



UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

June 16, 1998

LICENSEE: Portland General Electric Company
FACILITY: Trojan Nuclear Plant
SUBJECT: TROJAN MEETING SUMMARY

A public meeting was held on March 18, 1998 at 9:00 a.m., between representatives from Portland General Electric's (PGE) Trojan plant, their consultants and members of the NMSS and NRR staff. The meeting was attended by several members of the public. A list of attendees is attached.

The public meeting was started with the introduction of the participants. Lee Thonus announced that the meeting was open to public observation and that the purpose was for PGE to provide information to the NRC staff regarding their plans for the disposal of the Trojan reactor vessel (RV). PGE would be providing models, assumptions, and dose calculations related to long-term burial of the RV.

Steve Nichols of PGE presented a brief overview and turned over the presentation to Art Palmer of Chase Environmental Group (CEG). Mr. Palmer gave a presentation of the scenarios evaluated, the models and assumptions used, and the resulting dose calculations. The viewgraphs used in Mr. Palmer's presentation are attached. Dr. Tom Gangwer of SAIC gave a presentation on the modeling of corrosion of the RV after burial.

During the presentations the members of the NRC staff had several questions and made a number of comments regarding the scenarios, models, and assumptions used by PGE's consultants. Tim Johnson stated that PGE's scenarios, models, and assumptions could either follow the models used in NUREG-0782 Environmental Impact Statement on 10 CFR 61: Licensing Requirements for Land Disposal of Radioactive Waste or PGE could provide strong site specific technical justification for other models and assumptions.

There was discussion of whether models and assumptions were acceptable to the NRC without further technical justification (e.g. institutional control and RV intact for 500 yrs). There was also discussion as to the extent of technical justification required to use alternate models and assumptions.

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March 18, 1998

The meeting resulted in significant information exchange and clarification of a number of positions. The meeting was adjourned at approximately noon.

ORIGINAL SIGNED BY:

Lee H. Thonus, Project Manager
Non-Power Reactors and Decommissioning
Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 50-344

Attachments:

1. List of Attendees
2. Trojan Reactor Vessel
Dose Pathways Evaluation

cc w/attachment 1 and w/o attachment 2:
See next page

DISTRIBUTION:E-MAIL w/o attachment 2

SCollins/FMiraglia (SJC1/FJM)
BBoger (BAB2)(RPZ)
JRoe (JWR)
SWeiss (SHW)
SGagner (SFG)
SBrown (SWB1)
JCook (JRC1)
MHaisfield (MFH)

TMartin (SLM3)
DLange (DJL)
Region IV
PDND (NPRs staff)
JHickey (JWH1)
TJohnson (TPJ)
MThaggard (MXT3)
JGreeves (JTG1)

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MMasnik
LThonus
OGC (O15-B18)

PDND:PM
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PDND:LA
EHylton
6/ /98

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MMasnik
6/ /98

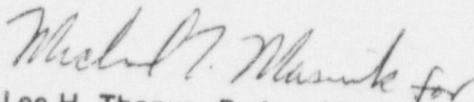
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SVeiss
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Non-Power Reactors and Decommissioning
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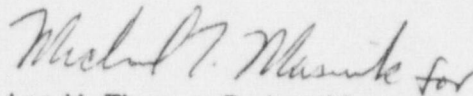
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Mr. Stephen M. Quennoz
Portland General Electric Company

Trojan Nuclear Plant
Docket No. 50-344

cc:

Chairman of the Board of County
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Regional Administrator, Region IV
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Harris Tower and Pavilion
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

Mr. H. Ray Pate
Manager Licensing, Compliance
and Commitment Management
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Trojan Nuclear Plant
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Mr. Lloyd K. Marbet
19142 S.E. Bakers Ferry Road
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Mr. Jerry Wilson
Do It Yourself Committee
570 N.E. 53rd
Hillsboro, Oregon 97124

Mr. Eugene Rosolie
Northwest Environmental Advocates
302 Haseltine Building
133 S.W. 2nd Avenue
Portland, Oregon 97204

LIST OF ATTENDEES

NRC

S. Brown, Project Manager, NMSS/DWM
R. Burrows, Project Manager, NRR/DRPM/PNDD
J. Cook, NMSS/SFPO
T. Frederichs, Project Manager, NRR/DRPM/PDND
S. Gagner, OPA
M. Haisfield, Project Manager, RES
J. Hickey, Branch Chief, NMSS/DWM/LLDP
T. Johnson, Section Leader, NMSS/DWM
M. Thaggard, Sr. Analyst, NMSS/DWM
L. Thonus, Project Manager, NRR/DRPM

PGE

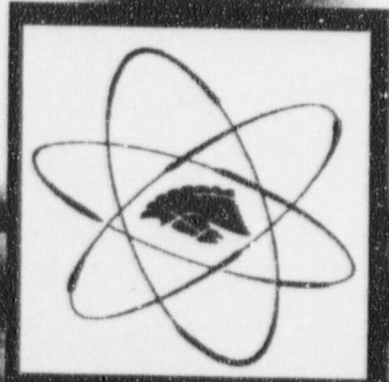
L. Dusek, Licensing Engineer
M. Murdock, Health Physics Engineer
S. Nichols, Manager, Decommissioning Projects

PGE Consultants

T. Gangwer, SAIC
A. Palmer, Chase Environmental Group
R. Sauer, Chase Environmental Group
J. Schaffner, US Ecology
P. Tuite, WMG, Inc

Public

B. Borsum, FTI
N. Chapman, Bechtel
P. Genoa, NEI



TROJAN REACTOR VESSEL DOSE PATHWAYS EVALUATION

Nuclear Regulatory Commission

March 18, 1998

Order of Presentation

INTRODUCTION

Steve Nichols

Portland General Electric

DOSE PATHWAYS EVALUATION

Art Palmer

Chase Environmental Group, Inc.

