of future trends for institutional control or protection of inadvertent intruders at MSWLFs. Many facilities are owned and operated by local governments, but large corporations, such as WMX Technologies (formerly Waste Management, Inc.) and BFI (Browning-Ferris Industries) also provide landfill services commercially.

It is not possible, presently, to know whether the practice of allowing public access to closed landfill sites will continue. It is not difficult to believe that regulators will wish to see monitoring and maintenance continued for as long as indicator parameters are found by monitoring systems. It is possible that protection of the landfill covers and monitoring systems may at some time be considered incompatible with public access, although at present there does not appear to be a movement in this direction.

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PROGRAM TYPE: SUPERFUND

PROJECT DESCRIPTION

EPA is responsible for remediation of hazardous releases into the environment under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA). This program is commonly referred to as the Superfund Program and it involves the formidable task of remediating more than 1400 contaminated sites currently listed on the National Priorities List (NPL), along with up to 10,000 additional sites that may be identified and added to the NPL for remedial action in the future. Once a site is listed on the NPL, EPA or a State agency assesses the risks posed by the site and identifies alternative remedial remedies to address the contamination, which provides the basis for selecting the remedial action. After the remedial action has been selected and designed, the remedial action is performed to remove contamination from the site, treat it to reduce its risk to the public and environment, or otherwise stabilize it in accordance with applicable requirements. Assessment and remedial actions at Superfund sites are paid for by responsible parties or, if sufficient funds cannot be recovered from the responsible parties, by EPA (from the Superfund) and States. The current average cost of a Superfund remedial action is 20 to 30 million dollars. EPA recently initiated an effort to streamline the remedial action process; these changes in the program should be implemented by late 1993 or early 1994.

REGULATORY FRAMEWORK

The National Oil and Hazardous Substances Pollution Contingency Plan, or National Contingency Plan (NCP), in 40 CFR Part 300 provides the organizational structure, procedures, and criteria for the Superfund Program. CERCLA Section 105 requires the NCP. The President delegated responsibility for amending the NCP to EPA, in Executive Order 12580 (January 29, 1987; 52 FR 2923). In developing the NCP, EPA coordinates with all members of the Federal National Response Team, including NRC, to avoid inconsistent or duplicative requirements in emergency planning responsibilities of the agencies [40 CFR 300.2]. The NCP includes the NPL, the Hazard Ranking System used for determining whether a site should be listed on the NPL, procedures for coordinating and implementing remedial actions at NPL sites, and criteria for the selection of remedial actions.

PERMITTING HISTORY

To date, a relatively small proportion of the sites listed on the NPL have actually completed remedial actions. A 1989 assessment of the Superfund Program, by the Office of Technology Assessment concluded that many Superfund remedies relied on institutional controls as a part of the selected remedy. For example, more than 90 percent of actions involving expedited responses (e.g., "removal actions") used a combination of land disposal and institutional controls of some type.

Superfund remedial actions at 21 sites that involved radioactive contamination included institutional actions as a part of the selected remedies at 12 of the sites. However, at eight of these sites, institutional controls were only selected for some interim period, until the final remedy was implemented, which required development of offsite waste disposal capacity. For all the sites ultimately involving offsite disposal of the contamination, institutional controls were presumed at the waste disposal facility.

Institutional controls selected in the temporary remedies included access control, fencing, waste storage, surveillance, and monitoring. For the three sites where permanent remedies were selected, institutional controls included access controls, deed restrictions, leachate collection and treatment, groundwater monitoring, drilling and pumping restrictions, cover maintenance, and procedural controls (to remove contaminated material buried beneath streets whenever street maintenance was conducted that would disrupt the pavement). For example, at the Maxey Flats LLW disposal facility, Maxey Flats, Kentucky, EPA's final remedial action includes institutional controls to restrict use of the site and to ensure monitoring and maintenance of the site in perpetuity, because the preferred remedy stabilized the radioactive and hazardous waste onsite. RCRA post-closure controls were only imposed at one facility, which involved leachate collection and treatment and groundwater monitoring. The principal contaminants at this facility were volatile organics, heavy metals, and other non-radiological constituents. Institutional controls were applied at all the sites during remediation, to prevent intrusion and ensure security the contaminated sites, before completion of remedial actions.

