OFFICE OF WASTE ISOLATION
PROGRESS REPORT

JANUARY 1978

MASTER

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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PROGRESS REPORT

JANUARY 1978

C. D. Zerby, Director

Issued February 28, 1978

Edited by R. C. Rhines

OFFICE OF WASTE ISOLATION
Union Carbide Corporation-Nuclear Division
Oak Ridge, Tennessee 37830

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HIGHLIGHTS

. . .	Sandia Laboratories completed work on the Cask Scoping Study, and their final report draft is under review at Oak Ridge	38
. . .	The baseline OWI Program Control System (PCS) was updated to reflect present program and budget assumptions. Documentation of the PCS instructions was completed	44
. . .	The Waste Inventory Study was initiated by NUS Corporation	45
. . .	An outline for a comparative study of spent fuel and reprocessing waste disposal systems and other materials were provided to DOE-HQ for use in connection with participation in the International Nuclear Fuel Cycle Evaluation Working Group 7	45
. . .	Tentative agreement on the annotated Safety Analysis Report outline to the third level of detail was reached by OWI, Bechtel, and NUS	52

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FOREWORD

As in the past, the format of this report generally follows the organizational structure of the Office of Waste Isolation (OWI) and the programmatic structure of the National Waste Terminal Storage (NWTs) Program. The report contains project reports on work performed by commercial and/or nonprofit organizations under subcontract to OWI, by Department of Energy (DOE) contractors (including UCC-ND), by OWI consultants, and by other federal agencies supporting and participating in the NWTs Program. Each project report identifies the OWI staff member responsible for managing the project, as well as the names of the consultants, subcontractors, or DOE facilities conducting the work.

1. TECHNICAL PROJECTS

W. C. McClain

1.1 Geologic Evaluation

R. B. Laughon

1.1.1 GULF COAST INTERIOR SALT DOME BASIN . . . R. B. Laughon

1.1.1.1 Geologic Project Manager for Gulf Coast Salt Domes . . . J. E. LaBastie, Law Engineering Testing Company (LETCO)

Law Engineering Testing Company submitted their draft report to OWI summarizing the results of their regional reconnaissance survey and submitting their proposed program plan for further evaluation of the six salt domes that they recommended. The LETCO recommendations for both the study dome selection and the proposed evaluation plan are expected to be reviewed by OWI, DOE, and interested state agencies during February 1978.

1.1.1.2 An Investigation of the Utility of Gulf Coast Salt Domes for the Storage and/or Disposal of Radioactive Wastes . . . J. D. Martinez, Louisiana State University (LSU)

Geomechanics

Monitoring and maintenance of tiltmeters over Vacherie and Rayburn's domes are continuing. One of the installations over Rayburn's dome was vandalized. That is, the cover was pried off (lock hasps broken), and two batteries were stolen. No other damage was noted. Tilt readings (± 1 microradian sensitivity) were obtained from one of the tiltmeters over Vacherie, and the correlation between tilt and temperature readings was noted. In December, a-c power was connected to the tiltmeter at site 1 over Rayburn's dome.

Laboratory testing of soil samples around the tiltmeter sites over Vacherie is under way. The data collected will be used in estimating mechanical properties of the soils around the tiltmeter installations.

Planning was completed to perform precise releveled over Vacherie and Rayburn's domes. Negotiations for the subcontract will be started in February 1978, and the work should be completed during the summer of 1978. The time interval will have then been approximately one year since the initial precise leveling.

Geohydrology

The thermal infrared survey of North Louisiana dome sites planned for this winter has been postponed because the contract award has been delayed for approximately two months. By that time, the vegetation cover is expected to be too dense to permit optimum results from the survey. The survey is now planned for the winter of 1978-79. A series of diagrams using data from exploratory borings, which illustrates the post-Cretaceous

history of Vacherie dome is being developed with emphasis on geohydrologic changes during dome growth. This study of hydrologic, tectonic, and sedimentary events should assist in an updated understanding of the current structure and geohydrologic history of the dome.

A new petrographic microscope was received and checked. The instrument will be used in the analysis of salt and caprock samples from core holes and salt mines.

A paper by J. D. Martinez entitled Salt Dome Caprock - A Record of Salt Dome Processes is in final preparation. The paper is scheduled to be delivered at the Fifth International Symposium on Salt in May 1978, in Hamburg, Germany. Some relevant new ideas are presented as well as a restructured perspective on older methodologies.

Regional geology

The geochemistry group processed the remaining Cote Blanche salt samples for chloride, sodium, magnesium, and calcium. All other data have been compiled and reduced to atomic ratios to determine possible mineral abundance. Sylvite (KCl), halite (NaCl), and anhydrite (CaSO₄) were found to be present in the Cote Blanche salt samples by means of x-ray diffraction techniques, which determine the presence of minerals qualitatively. A flameless technique of atomic absorption spectrophotometry was used for strontium, magnesium, and other elements by using the Perkin-Elmer 2100 graphite furnace for determination of metals near the detection limit.

Integration of gravity data obtained from several oil companies in the vicinity of Rayburn's dome was completed. The integrated data will be used for generation of a preliminary Bouguer gravity map. In an effort to reproduce the observed gravity, construction of density models of the dome is anticipated to take place in February 1978. In the absence of critical gravity data to the north and northeast of the inferred dome center, the possibility cannot be ruled out that Rayburn's dome is elongate in shape (as is Vacherie dome). Additional gravity surveys and other geophysical studies to determine the shape of the dome are clearly indicated.

Analysis of seismic profiles in the vicinity of Vacherie dome continues. The presence of apparent diffractions on the inferred flanks of the dome suggests that migration of the diffractions will probably provide additional, more precise constraints on the shape of the upper few thousand feet of the dome. Together with interpretation of the shape of the subsalt reflector at depth, the diffraction migration will provide valuable control for the optimum location of future seismic reflection and refraction lines.

Quaternary studies

The draft of a topical report on Quaternary studies completed over Vacherie dome is in the final stages of preparation. All boring logs, soils laboratory data, downhole geophysical logs, and color photographs of borings have been assembled. Subsurface soil sections within the Quaternary have been finalized and are being prepared in color for inclusion in the topical report. These Quaternary subsurface sections are now being drafted in black and white.

With the use of the 1976 seismic profiles and the results of the 1977 boring program, refinements have been made in delineating the map extent of the Quaternary above Vacherie dome. Attempts are being made to identify, map, and correlate surfaces of Quaternary terraces at Vacherie through the use of aerial photographs, published geologic maps, and soils maps.

Work continued on processing shallow seismic refraction data from Rayburn's dome using the LSU computer. Slight modifications in the computer program supplied by Harding-Lawson of San Rafael, California, were necessary for it to be compatible with the LSU computer system. A three-dimensional plexiglass model illustrating the results of the Harding-Lawson shallow seismic survey has been prepared.

Specifications for borings to be made in areas of legal access at Vacherie and Rayburn's domes are being prepared in cooperation with LETCO. It is hoped that these specifications can be completed, bids received and evaluated, and a contract let by mid-February 1978.

Drilling

During January, LSU finalized a contract with the Rosamond Drilling Company of West Monroe, Louisiana, for drilling core holes at Vacherie and Rayburn's salt domes. Drilling is expected to begin early in February 1978. Final preparation of the Vacherie site was completed, including digging of water pits and mud reserve pits, installation of conductor pipe, and the laying of an additional 2 in. (for a total of 4 in.) of gravel on access roads and the well location.

1.1.1.3 Hydrologic Studies of Louisiana Salt Domes . . . R. L. Hosman, U.S. Geological Survey (USGS)

Work on data compilations for regional geohydrologic mapping is continuing. Total thickness and sand-percentage maps for the Sparta Sand, the principal aquifer in the area, are nearly complete.

The project chief spent most of the past month preparing for a training course in digital modeling of ground-water flow. The course ran from January 16 through January 27 and was conducted by USGS at the Training Center in Denver, Colorado. A regional ground-water flow model is planned for a later phase of the salt dome study.

No information has been received regarding the status of the test drilling proposal submitted to the USGS coordinating office in November 1977.

1.1.1.4 Evaluation of the Potential of the East Texas Interior Salt Domes . . . C. W. Kreitler, Texas Bureau of Economic Geology (TBEG)

The study of East Texas salt domes for nuclear waste isolation has been subdivided into three groups: (1) Hydrogeology (directed by Charles W. Kreitler), (2) Surficial Geology and Geomorphology (directed by E. G. Wermund), and (3) Subsurface Geology (directed by Edgar Guevara). The first task for all three groups is the identification of three specific

salt domes to be recommended to DOE for more specific detail study. Preliminary recommendations are being made so that LETCO can begin land acquisition and subcontracting for necessary services.

Hydrogeology

The hydrologic stability of the seven domes recommended by Anderson* plus others (including the Oakwood dome) is being evaluated by considering (1) the presence of surface salines over the domes and (2) the salt dissolution of the domes by meteoric ground water.

Saline plumes are being mapped by determining the salinity from electric log data and water chemistry data around the domes. All electric logs available through the Texas Department of Water Resources and from commercial electric log libraries, as well as, well location maps, have been acquired. Wells have been located, and salinity mapping has begun. All available water quality data have been gathered, and water wells have been located. Water chemistry around the domes is being interpreted.

Surficial geology and geomorphology

Three data sets have been accumulated - namely, a bibliography on Quaternary deposits in East Texas, a preliminary series of topographic profiles, and outlines of drainage patterns in the immediate vicinity of salt domes.

The previous work on Quaternary rocks in East Texas is minimal, especially in the East Texas basin where the salt domes occur. Compared with the work done by the LSU group, a positive identification of Quaternary sediments in East Texas appears to be difficult to make.

Preliminary profiles of topography in the vicinity of salt domes show that surfaces of variable levels occur. The determination whether these surfaces can be distinguished according to age and their history resolved is unknown. Subtle movements of salt probably cannot be seen using this method.

Drainage patterns were outlined for each dome using standard topographic maps (scale 1:24,000 and 1:62,500). The purpose of the pattern outline was to determine if dome-controlled drainage patterns could be detected using this technique with available maps. The results were inconclusive.

Subsurface geology

The main effort has been to gather the basic sources of information for the studies on the subsurface geology of the East Texas salt dome area and to catalogue and file the material obtained. Law Engineering Testing Company provided electric logs and scout cards for wells in the 5-mile radius area around Oakwood Dome and the seven domes that were not eliminated in previous investigations. Base ownership maps and Volumes I (1963) and 2 (1976) of Petroleum Information Corporation, East Texas Well Log Service are being used to list wells from which logs are

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*Anderson, R. E.; Eargle, D. H.; and Davis, B. O.; Geologic and Hydrologic Summary of Salt Domes in Gulf Coast Region of Texas, Louisiana, Mississippi, and Alabama, U.S. Geological Survey, USGS-4339-2 (1973).

to be requested. These wells are generally 2 to 5 miles apart and will be used in the regional subsurface work. Electrical logs received for Mount Sylvan, Bullard, and Whitehouse domes are being correlated, using published information and scout-card data.

1.1.1.5 Northeast Texas Salt Dome Basin Study . . . J. E. Carr, U.S. Geological Survey

This one-year study by the Water Resources Division of the USGS is concerned with describing the regional geohydrology of the Northeast Texas salt dome basin. This effort is part of a larger program to provide background information on several possible types of radioactive waste repository sites in order to evaluate the hydrostability characteristics of each site. Although this study is of a regional nature, special consideration will be given to the ground-water conditions within the vicinity of three particular salt domes - Oakwood, Palestine, and Mount Sylvan.

The description of the regional geohydrology will be primarily concerned with geologic units of Upper Cretaceous (and younger) age. These units will be described mainly by a series of maps showing (1) structural contours on all major units, (2) net sand thickness and potentiometric surfaces of aquifer units, (3) confining bed thicknesses, and (4) water quality variations. These maps and additional information will be used to interpret the regional hydrology.

Current progress on the study area includes the computation of net sand thickness and total thickness of about two-thirds of the geophysical logs. Structural contours on several of the geological units were re-evaluated in the northern part of the basin.

Planned accomplishments for the next report period are construction of net sand thickness maps on the Wilcox, Carrizo, and Queen City aquifers and construction of a net clay thickness map on the Reklaw Formation.

1.1.1.6 Hydrology Studies of the Mississippi Salt Dome Basin . . . E. H. Boswell, U.S. Geological Survey

No activity has been reported for January.

1.1.2 SALINA SALT BASIN . . . R. B. Laughon

1.1.2.1 Geologic Project Manager for Salina Salt Basin . . . J. Briedis, Stone & Webster Engineering Company

Stone & Webster submitted Volume II of their draft report on the Salina basin to OWI. This volume supplements Volume I, which presented the results of their regional reconnaissance survey, and contains their recommendations for the selection of proposed study areas and a proposed program plan for the further evaluation of these areas. These recommendations are expected to be reviewed by OWI, DOE, and interested state agencies during February 1978.

1.1.2.2 Hydrologic Studies of the Salina Salt Basin . . . S. E. Norris,
U.S. Geological Survey

No activity has been reported for January.

1.1.2.3 Appalachian Basin Remote Sensing . . . L. C. Rowan, U. S. Geo-
logical Survey

No activity has been reported for January.

1.2 Geological Studies

T. F. Lomenick

1.2.1 PARADOX BASIN . . . T. F. Lomenick

1.2.1.1 Paradox Basin Waste Emplacement Studies . . . R. J. Hite, U.S.
Geological Survey

No activity has been reported for January.

1.2.1.2 Paradox Basin Remote Sensing . . . L. C. Rowan, U.S. Geological
Survey

Jules Friedman, USGS, reports one new finding in the continuing Landsat investigations of the Paradox basin. In the northwest core of the 2° Moab quadrangle, a previously unmapped lineament (trending east-east northeast) extends from Township 21 South, Range 20 East, westward to the border of the Salina 2° quadrangle where it meets and coincides with a major mapped fault. The Landsat frames show this lineament clearly offsetting lithologic units in the northwestern, plunged part of Courthouse syncline. The northwestern extension of Salt Valley anticline may be affected by this structure.

1.2.2 PERMIAN BASIN . . . T. F. Lomenick

1.2.2.1 Texas Panhandle Studies . . . T. C. Gustavson and W. C.
Galloway, Texas Bureau of Economic Geology

Remote sensing and shallow stratigraphy . . . T. C. Gustavson

During January, preliminary environmental geologic mapping of fourteen 7.5 min. quadrangles was completed.

A manuscript entitled Geomorphic Mapping on the Llano Estacado was prepared by C. M. Woodruff. A discussion of the findings reported in this paper will be presented to Texas A&M University in February 1978.

The acquisition of climatological data is essentially complete. Maps depicting average annual temperature, precipitation, and daily precipitation for selected rainfall events are under construction.

A climate and geomorphic monitoring station was installed at the Buffalo Lake National Wildlife Refuge. Rainfall and air and soil temperatures will be continuously recorded. Mass movement, slope and soil erosion processes and rates will be recorded and related to climatic data.

One or two additional monitoring sites will be installed in February 1978. Environmental geologic mapping and climatologic mapping will also continue throughout February.

Basin analysis . . . W. E. Galloway

The stratigraphic sequence of the Palo Duro/Dalhart basins may be logically subdivided into six genetically related units, including (1) pre-Pennsylvanian carbonates, (2) Pennsylvanian mixed clastics and carbonates, (3) Lower Permian carbonate, clastic, and evaporite facies, (4) Upper Permian carbonate, evaporite, and clastic facies, (5) Triassic clastics, and (6) Plio-Pleistocene clastics. New developments in the analysis of each of these units are summarized below.

Pre-Pennsylvanian. No new developments have occurred this month in the analysis of the pre-Pennsylvanian unit.

Pennsylvanian. No new developments have occurred this month in the analysis of the Pennsylvanian unit.

Lower Permian. Limestone percentage and total Wolfcamp carbonate thickness maps that outline the general development of the shelf-edge and mudstone-rich basin facies were completed. A net sandstone map of the same interval shows that source areas to the west, north, and east continued to provide sand to the peripheral shelves.

Upper Permian. Isopach and paleogeographic maps of the Tubb and lithologic cross sections show that the Tubb can be further subdivided using widespread salt beds that occur within the dominantly mudstone unit. Salt deposition within the Tubb interval was concentrated at the southern margin of the basin and locally in Briscoe County. Individual salt-bounded terrigenous clastic lobes that comprise the Tubb have been mapped, and patterns of salt deposition in these clastic-dominated zones within the Permian are being documented.

In addition to the clastic salt facies association, clastic/dolomite/thick salt and dolomite/anhydrite/clastic facies assemblages comprise the Upper Permian section. Detailed cross sections and mapping of salt beds within the San Andres Formation illustrate patterns of salt distribution in the salt/dolomite assemblages.

Correlations for the Glorietta Formation, and a regional isopach are complete.

Triassic. Analysis of the regional subsurface log grid is complete, and uranium anomaly data are being integrated into the stratigraphic studies.

Plio-Pleistocene. No new developments have occurred this month in the analysis of the Plio-Pleistocene unit.

Significant new results. Combination of log types, calibrated against caliper logs where available, appears to make a reasonably accurate mapping of salt beds possible. Purity of these beds will remain unknown until cores are taken. Up to 150 ft of "massive" salt (as defined by the geophysical log parameters) occur in the central portion of the basin.