REACTOR VESSEL PACKAGE EVALUATION

Tom Gangwer

Science Applications International Corporation

SUMMARY

Steve Nichols

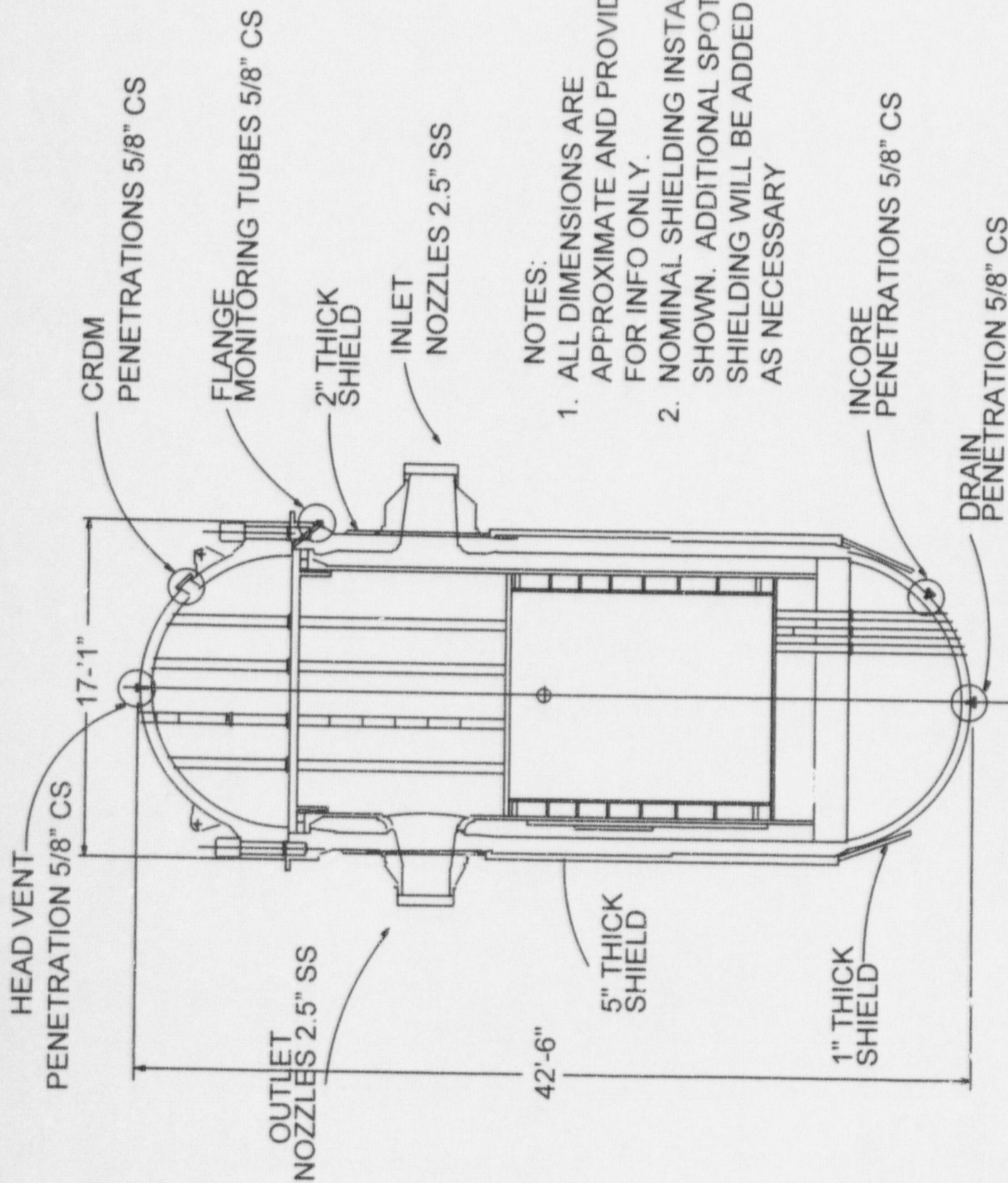
Portland General Electric

Purpose

- **Discuss Comprehensive and Defensible Pathways Analysis**
- **Demonstrate 10 CFR 61 Performance Objectives are Met**
- **Show RPV Suitable for Burial at US Ecology Site as Class C Waste**

Description of Proposed Disposal Package

- **Reactor Vessel Shell**
- **Reactor Vessel Head**
- **Plate Steel Over Penetrations**
- **Additional Shielding Over Portions of
Vessel for Transport**
- **Filled with Low Density Cellular Concrete**



NOTES:

1. ALL DIMENSIONS ARE APPROXIMATE AND PROVIDED FOR INFO ONLY.
2. NOMINAL SHIELDING INSTALLATION SHOWN. ADDITIONAL SPOT SHIELDING WILL BE ADDED AS NECESSARY

