Y/OWI/TM-11/3

NATIONAL WASTE TERMINAL STORAGE PROGRAM

INFORMATION MEETING

MASTER

VOLUME III

December 7-8, 1976

**UNION
CARBIDE**

OFFICE OF WASTE ISOLATION
OAK RIDGE, TENNESSEE

prepared for the **U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION**
under **U.S. GOVERNMENT Contract W-7405 eng 26**

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Office of Waste Isolation

Union Carbide Corporation
Nuclear Division

Oak Ridge, Tennessee 37830

Prepared for the U. S. Energy Research and Development Administration
Under U. S. Government Contract W-7405-eng 26

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FOREWORD

In February 1976, the Energy Research and Development Administration (ERDA) announced a greatly expanded waste management program for defense and commercial radioactive waste. In that announcement, ERDA indicated that the Oak Ridge Operations Office (ORO) of ERDA would have lead responsibility for overall coordination of the expanded commercial geologic disposal program and that an Office of Waste Isolation (OWI) would be created within Union Carbide Corporation-Nuclear Division (UCC-ND) with the responsibility for program management of that activity.

The commercial geologic disposal program was named the National Waste Terminal Storage (NWTs) program. It represents the principal programmatic effort of ERDA for ultimate and final disposal of commercial nuclear waste.

In March 1976, OWI was formally created within UCC-ND reporting directly to the President of the Nuclear Division. All geological disposal work within UCC-ND, which had previously been under the management of Oak Ridge National Laboratory (ORNL), was then consolidated within OWI.

In December 1976, an information meeting on the NWTs program was held in Oak Ridge, Tennessee. The purpose of the meeting was to report on program progress during the period from April 1, 1975, through September 30, 1976. The agenda for the first day included an overview of the program plus presentations on such subjects as schedules and controls, facility projects, systems studies, regulatory affairs and technical support. The second day was devoted to geologic studies.

Persons attending the meeting received copies of Y/OWI/TM-11/1 and 11/2, two documents which contained copies of the slides shown at the meeting. Volume I contained the material discussed on the first day; Volume II contained the material discussed on the second day; Volume III contains copies of the viewgraphs which the speakers elected to incorporate in their presentations after Volumes I and II had gone to press.

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Part 6

REPOSITORY FACILITIES

S. C. Matthews
Office of Waste Isolation
UCC-ND

SITE PLAN
(GENERIC REPOSITORY DESCRIPTION)

OWI-76-332

OWI-76-61

THERMAL CRITERIA FOR BEDDED SALT

1. MAXIMUM PERMISSIBLE WASTE TEMPERATURE IS THE MAXIMUM THAT EXISTED DURING WASTE PROCESSING.
2. NO MORE THAN 1% OF THE SALT VOLUME IN A UNIT CELL SHALL EXCEED 482°F (250°C).
3. NO MORE THAN 25% OF THE SALT VOLUME IN THE UNIT CELL SHALL EXCEED 392°F (200°C).
4. MAXIMUM TEMPERATURE RISE AT THE EARTH'S SURFACE AND IN THE FORMATION OUTSIDE THE CONTROLLED ZONE SHALL BE LESS THAN 1°F.
5. MAXIMUM PERMISSIBLE TEMPERATURE RISE IN STAGNANT AQUIFERS OR MINERAL DEPOSITS AT DEPTHS OF 100 AND 300 FEET ARE 15 AND 50°F, RESPECTIVELY.

OWI-76-349 R1

Part 10

HEAT TRANSFER

H. C. Claiborne
Office of Waste Isolation
UCC-ND

FACTORS AFFECTING ALLOWABLE HEAT LOADS IN A REPOSITORY

FACTORS THAT INFLUENCE THE ALLOWABLE HEAT RELEASE RATES PER UNIT AREA OF THE DISPOSAL HORIZON AND THE INTEGRATED HEAT INCLUDE:

1. STABILITY OF WASTE
2. STRUCTURAL INTEGRITY OF MINE DURING OPERATION
3. STRUCTURAL INTEGRITY OF ENTIRE GEOLOGIC FORMATION
4. MIGRATION OF BRINE OCCLUSIONS OR WATER IN NON-SALT FORMATIONS
5. WASTE/ROCK CHEMICAL REACTIONS
6. TEMPERATURE RISE IN AQUIFERS
7. TEMPERATURE RISE BEYOND BOUNDARIES OF THE CONTROLLED AREA
8. TEMPERATURE RISES AT AND NEAR THE EARTH'S SURFACE

MATHEMATICAL MODEL

THE FLOW OF HEAT IN THIS MODEL IS DESCRIBED BY THE CLASSICAL HEAT CONDUCTION EQUATION

$$\nabla \cdot K \nabla T + Q = c_p \rho \frac{\partial T}{\partial \theta},$$

WHERE

K = THERMAL CONDUCTIVITY

T = TEMPERATURE

Q = HEAT GENERATION RATE

c_p = HEAT CAPACITY

ρ = DENSITY

θ = TIME

∇ = VECTOR OPERATOR

WHEN $K \neq F(T)$, $\nabla \cdot K \nabla T = K \nabla^2 T$, AND IN RZ GEOMETRY

$$\nabla^2 T = \frac{1}{R} \frac{\partial T}{\partial R} + \frac{\partial^2 T}{\partial R^2}$$