1.2.3 BASIC GEOLOGIC STUDIES . . . T. F. Lomenick

1.2.3.1 Pierre Shale . . . H. E. Simpson, U.S. Geological Survey; T. F. Lomenick, OWI

No activity has been reported for January.

1.2.3.2 Crystalline Rocks . . . L. B. Cobb and R. B. Laughon

No activity has been reported for January.

1.2.3.3 Studies for Geologic Storage of Radioactive Waste in the Southeast . . . I. W. Marine, Savannah River Laboratory

The studies for storage of radioactive waste fall into two categories: (1) those with the aim of ultimately designating a suitable site and host rock for initial-phase repository operations and (2) those concerned with research applicable to storage in rock types of interest irrespective of the specific location.

Category 1 studies. Letters were sent to the State Geologists in the southeastern region to inform them of recent redirections in the program and of the impending contract awards for literature surveys of potential host rocks in the southeastern United States.

Category 2 studies. Research applicable to radioactive waste storage in rock types of interest irrespective of specific site is reported below.

The Parametric Study of Geologic and Hydrologic Performance Characteristics for geologic waste repositories has been completed. The objective of this study was to aid in the selection of repository sites by quantifying and presenting, in graphical form, the effects of significant geologic, hydrologic, and other performance characteristics that influence the movement of radionuclides to the biosphere from a storage site in a rock unit (excluding salt). The study emphasized the transport of radionuclides from the repository by ground water because this means is the most likely method of radionuclide escape.

The major performance characteristics that could influence transport of radionuclides from a repository to the biosphere by ground water are (1) hydraulic conductivity, (2) hydraulic gradient, (3) osmosis, (4) leach rate of radionuclides from waste form or spent fuel, (5) ion exchange characteristics, (6) hydrodynamic dispersion, (7) radioactive decay, and

(8) travel distance from repository to biosphere. The first three parameters influence the water velocity. The water velocity combined with the fourth parameter determines the radionuclide concentration in the water leaving the repository. This concentration combined with the next three parameters determines the radionuclide velocity, which, in turn, when combined with the distance to the biosphere, determines the radionuclide concentration entering the biosphere.

A series of 19 graphs was prepared to show the interrelationships of these eight parameters on the transport of radionuclides. Most graphs show three parameters - one on the ordinate, one on the abscissa, and one as a family of curves. Wide ranges for the various performance characteristics were chosen so that the graphs would be useful for determining the meaning of almost any value that might be measured in field studies.

In the early screening process of site selection, the graphical form of presentation should be useful for evaluating components of conceptual models for waste storage. As site selection becomes focused on more specific geologic models, host rocks, and locations, more detailed numerical simulations of conditions will be required.

The draft report of the results of this study is being internally reviewed.

The data collection phase of the study to Document and Evaluate the Damage to Mines, Wells, and Underground Facilities Due to Earthquakes has been completed by the subcontractor, and the draft report is nearly complete.

The design for the testing machine to be used in the Studies of Geologic Membrane Phenomena is complete, and fabrication of the machine should begin soon.

1.2.3.4 Cooperative Work Program with the Swedish State Power Board on Waste Storage in Mined Caverns* . . . C. A. Brown, Lawrence Berkeley Laboratory (LBL)

Drilling. All drilling in the full-scale and time-scale heater rooms has been completed ahead of schedule. The only drilling that remains to be completed is for subsurface and surface hydrological and geophysical testing; this drilling is not scheduled to begin before the end of the third quarter of FY 1978.

Task 1: Full-scale heaters. Testing of the three full-scale heater canisters, the nine peripheral heater units, and one spare heater element has been completed. Nearly all TerraTek-supplied data acquisition equipment and instrumentation has been shipped to Sweden. The data-logger-associated data acquisition equipment supplied by LBL, including thermocouple ice-point references, has been assembled in racks. Cabling and testing of this equipment are scheduled for completion on January 27.

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*This report covers activities from December 15 through January 15, 1978.

Work is continuing on the computer tabulation and cross referencing of the instrumentation to the data acquisition devices and MODCOMP computer. The first tabulated work sheets are expected to be completed by February 10, 1978.

Production has begun on 14 full-scale heater power driver and monitor chassis, and eight voltage regulator chassis. Other full-scale and peripheral heater-associated electronics chassis are in the final stages of design.

Guide tube assemblies for the full-scale heaters have been fabricated, and insulator and screens have been modified to accept the guide tubes. Testing of ten peripheral heater units is completed.

Construction of the instrumentation shed was completed, and work on the construction of the walkway continued. Detailed fracture mapping and evaluation proceeded in the H-9 and H-10 areas. Television logging of the 76-mm holes was completed, and the computer room was finished. The VIAK borehole survey of holes in the full-scale drift has also been completed. Final results showing theoretical and real coordinates of all drilled holes in the full-scale and time-scale drifts will be available about January 20. Water-flow measurements were taken in the heater holes.

Task 2: Time-scale heaters. All heater elements have been electrically checked cold and checked at full power outside of their canisters. Nearly all TerraTek-supplied data acquisition equipment and instrumentation has been shipped to Sweden. The data-logger-associated data acquisition equipment supplied by LBL, including thermocouple ice-point references, has been assembled in racks. Cabling and testing of this equipment are expected to be completed by January 27. (This work is being done parallel to similar work for Task 1.)

Work is continuing on the computer tabulation and cross referencing of the instrumentation of the data acquisition devices and MODCOMP computer. The first tabulated work sheets should be completed by February 10, 1978. (This work is being done simultaneously with documentation for Task 1.)

The detailed design of the time-scale heater power driver and monitor chassis is completed and ready to be prototyped. Production of voltage regulator chassis for Task 2 is included in the production of the eight chassis mentioned for Task 1. Design is continuing on the other electronics chassis for this experiment.

The writing of specifications for equipment to measure decrepitation and dewatering is continuing. Laboratory tests were conducted for a dewatering air-bubble lift system, and a full-size mock-up was constructed. Time-scale heater elements were received and checked.

Rock bolting and wire meshing of the roof in the time-scale room have been completed. Construction of the instrumentation shed and walkway is in progress.

Water inflow measurements in holes H-3 and H-4 were completed. Measurements will continue to be taken to determine the source and location of inflowing water.

Task 3: Fracture hydrology. The inclined borehole SBH-2 was shortened and terminated at a depth of 369.74 m because of a deviation

of the hole and also because of its proximity to the ventilation shaft and the 310-m level underground drifts. Reflex-Photobar measurements were taken at 264- and 330-m depths. All core has been logged, photographed, and stored.

Task 4: Geophysical assessment of fracture system. Geophysical holes N1 to N4 and monitoring holes M4 to M10 have been completed.

Task 5: Laboratory measurement. A quality assurance and testing program has been designed and is being reviewed by the various task investigators.

A large core, 105 cm long and 100 cm in diameter, was drilled and removed but found to be unsatisfactory. A site for drilling a new core was selected.

Task 6: Ventilation experiment. The roof and walls of the ventilation drift have been scaled, and lights have been installed. Also, the drift has been completely cleaned and readied for photomosaic photography. Locations of eight hydrology holes have been selected, and the specifications drawn.

Task 7: In situ stress measurement. No activity has been reported for January.

1.2.4 GENERAL GEOLOGY AND GENERAL HYDROLOGY . . . T. F. Lomenick

1.2.4.1 Borehole Geophysics . . . J. Daniels, U.S. Geological Survey

The request for proposal for USGS procurement of borehole cables for deep holes was completed. Gary Olhoeft completed electrical properties measurements on salt samples obtained from the Sandia Laboratories New Mexico Waste Isolation Pilot Plant (WIPP) site. The samples have d-c resistivities of approximately $10^6 \Omega\text{-m}$ with no axial pressure applied and $10^8 \Omega\text{-m}$ with a 1500 psi axial load applied. Further physical property studies will be performed on these samples.

1.2.4.2 Seismic Risk Analysis . . . S. T. Algermissen, U.S. Geological Survey

Materials and data for this project are being assembled. Major changes in existing risk models and the computer programs to run them are being made in order to consider the low risk levels and long time periods involved in waste disposal. Geological, geophysical, and seismological data that will be used as input for the risk models are being collected.

By the fourth quarter of FY 1978, the most important parameters for seismic risk at low levels of risk are expected to be identified, and one or more working models for the estimation of such risks are expected to be developed.

1.3 Technical Support Projects

W. C. McClain

1.3.1 HEAT TRANSFER/THERMAL ANALYSIS . . . W. A. Burnett

1.3.1.1 Thermal Conductivity Measurement Development . . . J. G. Moore,
Chemical Technology Division, Oak Ridge National Laboratory

The thermal conductivities of two specimens of Avery Island (AI) salt were measured at various temperatures, as shown below:

Temperature (°C)	Thermal conductivity (W/m·°K)	
	AI-1	AI-2
31	not measured	4.62
66	4.17	4.06
103	3.68	3.64
174	3.05	3.02
204	not measured	2.77
210	2.80	not measured
281	not measured	2.46
300	2.42	not measured
344	2.28	not measured
353	not measured	2.24

These values are probably within 10 to 15% of the true thermal conductivities. To determine the degree of accuracy of the measurements, extensive studies were made to establish and measure possible sources of error. Results indicated that the major source of error is in the value assumed for the Pyroceram standards. The recommended values for the thermal conductivity for Pyroceram 9606 are believed to be accurate within 5% at room temperature and 5 to 10% at other temperatures.*

1.3.1.2 Thermal Properties of Rocks . . . E. C. Robertson, U.S.
Geological Survey

Laboratory measurements on the thermal conductivity of samples ranging from loosely consolidated shale (soil) to moderately consolidated shale (rock) show variations with solidity (1-porosity), quartz content, clay mineral content, and water content. The measured samples of unconsolidated shaly soils have solidities from 0.2 to 0.7, and the more

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*Touloukian, Y. S., (Ed.), Thermophysical Properties of Matter, Vol. 2, p 942, Plenum Publishing Corporation, New York (1970).

dense, shaly rock samples have solidities from 0.5 to 0.99. Data on the mineralogical composition (chemical analyses from which approximate modes can be calculated) are essential in determining how conductivity varies but unfortunately, are not usually available for shales.

The conductivity results for sandstones serve as a model to measure the effect of the quartz and clay content on the conductivity of shales. Shales contain 0 to 50% quartz and 25 to 95% clay minerals, while sandstones contain 0 to 100% quartz and usually less than 10% clay minerals. Data for water-saturated shales fit the plot of the square of solidity as a function of thermal conductivity for saturated sandstones if a negative correction for clay mineral content is applied. A 2% decrease in clay content has about the same effect as a 1% increase in quartz content. Conductivities of wet shaly soils range from 1.5 to 7×10^{-3} cal/cm·sec·°C, and wet shale conductivities range from 3 to 13×10^{-3} cal/cm·sec·°C.

The plotting of thermal conductivities of rocks as a function of porosity, water content, and mineral composition was completed. The rock types for which thermal data were compiled include: felsic rocks, basalt, limestone, dolomite, rock salt, sandstone, and shale (including soils). These data are being checked and prepared for external review. Investigators who can supply additional data for these compilations are encouraged to do so. A final report on these compilations has been started.

1.3.1.3. Hybrid Computer Heat Transfer Program . . . R. S. Stone and O. W. Burke, Instrumentation and Controls Division, Oak Ridge National Laboratory

No activity has been reported for January.

1.3.1.4. Thermal Conductivity of Avery Island Dome Salt . . . D. D. Smith, Y-12 Development Laboratory, UCC-ND

The thermal conductivity of AI dome salt has been determined for temperatures between 56 and 300°C using a comparative, unidirectional heat flow apparatus. Two specimens, each having a density of 2.14 g/cm³, were tested in a dry nitrogen atmosphere using Santocel insulation. Data obtained from the first test were equivalent to data obtained from a test on a Jefferson Island bedded salt specimen, having approximately the same density. Tests on this specimen of AI salt with a duplicate apparatus yielded values that were 10 to 25% lower. Subsequent evaluations for this discrepancy indicated that significant thermal conductivity variations, 12 to 20%, were found when one set of Pyroceram standards were tested against other sets of identical standards. Independent tests with the two different instruments also indicated that not only should the standards be checked by absolute methods but also that they should be fitted with thermocouples identical in size and placement to those of the test sample. Surface finishes and flatness were also found to be important variables in the magnitude and reproducibility of test data.

Thermal conductivity data were identical (within the $\pm 5\%$ measurement accuracy) for the two instruments on the two specimens when standards, surface finishes, and thermocouple placements were identical. Thermal conductivity data ranged from 4.2 w/m·°K at 329° K to 2.3 w/m·°K at 572° K.

1.3.1.5 Computing Support on Thermal Analysis Work for OWI . . . D. C. Elrod and W. D. Turner, Computer Sciences Division, UCC-ND

THAC-SIP-3D code . . . W. D. Turner

Work on adding refinements to the three-dimensional heat conduction code THAC-SIP-3D continued. Additional output features used in HEATING5 were added to THAC-SIP-3D. These features included (1) an option, independent of the standard output, to print out the temperature distribution in map form for selected planes at times specified by the user, (2) an option to tabulate the temperatures at selected nodes as a function of the number of time steps, (3) an option to generate a data set that can be used by the latest version of HEATPLOT to generate graphical output of the transient temperature distribution, and (4) an option to generate the output of the maximum and minimum values of each temperature distribution and the nodes where they occur.

A significant portion of a draft report documenting THAC-SIP-3D has been completed. The major portion of work that remains to be completed on the code development consists of restructuring the common block configuration and generating a number of test cases to check out the various options of the code. With the exception of appendices showing sample problems and flow charts, the remaining work on the draft can be completed in a few days. All work on the code development and documentation should be completed in February 1978 with the exception of the test cases.

HEATPLOT code . . . D. C. Elrod

Debugging of the HEATPLOT plotting package continued during January.

1.3.1.6 Spent Fuel Disposal . . . G. H. Llewellyn, Engineering Division, UCC-ND

The draft final report is being prepared and should be ready for publication by February 10, 1978.

1.3.1.7 Heat Transfer Studies in Salt and Granite . . . R. A. Just, Engineering Division, UCC-ND

The thermal analysis associated with the heat transfer studies in salt and granite was completed. Repository concepts for terminal storage of nuclear waste in salt and granite formations were examined to determine the feasibility of a multilevel burial scheme rather than a single-level plan.

The results of this study are being documented, and the outline and approximately 75% of a first draft were completed. The first draft of the report is scheduled for completion and OWI review in February 1978.

1.3.2 WASTE/ROCK INTERACTION . . . G. H. Jenks and L. R. Dole

1.3.2.1 Nuclide Transport Data* . . . L. R. Dole, OWI; R. H. Serne, Battelle Pacific Northwest Laboratories (PNL)

Technical progress summary[†]

I. General - R. J. Serne. A sample of Conasauga shale was obtained from L. R. Dole at OWI. Lawrence Livermore Laboratory (LLL) is sending 100 lb of Climax Stock granite.

During crushing operations on dolomites from the Sandia WIPP site, the jaw crusher succumbed to metal fatigue. Repairs were completed on the last day of this reporting period. Two dolomites, an anhydrite, the Conasauga Shale, and the Climax Stock granite should be ready to distribute in February 1978.

A subcontract to study the movement of radionuclides bound to fine particulates and colloids was finalized with the Georgia Institute of Technology (Geoffrey Eichholz).

The ^{237}Pu tracer arrived from the Argonne National Laboratory, was dissolved, and divided for shipment to the subcontractors. Department of Transportation regulations forced all shipments to be made by surface transportation. Paperwork was initiated to obtain a variance from the use of this slow method, but after review by DOE-RL personnel, the request was tabled. Transportation delays have caused almost one, half-life decay of the plutonium. In the future, more expeditious transport methods will be investigated. DOE has assured PNL that shipments of neptunium and technetium can be made via air transport.

II. PNL Internal Research - J. Relyea, D. Rai, and R. J. Serne, "Collection and Generation of Transport Data." An ND660 programmable multichannel analyzer was delivered this month and is being linked to eight surface-barrier detectors (α counters), a Ge(Li) detector (γ counter), and an intrinsic Ge detector (γ and x-ray counter).

Batch K_d data were not obtained this month because of counter failure and the low priority of the samples on jointly-shared equipment. When the ND660 system comes online, it will be dedicated solely to WISAP[§] needs.

The study on dissolution of plutonium compounds continued. The original pH of some of the plutonium-contaminated soils, possibly containing PuO_2 , was about 3.5. The pH of these soils was adjusted to various values up to pH 8, and the samples were equilibrated. With the increase in pH, the plutonium concentration in solution was thought to stay constant until the precipitation of $\text{Pu}(\text{OH})_4$ occurred. Plutonium concentration would therefore follow the $\text{Pu}(\text{OH})_4$ solubility line. However, the plutonium concentration followed the PuO_2 solubility line with increase in pH until approximately pH 7. At pH 7, the plutonium concentration increased to the $\text{Pu}(\text{OH})_4$ solubility line. The reasons for this behavior and the mechanisms involved are under further investigation.

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*This report covers activities from December 15 through January 15, 1978.

[†]A detailed report may be requested.

[§]WISAP = Waste Isolation Safety Assessment Program.

Testing of the oxidation states of plutonium stock solutions with various methods continued.

Near-term plans. Batch K_d experiments on the controlled samples will be performed. The backlog of counting should be completed. The new counting system will be assembled if all detectors arrive on schedule. Controlled Eh experiments on plutonium valence states continue.