REACTOR VESSEL PACKAGE

Dose Pathways Evaluation

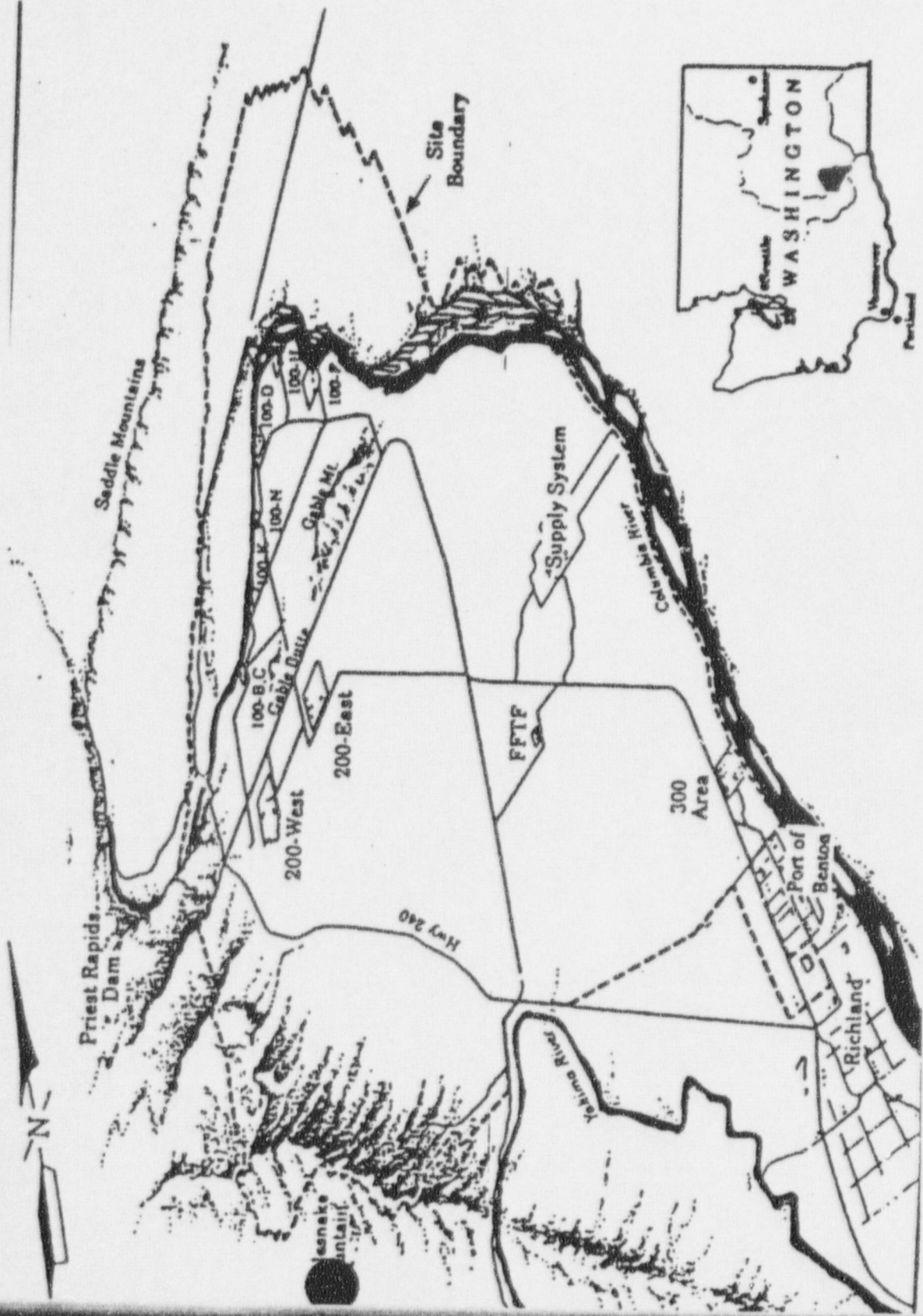
Art Palmer

Chase Environmental Group, Inc.

Disposal Site

- **US Ecology, Inc. - Hanford Site**
- **200 Area Plateau**
- **Arid Climate**
- **Thick (300') Vadose Zone**
- **Area Dedicated for Long Term Waste Management and Disposal**