INTRUDER PROTECTION MEASURES

In terms of institutional controls, the NCP is sufficiently general to allow the use of a wide range of institutional controls, if necessary to protect human health and the environment. The NCP states that the purpose of the remedy selection process under Superfund is to implement remedies that eliminate, reduce, or control risks to human health and the environment [40 CFR300.430(a)(1)]. The NCP also states that EPA expects to use institutional controls such as water use and deed restrictions to supplement engineering controls, as appropriate, for short- and long-term management, to prevent or limit exposure to hazardous substances. This includes use of such controls during conduct of the Remedial Investigation/Feasibility Study, as well as after remedial action, as a component of the completed remedy. EPA states, however, that institutional controls shall not substitute for active response measures, such as treatment or containment of contamination, as the sole remedy, unless active measures are not practicable, based on balancing of trade-offs among alternative remedies [40 CFR 300.430(a)(1)(iii)(D)].

The NCP also directs EPA to consider the long-term effectiveness and permanence of institutional controls. Procedures in 40 CFR 300.430(e)(9)(iii)(C)(2) require EPA to consider the adequacy and reliability of institutional controls necessary to manage treatment residuals and untreated waste. EPA is particularly directed to consider the uncertainties associated with land disposal, for providing long-term protection from residuals. If contaminants remain on site, EPA generally requires that post-remedial action activities include continued groundwater monitoring and may involve application of the post-closure care requirements under RCRA, if RCRA hazardous wastes are involved at the site. The RCRA post-closure care period may extend for 30 years or more; the period is set by the EPA Regional Administrator on a site-specific basis. In addition, if a remedial action results in hazardous contaminants remaining on the site above unrestricted use levels, the NCP directs EPA or the State agency (lead agency) to review the action at least every 5 years after initiation of the remedy [40 CFR 300.430(f)(4)(ii)]. Therefore, remedies that rely on institutional control to restrict exposure to, or contain contaminants, would be reevaluated on a periodic basis, to reaffirm the remedy selection. Conceptually, these periodic reevaluations could result in a determination, at some point in the future, that an alternative remedy is preferable compared with the original remedy.

In support of this continuing obligation, where something other than a permanent remedy is selected, the NCP requires assurance, from a State, that the State will assume responsibility for operation and maintenance, for the expected life of the remedy, for remedial actions funded by the Superfund, under Section 104(c) of CERCLA. The State must ensure that institutional controls are reliable and will remain in place after initiation of operation and maintenance [40 CFR 300.510(c)(1)].

In addition, EPA may determine that government ownership of the land is required to conduct the remedial action. The NCP states that, as a general rule, the State must agree to acquire and hold the property, including any interest in the property necessary to ensure the reliability of institutional controls restricting the use of the property. If it is necessary for Federal ownership of the property, the State must accept transfer of the property on or before completion of the response action [40 CFR 300.510(f)].

Detailed selection of institutional controls occurs as a part of the remedial design, after the selection of the remedy in the Superfund Record of Decision. EPA or the State agency negotiates the type and necessary duration of the institutional control(s) with responsible parties and affected interests. EPA recognizes and implements land-use restrictions and other institutional controls, to help maintain existing land uses at and near contaminated sites. Examples of such institutional controls include fences to restrict access to contaminated areas, deed restrictions and ordinances to restrict access or resource use, and provision of alternate water supplies or prohibitions against the onsite extraction or use of groundwater for domestic purposes.

In addition, EPA has developed guidance, under the Superfund Program, on identifying future land-uses and procedures for assessing human health risks associated with alternate land use scenarios, including residential and commercial/industrial uses. For example, in EPA's *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors* (March 1991), EPA states that residential exposure scenarios should only be assumed when there are homes on or near a site, or when residential development is reasonably expected in the future. The same guidance states that the farm family exposure scenario should only be evaluated if it is known that such families reside in the area of a contaminated site. Occupational scenarios associated with commercial/industrial land uses are to be assumed when the land is or is expected to be used for commercial or industrial purposes. Because most contaminated sites are already located in commercial areas, the guidance presumes that these sites are expected to remain in use for commercial activities in the future, thus restricting the greater exposures that might be assumed with residential or agricultural uses of the land.

REGULATORY AND INDUSTRY TRENDS

EPA recognizes that considerable uncertainty exists in forecasting future uses of contaminated sites and that future residential communities may be developed at sites that are presently located in heavily industrialized areas. However, as a practical matter, EPA may assume that existing land use is a reasonably good predictor of future land uses. For example, in its proposed regulations for hazardous waste site corrective actions (40 CFR Part 264, Subpart S), EPA recognized that it may be appropriate to assume that sites located in industrialized areas are likely to remain industrial, in the foreseeable future. EPA appears to be moving in the direction of a more pragmatic approach and assumptions for future land use and reliance on institutional controls.