III. Argonne National Laboratory (ANL) - P. Rickett, M. G. Seitz, A. Friedman, and S. Fried, "Transport Properties of Nuclear Waste in Geologic Media." The mineralogy of rock samples as determined by x-ray diffraction and chemical data obtained by initial spectrochemical analyses are reported below. Additionally, analyses of totally dissolved solids in solutions, as determined by evaporating water and weighing the residue, are presented. This work represents the start of a continuing program to characterize the rocks, aqueous solutions, and radionuclides used in the migration studies.

The properties of lithic columns can affect radionuclide migration and are important in interpreting the results of experiments. Methods of determining important properties of columns were examined in December 1977. One method, use of tritiated water to mark the advancing water front, was implemented in experiments begun during January.

Results of experiments performed to investigate the cause of synergistic behavior between plutonium and americium in static absorption experiments were analyzed. In columns of aggregated rock, the wetting fronts during the initial infiltration of water were observed. Wetting fronts (one of unsaturated flow and one of saturated flow) that proceeded with uniform velocities through the columns were taken to be indicative of homogeneity in the columns. In solid rock columns, an abrupt increase in a flow rate was considered to be evidence for formation of cracks. Other observations that indicated conditions within the columns were also used.

As an additional aid in examining the characteristics of rock columns, experiments using tritiated water to trace the migrating water front in columns were begun. Four rock-aggregate columns, two of shale and two of chalk, were prepared in a manner analogous to that used to prepare previous columns. Columns were formed by packing successive 20-g layers of ground material in a Buchner funnel. The columns were infiltrated with rock-equilibrated water (REW), followed by 0.5 ml of REW containing tritiated water ($\sim 1.63 \times 10^5$ dpm/ml), and then followed by REW without tritium. The eluate is being collected manually in fractions and will be analyzed for tritium activity. The elution of the tritiated water, which will be seen from the analyses, will aid in determining the extent to which the water moves uniformly through the column.

Experiments were performed to investigate the synergistic behavior seen in previous static absorption experiments. In the previous work, the addition of plutonium-bearing solutions to solutions containing americium often had a significant effect on the partitioning of americium between rock and solutions. The source of the synergistic behavior was postulated to be due to auxiliary chemicals in the plutonium solution rather than to the plutonium itself. The plutonium solutions used in the experiments were purified by passing them through cation exchange

columns twice, rather than once, to increase their purity. The plutonium solution was otherwise treated in a manner similar to that previously used (i.e., the solution was dried, and the plutonium was redissolved in distilled water, etc.).

In four tests in which plutonium was added to an americium solution that had reacted with limestone tablets, no synergistic effect was observed. This absence of effect suggests that the purification procedure did remove auxiliary chemicals that affected the absorption of americium on limestone. However, other conclusions could also be drawn from these results. For example, one alternate conclusion could be that the americium used in the most recent experiments was not sensitive to the addition of plutonium and therefore would not show the synergistic behavior previously seen. This point could be checked by performing experiments with the americium solution and the once-purified plutonium solution in order to produce the synergistic behavior previously observed. The absence of an observed synergistic effect could be a result of a difference in the chemical form of the americium or the presence of plutonium or auxiliary chemicals in the initial americium solution which would mask the synergistic behavior in the experiments performed.

Near-term plans. Controlled samples will be incorporated in existing experimental plans.

IV. Oak Ridge National Laboratory - R. E. Meyer, K. A. Kraus, and J. Johnson, "Systematic Study of Nuclide Adsorption on Selected Geologic Media." Using batch methods and radiometric tracers, exchange data have been obtained for $\text{SO}_4^{2+}/\text{Na}^+$, $\text{Ba}^{2+}/\text{Na}^+$, and $\text{Eu}^{3+}/\text{Na}^+$. Three sets of data for strontium were taken by three different investigators. For all sets of data except the new strontium set, sodium montmorillonite purified by the complete Jackson procedure was used; for the new strontium set, the clay was treated only to remove sand and carbonates. Little difference is noted among the three sets of strontium data and between the partially and completely purified clay. The data for Ba^{2+} and Sr^{2+} show the expected slope of -2 when plotted as $\log D$ vs $\log \text{conc Na}^+$. For calcium, the slope is close to -1.5, the point at 4 M is questionable. The Eu^{3+} data are to be regarded as preliminary because the purity of the tracer, ^{155}Eu , which was used in the carrier-free form in the experiments, has not been checked.

Capacity measurements for the sodium-montmorillonite using Ca^{2+} as the index cation have also been performed. After saturation with calcium, the clay was washed with a solution of 60% methanol-40% H_2O several times and then washed with either CsCl or NaCl to displace the calcium. Analysis of the calcium gave the result 1.04 equivalents/kilogram of clay.

Near-term plans. A continuation of the studies of 2:1 and 3:1 exchange with emphasis on studies of loading effects is planned.

V. Lawrence Livermore Laboratory (LLL) - L. D. Ramspott, Homer Weed, David Coles, and Don Jackson, "Studies of Radionuclide Availability and Migration at the Nevada Test Site." High-pressure intact core K_d experiments with volcanic tuff are under way. Batch K_d experiments on the controlled samples have been started.

Near-term plans. Experimental work will continue according to the work plan.

VI. Rockwell Hanford Operations - G. S. Barney, M. Brutzeck, and R. A. Deju, "Kinetics and Reversibility of Radionuclide Sorption Reactions with Geologic Media." During this report period, the rate of sorption of ^{137}Cs and ^{85}Sr on basalt, granite, and argillite was measured. Sorption of these radionuclides was measured over a period of 7 hr. Future experiments will cover longer reaction times so that very slow sorption reactions can be examined.

Crushed samples of Umtanum basalt, Eleana argillite, and Climax Stock granite were preequilibrated twice with the appropriate synthetic ground water. This preequilibration was done to saturate the sorption sites on the rocks with ground-water components and thus prevent their sorption and subsequent alteration of ground water composition during radionuclide sorption runs. A third measured amount of synthetic ground water was then added to the crushed rock, and the radionuclide spike was pipetted into the mixture to begin the reaction. A sample of the mixture was taken. Samples of the mixture were withdrawn into a syringe and filtered using a 0.3 μm Millipore syringe filter and filter holder. The sampling schedule was as follows: 5 min, 15 min, 30 min, and once each hour for 7 hr. The filtrates were then analyzed for ^{137}Cs or ^{85}Sr activity.

Rate curves for sorption of ^{137}Cs and ^{85}Sr were obtained. The curves show that sorption is very rapid for both ^{137}Cs and ^{85}Sr for the first 5 min. This is probably due to rapid ion exchange sorption on the rock surface. Sorption of ^{85}Sr appears to be complete after about 2 hr since the curves level off at this point. However, ^{137}Cs sorption is not complete even after 7 hr. A slow sorption reaction is occurring which must be studied at longer reaction times. This slow reaction is particularly important for sorption of ^{137}Cs on granite since the reaction is far from equilibrium even after 7 hr.

The slow reaction of ^{137}Cs with granite can be explained by assuming a slow mineral transformation reaction between the biotite mineral phase in the granite and cesium ions. Cesium is known to react with mica-like minerals replacing other cations and forming a very tightly-bound structure. This reaction would also explain the irreversibility of cesium sorption by granite.

The ^{85}Sr sorption reaction appears to be at equilibrium after 7 hr. No measurable differences in K_d values at 7 and 48 hr were noted.

Near-term plans. Rates of sorption of ^{237}Np , ^{241}Am , ^{233}U , and Pu will be measured over 7 hr. Long-term reactions that last several months will be started. Additional experiments with actinide tracers will be started to determine the reversibility of sorption.

VII. Adaptronics, Inc. - A. N. Mucciardi and Elsie Orre, "Statistical Investigation of the Mechanics Controlling Radionuclide Sorption." No activity was performed this month pending the formal contract being implaced and additional data being supplied.

VIII. Lawrence Berkeley Laboratory - John Apps, Sidney Phillips, and John Neil, "Theoretical and Experimental Evaluation of Waste Transport in Selected Rocks." A test case involving the reaction between a suite of minerals representing a typical gabbro and a dilute sodium bicarbonate ground water was simulated at 100°C using the FASTPATH code.

A suite of minerals typical of propylitic alteration was obtained. A further simulation involving nine minerals, typical of a granite, reacting with a 19-component ground water at 200°C was obtained. This simulation identified the source of earlier problems with the code. The source of the problems was rectified, and the simulation was successfully accomplished. No less than 36 events occurred during the run, which constituted the most complex simulation so far attempted with FASTPATH.

Work this month concentrated on a review of the thermodynamics of sorption at the solid-liquid interface. A preliminary report on this subject is in preparation.

Permeability data on Umtanum basalt indicated that both unaltered and vesicle-filled basalt have crack permeabilities of a few millidarcies. Porosities of these samples were in the range of 6 to 8%. Permeabilities of the Eleana shale and Climax quartz monzonite are most likely in the nanodarcy range and will be reported when tests by TerraTek are complete.

The inert-atmosphere box and the pulse-height analyzer have been received. The pulse-height analyzer system has been assembled, and a preliminary checkout made. The Ge detector still has not arrived but has been promised by February 1, 1978. The inert-atmosphere box requires final assembly and onsite testing as well as the construction of minor items. This schedule of assembly and testing is expected to be completed by February 1, 1978.

Stock solutions of ^{233}U , ^{237}Np , ^{242}Pu , ^{243}Am , and ^{248}Cs have been purified by cation-ion exchange column methods.

Near-term plans. Efforts will be made to incorporate the thermodynamic data collected during FY 1977 into the FASTPATH code.

A review of the thermodynamics of sorption will be completed. Also, electrical models and transport codes using adsorption models will be examined.

The petrographic study of the core mounts will be initiated including point-counting of the mineral phases in the principal rock types.

Work with the emulsions continues through January. The next step is to place alpha-active deposits on rock wafers and work out the techniques of exposure and processing. Methods for photographic reproduction and enlargement will also be sought.

Hardware for the rock-water contact studies will be assembled and tested.

IX. Oak Ridge National Laboratory - C. W. Francis, M. Reeves, and E. A. Bondietti, "Soil Chromatograph K_d Values." Batch and column experiments on the controlled samples are under way.

Near-term plans. Experimental work will continue according to plan.

X. Sandia Laboratories (SLA) - T. E. Hinkebein, R. L. Schwoebel, R. G. Dosch, and R. E. Cohen, "Microstructural Interactions of Geologic Media with Waste Radionuclides." This contract has not been reinstated in FY 1978.

XI. Los Alamos Scientific Laboratory (LASL) - D. C. Hoffman, K. Wolfsberg, B. Erdal, R. Vidale, and E. Norris, "Laboratory Measurements of Radionuclide Distributions." The materials for the controlled sample program have been received, and the specified waters have been

prepared. The measurements are in progress on ^{85}Sr and ^{137}Cs and will be started on ^{237}Pu as soon as it is received.

Selected particle-size fractions of the shale and granite samples prepared for K_d measurements have been sent to the LASL Materials Technology Group for measurement of particle-size distribution and surface area by the Brunauer-Emmett-Teller (BET) method. The surface area is also being measured by the ethylene glycol method. Samples from the same fractions have also been sent to LLL and SLA for intercomparison of surface area measurements.

Two cores of argillaceous shale [Eleana shale, Nevada Test Site (NTS)] were crushed and sieved into the following fractions expressed in microns: >500, 355 to 500, 250 to 355, 180 to 250, 150 to 180, 106 to 150, and <106. The 106- to 150- μ and 355- to 500- μ fractions from core 1 were chosen for measurements. A synthetic water was prepared to simulate water from the shale formation. Measurements of K_d will be made using ^{85}Sr , ^{137}Cs , ^{152}Eu , ^{141}Ce , ^{133}Ba , ^{239}Pu , and ^{241}Am . The rare earth ^{239}Pu and ^{241}Am tracers will be added in as small a volume of dilute HCl as possible, and the pH will then be readjusted with NaOH.

A temporary darkroom has been prepared. Suitable thin coatings for the geologic thin sections are being investigated so that the stripping film emulsion will adhere through the exposure and development processes. A combination collodion-gelatin coating appears most promising because the collodion is applied in an organic solution first and the dissolution of water soluble radionuclides will not occur. The gelatin is then subsequently applied from an aqueous solution.

Near-term plans. Experiment work will continue according to the work plan.

1.3.2.2 Criticality Study of Nuclear Waste . . . G. H. Jenks, OWI;
E. J. Allen, Engineering Technology Division, Oak Ridge
National Laboratory

The critical mass calculations have been completed and were presented to OWI staff on January 30. The final report is in preparation.

1.3.2.3 Natural Fission Reactor Program (NFRP) . . . K. E. Apt, Los
Alamos Scientific Laboratory

The meeting of the Technical Committee (Expert Group) on Natural Fission Reactors sponsored by the International Atomic Energy Agency (IAEA) and the French CEA was held in Paris, France, on December 19 to 21, 1977. Results of recent studies of the Oklo natural fission reactor system and related topics were communicated. The reports, mostly by French investigators, described the latest theories of the geology of the Oklo deposit, the formation of the reactor zones, the operation and effects of the reactors, and the fate of the Oklo reactor products. The discovery of a second natural reactor system nearby at Okelobondo was announced, and consideration was given to still other possible natural reactors. The IAEA International Working Group on Natural Fission Reactors met on December 22 to 23, 1977. The findings presented at the main meeting were summarized, and recommendations for future study were drafted.

Presentations made by U.S. representatives associated with the Natural Fission Reactor Program were as follows:

1. "Migration Paths for Oklo Reactor Products and Applications to the Problem of Geologic Storage of Nuclear Wastes," G. A. Cowan.
2. "A Possible Uranium-Ruthenium Method for Measurement of Ore Age," by W. J. Maeck, K. E. Apt, and G. A. Cowan.
3. "Application of Eh-pH Diagrams to Problems of Retention and/or Migration of Fissiogenic Elements at Oklo," by D. G. Brookins.
4. "The Measurement of Ruthenium in Uranium Ores and ^{238}U Spontaneous Fission Yields," by W. J. Maeck, et al.
5. "Uranium Solubilities in the Oklo Reactor Zones," by C. J. Duffy.
6. "Search for Other Natural Fission Reactors," by K. E. Apt, et al.
7. "A Nondestructive Field Measurement of the Ratio $^{235}\text{U}/^{238}\text{U}$ in Depleted to Moderately-Enriched Uranium," by J. P. Balagna and G. A. Cowan.
8. " 2.05×10^9 Year U-Pb Age of the Oklo Uranium Deposit," by A. J. Gancarz.
9. "The Highest Temperatures Recorded by the Oklo Mineral Phase Assemblages and Rock Textures," by R. Vidale.

These papers will be published in the IAEA volume of proceedings of the conference.

During the first quarter of FY 1978, isotopic analyses were completed for Canadian, Australian, and African uranium ore samples that were previously collected from promising locations for other natural fission reactors. All samples analyzed had neodymium or uranium isotopic ratios that were indistinguishable from natural ratios.

Uranium-thorium-radium radiogenic equilibrium measurements are being conducted on natural uranium ores in order to study the relative geochemical migration rates of these species. Seven ore samples have been selected as likely prospects for disequilibrium, and uranium analyses are proceeding. Thorium and radium analyses have been completed on two of the samples, and work is continuing on the other samples.

Petrographic measurements on a suite of peripheral Oklo samples have been completed except for x-ray diffraction measurements. Lead isotopic analyses of Oklo samples are being conducted, and quantitative lead analyses have been completed. Lead isotopic measurements have been completed, and the results will be reported in the above IAEA conference publication.

K. E. Apt has begun a two-year assignment with the IAEA in Vienna. A. E. Norris has assumed his duties.

1.3.2.4 Near-Field Waste/Rock Interaction . . . D. M. Roy, G. W. Brindley, J. V. Biggers, G. H. McCarthy, W. B. White, S. Komarneni, B. E. Sheetz, and J. M. Bind, Pennsylvania State University

Salt consolidation and brine migration

The preparation of hot-pressed polycrystalline salt samples for the strength and migration studies was completed. The strength measurements as a function of density and microstructure are nearly complete. The

microstructural studies on the four-point bend specimens have started, and a final report for this phase of the work should be completed during February 1978.

The brine migration cell, which will use 1-in.-thick $\times$ 2-in.-diam specimens, has been completed, and initial tests have been run. Brine migration data will be collected by exposing one face of the right circular cylinder of salt to a saturated brine solution. The other face is in contact with a heated porous disk. A temperature gradient of about 40°C/cm will be used to drive the brine through the sample.

Near-term plans. Work is continuing on the construction of deformation maps for "pure" NaCl. The computer modeling is under way, and experimental checks of the calculated data will soon begin.

Shale-waste compatibility

Chemical analyses of the complete set of reference shales including samples of the Eleana and Conasauga Formations have been made. Mineralogical analysis of the reference shales is in progress. X-ray diffraction patterns have been obtained for all specimens, and their interpretation is under way.

Experiments with the four waste forms and the two initially available shales (Eleana and Conasauga) were carried out at 200 and 400°C at pressures of 300 to 400 bars for 30 days. These run conditions, along with 100 and 300°C runs, will be performed using the remaining reference shales and two waste forms [PNL-76-68 glass and spent unprocessed fuel (SURF)].