Hanford Site Map

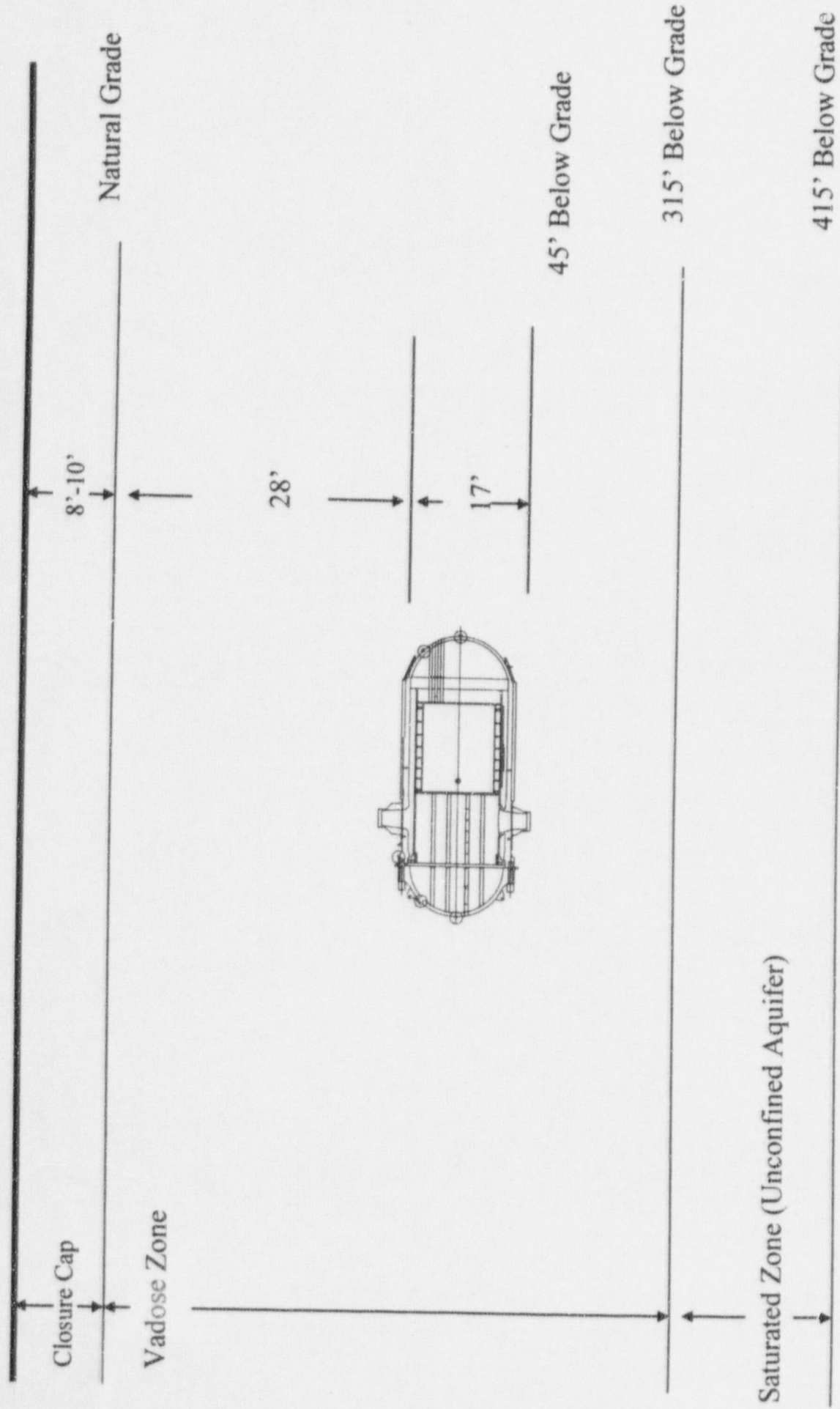


Disposal Overview

- Trench especially Constructed for RPV
- Backfill with Native Soil
- Install Closure Cap During Site Closure

Relative Elevations

Notes:
All Dimensions Nominal
Drawing is not to Scale



Potential Exposure Scenarios

Qualitative Assessments

- Waste Container Breakage
- Trench Fire
- Vessel/Truck Fire
- Waste Decomposition Gas
- Vessel Exposure Due to Natural Erosion
- LLRW Site Flooding
- Biotic Transport

Potential Exposure Scenarios, Cont.

Quantitative Assessments

- Agricultural
- Construction
- Residential (Basement)

Agricultural Scenario

Pathway / Dose Analysis Overview

- **Site Lithology**
- **Hydrologic Model**
- **Wastes and Leaching**
- **Pathways**
 - **Ingestion**
 - **Direct Gamma Exposure**
 - **Inhalation**

Agricultural Scenario, Cont.

Pathway/Dose Analysis Overview

● Transport Mechanisms

- Groundwater
- Surface Water
- Biotic Intrusion
- Wind
- Seismic

● Pathways Analyzed for up to 10,000 years

Agricultural Scenario, Cont.

Models and Dose Assessments

- **Agricultural Model**
- **Two Scenarios**
 - No Credit for Holdup from Vessel Containment
 - Credit Taken for Holdup from Vessel Containment

Conceptual Model

- **Cover**
- **Reactor Vessel**
- **Vadose Zone**
- **Saturated Zone**

Agricultural Scenario, Cont

Dose Calculation

- **Radionuclide Source Term**
- **Radionuclide Travel Time**
- **Release Rate**
- **Mixing and Dilution**
- **Well Concentration**
- **Dose Analysis**

Agricultural Scenario, Cont

Source Term Screening

- **Long Travel Times Through Vadose Zone (>1,000 years)**

● Radionuclides Screening Criteria

- Activity >1Ci and Half-life >100 years

● Exceptions to Screening Criteria

- Radionuclides with Extremely Long Half Lives
- Radionuclides with Extremely Large Activities

● Method Consistent with NUREG-1573 Section 3.3.5.2

Agricultural Scenario, Cont.

Travel Time Through Vadose Zone

- **Function of Infiltration Rate**
- **Two Cases Evaluated**
 - 0.05"/year (Assumes Closure Cap Functional)
 - 0.2"/year (Assumes Closure Cap Failure)

Agricultural Scenario, Cont.

Release Rate

- First Scenario Assumes Vessel Wall and Stainless Steel Matrix Completely Ineffective In Retarding Radionuclides Migration
- Second Scenario Assumes Vessel Degrades Over Time and that Radionuclides are Released as Vessel Plates Degrade
 - Time Periods Based on Corrosion Evaluation

Leaching Factors

- Solubility Controlled
- Sorption Controlled

Agricultural Scenario, Cont.

Mixing and Dilution

- **Well Downgradient at Site Boundary**
- **Screened at Bottom of Aquifer**
- **Complete Mixing Assumed**