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PROGRAM TYPE: WASTE ISOLATION PILOT PLANT

PROJECT DESCRIPTION

The Waste Isolation Pilot Plant (WIPP) is a DOE research and development project. The WIPP is intended to study the characteristics of bedded rock salt and how it interacts with, and can safely contain, mixed transuranic (TRU) wastes. It includes a test program to collect information relevant to determining whether or not TRU wastes can be safely disposed of in a deep, underground, bedded salt formation. The WIPP repository will be at a depth of 2150 feet and will rely upon the creep of thick salt deposits to entomb the buried waste. The repository will cover 100 acres, when completed, and will have the capacity to store 850,000 drums of transuranic radioactive waste. About 97 percent of the waste, by volume, will be contact-handled TRU waste, and about 3 percent will be remote-handled radioactive waste.

REGULATORY FRAMEWORK

EPA has the regulatory authority to promulgate generally applicable environmental standards for potential sites other than Yucca Mountain for the management and disposal of spent nuclear fuel and HLW and TRU wastes, pursuant to the Nuclear Waste Policy Act of 1982, as amended and to the Atomic Energy Act of 1954, as amended. EPA is implementing this authority by promulgating 40 CFR Part 191. EPA also has oversight responsibilities over DOE activities at WIPP, under the WIPP Land Withdrawal Act of 1992. The generally applicable environmental standards contain assurance requirements that are intended, in part, to address the potential for human intrusion into disposal sites. These requirements include both active and passive controls that are to be instituted for disposal facilities.

EPA first promulgated 40 CFR Part 191 in 1985. Following a legal challenge, the U.S. Court of Appeals for the First Circuit remanded the disposal standards in 1987. The WIPP Land Withdrawal Act reinstated the 1985 disposal standards, except for those parts that were specifically found problematic by the Court. The Act puts EPA on a statutory timetable to finalize those portions of the standards. The Act also limits those final standards to those sites that are not required to be characterized under Section 113(a) of the Nuclear Waste Policy Act. These standards apply to the WIPP. The Energy Policy Act of 1992, however, requires EPA's promulgation of public health and safety standards for a potential repository at Yucca Mountain.

EPA addresses issues pertaining to human intrusion in the statements of consideration that accompany the final rule (50 FR 38066, September 19, 1985). In its statements, EPA expresses its belief that the type of inadvertent human activities that could lead to significant radiation exposures or releases of material from geologic repositories appear to call for much more intensive and organized effort than those that could cause problems at, for example, an unattended surface disposal site. It also reiterates that its overall objective has been to protect public health and the environment from disposal of radioactive wastes, without relying on institutional controls for extended periods of time, because EPA does not believe that such controls can be relied on to completely eliminate the possibility of inadvertent intrusion.

The statements of consideration indicate that the use of active institutional controls is to be encouraged, but that such controls cannot be relied on to isolate waste for more than 100 years. This limited reliance on active controls is exemplified by EPA's comments on monitoring of the disposal system. It contends that "A monitoring system based only on detecting radionuclide releases - a system which would almost certainly not be detecting anything for several times the history of the United States - is not likely to be maintained for long enough to be of much use." EPA also articulated its position that limiting reliance on these controls will reduce the risks if future generations do not maintain surveillance of disposal sites.

In contrast to its hesitancy to rely on active controls, EPA expressed a belief that certain passive institutional controls can reduce the probability and extent of future intrusion, over extended periods. The use of passive institutional controls are designed to reduce the probability of inadvertent intrusion. These passive controls would consist of extensive permanent markers, extensive records, and the avoidance of sites with known resources, during site selection. The markers and records are intended to convey knowledge about a repository to future generations, whereas the siting requirements are designed to reduce the likelihood of exploring around a repository, even when the knowledge passed on is misunderstood or ignored. These passive controls are not intended to preclude the potential for intrusion, but are expected to deter systematic or persistent exploitation of a disposal site. EPA also indicated that the Federal Government is committed to retaining control over disposal sites for the waste.