Individual spheres of PNL-76-68 glass have been treated hydrothermally at 300°C, 300 bars for 7 and 14 days. The glass is almost totally altered after the 14-day treatment. Alteration products of the glass sphere have been identified as crystalline acmite and weeksite. Analyses of solutions indicate a release of 2% of the cesium present in the glass after 7 days and 14% after 14 days. Samples containing glass + shale + water are being treated hydrothermally at this time.

Study of the interactions of the components of SURF with shales has been initiated. Runs with UO_2 and five reference shales have just been taken down, and examination of these is proceeding. X-ray diffraction analysis of the CsOH-clay interaction products indicate that pollucite has formed with all of the clays. Analysis of the solutions of these runs for cesium indicated that over 70% of the added cesium was fixed mainly as pollucite. The Cs_2MoO_4 did not appear to react with the clays as readily as the hydroxide of cesium. Pollucite was formed only with kaolinite and Fithian illite. The scheelite CaMoO_4 phase was formed with montmorillonite indicating an exchange of cesium for calcium in the interlayers of the Ca-saturated montmorillonite. Mixtures of the four clays with SrZrO_3 have been hydrothermally treated at 200°C, 300 bars for 30 days. These runs have been taken down, and the analysis of the fluid phase is under way.

Experiments with disk-pelletized spheres of supercalcine and water have been run at 300°C, 300 bars for 7 days and 14 days. Analyses of the solutions from these individual runs indicate that 0.9% of the cesium present in the supercalcine was lost to the solution after 7 days and

0.4% after 14 days. Presumably, under these hydrothermal conditions, small amounts of "mobilizable" cesium recrystallize slowly to a more stable phase, probably to pollucite.

Repository simulation runs have been taken down in which PNL-76-68 + Eleana + stainless steel + synthetic ground water (Hanford formulation) and simulated SURF + Eleana + stainless steel + zircaloy + synthetic ground water mixtures have been treated hydrothermally at 300°C, 300 bars for two weeks. Similar runs are being reacted for 30 days. A full range of characterization of the solid phases and solutions is under way.

Weeksite is one of the major solid products of the breakdown of PNL-76-68 simulated waste glass under hydrothermal conditions. Weeksite compositions have been formed for sodium, potassium, rubidium and mixed sodium/rubidium substitutions into the alkali site of $(\text{Alk})_2(\text{UO}_2(\text{Si}_2\text{O}_5)_3 \cdot 4\text{H}_2\text{O})$. The weeksite structure phases have thus far been found to be stable up to 500°C at which temperature they decompose into $\text{SiO}_2 + \text{UO}_{2+x} (\text{U}_4\text{O}_9)$ + an x-ray amorphous phase.

1.3.2.5 Strain-Related Radiation Damage Measurements on Rock Salt for Waste Disposal Applications . . . K. J. Swyler, R. W. Klaffky, and P. W. Levy, Brookhaven National Laboratory (BNL)

Reduction and analysis of previously obtained data continued during this report period. Also, additional electron-irradiation-induced F-center and colloid particle absorption vs dose curves were obtained for synthetic NaCl at 163, 187, and 225°C. These curves provide additional temperature effect data and information needed to determine how F-center formation depends on total dose and dose rate in the high dose region where F-center saturation might be occurring.

Data analysis produced several new results. First, a numerical procedure has been successfully implemented which resolves the overlapping F-center and colloid absorption bands into individual components. This procedure has been applied to synthetic NaCl absorption spectra obtained by electron irradiation at 150°C. The improved growth curve was obtained at a dose rate of 1.2×10^8 rads/hr and can be divided into three regions. The first stage resembles a saturating exponential and extends up to 5×10^7 rads. The second one is linear and extends from 5×10^7 rads to 2.3×10^8 rads. In the third region, which extends up to 4.3×10^8 rads, the F-center curves continuously increase with increasing dose. Consequently, because of the increasing third stage, saturation is not observed. These results must be confirmed. In the third, or high dose region, the colloid absorption is increasing very rapidly. Thus, to obtain an understanding of the colloid formation process, a determination of the nature of the F-center curves in this region is essential.

To determine if F-center saturation could be obtained in synthetic NaCl during irradiation at 150°C, measurements were made at higher dose rates (6.5×10^8 rads/hr) and higher total doses (greater than 10^9 rads). The preliminary analysis indicates that saturation was not observed. Also, at these high dose rates, the colloid formation rate appears to be less than that observed at lower dose rates.

Further measurements are under way to determine the factors influencing rapid colloid growth, and the analysis of previously obtained dose rate and annealing data is continuing. Also, the recently delivered

Instron testing machine appears to operate properly. The machine will be used to deform samples for irradiation during the next report period. These samples will be the first crystals studied for which stress-strain curves will be available.

1.3.2.6 Geochemical Interactions and Characterizations . . . D. B. Stewart, R. W. Potter, II, and M. Clynne, U.S. Geological Survey

Research was begun in three areas during the report period: (1) solubility studies in the system $\text{NaCl-KCl-CaCl}_2\text{-MgCl}_2\text{-H}_2\text{O}$, (2) vapor pressure measurements of bitterns, and (3) theoretical modeling of the boiling point elevations for bitterns.

The solubility studies were conducted over the temperature range of 20 to 107°C and were exploratory in nature. Their objective was two-fold - to test the reliability of currently available experimental data from the literature and to obtain some idea of the temperature stability of the hygroscopic phase tachyhydrite ($\text{CaMg}_2\text{Cl}_6 \cdot 12\text{H}_2\text{O}$). Two different ratios of Ca:Mg were used in the experiments. The results demonstrated, as do previous studies, that much of the literature data contains systematic compositional errors. These systematic errors are consistent with the errors expected in flame photometric analyses of such concentrated brines. The temperature stability of tachyhydrite increases with increasing Mg content, as might be expected. Its stability extends to temperatures greater than 110°C. This material may be very important in solid fixation of H_2O in the presence of dense bitterns and hence merits further study.

Five vapor pressure runs were conducted up to temperatures as high as 400°C. Two runs were on concentrated bitterns (~70% total dissolved solids) to test the effect of MgCl_2 on the vapor pressure. Increasing the ratio of Mg:Ca from 1:6 to 4:5 lowered the vapor pressure 21 bars at 375°C (from 51 bars to 30 bars). Many natural bitterns typical of the fluids in inclusions have Mg:Ca ratios in excess of 10:1. The remaining three vapor pressure runs were done to test the effect of SO_4 on bittern vapor pressures. In general, little effect was noted to be due to the low solubility of anhydrite.

Theoretical models developed by the USGS were applied to the problem of determining the boiling point elevation of bittern brines. Since most bitterns are dominantly MgCl_2 and CaCl_2 , the problem has been simplified by considering boiling points in the system $\text{CaCl}_2\text{-MgCl}_2\text{-H}_2\text{O}$. The boiling points for Ca:Mg ratios of 3:1, 1:1, and 1:3 are then calculated as a function of the total molality of the system. These calculations indicate that boiling temperatures greater than 200°C are achievable and that boiling points in excess of 250°C may be possible.

The vapor pressure measurements give tentative confirmation to the calculations although they were made in the system $\text{NaCl-KCl-CaCl}_2\text{-MgCl}_2$. Preliminary calculations in this system have been started.

Experimental data are now available for the following systems:

1. To 435°C (vapor pressure to 515°): $\text{NaCl-CaSO}_4\text{-H}_2\text{O}$.
2. To 400°C: $\text{NaCl-H}_2\text{O}$; $\text{KCl-H}_2\text{O}$; and $\text{NaCl-KCl-H}_2\text{O}$.
3. To ~375°C (vapor pressure only): $\text{MgCl}_2\text{-H}_2\text{O}$ and $\text{CaCl}_2\text{-H}_2\text{O}$.

4. To 300°C (vapor pressure and pH of steam phase): WIPP-A (NaCl-KCl-MgCl₂-KCl) + CaSO₄.
5. To 100°C: NaCl-KCl-CaCl₂-H₂O; NaCl-KCl-H₂O; NaCl-CaCl₂-H₂O; KCl-CaCl₂-H₂O; NaCl-MgCl₂-H₂O; KCl-MgCl₂-H₂O; CaCl₂-MgCl₂-H₂O; NaCl-HCl-H₂O; KCl-HCl-H₂O; MgCl₂-H₂O and CaCl₂-H₂O; Na₂SO₄-H₂O and K₂SO₄-H₂O and MgSO₄-H₂O.

1.3.2.7 Geothermometry Methods for Determining the Thermal History of Shale . . . C. E. Weaver, Georgia Institute of Technology

A preliminary attempt was made to rank the shale samples in terms of increasing degree of burial temperature. A number of parameters (crystallinity, sharpness, K/Ar apparent age of 2- to 44- μ m size) show a fairly good linear relation with respect to distance from the area containing samples exposed to the highest temperatures. The relation is best developed in Georgia and extends in a northwest-southeast direction. The Tennessee samples do not show any apparent pattern. This lack of pattern is partly because the paleo temperature range in this area was relatively narrow. Additional samples were collected from Georgia.

Paragonite is present in three samples taken adjacent to the Cartersville Fault. The distribution of the paragonite is not related to the regional temperature gradient, but the distribution apparently reflects the high pressure developed near the thrust fault.

1.3.2.8 The Effects of Water in Salt Repositories . . . G. H. Jenks, OWI; C. F. Baes, Jr., H. F. Holmes, and R. E. Mesmer, Oak Ridge National Laboratory

The test reported in the OWI November 1977 progress report (Y/OWI/TM-43/2) in which brine was passed through a column of salt under a decreasing temperature gradient was continued. The results were compared with a simple model that assumes the passages through the salt are capillaries of the same diameter and length and are filled uniformly by salt deposited from the flowing brine. This yields an expression of the form: $G = a \cdot t / (1 + b \cdot t)$, where G is the weight of brine passed in time, t . This expression fits the data reasonably well. In the early stages $G \cong a \cdot t$ and in the later stages G approaches a limiting value of a/b . Development of an improved apparatus for such studies of salt consolidation that would permit operation at higher flow rates, with pressure drops, and with better-defined temperature gradients is being planned.

An apparatus is being assembled to measure the rate of water loss from halite core specimens subjected to a thermal gradient. A cylinder of halite was machined, photographed, and then potted in a 6-in.-diam section of glass pipe. Copper end plates are being fabricated with heating and cooling elements. Procedures are being tested for cleaning and drying the compressed air to be used as a sweep gas.

For studies of the movement of brine inclusions along grain boundaries in polycrystalline halite in a temperature gradient and under compressive stress, consideration was given to the use of glass cylinders for containment. However, elaborate grinding and polishing would be required before

a cylindrical correction lens would give the desired resolving power. Thus, in spite of the obvious advantages of a cylindrical configuration, alternative designs employing planar windows will be considered.

Consideration is being given to a method for determining the free water content of halite samples by dissolution in a suitable anhydrous solvent, probably methanol, which might not attack the hydrated gypsum present. The water could then be determined by a Karl-Fisher titration of the solvent.

1.3.3 ROCK MECHANICS . . . J. E. Russell

1.3.3.1 RE/SPEC Studies* . . . G. D. Callahan, RE/SPEC Inc.

The RE/SPEC efforts for the OWI Program primarily involve rock mechanics analyses. The proposed work plan has been divided into seven tasks, all of which are interrelated. The first, second, third, and fourth tasks involve finite-element analyses of the thermal/mechanical behavior of both near-field and far-field repository concepts, as well as laboratory bench-scale experiments. The fifth task involves continuing studies of the deformational behavior of salt under simulated environmental and loading conditions, along with fabric analyses and constitutive law development. The sixth task encompasses the data reduction from and simulation of the AI heater test, including ongoing instrumentation calibration studies by laboratory and analysis techniques. The seventh task is directed toward special projects and problems that are specified by OWI.

During this report period, two draft reports were generated and forwarded to OWI for review.^{†§}

Task 1: Mine stability studies. The parameter matrix for the thermo/viscoelastic room closure analyses includes three depths (1500, 2000, and 2500 ft), three pillar-height-width ratios (H:W = 1:3, 1:4, and 1:5) for an 18- x 18-ft room, and three thermal loadings (30, 36, and 45 kW/acre) of 10-year-old pressurized-water-reactor (PWR) spent fuel.

Baseline finite-element meshes have been analyzed in relation to stability and convergence characteristics for the viscoelastic and heat transfer simulations. A preliminary analysis (depth = 2000 ft, H:W = 1:4.86, and 36 kW/acre of 10-year-old PWR spent fuel) is being performed to compare with the results obtained by the University of Minnesota.

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*This report covers activities from December 16 through January 15, 1978.

[†]Carter, N. L., Petrofabric Analysis of the Deformational Behavior of Lyons, Kansas, and Jefferson Island, Louisiana, Rock Salt, prepared by RE/SPEC Inc. for Union Carbide Corporation, Nuclear Division, Office of Waste Isolation, Y/OWI/SUB-78/22303/9 (in preparation).

[§]Callahan, G. D., and Gnirk, P. F., Analytical Approximations to the Thermoelastic Behavior of Repository Configurations, prepared by RE/SPEC Inc. for Union Carbide Corporation, Nuclear Division, Office of Waste Isolation, Y/OWI/SUB-78/22303/10 (in preparation).

Task 2: Near-field studies. The parameter matrix for the analysis of drillhole closure and pressures generated by various salt/sleeve/back-fill arrangements will be similar to that set forth in Task 1. The acceptable parameter limits determined from Task 1 will be used in analyzing the drillhole area in more detail.

Task 3: Far-field studies. An updated version of the RE/SPEC heat transfer computer code, including ground-water flow, has been completed. Validation of the code, including comparisons with analytical solutions, is in progress. Once fully operational, the code will be used in analyzing the perturbation of aquifers in the vicinity of waste repository sites.

Task 4: Quality assurance studies. No activity has been reported for January.

Task 5: Laboratory studies - F. D. Hansen. The baseline quasistatic strength and creep experiments on AI salt are essentially complete. These experiments involved specimens from three groups of AI field samples: (1) core retrieved in the spring of 1976, (2) a grab sample from the belt line, and (3) several NX cores (retrieved in December 1977) from the vicinity of the in situ experiments. As a consequence of the different histories of the samples, evaluation of the test data is necessary for general quality assurance.

The field crew at AI completed drilling of approximately 30 ft of 6-in.-diam salt cores. The core will be used to continue the present experimental effort and to supply supplementary data where necessary, based on evaluations of the test results to date. Science Applications, Inc., and University of Minnesota modelers are expected to submit a recommended matrix of tests to assist in verification of their respective creep models. Some of the new core will be used for this purpose. In addition, several of the 6-in.-diam cores will be tested in unconfined compression, and the results will be compared with the results obtained for similarly tested 6-in.-diam cores from Jefferson Island. The shipment of salt core is being made by truck from Louisiana, and the estimated arrival time is two weeks from date of shipment.

Formulation of constitutive relationships is continuing. Previously generated data is being used; however additional experimentation is necessary in support of this effort. For example, hydrostatic creep/consolidation tests are in progress.

Progress toward the fabrication of a new testing apparatus to be used in the referenced tests has been made. Work began with regard to software adaptation for data handling, which involves program modification. This adaptation involves requisite accounting logistics because the program plan presently proposes to run seven triaxial apparatuses through a single data logging system.

As of January 18, all necessary equipment and components have been ordered except miscellaneous items such as electrical wires, connectors, etc. Most of these items are expected to arrive within the next three weeks. At that time, the mainframes and differential pressure gauge assembly can be completed. Laboratory personnel are working on diagrams and schematics for hydraulic and electrical systems. These drawings are to be submitted to the panel manufacturer by February 3, 1978, so that the estimated completion date of March 1, 1978, can be met.

In addition, electrical components for the lateral servo-control system have been ordered. Delivery is expected by early February 1978.

Task 6: In situ heater test support. Progress for this task is reported in Sect 2.1.

1.3.3.2 Displacement Discontinuity Modeling* . . . C. M. St. John,
University of Minnesota

During the reporting period, the two-dimensional displacement discontinuity code, SALT 2, was used to assess the relationship between possible initial thermal loading of a repository and radioactive waste age. Room closure, over a 25-year period, was determined to be largely controlled by the total energy input over the simulated life. SALT 2 is also being used to assess the acceptability of 5- and 25-year conceptual design plans.

Development of the means of coupling the boundary-element method with either the finite-element or fine-difference method is in progress. Work with MARC is also continuing. Agreement between the thermal analysis presented by RE/SPEC[†] and those analyses obtained using MARC has been demonstrated. Simulation of one of the pillar model tests reported in Project Salt Vault[§] is being undertaken to validate the creep model being used.

1.3.3.3 Explicit Finite-Difference Modeling . . . J. E. Russell, OWI

A contract is currently being negotiated with the successful bidder.

1.3.3.4 Bench-Scale Creep Testing . . . W. H. Grams, South Dakota School
of Mines and Technology

No activity has been reported for January.

1.3.3.5 Thermal Properties and Thermal-Mechanical Behavior of Rocks Under Pressure . . . Hugh Heard and A. E. Abey, Lawrence Livermore
Laboratory

No activity has been reported for January.

1.3.3.6 Handbook of Salt Properties . . . L. H. Gevantman, National
Bureau of Standards

The data centers continue to peruse the literature and collect pertinent articles from which data of interest will be extracted.

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*This report covers activities from December 16 through January 15, 1978.