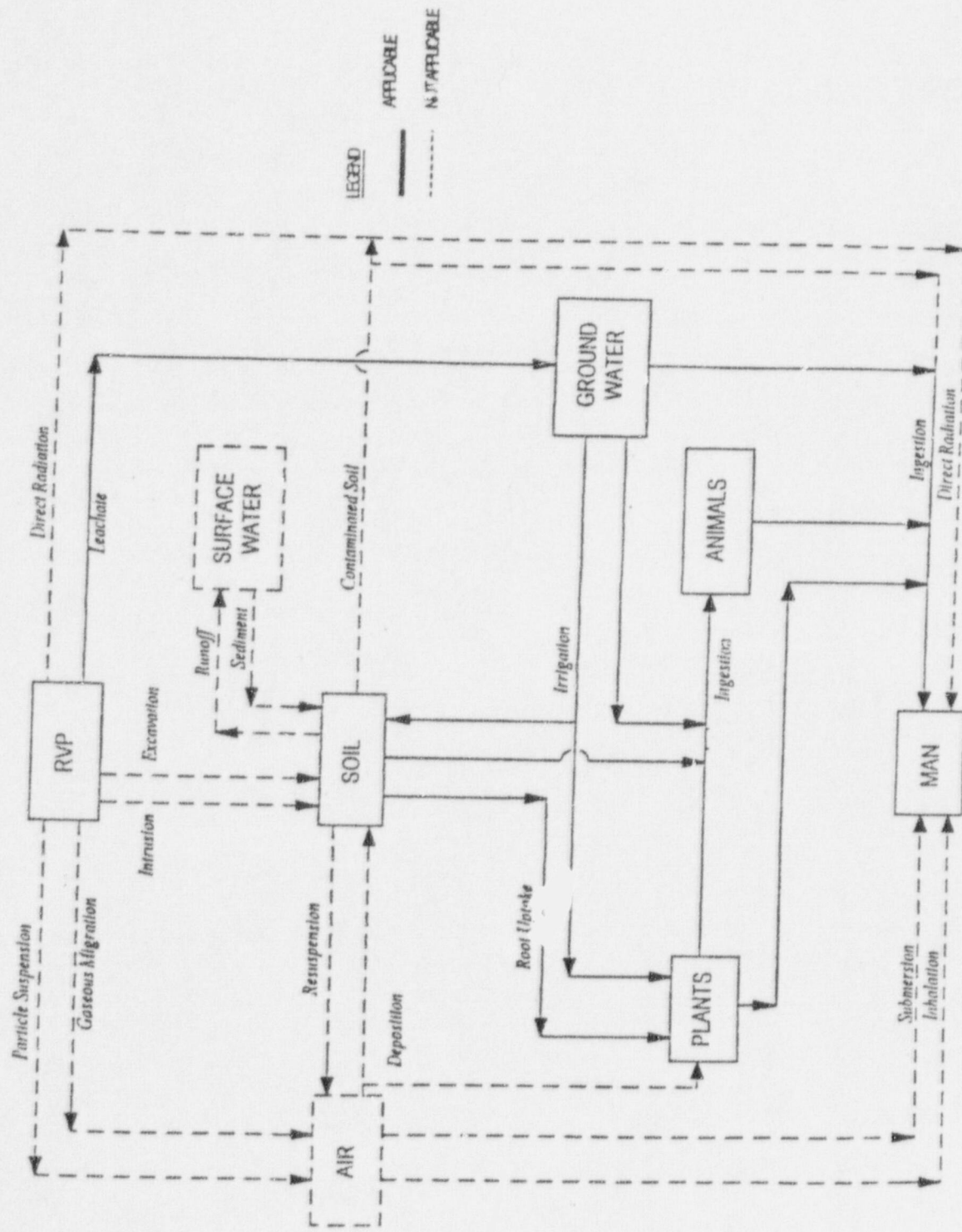
Agricultural Scenario, Cont.

Well Water Use

- **Drinking Water**
- **Irrigation For Vegetables**
- **Irrigation For Pastureland For Dairy Cow**

**Dose Calculation Approach Consistent
With NUREG-1573 Section 3.3.7**

RADIATION RELEASE, TRANSPORT, AND EXPOSURE PATHWAYS TO INDIVIDUAL INTRUDER-AGRICULTURE/FARM SCENARIO



Agricultural Scenario, Cont.

Time Periods Analyzed - Scenario 1 (No Holdup from Vessel Containment)

- **Up to 10,000 years**
- **Results Calculated for:**
 - 1,000 years
 - 5,000 years
 - 10,000 years
 - 0.05"/year Infiltration Rate
 - 0.2"/year Infiltration Rate

Agricultural Scenario, Cont.

Time Periods Analyzed - Scenario 2 (Holdup from Vessel Containment)

- **1,450 years (5/8" Plate Corroded in Water)**
- **2,350 years (5/8" Plate Corroded in Hanford Soil)**
- **5,000 years**

Agricultural Scenario, Cont.