The following provisions, in the Part 191 regulations, address matters of institutional controls and human intrusion:

191.12 - includes definitions such as "passive institutional control" and "active institutional control" and "undisturbed performance." These definitions are integral to the assurance requirements. They are also important in defining the degree to which intrusive scenarios are to be considered during implementation of the standards.

191.14 - provides details of the assurance requirements. These requirements include active institutional controls, monitoring of the disposal systems, site selection, and passive institutional controls.

Appendix B - "Guidance for Implementation of Subpart B" is intended to portray the EPA's assumptions regarding the implementation of Subpart B, and is not intended to be bounding on the implementing agencies.

PROGRAM HISTORY

In July 1981, DOE signed a cooperative agreement with the State of New Mexico, to develop the 10,240-acre WIPP site; full facility construction was authorized on July 1, 1983. In October of 1992, the Waste Isolation Pilot Plant Land Withdrawal Act (LWA) was signed into law. Under the Act, EPA was given an extensive role in the oversight of the DOE activities at the site and ensuring that those activities comply with environmental laws and regulations. These include provisions in RCRA and the "Environmental Radiation Protection

Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes" (Part 191). EPA is currently in the process of amending Part 191, in response to the WIPP LWA and issues raised by the Court. Under the WIPP LWA, EPA is required to develop criteria for the Administrator's certification of compliance with Part 191. DOE must also follow provisions under the Clean Air Act, the Toxic Substances Control Act, CERCLA, NEPA, the Solid Waste Disposal Act, and the Safe Drinking Water Act.

INTRUDER PROTECTION MEASURES

The regulations contained in 40 CFR Part 191 and the accompanying statements of consideration indicate several measures that are to be taken in the siting, construction, and closure of disposal facilities. Many of the assurance requirements are intended to reduce the likelihood of human intrusion into the facilities. These include siting requirements and both active and passive institutional controls. EPA assumes that passive institutional controls can deter the systematic or persistent exploitation of disposal sites for as long as the controls endure and are understood.

REGULATORY AND INDUSTRY TRENDS

WIPP is currently under a no-migration determination, under RCRA, that will expire after 10 years; conditions include requirements that air monitoring and waste analysis must be performed. The presence of gas and oil leases on and around the WIPP site has raised concerns about the possibility for human intrusion at the site and the ability of the repository to contain the waste. Under the WIPP LWA, EPA must determine whether Federal Government acquisition of existing oil and gas leases at the WIPP site is required for the WIPP to comply with 40 CFR Part 191 or RCRA. EPA is developing compliance criteria for Part 191 and has a statutory deadline of October 30, 1994, for issuing its criteria.

PROGRAM OPERATED BY THE U.S. DEPARTMENT OF ENERGY

PROGRAM TYPE: DOE LOW-LEVEL RADIOACTIVE WASTE DISPOSAL

PROJECT DESCRIPTION

DOE owns and operates numerous research, manufacturing, testing, storage, and disposal facilities related to the nuclear programs of the Federal Government. Many of these programs are protected by rigorous physical security measures because they are related to the national defense, involve special nuclear material (SNM), or both. DOE defines LLW to be all wastes except high-level wastes, spent nuclear fuel, or 11e(2) byproduct material; wastes generated through research and that have activities of TRU radionuclides less than 100 nano-Curies per gram are also considered to be LLW. DOE disposes of its LLW at six sites: Savannah River, Oak Ridge, Los Alamos, the Idaho National Engineering Laboratory, the Nevada Test Site, and Hanford. Wastes are accorded disposal within the security perimeters of these facilities, and DOE has no present intention of releasing these sites from institutional control. However, performance assessments, required by DOE to ensure the radioactive safety of each LLW disposal site, implicitly assume that institutional control ceases after 100 years.

REGULATORY FRAMEWORK

Because of its unique mission, DOE regulates its own nuclear activities and is not required to have a license from NRC for its LLW disposal activities. The Atomic Energy Act of 1954 authorizes DOE to "Prescribe regulations and orders as it may deem necessary... to provide safe...disposal of radioactive waste..." resulting from its operations. The Low-Level Radioactive Waste Policy Amendments Act of 1985 specifically makes it the responsibility of the Federal Government to dispose of LLW owned or generated by DOE. LLW management for DOE is covered in Chapter III - "Management of Low-Level Waste," of DOE Order 5820.2A - "Radioactive Waste Management." DOE Order 5820.2A was promulgated on September 26, 1988, replacing DOE Order 5820.2, issued February 6, 1984. DOE Order 5820.2A is itself currently undergoing revision, which is tentatively expected to be completed during the first part of 1995.