[†]Callahan, Gary D.; Ratigan, Joe L.; Russell, James E.; and Fossum, Arlo F.; Heat Transfer Analysis of the Waste-Container Sleeve/Salt Configuration, prepared by RE/SPEC Inc. for Union Carbide Corporation, Nuclear Division, Oak Ridge National Laboratory, ORNL/SUB-4269/7 (March 31, 1975).

[§]Bradshaw, R. L., and McClain, W. C., (Eds.), Project Salt Vault: A Demonstration of the Disposal of High-Activity Solidified Wastes in Underground Salt Mines, Oak Ridge National Laboratory, ORNL-4555 (April 1971).

Computer searches are also being employed to assure complete coverage of the literature. To date, over 1000 citations have been examined for the relevant data.

1.3.4 BOREHOLE PLUGGING . . . G. D. Brunton

1.3.4.1 Characteristics of Cement and Concrete . . . J. G. Moore, Chemical Technology Division, Oak Ridge National Laboratory

The investigation continues on the effect of salt on the physical characteristics of salt-cement solids. Current studies concern the effect of water content and small additions of copper filings on the compressive strength and thermal conductivity of the resulting saltcretes. With specimens containing 29 wt % NaCl, decreasing the water-to-cement (w/c) ratio from 0.59 to 0.49 increased the 7-day compressive strength from 10.5 MPa to 18.3 MPa. For comparison, a neat cement paste with a w/c ratio of 0.485 had a 7-day compressive strength of 30 MPa. Measurements on the specimens containing the copper admixture will be made after additional curing.

Other programs that were initiated this month include the effect of lignite fly ash on cement-fly-ash concretes, the effect of long-term curing on the permeability of cement-fly-ash mixtures, and a study of methods for measuring the permeability of concretes to water. Results from these studies will be reported when available.

1.3.4.2 Preparation, Properties, and Optimization of Characteristics of Cements for Radioactive Waste Isolation . . . D. M. Roy, M. Daimon, E. L. White, and B. E. Scheetz, Pennsylvania State University

In a continuing effort for a better phenomenological understanding of the mechanism for the workings of high-gain water-reducing admixtures, several additional experiments have been performed. Optical microscopic examination of suspensions of cement powders in dilute surfactant solutions clearly shows that the strong repulsive forces acting between the cement particles and the glass slides must be an electrostatic force. In addition, near-infrared spectroscopic measurements on solutions of mixtures of $\text{Ca}(\text{OH})_2$ and surfactants show the slow development of a fine precipitate. The development of this precipitate seems to be the origin of the slow increase in apparent viscosity of fresh cement pastes or concrete with superplasticizers (called slump loss).

Beer's law has been applied to surfactant solution measurements for the quantitative determination of solution concentrations. These measurements, in turn, have been used to calculate an adsorption isotherm for MY-2 and a type I Portland cement. The problems with the Brookfield Rhealog viscometer have finally been corrected. The performance of the Rhealog is being evaluated with a variety of standard viscous liquids. Concurrently a standard procedure for use on the viscometer has been developed and tested for cement pastes, which change over time and produce an "exponential-decay-type" curve.

Preparations have been completed for a series of experiments that will attempt to improve the long-range properties of hydrated cementitious compositions by suitably adjusting the composition and seeding with crystalline material. The establishment of pressure, temperature, and composition (P-T-X) conditions under which tobermorite can routinely be synthesized has been completed. Several large-scale autoclave syntheses have also been completed.

Microhardness testing techniques (as a supplement or option to strength testing) have routinely been applied to metals and ceramic materials but have not routinely been applied to cement pastes. A Leitz miniload microhardness tester with attachments to yield hardness values on the Vickers methods has been used in the program.

Samples for the Hoek-Franklin permeability cell, which can operate under confining pressures of up to 5000 psi, are being prepared. In order to minimize possible leakage around the circumference of the sample, the 1-in.-diam samples are encased in a stainless steel cylinder with General Electric R.T.V. as a sealant between the steel walls and the concrete sample. This cylinder is then enclosed inside 1-in. butyl rubber tubing and inserted into the pressure cell.

Thermogravimetric analysis techniques are being applied to a measurement of chemically-combined water and physically-sorbed water in cement paste samples. Work this month centered on the effects of different handling techniques on the final weight losses, and a comparison of those techniques with a static method.

1.3.5 SAFETY AND RELIABILITY . . . H. C. Claiborne

1.3.5.1 Long-Term Safety Assessment (WISAP,* Tasks 1-3)[†] . . . H. C. Burkholder, Battelle Pacific Northwest Laboratories

Task 1: Release scenario analysis - Jess Greenborg and J. A. Stottlemire. J. J. Jacobson and R. W. Wallace are preparing for three trips during early February 1978 to meet with members of the consultants' teams. The objective of these meetings will be to focus the consultants' work plans on the needs of the repository simulation modeling effort. Work continued on the preparation of the simulation model flow chart and the development of statistical procedures for output format. The acquisition of a simulation language software package, SIMSCRIPT, was initiated.

Near-term plans. All but one of the consulting contracts should soon be in place, and work to characterize the potentially disruptive phenomena will begin. Visits will be made to all consultants. The development of the repository simulation analysis computer code and the geologic/geophysical data base will continue.

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*WISAP = Waste Isolation Safety Assessment Program.

[†]This report covers activities from December 15 through January 15, 1978.

Task 2: Waste Form release rate data - D. J. Bradley and R. P. Turcotte. A form 189 concerning the low-level TRU waste leaching program has been received from Brookhaven National Laboratory (BNL) and is being processed.

The open face hood/glove box has been ordered and will be used to start static leach tests on the doped glass beads, allowing room to study the next doped glass series.

A procedure has been formulated for studying devitrification effects on the leaching of high-level waste glasses. The glass sample is held at melt temperature for 2 hr and then cooled at the rate of 6°C per hour. This procedure maximizes the effect of devitrification. Since the beads will not retain their shape, cylindrical samples, made by core drilling, will be the standard devitrified waste form.

Preparations have been made to examine the H. B. Robinson reactor spent fuel by optical metallography.

Near-term plans. Spent fuel from the H. B. Robinson reactor will be transferred by cask to the metallographic examination facility, and the analyses will be started.

Task 3: Release consequence analysis - J. R. Raymond and J. K. Soldat. Work continued on the conversion of the GETOUT Transport Model and the Dose Models to the 1100/44 computer. Documentation for the Davis Finite-Element Model was completed, and final drafts of the report are being typed. Additional tests and improvements were completed on the Davis code.

Major progress was made in converting, modifying, and testing the PATHS and LOCQAR programs for use on the UNIVAC 1100/44. Specifically, the conversion is completed and tested except for the plotting control aspects, which have been delayed because of the UNIVAC system constraints.

The batch part of the PATHS program has also been modified and tested to allow calculation of the sorption delay due to exchange of a single trace constituent with the porous material. The program was further modified to enable calculation of the flow-path length. This feature is being tested. Another enhancement, closely related to the flow-path length modification, was incorporated in the program to allow greater flexibility in reaching solutions for several path lines originating at different locations at different times. Without this enhancement, all of the starting locations for path lines had to begin at the same time, often requiring many separate cases to be run. With the new feature, each different path line may begin at a different time, if that option is used. The debugging of the path-length and more flexible, initial-time features are under way.

The documentation of the PATHS program was started during the month. Appendices A and B were completed and present the basic equations used in PATHS. These appendices also provide some closed-form mathematical solutions that will be used to verify some of the numerical aspects of the PATHS program. More useful, closed-form solution results were obtained than originally expected.

Near-term plans. Testing of PATHS and LOCQAR programs on the UNIVAC 1100/44, including the plotting capability, will be completed. Work on the documentation of the PATHS program will continue. Analysis of test cases for PATHS will begin, and the PATHS implementation on the

PDP-11/45 will be completed. Work will begin on the compilation and evaluation of site-specific geohydrologic data. Retesting of the GETOUT Transport Model on the PDP-11/45 computer and the interface of GETOUT with PATHS (PDP-11/45 version) will be completed.

Work will continue on the conversion of the Dose Models and the GETOUT Transport Model to the UNIVAC 1100/44 computer.

1.3.5.2 Operational-Phase Safety Assessment

This phase is currently inactive.

1.3.6 DATA MANAGEMENT . . . L. B. Cobb

1.3.6.1 Geologic Data Management . . . R. C. Durfee, Computing Applications Department, Computer Sciences Division, UCC-ND

Software

I. Borehole plotting package. Several improvements have been added to the borehole plotting package, including the automatic scaling and spacing of multiple boreholes. This improvement enables presentation of several boreholes for stratigraphic section display. For areas having sparse or irregularly spaced boreholes, a feature has been added to indicate the distance between boreholes rather than scaling the final display for boreholes that are great distances from their neighbors. These changes have been debugged, and the program is presently operational. Several plots have been made using a borehole data file on North Louisiana compiled by M. B. Kumar, LSU. A user-specified option to this package allows the plotting of age and lithologic data. The next improvement to this program will consist of an input conversion subroutine that will allow boreholes to be input by latitude/longitude rather than the northings and eastings used in the North Louisiana data file.

II. Planar plots of borehole networks. In order to debug and improve the interpolation/extrapolation subroutines, a series of planar maps has been made showing the locations of computed networks between the boreholes in the North Louisiana data base. These plots have been scaled to overlay base maps sent to UCC-ND by LSU. The network plots are of two types. The first type consists of the Thiessen polygons around each borehole showing its influence area. The second type consists of triangulation networks computed from the Thiessen polygons to show all neighbor linkages between the boreholes. From these plots, a determination of the regions in which extrapolation is being done (exterior to the boreholes) and the regions in which interpolation is being done (interior to the boreholes) is possible. Also, a determination of the spatial variation that should be produced by the interpolation subroutines is possible. Work with these plots indicated a major conceptual bug in the routines used both for contour mapping and for producing the geologic cross-section plots. This bug has been corrected, and a new routine written that uses a weighted least-squares procedure with a linear spatial interpolant.

III. Isopach and structure contour mapping. The initial software development to extract data from the North Louisiana well data file and subsequent interpolation to a grid system for contour mapping have been completed. Final debugging is being performed. Data from three different parishes in the Northern Louisiana area (Webster, Bienville, and Winn) are being plotted. Initial, shaded printer maps were made to test the gridding process, and computer-generated maps are now being made to compare with geologist-interpreted structure contour maps for three different geologic formations. Computer plots are being made to approximately overlay the geologist base maps. Since the North Louisiana well data file does not contain exact latitude-longitude coordinates but uses inexact northing-easting coordinates instead, these maps cannot be produced to an exact overlay scale. From initial structure contour plots, the determination was made that the previous interpolation procedure for contouring is inadequate. As previously mentioned, a new, weighted, least-squares interpolant is being developed, and the resulting contour maps are being studied. In a comparison of the computer plots with the geologist-interpreted hand-drawn maps, regions appear to be evident in which there are no borehole data to produce contour lines to exactly match the interpreted maps.

IV. Stratigraphic sections. Preliminary computer plots are being made with the geologic cross-section display program. Four major debugging phases have been completed, and the current cross-sectional plots using the North Louisiana data file appear to be reasonably successful. Map cosmetics will be added to the cross-section program for plotting such things as titles, latitude-longitude identification marks, textual names within each layer to identify rock types, and perhaps shading of each geological unit. As a first cut to producing elevations for the ground surface, the Kelley bushing elevations minus a constant offset are being used. At a later date, the TOPOCOM elevation data may actually be used to provide a better ground surface between the boreholes.

V. TOPOCOM ground-elevation processing. This task of producing FORTRAN-readable elevation data files from the binary TOPOCOM tapes for any area in the continental United States is proceeding at a relatively slow pace. The software has been checked out, and the test runs finished. Rectification data are being added to the header records of the FORTRAN tapes so that an exact latitude-longitude rectification may be used. The current delay is because the Operations Department has not yet made a decision as to whether 500 new tapes from the existing tape library at X-10 may be obtained.

VI. Improvements to map data plotting programs. In using the U.S. county mapping program and the Polygon mapping program, several bugs were found that required changes to these programs. Corrections were made to the Calcomp versions and the Versatec electrostatic versions. The cell mapping program, MAPGEN, which was previously operational only on the Calcomp plotter, has been converted to the Versatec electrostatic plotter for production work. The Versatec version runs approximately 15 times faster than the Calcomp version, but the resulting plots can only be made in black and white.

VII. Geographic digitization software. Progress continued on two separate efforts for improving the digitization system used for OWI geographic and geologic data input. As part of the first effort, a new program is being written for the Tektronix system to read disk files containing previously digitized data for quick plotting on the Tektronix screen before transferring the data to the IMB/360 for plotting on the Calcomp plotters. This quick-view plotting program is intended only to give the user a last look at his data in graphical form before hard-copy plotting. Although the displays cannot be made to scale on the CRT (cathode ray tube) screen, certain types of relative errors may be detected on the screen before sending the job to the large IBM computers.

The second effort to improve the current system involves the development of a new system to drive the recently-purchased Oak Ridge Interactive Digitization System (ORIDS) equipment. In planning for this effort, a detailed outline of the tasks required was written. Time schedules and task assignments are being prepared, and a new employee, S. M. Margle, was hired specifically to work on this project. He and C. A. Dillard will be attending three weeks of specialized training schools conducted by MODCOMP during February 1978. One of the major tasks will be the development of a direct access storage/retrieval package for the MODCOMP system to manage the massive amounts of geographic and geological data to be digitized. A 20-page set of specifications was written and reviewed describing this data management capability. Before beginning the software development, other direct access systems that might provide part of the capabilities needed have been studied. At this point, the JJS system from Savannah River Laboratory (SRL), written primarily in FORTRAN, appears to be a possibility for use as the front end to the data management package needed by ORIDS. Initial documentation of the JJS system has been studied, and FORTRAN listings from SRL will be received shortly.

VIII. ORIDS assembly language software. The interface software between the MODCOMP II and the video display generator is now operational, and the documentation is almost complete. The next task under way is the development of a set of Calcomp-type subroutines for the video projector (e.g., subroutine PLOT). This set of subroutines will enable other programmers to use the video projector with FORTRAN programs. These routines will be used as a stop-gap measure until the memory-management software and refresh-display software have been written for the video display generator-projector.

IX. Documentation. A paper has been written by R. G. Edwards and R. C. Durfee entitled "Geographic Data Structure Supporting Regional Analysis" to be presented to the American Nuclear Society Meeting on June 18 to 23, 1978, in San Diego, California. This paper describes the geographic data structures used for managing and analyzing geographic and geological data bases. The paper was written as an introduction to the topic and uses a variety of projects and examples to show how different data structures affect the type of spatial analysis that can be done on geographic data.

Documentation of the assembly language software, DGPACK, for the interface between the MODCOMP II and the video display generator of the

digitization system has almost been completed by R. G. LeBlanc. When finalized, the report will be published describing this software for other users and for developers of the digitization system.

Data bases

I. North Louisiana borehole data base. The extraction and use of borehole data for several Northern Louisiana parishes is continuing. The original maps on which the borehole sites were placed have not yet been obtained. Thus, each parish is being handled independently with its own northing and easting coordinate system. Improvements to the extrapolation techniques used for calculating elevations of each geological unit has somewhat alleviated the problem of unknown borehole depths. Pam Raby recently catalogued all slides, glossies, and viewgraphs produced from plots of OWI project data.

II. Vacherie site. Calcomp plots of data digitized for the Vacherie salt dome area showed several minor problems with the original data. Some tracts of land showing right-of-entry locations were not uniquely identified so that each one could be handled independently. Corrections are being made to these problems, and new, colored Calcomp plots will be produced.

III. Petroleum Information Corporation well-history data base. In the OWI December 1977 progress report (Y/OWI/TM-43/3), the National Uranium Resource Evaluation (NURE) program was cited as attempting to acquire access to the Petroleum Information Corporation well-history data base through interagency agreements with the USGS who have already acquired this data file. Rather than set up duplicating direct-acquisition procedures for this information for the two UCC-ND projects, a decision was made to obtain selected borehole data for OWI analysis through the NURE program. In addition to eliminating red tape, this method of procurement will have the advantage of offering access to future updates to the Petroleum Information Corporation file which are done continuously by the USGS Denver office. These data can be obtained at a minimal cost to OWI.

IV. U.S. rail line data base. A data base is being obtained from the Federal Rail Administration. The information in this data base may be useful to the OWI project in terms of siting repositories near rail lines and in performing transportation studies for shipment of radioactive material from reactor sites to the repositories.

Hardware

Development in the use of recently-acquired hardware is continuing. Requests for bids on the color-image processing system mentioned in the OWI December 1977 progress report have gone out. The MODCOMP IV Mini-computer System will be delivered in early March 1978, and ORNL laboratory space is being converted into an equipment room for the new systems.

2. FACILITY PROJECTS

A. L. Boch

2.1 Engineering Projects

2.1.1 FIELD TESTING . . . P. D. Fairchild

2.1.1.1 Shale In Situ Tests

Site operation of the Conasauga near-surface heater experiment is proceeding without major difficulties. Application of air pressure to the central heater holes is being maintained and has stabilized the power input to both heaters. Laboratory studies are continuing with the objective of documenting the degree of parameter variation to be expected from the diverse lithologies at the site.