Part 12

ROCK MECHANICS

P. F. Gnirk
RE/SPEC Inc.
Rapid City, South Dakota

ROCK MECHANICS INVESTIGATIONS

FINITE-ELEMENT ANALYSIS:

THERMAL
THERMOELASTIC
ELASTIC
VISCOELASTIC
THERMO/VISCOELASTIC
THERMOELASTIC/PLASTIC

SALT LOADING ON WASTE-CANISTER-
SLEEVE ASSEMBLY
POTENTIAL FOR THERMALLY-INDUCED
ROCK FRACTURE
SOLUTION CAVITIES IN DOME SALT
CASE HISTORY ASSESSMENTS

LABORATORY TESTING OF BEDDED AND DOME SALT:

UNIAXIAL COMPRESSIVE AND INDIRECT TENSILE STRENGTHS
TRIAxIAL COMPRESSIVE STRENGTH AND DEFORMATION
TRIAxIAL CREEP DEFORMATION
CONSOLIDATION OF GRANULATED SALT

ELEVATED
TEMPERATURE

FIELD STUDIES:

IN SITU STRESS MEASUREMENTS IN A DOME SALT MINE
TECHNICAL SUPPORT TO OWI ON DESIGN OF INSTRUMENTATION
IN SITU HEATER EXPERIMENTS IN DOME SALT

PRE-DESIGN ENGINEERING ASSESSMENTS (ALPHA REPOSITORY):

CONCEPTUAL LAYOUTS OF UNDERGROUND REPOSITORY FACILITY
LABORATORY SALT STRENGTH TESTING
STRUCTURAL EVALUATIONS OF DISPOSAL ROOM GEOMETRIES
APPLICABLE EQUIPMENT FOR DRILLING WASTE CANISTER-SLEEVE
ASSEMBLY EMPLACEMENT HOLES IN DISPOSAL ROOMS
APPLICABLE SALT MINING EXCAVATION/HAULAGE SYSTEM

RSI-2

FINITE ELEMENT MESH FOR EXCAVATION
SIMULATION OF A SPHERICAL CAVITY

OWI-76-624

JEFFERSON ISLAND SALT MINE

EFFECTIVE STRESS CONTOURS AFTER
EXCAVATION OF A 160 BY 160
FT. ROOM ON THE 1,500 FT. LEVEL

(ASSUMING NO EXCAVATED ROOMS
ON THE 1,300 FT. LEVEL)

JEFFERSON ISLAND SALT MINE

EFFECTIVE STRESS CONTOURS AFTER
EXCAVATION OF A 160 BY 160
FT. ROOM ON THE 1,500 FT. LEVEL

(WITH EXCAVATED ROOMS ON THE
1,300 FT. LEVEL)

COMPARISON OF FINITE ELEMENT TEMPERATURES WITH
PROJECT SALT VAULT RESULTS

COMPARISON OF ANALYTICALLY PREDICTED AND EXPERIMENTALLY
 OBSERVED TEMPERATURE RISES AT PROJECT SALT VAULT
 AFTER 1.5 YEARS

Temperatures at the Canister-Rock Interface as a Function of Time for the Five Different Materials.

Normalized Thermoelastic Radial Stress at the Waste Canister-Rock Interface as a Function of the Fourier Number.

THERMO/VISCOELASTIC RADIAL PRESSURE LOADING AND TEMPERATURE RISE
HISTORY AT THE SLEEVE-SALT INTERFACE AT A DEPTH OF 2,013 FEET
(INWARD RADIAL DISPLACEMENT OF SLEEVE RESTRICTED)

TRIAXIAL COMPRESSION (CREEP) MACHINE

JEFFERSON ISLAND (DOME) SALT

RSI-14

JEFFERSON ISLAND SALT MINE: 1,500 FT. LEVEL
IN SITU STRESS MEASUREMENT

ONI-76-636

JEFFERSON ISLAND (DOME) SALT

MINE LAYOUT FOR THE ALPHA REPOSITORY CONCEPT

OPERATING COSTS BY MINING METHOD FOR A MAXIMUM HAULAGE DISTANCE OF 2,500 FT.
SIMULATION RESULTS FOR ALPHA REPOSITORY CONCEPT

SIMULATION RESULTS FOR THE INFLUENCE OF DRILL PENETRATION RATE ON THE TOTAL COST PER WASTE CANISTER EMPLACEMENT HOLE FOR THE ALPHA REPOSITORY CONCEPT