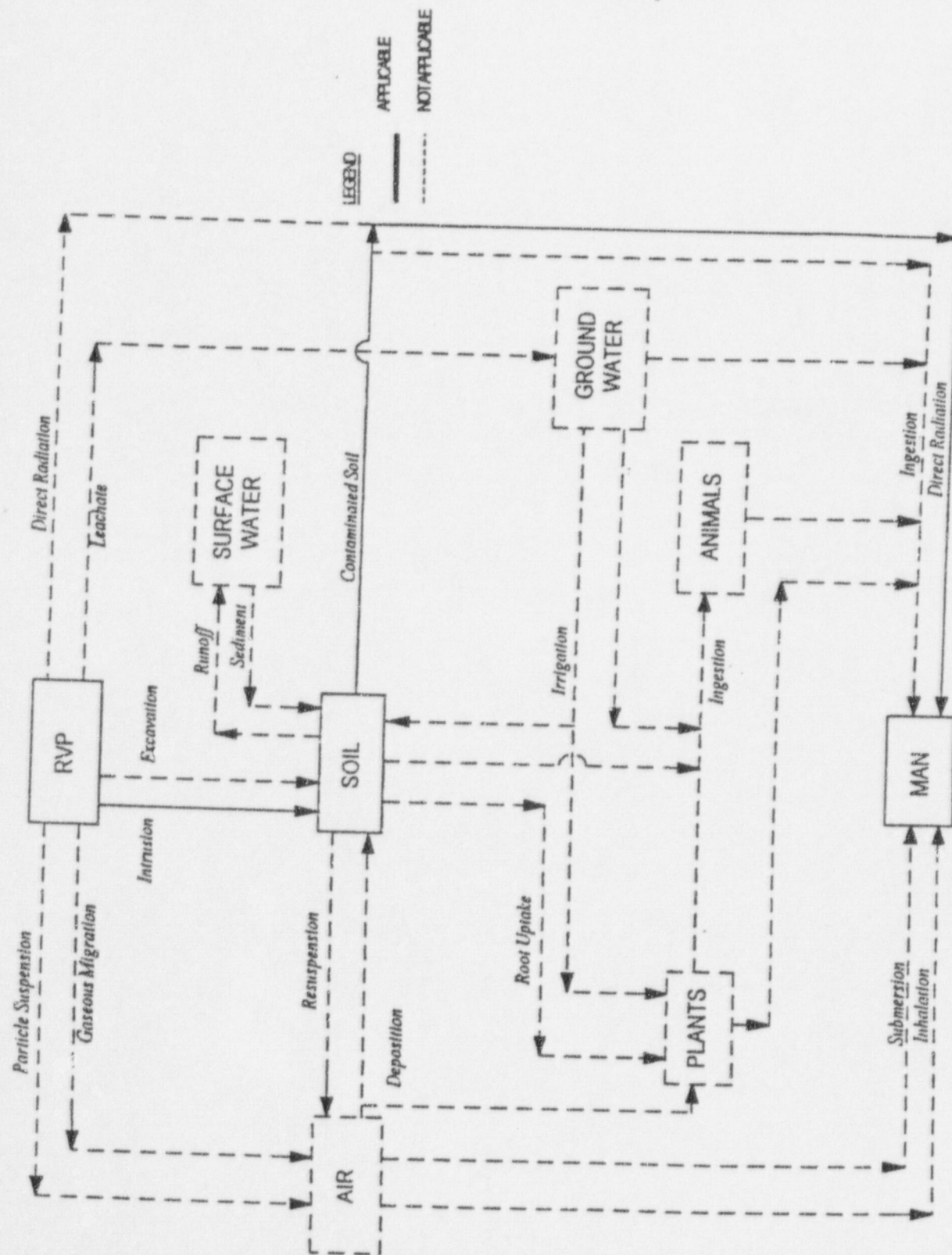
Doses Calculated for

- Whole Body
- Thyroid
- Critical Organ Dose

Construction Scenario

- **Attempted Drilling Into Reactor Vessel**
- **Occurs at end of Institutional Control Period**
- **Drill Unable to Penetrate Reactor Vessel Shell**
- **Drilling Through 5/8" Plates Not Credible Due to Vessel Orientation**
- **Drill Penetrates Inlet Nozzle Cover Plates**
- **Individual Stands Next to Drill Cuttings**
- **Doses Calculated for Whole Body**

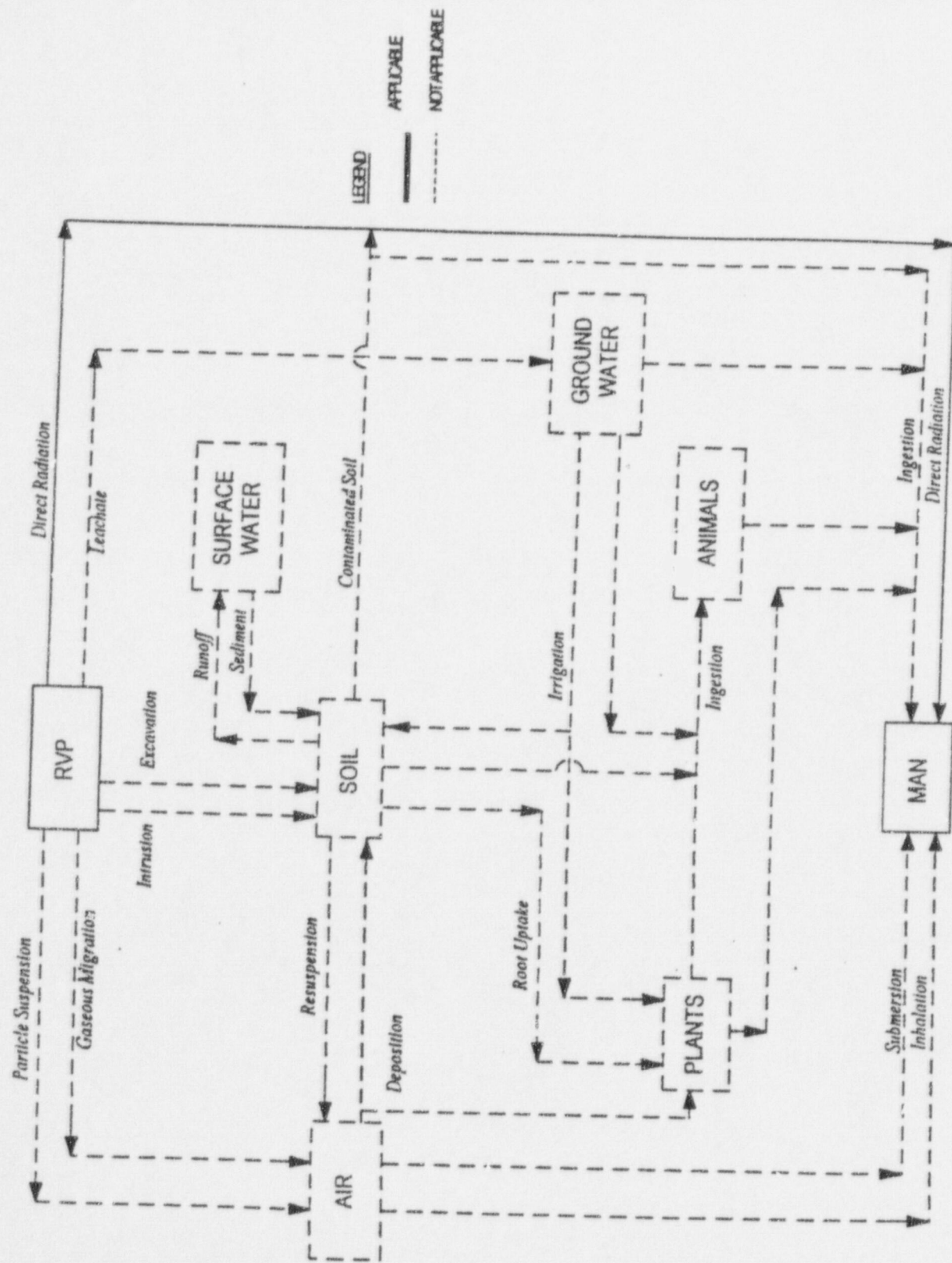
RADIATION RELEASE, TRANSPORT, AND EXPOSURE PATHWAYS TO INDIVIDUAL INTRUDER-WELL DRILLING SCENARIO