Field experiments . . . J. F. Cuderman, Sandia Laboratories

Operation of the two Conasauga sites is continuing. The Site 1 temperature 32 days after turn-on was 175°C at a point 2 ft from the heaters on the median plane. The corresponding Site 2 temperature at 32 days after turn-on was 120°C. The respective power inputs for the two sites are 10 and 12 kW, with median temperatures on the heater surfaces of 385°C. One month of operation has produced no significant phenomenological changes with one possible exception; the temperature gradient near the heater has apparently increased since start-up at Site 1 but not at Site 2. Gas samples were retrieved from Site 1 and are being analyzed. Data-reduction personnel have entered all data received on disk storage and have completed assembly of plot routines. A "chain" program that will join data from successive tapes for sequential plots and analyses is near completion.

Laboratory studies . . . J. L. Krumhansl, Sandia Laboratories

Work continues in the areas of thermal and mechanical modeling. Additional detailed mineralogic studies and analytic work related to gases that are evolved upon the heating of Conasauga samples are under way. Samples have been prepared for additional thermal conductivity measurements and for determination of relevant mechanical parameters. Thermal expansion measurements on siltstone indicate that, like limestone, this rock expands monotonically with increasing temperature.

2.1.1.2 Dome Salt In Situ Tests

Activity on the Avery Island heater experiment in Louisiana continued on schedule in the field, in the RE/SPEC facilities at Rapid City, South Dakota, and on equipment fabrication and packaging (for shipment) at Oak Ridge. Drilling of the instrumentation and heater holes is progressing well at the underground experiment site, although

some difficulties have been experienced with the 16-in.-diam core hole. However, drilling on the small-diameter instrument array holes is ahead of schedule. Overall, the drilling is on schedule with the first of the three sites scheduled to be ready for hardware installation by February 15, 1978. The second shipment from Oak Ridge to Avery Island, consisting of all major mechanical equipment, was successfully completed during the week of January 23.

Field operations* . . . G. D. Callahan, RE/SPEC Inc.

Drilling of the required instrumentation holes is continuing, and 6-in.-diam core has been obtained for further testing in the RE/SPEC laboratory. Drilling of the first 16-in.-diam holes was started. The drilling is ahead of schedule, and the first heater site is expected to be completed by February 15, 1978. In addition, asbestos sheeting is being incorporated into the control shack for fireproofing purposes.

In situ heater test support . . . G. D. Callahan, RE/SPEC Inc.

Thermal simulation of the Avery Island heater experiment is continuing in an effort to quantitatively assess the parametric influence of material properties and model boundary conditions. RE/SPEC Inc. has requested detailed operational procedures for the experiment from OWI. Upon receipt of the procedures, the heater experiments will be simulated using the most representative operational characteristics.

Various laboratory experiments are being performed in an effort to calibrate the vibrating-wire stressmeter for use in soft rock or a visco-elastic medium at elevated temperatures. Experiments to date included dead and cyclic loading in steel, lucite, and salt samples. Results have shown that the stressmeter itself is relatively insensitive to temperature fluctuations. However, the overall design of the components used in setting the stressmeter appears to need improvement. Preliminary tests indicated a need to eliminate slipping of the setting wedge. This need has also been confirmed in discussions with Sandia Laboratories personnel.

Equipment design and fabrication . . . E. G. St. Clair, Engineering Division, UCC-ND

Equipment fabrication was completed in the Oak Ridge shops. The second major shipment, which consisted of the heaters, sleeves, etc., was made to Avery Island, Louisiana, on January 25.

The only notable item that remains to be completed is the instrument panel/data logger checkout. The data loggers were successfully interfaced at the Accurex plant, and the tests were witnessed by UCC-ND Engineering personnel. Subsequently, the data loggers were shipped to Oak Ridge, where they are being installed in the appropriate panel for final panel checkout.

The third and final shipment to Avery Island is planned for early February 1978 and will consist of the instrument panels, the electrical control panels, and one crate of peripheral thermocouples.

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*This report covers activities from December 16 through January 15, 1978.

2.1.2 DESIGN STUDIES . . . P. D. Fairchild

Both studies (the FMC Canister Transporter Design Study and the Sandia Laboratories Cask Scoping Study) reported in this section will be concluded during the coming month; therefore, this section will be deleted in the February 1978 issue of this report.

2.1.2.1 Canister Transporter

The final report on the canister transporter conceptual design is scheduled to be issued by FMC on February 3, 1978. The FMC effort in January was to revise the draft report to incorporate comments from the technical review.

2.1.2.2 Cask Scoping Study

The final report draft by Sandia Laboratories on the Cask Scoping Study has been received and is currently under technical review at Oak Ridge.

2.2 Repository Projects

S. C. Matthews

2.2.1 CONCEPTUAL DESIGN OF NWTS REPOSITORIES 1 AND 2

Conceptual design efforts continued with Stearns-Roger (SRENCO) working on NWTS Repository 1 and Kaiser Engineers (KE) working on NWTS Repository 2.

A scope of work for a special study by each of the architect-engineers (A-Es) was drafted and submitted to DOE. This special study will provide an operating-cost parametric study and sensitivity analysis. Requests for directive modifications were prepared to reflect funding requirements for this study and to revise participants' costs per updated information.

Late in the month, KE submitted material for their 50% design review. The formal review meeting to discuss comments on this material is to be held in Oak Ridge on February 14-15, 1978.

The approximate percentage of completion for Repository 1 (SRENCO) is 57%, and for Repository 2 (KE), is 65%.

2.2.1.1 NWTS Repository 1 . . . S. C. Matthews, OWI; J. H. Jones, Stearns-Roger Engineering Company

General design efforts continued with major emphasis placed on the development of data for the final Cost Estimate. A final drawing list and a list of conceptual design reports (with scheduled dates for completion) were prepared and submitted to DOE.

In the area of underground development, six final drawings have been completed and submitted to DOE for approval. The development of

data for the final Cost Estimate and the preparation of final drawings were the major activities conducted in the underground facilities design area. Woodward-Clyde Consultants continued the development of the final report covering their activities.

A final arrangement concept for the canistered waste hot-cell facilities was completed, and the remaining structural design concepts are being developed. The parameters (weight, diameter, height, etc.) for the transfer cask have been established.

Development of data for the final Cost Estimate continued in the low-level-waste (LLW) area. The writing of design description reports was begun.

Energy Incorporated completed their evaluation of the shielding requirements for the transfer cask and continued to develop the data required for the Occupational Exposure and Health Physics Studies. Their efforts with the accident analysis studies also continued.

The draft Quality Assurance (QA) Plan for Titles I, II, and III was reviewed by project personnel, and the final draft is being prepared. A draft of the security design basis for the NWTS Repository 1 was completed.

General conceptual design efforts will continue during the next month with emphasis on activities associated with the final Cost Estimate, the final draft of the QA Plan, and production of final drawings. The conceptual design of the underground canistered waste transporting system will also be completed.

2.2.1.2 NWTS Repository 2 . . . S. C. Matthews, OWI; J. S. Ritchie, Kaiser Engineers, Inc.

Kaiser Engineers' technical effort continued in the areas of thermal and nuclear analyses, mining studies for the conceptual design, preliminary facility layouts, documenting design decisions, and preparation of conceptual design drawings.

Conceptual design activities continued for each of the disciplines involved, with the exception of electrical. Design review material (viz., updated drawing lists, a Conceptual Design Report (CDR) outline, a first-draft Basis of Design Document, Conceptual Design Decisions, CDR drafts, and copies of CDR drawings currently in progress) was sent to Oak Ridge for review and is to be discussed at the upcoming design review meeting. Drawings submitted for this meeting consisted of 16 drawings issued for approval and another 41 drawings that were in progress on January 26. The design-status review meeting is to be held in Oak Ridge, February 14-15, 1978.

Additionally, development of presentation material consisting of narrative comment on and viewgraphs of the present NWTS Repository 2 design was begun for a presentation to be given at Battelle Memorial Institute on March 2, 1978, at Columbus, Ohio.

Mine closure calculations, based on Project Salt Vault data, have been completed, and conclusions have been closely substantiated by the University of Minnesota using NWTS Repository 2 temperatures and mine geometry. The KE-calculated room-height decrease is 20 in. in 5 years for 5-year retrievability vs 11 in. in the Minnesota calculation. The mine-room-height decrease for 25-year retrievability was calculated by KE as 36 in. over the 25-year period.

Work was initiated on the Occupational Exposure and Health Physics Program for NWTS Repository 2. Sources of noise were identified for the construction and operations phases of the project. Planning for the performance of dose equivalent and dose commitment calculations was also completed.

Heat transfer consultants V. E. Schrock and C. Tien are performing a review of the mine-level thermal analyses performed to date with the objective of confirming the validity of method and results obtained. A study is also being performed to verify the thermal conductivity variation with temperature of the fuel assembly canister package.

2.3 OWI Facilities

S. C. Matthews

No activity has been reported for January on any of the general plant projects or line-item projects submitted as support facilities for OWI.

2.4 Generic Preconceptual Facility Studies

R. K. Kibbe

In a meeting on February 7-8, 1977, between representatives of OWI, ERDA-OR, ERDA-RL, ERDA-HQ, and Battelle Pacific Northwest Laboratories (PNL), OWI was requested to perform an accelerated series of preconceptual repository design studies considering alternative fuel cycles and alternative rock formations. This work is intended to generate baseline information on a systematic basis which will allow a comparison of both the technical and economic impacts of the various alternatives. The results would also be available for inclusion in the generic environmental impact statement (GEIS) on radioactive waste disposal, which is being prepared by PNL.

To accomplish this work, UCC-ND has contracted with three firms: (1) the A-E firm of Parsons, Brinckerhoff, Quade & Douglas, Inc. (PBQ&D), to generate preconceptual repository designs and to analyze the costs associated with the various alternatives; (2) the geotechnical firm of Dames & Moore (D&M), to analyze the geophysical properties of the various host formations of interest for potential geologic isolation of commercial waste; and (3) the multidisciplinary firm of Science Applications, Inc. (SAI), to analyze the nuclear, thermal, and effluent releases that may be associated with these facilities under normal operations or accident conditions. In addition, SAI is assisting OWI in program planning and organization and in the generation of the OWI GEIS submittal, in which the results of these studies will be included. Contracts with each of these firms were effective June 3.

The initial phase of this work resulted in a GEIS description of generic repositories located in salt, granite, and shale and an identification of effluents anticipated from these facilities. This GEIS submittal was delivered on September 30, 1977. Subsequently, expanded studies have been initiated which emphasize the generation of preconceptual repository designs in basalt and the analysis of a set of waste forms defined by PNL. These expanded studies will result in the issuance of a final version of the OWI GEIS submittal plus 23 volumes of technical support documentation by April 3, 1978. (These volumes will comprise documents Y/OWI/TM-36/1-23 when completed.)

The baseline project plan has been finalized, incorporating comments from the review by OWI personnel and the participating contractors. Review sessions have been held with the various contractors to assure understanding of OWI personnel comments made on the working drafts of the technical support documentation (Y/OWI/TM-36/1-23) which were submitted with the September version of the GEIS. These comments will be incorporated into the final technical support documentation.

The participating contractors met at SAI in Oak Ridge on January 12 for a project review and also, to specify the format and contents of the GEIS and technical support documentation. This meeting resulted in a more complete outline of the documentation, as well as detailed plans for meeting the April 3, 1978, delivery date.

The technical work on the expanded studies is nearing completion. The thermal loading limits defined for the basalt repository have been established, and the repository preconceptual design is nearly completed. Also, the salt repository designs for the alternative waste packaging defined by PNL are nearing completion. The costing efforts for both of these repository designs are progressing. Effluents from these designs have been calculated.

The two special studies under the expanded effort (nuclide leaching/migration and a mine fire analysis for combustible waste forms) are proceeding.

2.4.1 GEOTECHNIC ANALYSIS FOR PRECONCEPTUAL FACILITY STUDIES . . . J. R. Swaisgood, Dames & Moore

Ground-water flow patterns and flow rates have been defined for the granite, shale, and basalt repositories for the period after repository decommissioning. These flows can be divided into two distinct phases: (1) a flow into the repository region until the void spaces in the back-filled repository are filled and (2) a flow through the repository after equilibrium hydrologic gradients are reestablished. This latter flow is influenced by the temperature gradients generated by the isolated waste. Nuclide migration along the paths of the ground-water flow through the repository are being computed using the nuclide leaching and solubility data supplied by SAI.

Preliminary drafts of six of the seven D&M technical support volumes (for Y/OWI/TM-36/1-23) have been completed and are being reviewed within D&M. The seventh volume (Ground-Water Movement and Nuclide Transport) is being prepared.

2.4.2 ALTERNATIVE PRECONCEPTUAL REPOSITORY DESIGNS AND ASSOCIATED COST IMPACTS . . . T. Hoover, Parsons, Brinckerhoff, Quade & Douglas, Inc.

The basalt mine master plans, mining and waste placement schedules, mine partial plan, and mine section drawings for both reprocessing waste cycles were completed. Shaft sizes based on ventilation requirements were established, and drawings for the Subsurface Receiving Stations were prepared. For these two designs, high-level-waste canisters would be stored in drilled holes, and intermediate-level- and cladding-waste canisters would be stored in trenches. This arrangement is similar to the scheme prepared for a repository in granite. Ventilation design calculations for both surface and subsurface facilities were completed. Air velocities in the main airways were calculated, and the mine ventilating fan duties were determined. The design and drawings for the surface facilities, the excavated materials handling facilities, and the onsite radioactive waste management system were completed. These designs and drawings resemble those prepared for repositories in the other media.

The basalt repository design for the spent unprocessed fuel (SURF) cycle has been completed. The costing effort for the SURF cycle repository design is almost completed, and the efforts for the two reprocessing cycle designs are progressing.

All drawings and schedules for the PNL-defined, alternative waste packaging associated with the subsurface portion of the repository have been completed. A mine layout for salt was used which was similar to the design employed for the reference waste packaging. Special features to accommodate the alternative waste packaging were devised; their impact on the design and cost of the repository is being evaluated.

Repository construction and operating cost estimates for the PNL-specified waste packaging designs are being prepared.

Data have been received from SAI defining potential releases from a mine fire associated with the storage of combustible wastes in a repository (an alternative scenario proposed by PNL). These data will be incorporated into a PBQ&D computer code to determine the impact of the fire on the performance of the ventilation system and on the eventual dispersal of the effluents.

2.4.3 ENVIRONMENTAL, THERMAL, AND NUCLEAR STUDIES FOR PRECONCEPTUAL REPOSITORY DESIGNS . . . R. E. Wilems, Science Applications, Inc.

Additional information relating the internal temperatures of fuel assemblies to cladding temperatures* has allowed a more detailed assessment of the temperatures attained by canistered fuel assemblies stored in various host rocks. These new, more-detailed analyses indicate that the current OWI criteria for maximum cladding temperature for spent fuel assemblies during the retrievable phase (200°C) is not exceeded in the

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*Cox, Richard Lee, Radioactive Heat Transfer in Arrays of Parallel Cylinders, Oak Ridge National Laboratory, ORNL-5239 (July 1977).

salt designs. However, the pressurized-water-reactor cladding temperatures in the hard-rock designs exceed the desired limit by 15 to 20% at the design areal thermal loadings. The calculations assumed a 6-in. annulus of the fractured rock around the canister due to thermal stresses. Because of these results, qualifiers may have to be placed on the hard-rock repository designs for the SURF cycle.

Normal radioactive releases have been calculated for the basalt repository handling OWI-defined wastes and the salt repository handling PNL-defined wastes. In all cases, the maximum release concentrations at the top of the stack, even before dispersion is taken into account, are below the maximum permissible concentration allowed in 10 CFR 20 for continuous releases to uncontrolled areas. Also for these two repository designs, releases have been computed for the various accident scenarios that were defined during previous repository analyses. Accidental releases from handling the PNL waste packages are generally higher than those from equivalent OWI waste packages because more PNL packaging arrangements contain higher amounts of activity per container.

From the PNL data package, waste acceptance considerations have been prepared, and low-level and intermediate-level shielding calculations were completed. These latter calculations indicate that reasonable forklift shielding will protect the operator during the waste handling process for the PNL-defined LLW.

Canister integrity estimates have been completed using the chemical composition of ground water supplied by D&M. Present canister designs and emplacement procedures appear adequate to assure canister integrity during the retrievable phase of repository operation.

The availability of radionuclides for migration in circulating ground waters from hard-rock repositories toward the biosphere have been determined. These calculations take into account the leach rate of the nuclides from glass at elevated temperatures and their solubility in the ground water. These data have been supplied by D&M, who will determine estimates of nuclide concentrations in ground water released to the biosphere from hard-rock repositories.

The SAI internal review of selected volumes (prepared by other contractors) of the Y/OWI/TM-36/1-23 working draft, which was submitted to OWI in September 1977, has been completed. Review comments were given to the authors of the various volumes. Revisions of the SAI prepared volumes of Y/OWI/TM-36/1-23 and the SAI contribution of the GEIS are proceeding. Drafts will be completed during February 1978.

3. PLANNING AND ANALYSIS

J. M. Morrison

3.1 Schedule and Control System Development

J. R. Palmer

3.1.1 PROGRAM CONTROL SYSTEM . . . M. L. Bennett, J. R. Palmer, D. G. Shaner, and W. R. Musick

The baseline Program Control System (PCS) planning data were modified during the month to incorporate revised estimates for budgets, costs, and schedules which reflect program changes through December 1977. These data were used in a Program Review Meeting with personnel from Battelle Memorial Institute.