Part 22

WASTE EMPLACEMENT STUDIES
SALT VALLEY, UTAH

L. M. Gard, Jr.
United States Geological Survey
Special Projects Branch
Denver, Colorado

FIGURE 5.--CROSS SECTION THROUGH PARADOX VALLEY ANTICLINE,
TRACE OF SECTION SHOWN ON FIGURE 1

(ADAPTED FROM CATER, 1970)

FIGURE 17.
Section B - Interpreted

Part 24

WASTE EMPLACEMENT STUDIES
PIERRE SHALE PROJECT

G. W. Shurr
United States Geological Survey
Special Projects Branch
Denver, Colorado

OWI-76-644

OWI-76-645

OWI-76-646

OWI-76-647

OWI-76-648

● Epicenter
-- -- Outcrop
Contour Interval 1000 ft

Text Table 1.--Data arrays employed

Number of control points	Nature of data
113,500	Rocky Mountain Region, Well History Control System, Petroleum Information Corporation, 6/75.
34,000	Regional study area (see fig. 1), Well History Control System, Petroleum Information Corporation, 6/75.
33,000	Wells penetrating Pierre Shale in regional study area.
5,000	One well per township of Pierre penetrations.
550	One well per nine townships.
150	Wells in primary subsurface correlation grid (see fig. 4).
14	Outcrops (see fig. 4).

Part 29

PHYSICAL/CHEMICAL FACTORS
INHIBITING TRANSPORT OF WATER
IN DEEP SILICATE ROCKS

H. C. Heard
Lawrence Livermore Laboratory
Livermore, California

Table 1.--Reconnaissance Areas Compared

	SOUTH DAKOTA	COLORADO	NORTH DAKOTA
Area (square miles)	12,600	2,600	1,000
Depth to base (feet)	Generally less than 2,000	Half, 1,000 to 2,000 and half, 2,000 to 3,000	1,500 to 2,000
Shale thickness (feet)	Commonly greater than 1,500	Half, 1,500 to 3,000 and half, 1,000 to 1,500	Less than 1,500
Structural attitude (dip in feet per mile)	Less than 10	Less than 10	Less than 10
Epicenters (number)	2	0	0
Earthquake intensities (Richter scale)	Generally, less than III, locally IV	Less than III	Less than III
Total thickness of sedimentary rocks (depth in feet to crystalline basement)	3,000 to 8,000	6,000 to 8,000	6,000 to 8,000
Resources	Water, oil(?), and coal(?)	Oil, water, and salt(?)	Oil, salt, water, and coal(?)
Land use (agricultural)	Grazing; minor cash crop	Irrigated cash crop; minor grazing	Cash crop
Population densities (persons per square mile)	Less than 5	Less than 5	5 to 10

SELECTION OF ACCEPTABLE SITES FOR SAFE, LONG-TERM
DISPOSAL OF HIGH LEVEL RADIOACTIVE WASTES REQUIRES
PREDICTION (IN BOTH SPACE AND TIME) OF:

- 1) MECHANICAL STABILITY OF VAULT
- 2) PERMEABILITY TO GROUNDWATER

PREDICTION OF VAULT STABILITY AND ROCK PERMEABILITY

WITH TIME REQUIRES LABORATORY DETERMINATION OF:

- 1) EFFECT OF PRESSURE, STRESS ON ROCK STRAIN,
PERMEABILITY FOR BOTH "SOUND" AND "FRACTURED"
IGNEOUS INTRUSIVE ROCK
- 2) PHYSICAL PROPERTIES OF THESE ROCKS WHICH MAY
BE EASILY USED AS DIAGNOSTIC TOOLS FOR REMOTE
SENSING (E.G., ELECTRICAL RESISTIVITY, ACOUSTIC
VELOCITY)
- 3) EFFECT OF MODERATE TEMPERATURES (AFTER EMPLACE-
MENT OF WASTE CANNISTER) ON ROCK STRESS, STRAIN,
AND PERMEABILITY

SCHEMATIC OF TEST SAMPLE

Measure: σ , ϵ , ρ , V_p and K
Later explore their T dependence

Part 31

STUDIES FOR GEOLOGIC STORAGE IN THE SOUTHEAST

I. W. Marine
Savannah River Laboratory
Aiken, South Carolina

AFTER DETERMINING TIME DEPENDENCE OF ROCK BEHAVIOR
(σ , ϵ , T , K , ρ , v_p) FOR FRACTURED, UNFRACTURED CASE
PLUS

- 1) FIELD DATA (E.G., FRACTURE SPACING, INTENSITY,
IN SITU STRESS AND/OR STRAIN FIELD)
- 2) SIMPLE PREDICTIVE MODEL OF ROCK BEHAVIOR BASED
ON FIELD AND LABORATORY DATA

WE WOULD HOPE TO BE ABLE TO MEET THE STATED GOAL:

PREDICTION OF MECHANICAL STABILITY OF VAULT AS WELL
AS ITS PERMEABILITY TO GROUNDWATER OVER LONG DURATIONS.

STUDIES FOR GEOLOGIC
STORAGE OF RADIOACTIVE
WASTE IN THE SOUTHEAST