Residential Basement Model

- **House Construction into the Trench/Cover**
- **Occurs at End of Institutional Control Period**
- **Builds Directly on Reactor Vessel**
- **Individual Present 2000 Hours/Yr**
- **Doses Calculated for Whole Body**

RADIATION RELEASE, TRANSPORT, AND EXPOSURE PATHWAYS TO INDIVIDUAL INTRUDER-BASEMENT SCENARIO



Combined Site Dose Summary

- **Combine Doses From Vessel with Other Waste Buried at US Ecology Site**
- **Compare with 10 CFR 61 Performance Objectives**

10 CFR 61 Performance Objectives

- **Protect General Population**
 - 25 mrem/year Whole Body Dose
 - 75 mrem/year Thyroid
 - 25 mrem/year Any Other Organ
- **Protection From Inadvertent Intrusion**
- **Protection During Operations**
 - Maintain Radiation Exposure ALARA
- **Stability of Site After Closure**

Results

Results Show Calculated Doses are Well Below 10 CFR 61 Performance Objective Doses, Even When Combined With Other Waste at US Ecology Site

Reactor Vessel Package Evaluation

**Tom Gangwer
Science Applications International
Corporation**

Purpose

- **Present Reactor Vessel Package (RVP) Corrosion Analysis Methodology and Results for RVP Burial at Hanford**
- **Present RVP Structural Integrity Analysis Results From a 55' Soil Overburden Loading**

Agenda

- RVP Burial Configuration
- RVP Corrosion Overview
- Corrosion Analysis Assumptions
- Corrosion Methodology and Power Laws
- RVP Corrosion Analysis
- RVP Structural Integrity Analysis Results
- Summary

RVP Burial Configuration

RVP Burial Conditions

- Buried At Hanford
- 0 - 10,000 year
- 55' Soil Overburden

RVP Corrosion

RVP Corrosion will be a function of:

- **Component Material Type**

- Carbon Steel
- Stainless Steel

- **Component Thickness**

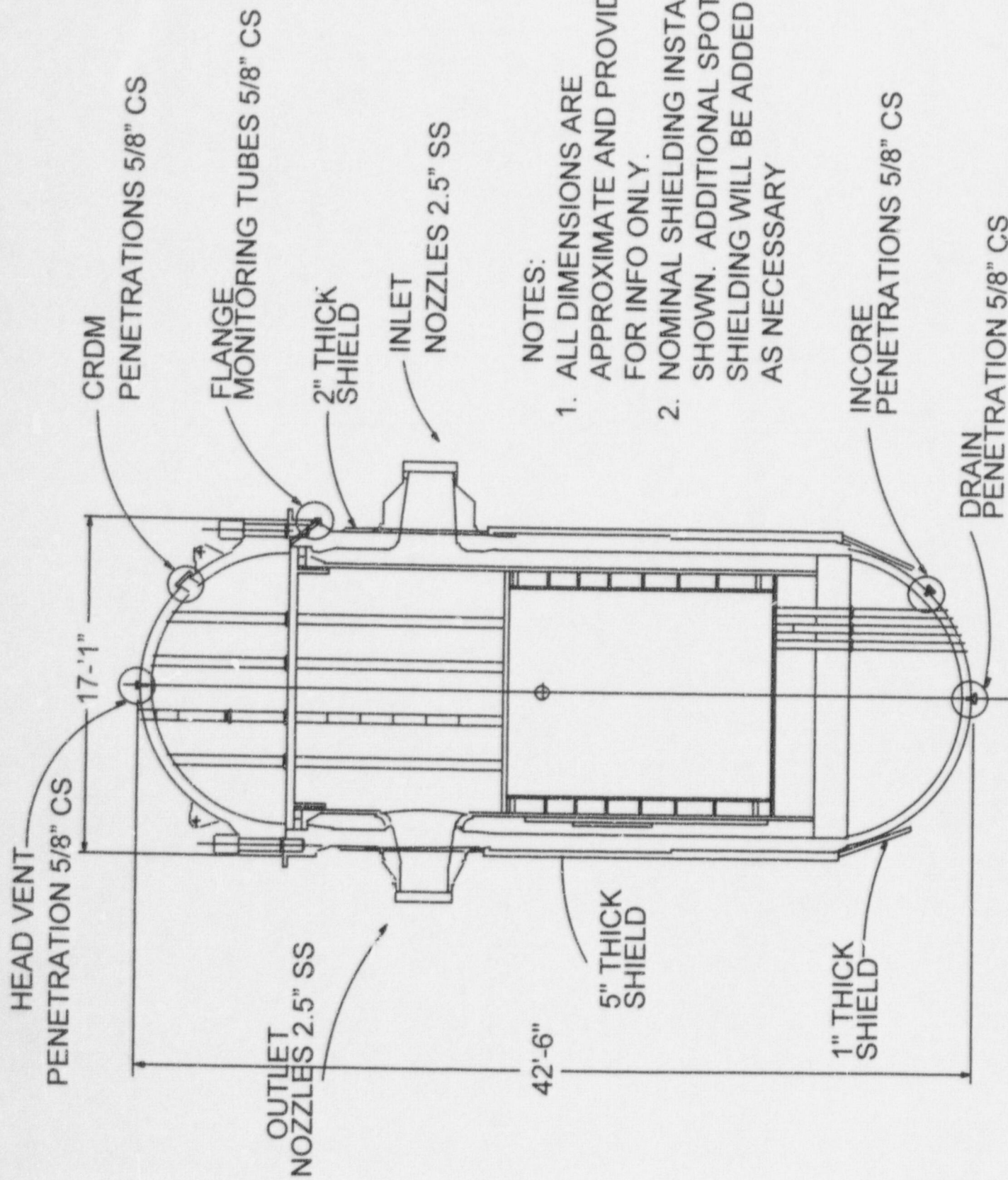
- **Soil Conditions**

- Soil Type
- Water Content
- Oxygen Content

- **Temperature**

RVP

- RVP is Carbon Steel Vessel
 - 42.5' Tall
 - 17' Diameter
 - 5" - 8" Thick
- Stainless Steel Internals
- Voids Filled with Low Density Cellular Concrete (LDCC)
- Cover Plates On RVP Openings



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REACTOR VESSEL PACKAGE

Corrosion Overview

● Two Types of Corrosion:

- General Corrosion = $Y(g)$
- Localized Corrosion (Pit Corrosion) = $Y(p)$
- $Y(\text{Net}) = Y(g) + Y(p)$

● Steel Corrosion from Water Immersion

● Steel Corrosion from Disposal Site Soil

Corrosion Analysis Assumptions

Aggressive Corrosion Conditions Assumptions:

- **Buried RVP General Corrosion Condition Modeled Using Water Corrosion Conditions**
- **Buried RVP Pit Corrosion Conditions Modeled Using Water Immersion Data**
- **Unimpeded O_2 Supply**
- **Temperature = 70° F**
- **Low Density Cellular Concrete Influence Insignificant**

Corrosion Methodology and Power Laws

- Corrosion Can Be Widely Described by the Power Law:

$$Y = K t^n$$

- Various References / Study Data Were Used to Obtain Values of K and n for:
 - Water Immersion Corrosion
 - Soil Corrosion
- Power Laws Developed for Both Carbon Steel and Stainless Steel

Corrosion Methodology and Power Laws (Cont.)

Steel in Water:

- Power Law Developed Based on Study of Steel Submersed in Tropical Lake Waters (Vinson 1995)
- Additional Information Developed from National Bureau of Standards Underground Corrosion Program (Zapp 1996)
- Results were Curve Fitted into Power Laws:
 - Carbon Steel:
 - $Y(gc) = 190 t^{0.46}$
 - $Y(pc) = 820 t^{0.35}$
 - $Y(\text{total}) = Y(gc) + Y(pc)$
 - Stainless Steel:
 - $Y(\text{total}) = 0.01 \times Y(\text{total}) \text{ Carbon Steel}$

Corrosion Methodology and Power Laws (Cont.)

Soil Corrosion:

● The Four Studies on Hanford Soil used to Develop the Power Law were:

- Anantamula (no date)
- Divine (1991)
- DEIS (1995)
- NuPac (1987)

● Results of the Study Were Curve Fitted into the Following Power Law:

- Sensitized 304 Steel $Y = 0.20 t^{0.71}$
- Carbon Steel $Y = 77 t^{0.49}$

Corrosion Methodology and Power Laws (Cont.)

- **NRC Study Results on General, Pitting and Galvanic Corrosion**
- **Minimal Impact of Thermogalvanic Couple Corrosion on RVP**
- **Minimal Impact of Radiolysis Product on RVP Corrosion**
- **Positive Benefit (With Respect to Corrosion) of Wet-Dry Cycling Results Will Be Ignored**
- **Galvanic Corrosion Which Will Occur in RVF is Addressed in the Corrosion Analysis**

RVP Corrosion Analysis

- **Net General Corrosion of Carbon Steel**
- **Pit Corrosion of Carbon Steels: Average
20 Deepest Pits**
- **Carbon Steel Water Immersion
Corrosion, 0-10,000 years**
- **Stainless Steel Water Immersion
Corrosion, 0-10,000 years**
- **Stainless Steel Soil Corrosion, 0-10,000
years**

RVP Corrosion Analysis, Cont.

- **Soil Corrosion of Carbon Steel Due to Stainless Steel/Carbon Steel Galvanic Coupling, 0-10,000 years**
- **Soil Corrosion of Stainless Steel Due to Stainless Steel/Carbon Steel Galvanic Coupling, 0-10,000 years**

Summary of RVP Corrosion Evaluation

- **Analysis Developed Time Dependent Corrosion Model**
- **Model Valid for up to 10,000 years**
- **Conservative Approach using More Aggressive RVP Corrosion Conditions**
- **Results Show Minimal RVP Corrosion**

RVP Structural Integrity Analysis

Ground Rules/Assumptions for Analysis:

- ASME Boiler and Pressure Vessel Code, Section III, Code Case N-284-1 Used in the Analysis
- Soil Pressure at the Bottom of 55' Deep Trench Estimated at 45.8 psi (Soil Density 120 lb/ft³)
- No Credit Taken for Structural Integrity Provided by Low Density Cellular Concrete in RVP

Results:

- A minimum SA-533 Carbon Steel Wall Thickness of 1.1" is Required to Maintain Structural Integrity
- Low Corrosion Rates
- Burial Site Slumping Due to RVP Structural Failure not a Concern

Summary

- **Comprehensive Pathways Analysis Completed**
- **10 CFR 61 Performance Objectives Met**
- **Reactor Vessel Can Be Buried as Class C Waste at US Ecology Site**