Updating of the documentation of the PCS program plans and system instructions was completed. Copies of the revised PCS Manual are being printed.

3.2 Program Planning

J. E. Vath

3.2.1 GENERAL PROGRAM PLANNING ACTIVITIES . . . J. E. Vath, R. S. Lowrie, and R. A. Kisner

The FY 1980 Operations, Plant, and Equipment Budget was prepared in draft format during the month. The guidelines provided by DOE-ORO for this budget were based on certification of at least two locations for a radioactive waste repository in a salt formation by the end of FY 1979 and the operation of one repository by October 1985. This budget complements the revision to the OWI Program Plan that is scheduled to be completed by the end of February 1978. Budget estimates were also included for a spent fuel geologic storage demonstration test and a hard-rock repository study.

Preparation of the FY 1980 zero base budget projections for submittal to DOE-HQ was initiated. These budgets use the President's FY 1979 Budget Request as the basis for the development of the zero base budgets. Three different funding levels for FY 1980 and the corresponding impacts on the program schedule are being addressed in this study.

3.2.2 WASTE PROJECTIONS STUDY . . . R. A. Kisner, OWI; J. R. Marshall and J. A. Nowicki, Operations Analysis and Planning Division, UCC-ND

J. R. Marshall gave a presentation of the computerized Source-Term Library Storage and Retrieval System to OWI staff members on January 17. This system provides easy computer access to the more than 30 million bytes of source-term information contained in this library. The source-term system user's manual, entitled PLOTLIB--A Computerized Source-Term Library Storage and Retrieval System (Y/OWI/TM-51), is currently undergoing internal review and will become available in March 1978.

The report Y/OWI/TM-34, entitled OWI Waste Projections and Source-Term Data for FY 1977, by R. A. Kisner, J. R. Marshall, D. W. Turner, and J. E. Vath, is undergoing formal editing and is now expected to become available in March 1978.

3.2.3 WASTE INVENTORY STUDY . . . H. N. Rosenberg

The contract with NUS Corporation for the Waste Inventory Study was approved by DOE during the month, and work was started. An initial meeting with NUS to discuss details of the study and early milestones was held at OWI on January 19.

3.2.4 CURRENT ACTIVITY ON ALTERNATIVE FUEL CYCLES . . . R. A. Kisner

No activity was reported for January.

3.2.5 DOE/INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION ASSISTANCE

On December 19, 1977, a request was received from DOE for OWI to provide assistance to DOE-HQ in connection with the U.S. participation on International Nuclear Fuel Cycle Evaluation (INFCE) Working Group 7, Waste Management and Disposal. The initial request was for an outline of an approach to a study comparing the disposal of spent fuel elements with the disposal of reprocessing waste in a geologic repository. This outline was provided by January 16 as requested. Preliminary information on the outline and associated narratives was provided earlier, as requested.

DOE also requested estimates of the current U.S. level of effort in the various areas of waste disposal as listed in the outline, as well as copies of bibliographies and reports issued by OWI that might be of use to the Working Group. Both requests were met within the time frame designated.

On January 23, another request was received to provide information associating the various topics listed in the outline with past or present studies under contract at OWI. OWI was also requested to identify such studies by name, contractor, funding, date of completion, and reports issued or to be issued. Response to this request was under preparation at the end of the month.

3.3 Systems Studies

R. S. Lowrie

3.3.1 WASTE CONTAINER STUDIES . . . W. H. Pechin

The nature of the waste container studies is such that they interface with, and to a certain extent overlap, numerous other activities sponsored by OWI, for instance, the Transportation/Logistics Study. The objective of the Rockwell Hanford Operations (RHO) canister envelope and waste packaging

studies (Sects. 3.3.1.1 and 3.3.1.2) is to develop sufficient information to determine the limitations imposed by the rest of the repository system on the high-level-waste (HLW) canister and other waste packages.

Detailed comments were prepared on the draft report Commercial Waste Packaging Studies, Task 2, High-Level-Waste Canister Acceptance Criteria and forwarded to RHO. Two additional draft reports, Status Report, Radioactive Waste Packaging Study and Spent Unreprocessed Fuel Package Acceptance Criteria for Storage in a Salt Repository were received and are being reviewed.

3.3.1.1 High-Level-Waste Canister Acceptance Criteria - Task 2 . . . E. L. Moore, Rockwell Hanford Operations

A draft of the report Spent Unreprocessed Fuel Package Acceptance Criteria for Storage in a Salt Repository was issued for comment during the report period. The criteria were prepared for OWI to be used in the design of a salt repository.

A preliminary report reviewing industry codes and standards for determining application to the design and fabrication of the HLW canister was received for comment. This report is scheduled for final issue January 30. As part of the continuing effort, a work scope was drafted covering follow-on heat transfer work that is needed to refine previously developed data to support the HLW canister acceptance criteria. The new study will employ three-dimensional computer modeling to better define the thermal limitations imposed on the HLW canister after emplacement in the geological repository.

3.3.1.2 Radioactive Waste Packaging Study . . . D. B. Calmus, Rockwell Hanford Operations

The objective of the Radioactive Waste Packaging Study, Task 1, is to establish waste package acceptance criteria and waste container design criteria for transuranic (TRU) waste to ensure that the container and contents (package) will be compatible with the handling equipment and environments encountered from the preparation stage through disposal in a federal repository.

A draft report covering work through November 1977 is in preparation. The report presents criteria developed to date.

Waste Package Acceptance Criteria will be issued by the end of FY 1978, and Container Design Criteria, by the end of FY 1979. Long-range plans will be directed toward the fabrication and testing of candidate waste containers that will be based on developed container design criteria.

Technical service subcontracts (to support the Waste Packaging Study) with Science Applications, Incorporated (SAI) for the Transportation Study and with Battelle-Columbus Laboratories for the Corrosion Study are under way and should be completed on schedule. Negotiations with the selected bidder for the Codes and Standards Study are continuing. Although the original procurement schedule is approximately one month behind, the report completion date (July 1, 1978) is still expected to be met.

3.3.2 TRANSPORTATION/LOGISTICS STUDY . . . D. W. Turner, OWI; L. B. Shappert, Chemical Technology Division, Oak Ridge National Laboratory

Documentation of the work performed during the systems analysis phase of the Transportation/Logistics Study is nearing completion. The report ORNL-5362, Radioactive Waste Transportation Systems Analysis and Program Plan, is being prepared for publication. The documentation of the logistics models developed by ORNL will be published next month as ORNL/TM-6192, Logistics Models for the Transportation of Radioactive Waste and Spent Fuel. The Rocky Flats Plant[†] report RFP-2728, National Waste Terminal Storage Program: Low-Level Transuranic Waste Transportation Study, is also nearing publication. A meeting with AGNS personnel was held January 19 at OWI for final review of their draft report Y/OWI/SUB-77/22330, Current Status and Future Considerations for a Transportation System for Spent Fuel and Radioactive Waste. The suggested changes are expected to be made, and the final report submitted to OWI by mid-February 1978.

Several calculations were made during the month with the Spent Fuel Logistics Model. The first calculation was for the OWI Economic Study (Sect. 3.3.4) and used multiple away-from-reactor (AFR)* sites and one repository site. These calculations assumed that (1) the repository would open in 1985, (2) the AFRs would open in 1982 and close in 1989, (3) only rail transportation would be used for shipments between AFRs and the repository, and (4) special trains of one to four cars would be used for loaded movements. One item highlighted by the calculations was that the AFRs would not have time to completely transfer the spent fuel to the repository under the assumed AFR unloading constraint of 2000 metric tons of uranium (MTU) per year. Additional calculations were made for OWI using single AFR sites so as to compare transportation system costs for different AFR sites.

The second group of rate quotations was received from the General Services Administration (GSA). These rates were plotted, and correlation is under way. A third request, which is for truck and rail rates from 23 geographic regions to additional destinations, was sent to GSA. When this latest request is filled, the spent fuel logistics model will have direct rate quotations on file from 23 geographic regions of the continental United States to the AFR and repository sites being postulated for logistics calculations.

Additional transportation data were provided to the OWI Economic Study. These data included commercial truck rates for legal weight shipments via a common carrier along with a detailed discussion of factors that must be considered when selecting a transport mode. The presentation included an outline of the other types of truck rates that need to be considered (e.g., legal weight heavy hauler, overweight heavy hauler, commodity, and contract). ORNL personnel assisted in the review of transportation assumptions for the Economic Study.

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*AFR = An interim storage water basin for spent fuel located at a site away from the supplying reactor.

[†]Rockwell International, Atomics International Division, Rocky Flats Plant, Golden, Colorado.

Detailed discussions were held with R. J. Merlini of the Rocky Flats Plant on TRU waste shipping and packaging design. Fiscal year 1978 work on TRU waste will concentrate on a preconceptual systems analysis and will include recommendations of the most probable shipping configurations for the near term (next 2 to 3 years), as well as configurations for the long term (beyond 1985). Information will also be developed for important problem areas of each concept, and the identification of the advantages and disadvantages for each shipping configuration will be made based on past experience in handling TRU waste.

3.3.3 SPENT FUEL DISPOSAL SYSTEM STUDY . . . H. M. Noritake

The contract for this study was signed by the successful bidder during the latter part of December and has been submitted to DOE-ORO for approval.

A letter was sent to the Peer Review Group to officially notify all members of their expected participation in this study. Copies of the scope of work for the Spent Fuel Disposal System Study were included in the letter.

3.3.4 ECONOMIC STUDY . . . H. N. Rosenberg

On January 10 and 11, a review meeting with TRW was held at OWI. During this meeting, all cost data prepared by TRW for both the costing study and the pricing extension to it were reviewed by OWI. Also, representatives from DOE-HQ, S. M. Stoller Corporation, and Savannah River Laboratory (for AFR cost review) participated in the meeting. A consensus on the cost inputs for the pricing study was reached.

The scenario assumptions for the pricing study were also reviewed, and agreement was reached on the assumptions for two of the four scenarios. Subsequent to the meeting, assumptions for the third and fourth scenarios were agreed upon by OWI and TRW via telephone conversations. The scenarios include consideration of the acceptance by the utilities and the system closure (cut-off time).

During the month of January, TRW efforts were expended in the following areas:

1. Engineering cost estimate - The generation of costs (based on basic cost data supplied by OWI and Savannah River Laboratory) required for the repository and the encapsulation plant was completed by TRW and reviewed with OWI personnel. Work is in progress on documenting these costs in a format suitable for a final report.
2. Computer programming - Work continued on the cost model, particularly on the flow model portion. The schedule was extended in order to release personnel to do coding of algorithms for the pricing study calculation.
3. Collection of special cost data for use in pricing model - Cost collection was completed for the items required for the pricing study. These items specifically included transportation costs, AFR costs, and research and development costs.

4. Development of methodology for pricing studies - This methodology was completed during January. The content was reviewed during the review meeting on January 10 and 11, and the methodology was approved for use in venture* cases for the pricing study. Subsequent to that meeting, extensions were made to the methodology to permit calculations of cases including a second repository.
5. Calculation of prices to be charged by DOE on receipt of fuel from utilities - The calculations were completed for the four scenarios investigated. Results are being reviewed prior to presentation at a briefing for DOE in February 1978.

3.3.5 WASTE ACCEPTANCE CRITERIA . . . W. H. Pechin

Negotiations are continuing on this contract. A revised proposal was received from the bidder and is being evaluated.

3.3.6 INTERNATIONAL WASTE REPOSITORY STUDY . . . H. M. Noritake

Negotiations on the contract for this study continued. The DOE audit was completed, and provisions related to the work scope are under review.

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*Venture cases are those in which all costs and revenues associated with a single "venture" or project are considered until the end of the useful life of the project.

4. REGULATORY AFFAIRS

A. S. Quist

4.1 Environmental Studies

4.1.1 ENVIRONMENTAL STUDY PLANS . . . A. S. Quist, OWI; R. J. Davis, NUS Corporation

Review comments on draft regional and study area survey plans were received from Texas, New York, Ohio, and Louisiana. The state agency review is in process in Utah and Mississippi. Copies of these plans were sent to regional expert reviewers in Texas, New York, Ohio, Mississippi, and Utah, and some comments have been received from each state. Letters explaining the program and requesting reviews were sent to regional experts in Louisiana. Copies of the plans have also been sent to a regional environmental coalition in each of the six states, with requests that the coalition act as a coordinator of reviews by environmental groups. Comments on the plans have also been received from OWI, DOE, Bechtel Corporation [a Regulatory Project Manager (RPM)], and Battelle Human Affairs Research Centers (HARC). The comments received have been collated by discipline and given to OWI and the RPMs for their information. Development of draft responses will proceed during February 1978.

The seven draft locational survey plans (i.e., for the Gulf Coast salt domes in Texas, Louisiana, and Mississippi; the Salina basin in New York and Ohio; the Permian Basin in Texas; and the Paradox basin in Utah) were reviewed and approved by OWI, are being printed, and are expected to be transmitted to reviewers during the first half of February 1978.

An annotated outline of the draft plans for the preparation of a draft environmental impact statement (DEIS) was developed and discussed with the interdisciplinary project team. A working draft plan for OWI review is expected to be provided during February 1978.

A meeting was held on January 24 in Seattle, Washington, with HARC personnel. They presented their programs and their comments on the survey plans.

4.1.2 REGULATORY PROJECT MANAGERS

4.1.2.1 Bedded Salt Formations . . . R. L. Shoup, OWI; J. J. DiNunno, NUS Corporation

NUS Corporation, as RPM for bedded salt formations, continued progress in the preparation of regional reconnaissance reports characterizing the environmental setting of the Permian and Salina basins; submission of

draft reports to OWI is scheduled for February 1978. The primary activity in all technical tasks was the acquisition, review, and documentation of available information on the regions. Standardized base maps were prepared. Figures have included color overlays where necessary to present the required information. NUS project management review was completed for initial drafts of all regional reconnaissance report sections except ground-water hydrology for the Permian region.

The NUS Technical Advisory Board conducted a scheduled review of the project on January 13. The review meeting, which was attended by R. L. Shoup, OWI, and A. F. Johnson, UCC-ND Purchasing, considered the management of and progress in the preparation of the draft regional reports. Also considered were future schedule milestones and budget constraints.

NUS Corporation continued planning for procurement of long-lead meteorological monitoring equipment required for the locational studies; also, advance work was initiated for area studies in the Salina and Permian basins.

A definitive subcontract covering NUS activities as RPM for the Salina and Permian bedded salt formations was approved by DOE.

4.1.2.2 Dome Salt Formations* . . . W. A. Goldsmith, OWI; N. A. Norman, Bechtel Corporation

Gulf Coast Interior salt dome region

Regional characterization. Report preparation continued and remains on schedule (approximately 80% complete). Some map preparation work and final report sections are still in process. The scheduled date for delivery to OWI is April 7, 1978.

Area studies. No progress was reported during the month.

Environmental baseline surveys. Negotiations for a subcontract to provide meteorological and radiation sampling equipment and services are proceeding. U.S. government audit results relative to this subcontract are under consideration. The subcontract being negotiated will provide for baseline surveys on four sites.

Paradox basin region

Regional characterization. The regional report is on schedule and will be delivered to OWI by February 17, 1978.

4.1.3 POSTDECOMMISSIONING MONITORING OF A REPOSITORY . . . A. S. Quist, OWI; J. A. Franco, EnviroSphere Company

The draft report describing a preliminary evaluation of the post-decommissioning monitoring of a waste repository in a rock salt formation was revised by EnviroSphere in accordance with OWI comments. The final OWI review was completed, and the final report is expected to be published in February 1978.

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*This report covers activities from December 24 to January 20, 1978.

4.2 Safety, Risk, and Hazard Studies

4.2.1 SAFETY ANALYSIS REPORT PREPARATION ACTIVITY

4.2.1.1 Regulatory Project Manager for Bedded Salt Formations . . . R. L. Shoup, OWI; J. J. DiNunno, NUS Corporation

In cooperation with OWI and Bechtel, NUS is continuing the development of an annotated safety analysis report (SAR) outline applicable to both the bedded salt and domed salt repositories. Key NUS and OWI personnel attended a working meeting at the Bechtel offices in San Francisco on January 18 and 19. Detailed outlines have been developed, and work to expand these outlines into annotated text is under way. Completion of the annotated outline by NUS and Bechtel has been tentatively scheduled for March 1978, depending on resolution of staffing and budget constraints.

4.2.1.2 Regulatory Project Manager for Dome Salt Formations . . . W. A. Goldsmith, OWI; N. A. Norman, Bechtel Corporation

On January 18 and 19, an SAR outline preparation meeting was held at the Bechtel San Francisco offices. A tentative agreement was reached among OWI, NUS, and Bechtel participants relative to an SAR outline down to the third level of subheadings. The outline applies to bedded salt formations as well as dome salt formations. Another working meeting has been planned for March 14, 1978, at an NUS facility to reach final agreement on the annotated outline to the third level of detail. Telephone and telefax coordination will be used in the intervening period to permit mutual review of annotations and to resolve the remaining outline questions. This annotated outline will be used to identify data requirements and to research the sources and probable availability dates of the required data.

4.3 Nuclear Regulatory Commission Licensing Requirements

A. S. Quist

No activity has been reported for January.