DOE Order 5820.2A requires the preparation and annual revision of Waste Management Plans, to ensure compliance with the provisions of the Order.

DOE Order 5820.2A defines Institutional Control as "A period of time, assumed to be about 100 years, during which human institutions continue to control waste management facilities."

Chapter III of DOE Order 5820.2A parallels Part 61 in many respects, although it is tailored to DOE's mission. Provisions affecting policy, performance objectives, performance assessment, waste acceptance criteria, and closure and post-closure activities are of particular interest here.

Policies relevant to institutional control and intruder protection require:

a. DOE-low-level waste operations shall be managed to protect the health and safety of the public, preserve the environment of the waste management facilities, and ensure that no legacy requiring remedial action remains after operations have been terminated.

...

c. DOE-low-level waste shall be disposed of on the site at which it is generated, if practical, or if on-site disposal capacity is not available, at another DOE disposal facility.

Performance objectives for the DOE LLW sites are similar to, but not identical with, NRC performance objectives:

1) Protect public health and safety;

2) Ensure that the maximum annual effective dose equivalent to any member of the public does not exceed 25 mrem, that releases to the atmosphere comply with the requirements of 40 CFR 61, and that releases of radioactivity to the environment are as low as reasonably achievable;

3) After loss of active institutional control (100 years), protect an inadvertent intruder from a committed effective dose equivalent of 100 mrem for a continuous exposure, or 500 mrem for a single acute exposure; and

4) Protect groundwater resources, consistent with applicable requirements.

DOE Order 5820.2A also requires that site-specific radiological performance assessments be prepared and maintained, to demonstrate compliance with the performance objectives.

PROGRAM HISTORY

Because most of the wastes disposed of by DOE are internally generated and subject to centralized supervision, DOE requires its facility operators to demonstrate, by performance assessments and monitoring, that the requirements of its performance objectives, including protection of inadvertent intruders, are being achieved. Techniques to be used for protection of inadvertent intruders must be specified in the Waste Management Plan for each site, but may vary from site to site.

Each DOE disposal site is required to establish individual waste acceptance criteria (WAC). These WAC include site-specific requirements for waste characteristics and waste classification, and may include limitations on radionuclide inventories. Wastes shipped from one site to a disposal facility at another must meet the WAC established for the disposal facility. Both the generators and the disposal facility are jointly responsible for ensuring compliance with the WAC. (Note that NRC licensees are required to use the waste classification system, specified in 10 CFR Part 61, where high-activity

Class C wastes are to be placed deep in the ground or behind barriers, to limit human intrusion.)

Disposal sites must be closed according to an approved closure plan; monitoring and maintenance activities at closed facilities will be terminated based on a performance analysis of the site at the end of the institutional control period. Permanent identification markers for disposal excavations and monitoring wells are required.

As noted, performance assessments are required and are being completed for each of the DOE facilities where LLW is disposed of, to ensure that all performance objectives, including protection of an inadvertent intruder, are met. Each performance assessment is subject to preliminary and final review. By February 1992, preliminary reviews of performance assessments for all sites except Savannah River had been completed. Although not specifically so stated in DOE Order 5820.2A, it may be anticipated that the results of properly validated performance assessments will be employed to modify operational procedures and closure plans, as necessary to help ensure conformance to the performance objective for intruder protection.

INTRUDER PROTECTION MEASURES

Presently, protection against inadvertent intrusion is provided as part of the general site security at each of the DOE operating sites. DOE does not use the NRC waste classification system, and no special measures are employed to emplace those DOE wastes comparable to NRC Class C wastes at greater depth or behind special barriers. However, at each site, specific plans for disposing of individual wastes are required to be developed through use of the performance assessment model for that site. Site closure must be consistent with an approved closure plan, and following closure, management of the site must conform to RCRA, CERCLA, and the Superfund Amendments and Reauthorization Act.

REGULATORY AND INDUSTRY TRENDS

As noted earlier, DOE is preparing revisions to Order 5820.2A. Changes are being considered to accommodate a recent integration of DOE waste management programs, to allow a greater focus on strategic and long-range planning, and to provide for greater clarity and specificity. DOE intends that the revised Order should:

1. Improve compatibility with non-DOE regulations;

2. Review waste classifications;

3. Establish performance-based policies; and

4. Develop requirements for contingency planning.

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