4.4 Socioeconomic Impacts of Repository Construction and Operation

4.4.1 SOCIOECONOMIC IMPACT ASSESSMENT AND SOCIETAL ACCEPTANCE . . . A. S. Quist, OWI; A. H. Schilling, Battelle Human Affairs Research Centers

A review of the HARC studies related to the OWI Program was held in Seattle, Washington, on January 25. Topics reviewed included social and

economic impact assessment and management, public perceptions and attitudes, institutional analysis, and conflict resolution. A draft report entitled Land Use Control Considerations in Selected States was transmitted to OWI by HARC. The report discusses problems associated with potential land acquisition, potential land use control, and property rights in six selected states with respect to federal ownership of land for a radioactive waste repository.

4.4.2 REPOSITORY BENEFITS, CONSEQUENCES, AND EFFECTS STUDY . . . A. S. Quist, OWI; R. D. Brenner, Princeton University

Work continued on developing the drafts of papers described in the OWI progress report for December 1977 (Y/OWI/TM-43/3). These papers give an overview of the short-term social, economic, and political impacts of a radioactive waste repository. Particular attention will be directed toward implications for understanding or managing impacts peculiar to a waste repository.

4.4.3 ANNOTATED BIBLIOGRAPHY ON CONFLICT RESOLUTION . . . A. S. Quist, OWI; R. S. Burt, University of California, Berkeley

A. S. Quist and A. H. Schilling (Battelle HARC) reviewed R. S. Burt's draft report entitled Resolving Community Conflict in the Nuclear Power Issue: A Report and Annotated Bibliography at a meeting with Burt in Berkeley on January 23. Final copies of this report are expected to be delivered to OWI in February 1978.

4.4.4 PUBLIC CONSULTATION IN POLICY FORMATION . . . A. S. Quist, OWI; A. Bruce Bishop, Intermountain Consultants and Planners, Inc.

All draft sections of the state-of-the-art report prepared by Intermountain Consultants and Planners, Inc., were delivered to OWI for review and comment in January. Review will be completed in early February, and the final report is expected to be delivered to OWI in March 1978.

4.4.5 COMMUNICATION OF TECHNICAL INFORMATION TO LAY AUDIENCES . . . A. S. Quist, OWI; J. E. Bowes, University of Washington, Seattle

A. S. Quist, A. H. Schilling (Battelle HARC), and L. M. Bronfman (OWI Consultant) reviewed the progress on this topic at a meeting with J. E. Bowes held in Seattle, Washington, on January 24. The initial draft of this report and bibliography is expected to be delivered to OWI in February 1978.

5. PUBLIC AFFAIRS

I. N. Kaplan

An erroneous date was cited in the December 1977 progress report (Y/OWI/TM-43/3) for the transfer of NWTs Program public affairs responsibilities from OWI to DOE-HQ. The correct date of the transfer was November 4, 1977.

Because the OWI Program is no longer responsible for the public affairs area of the NWTs Program, this chapter will not appear in future progress reports.

APPENDIX A
VISITORS TO THE OFFICE OF WASTE ISOLATION
DURING JANUARY 1978

Company	Visitor	Date	Principal Contact
AiResearch Manufacturing Company 2525 190th Street Torrance, CA 90266	R. W. Cass	1/26-27	K. K. Aydelotte
	J. B. Robbins	1/26-27	K. K. Aydelotte
Allied-General Nuclear Services P. O. Box 847 Barnwell, SC 29812	R. T. Anderson	1/19	D. W. Turner
	R. W. Peterson	1/19	D. W. Turner
	F. A. Shallo	1/19	D. W. Turner
Battelle Columbus Laboratories 505 King Avenue Columbus, OH 43201	S. J. Basham, Jr.	1/25-26	C. D. Zerby
	J. M. Batch	1/16	C. D. Zerby
	D. P. Brown	1/25-26	C. D. Zerby
	W. A. Carbiener	1/16	C. D. Zerby
		1/25-26	C. D. Zerby
	D. L. Keller	1/16	C. D. Zerby
		1/25-26	C. D. Zerby
	W. M. Pardue	1/16	C. D. Zerby
		1/25-26	C. D. Zerby
Battelle Pacific Northwest Laboratories P. O. Box 999 Richland, WA 99352	R. E. Heineman	1/16	C. D. Zerby
		1/25-26	C. D. Zerby
	J. D. Hughes	1/25-26	C. D. Zerby
Dames & Moore 6 Commerce Drive Cranford, NJ 07830	D. J. Supkow	1/11	R. K. Kibbe
Dames & Moore 1100 Glendon Avenue Los Angeles, CA 90024	A. K. Runchal	1/11	R. K. Kibbe
Dames & Moore 134 Fairbanks Road Oak Ridge, TN 37830	T. M. Gates	1/3	R. K. Kibbe
		1/11	R. K. Kibbe
		1/23-24	R. K. Kibbe
	G. Hocking	1/23	R. K. Kibbe
	J. R. Swaisgood	1/3	R. K. Kibbe
		1/5-6	R. K. Kibbe
		1/11	R. K. Kibbe
		1/23	R. K. Kibbe
		1/27	R. K. Kibbe
		1/31	R. K. Kibbe

APPENDIX A (continued)

Company	Visitor	Date	Principal Contact
Earth Resource Associates 125 Cedar Creek Drive Athens, GA 30605	S. Gonzales	1/13	T. F. Lomenick
Goodyear Atomic Corporation P. O. Box 628 Piketon, OH 45661	J. B. Fenton M. J. Rafferty	1/26-27 1/26-27	K. K. Aydelotte K. K. Aydelotte
Lawrence Berkeley Laboratory University of California Berkeley, CA 94720	M. T. O'Brien T. L. Simkin	1/12 1/12	T. F. Lomenick T. F. Lomenick
Louisiana State University Baton Rouge, LA 70803	M. O. Waguespack	1/27	L. B. Cobb
National Forge Company Irvine, PA 16329	V. F. Oberhofer	1/18	W. H. Pechin
NUS Corporation 4 Research Place Rockville, MD 20850	R. A. Martineit R. J. Stouky	1/19 1/19	H. N. Rosenberg H. N. Rosenberg
Rockwell International P. O. Box 464 Golden, CO 80401	R. J. Merlini	1/20	D. W. Turner
Savannah River Laboratory E. I. du Pont de Nemours & Company Aiken, SC 29801	F. E. Driggers R. P. Whitfield	1/10 1/10	J. E. Vath J. E. Vath
Science Applications, Inc. 114 Tulsa Road Oak Ridge, TN 37830	J. G. Arbital J. N. Baird, Jr. C. W. Craven, Jr. R. S. Howell L. B. LaMonica M. S. McKeown T. E. Myrick L. D. Rickertsen P. N. Stevens	1/20 1/10 1/30 1/11 1/19 1/20 1/19 1/20 1/10 1/20 1/19	R. K. Kibbe R. K. Kibbe R. K. Kibbe R. K. Kibbe H. C. Claiborne G. H. Jenks R. K. Kibbe R. K. Kibbe H. C. Claiborne G. W. Turk H. C. Claiborne

APPENDIX A (continued)

Company	Visitor	Date	Principal Contact
Science Applications, Inc. 114 Tulsa Road Oak Ridge, TN 37830	R. E. Wilems	1/10-11	R. K. Kibbe
		1/17-20	R. K. Kibbe
		1/23	R. K. Kibbe
		1/25	G. H. Jenks
S. M. Stoller Corporation 1250 Broadway New York, NY 10001	W. A. Franks	1/10	J. M. Morrison
		1/11	H. N. Rosenberg
	R. W. Kupp	1/10	J. M. Morrison
		1/11	H. N. Rosenberg
TRW Energy Systems 7600 Colshire Drive McLean, VA 22101	W. L. Akridge	1/10	H. N. Rosenberg
	E. R. Christie	1/10	H. N. Rosenberg
	S. Cohen	1/10-11	H. N. Rosenberg
	J. D. Forster	1/10-11	H. N. Rosenberg
	J. R. Gauthier	1/10-11	H. N. Rosenberg
	F. P. Mertes, Jr.	1/10-11	H. N. Rosenberg
University of Oklahoma Norman, OK 73019	K. S. Johnson	1/13	T. F. Lomenick

APPENDIX B

TRIPS TAKEN BY OWI STAFF MEMBERS DURING JANUARY 1978

Date	Place Visited	OWI Staff Member	Purpose
1/8-9	Washington, DC	J. E. Russell	To make presentations to the DOE Task Force on Waste Management.
1/9	Washington, DC	R. K. Kibbe S. C. Matthews	To meet with the DOE Task Force about the waste management policy concerning repository thermal loadings.
1/13	Rockville, MD	R. L. Shoup	To review the Regulatory Project Manager program with NUS Corporation.
1/18-19	San Francisco, CA	A. S. Quist R. L. Shoup C. S. Sims	To conduct a working meeting on safety analysis report development with Bechtel and NUS Corporation.
1/19	Washington, DC	L. R. Dole T. F. Lomenick W. C. McClain	To review the U.S. Geological Survey information concerning repositories in salts.
1/20	Biloxi, MS	C. D. Zerby	To speak on "The Disposal of High-Level Radioactive Nuclear Waste" at the Annual Meeting of the Deep South Chapter of the Health Physics Society.
1/23	Berkeley, CA	A. S. Quist	To review a draft report on conflict resolution with R. A. Burt, University of California.
1/24-25	Seattle, WA	A. S. Quist	To review a draft report on communication of technical information to lay audiences with J. E. Bowes, University of Washington. Also, to receive input from Battelle Human Affairs Research Centers on environmental survey plans prepared by NUS Corporation and to review Battelle Human Affairs Research Centers socioeconomic studies.

APPENDIX B (continued)

Date	Place Visited	OWI Staff Member	Purpose
1/29 - 2/1	New Orleans, LA	J. M. Morrison	To attend International Conference on Uranium Enrichment, Atomic Industrial Forum, Inc.
1/29 - 2/2	Midland, TX (and nearby communities over a several-hundred-mile radius)	R. B. Laughon	To participate in an orientation field trip for geologists (made with the NURE Group from ORGDP).
1/30 - 2/2	San Francisco, CA	W. R. Andrews W. A. Goldsmith	To review the Regulatory Project Manager program with Bechtel.
1/31 - 2/1	Berkeley, CA	T. F. Lomenick	To attend Stripa Sweden Review Meeting at Lawrence Berkeley Laboratory.

APPENDIX C
REPORTS GENERATED

The following reports were forwarded to DOE-ORO during January 1978:

Y/OWI/SUB-4112/37

An Investigation of the Utility of Gulf Coast Salt Domes for the Storage or Disposal of Radioactive Wastes, prepared by the Institute for Environmental Studies, Louisiana State University, for Union Carbide Corporation, Nuclear Division, Office of Waste Isolation (September 30, 1977).

Y/OWI/TM-18/4

Summary of Geologic Review Group Meeting, November 17-18, 1977, Office of Waste Isolation, Union Carbide Corporation, Nuclear Division (January 6, 1978).

APPENDIX D
FUTURE ACTIVITIES

Date	Activity
February 6-7	Project review meeting to be held at Avery Island with RE/SPEC Inc. and International Salt Company.
February 7-8	W. C. McClain and H. C. Claiborne to attend the Working Meeting on Salt at DOE-HQ.
February 9	A. S. Quist to review NUS Corporation progress on environmental survey plans and environmental studies at Rockville, Maryland. A. S. Quist to meet with DOE officials at Germantown, Maryland, regarding OWI activities in Ohio. A review of the results of the Spent Fuel Pricing Study to be held in Oak Ridge with TRW.
February 10	R. B. Laughon and A. S. Quist (along with DOE officials) to attend the quarterly meeting of Northeast Ohio Congressmen at Mentor, Ohio.
February 14	H. N. Rosenberg and J. E. Vath to review NUS progress on the Waste Inventory Study at Rockville, Maryland.
February 14-15	Conceptual design status review to be held in Oak Ridge with Kaiser Engineers for NWTs Repository 2.
February 15	J. M. Morrison, H. N. Rosenberg, and J. E. Vath to participate in the TRW presentation of results from the Spent Fuel Pricing Study to DOE at Germantown, Maryland.
February 21-23	Conceptual design status review to be held in Denver, Colorado, with Stearns-Roger Engineering Company for NWTs Repository 1.

APPENDIX E
SUBCONTRACTS NEGOTIATED DURING JANUARY 1978

<u>Subcontractor/Consultant</u>	<u>Subcontract Number</u>	<u>General Scope of Work</u>
Pennsylvania State University	4091	Borehole cement and rock properties studies for radioactive waste isolation (Supplement 9).
S. Gonzales	4310	Consultant for geologic and hydrologic studies (renewal).
J. B. Droste	7062	Consultant on the geology of the Illinois basin and on the distribution and mineralogy of shale deposits.
South Dakota School of Mines	7316	Bench-scale creep tests on rock salt (time extension only; Supplement 1).
Science Applications, Inc.	62Y-45700C	GEIS Preconceptual Design Study (Supplement 2).
Dames & Moore	62Y-45701C	GEIS Preconceptual Design Study (Supplement 2).
Parsons Brinckerhoff Quade & Douglas, Inc.	62Y-45702C	GEIS Preconceptual Design Study (Supplement 2).
NUS Corporation	86Y-42517C	Waste Inventory Study.
RE/SPEC Inc.	89Y-22303C	Continuation and addition to in situ heater test support (Supplement 2).

APPENDIX F

EMPLOYMENT LEVELS AS OF JANUARY 31, 1978

	<u>Exempt</u>	<u>Non-Exempt</u>	<u>Total</u>
Technical Projects	9	4	13
Facility Projects	4	2	6
Planning and Analysis	11	4	15
Regulatory Affairs	4	1	5
Administration	4	5	9
Director's Office	1	2	3
Total	33	18	51

No personnel changes took place during January 1978.

OFFICE OF WASTE ISOLATION
FEBRUARY 1, 1978

DISTRIBUTION

Department of Energy (29)

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 W. K. Overbey, Jr., MERC
 D. T. Schueler, Jr., NV
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 H. Postma
 G. W. Renfro
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 I. L. Thomas
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Office of Waste Isolation (75)

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 W. A. Burnett
 H. C. Claiborne
 L. B. Cobb
 L. R. Dole
 J. L. Ewing
 P. D. Fairchild
 W. A. Goldsmith
 R. M. Jenkins
 I. N. Kaplan
 R. K. Kibbe
 R. A. Kisner
 R. B. Laughon
 T. F. Lomenick
 R. S. Lowrie
 S. C. Matthews
 L. L. McCauley
 W. C. McClain
 J. M. Morrison
 W. R. Musick
 J. R. Palmer
 W. H. Pechin
 A. S. Quist
 H. N. Rosenberg
 J. E. Russell
 D. G. Shaner
 R. L. Shoup
 C. S. Sims
 G. W. Turk
 D. W. Turner
 J. E. Vath
 C. D. Zerby
 OWI Records (37)

Operations Analysis and Planning (3)

J. T. Bradbury
 J. D. McGaugh (2)

Paducah

C. C. Hopkins

Purchasing

C. A. Fritts

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Technical

W. J. Wilcox, Jr.

Y-12 Plant (12)

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H. I. Cobert
J. D. Griffin
R. F. Hibbs
G. R. Jasny
L. R. Phillips
P. R. Vanstrum
W. J. Yaggi
Y-12 Records - RC
Y-12 Records (3)

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R. J. Hite
E. Jenne
J. C. Reed, Jr.
D. B. Stewart
R. I. Tilling
N. J. Irask, Jr.
W. S. Twenhofel
W. W. Wood

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A. L. Brokaw
D. W. Byerly
J. B. Droste

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Consultants (continued)

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Stearns-Roger Engineering Company
Attn: J. H. Jones

Stone & Webster Engineering
Corporation
Attn: J. Briedis

Texas Bureau of Economic Geology
Attn: W. L. Fisher

Subcontractors (22)

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Bechtel Corporation
Attn: J. B. Kemp
N. A. Norman

FMC Corporation
Attn: M. Wallis

Foster-Miller Associates, Inc.
Attn: G. L. Riley

Georgia Institute of Technology
Attn: G. Eichholz

Kaiser Engineers
Attn: J. S. Ritchie

Law Engineering Testing Company
Attn: J. G. LaBastie

Louisiana State University
Attn: J. D. Martinez

NUS Corporation
Attn: J. J. DiNunno
M. I. Goldman

Pennsylvania State University
Attn: D. M. Roy

RE/SPEC Inc.
Attn: P. F. Gnirk

Science Applications, Inc.
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TRW Systems and Energy
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F. Mertes

University of Minnesota
Attn: S. L. Crouch

University of Texas at Austin
Attn: R. M. Knapp

Woodward-Clyde Consultants
Attn: H. Ewoldsen

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S. N. Davis
J. C. Frye
E. F. Gloyna
K. B. Krauskopf

American Association of
State Geologists Review Group (8)

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J. F. Davis
W. W. Hambleton
V. E. Livingston, Jr.
D. N. Miller, Jr.
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Nuclear Safety Associates

J. A. Lieberman

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Mound Laboratory

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L. H. Gevantman

California Energy Resources
Conservation Development Commission

Attn: G. Simon

Atomic Energy of Canada, Ltd.*

Attn: E. Rosinger

State Geologists (5)

Attn: H. R. Collins, Ohio
C. S. Groat, Texas
L. W. Lough, Louisiana
D. T. McMillan, Utah
W. H. Moore, Mississippi

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*Document issued following review by UCC-ND Law Department.