Y/OWI/TM-43/3

OFFICE OF WASTE ISOLATION
PROGRESS REPORT

DECEMBER 1977

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*

This document was prepared by the Office of Waste Isolation to report progress on its portion of the National Waste Terminal Storage (NWTS) Program to the management and technical staffs of U.S. Department of Energy, Union Carbide Corporation-Nuclear Division, and other NWTS Program participants. As a progress report, it contains information that is preliminary and may be fragmentary or of limited scope. Accordingly, persons using this report should use caution when referencing it in publicly available documents.

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PROGRESS REPORT

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DECEMBER 1977

C. D. Zerby, Director

Issued January 31, 1978

Edited by R. C. Rhines

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

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HIGHLIGHTS

- . . . Installation and start-up of both near-surface heater experiments in the Conasauga Shale Formation were completed 31
- . . . On December 13, FMC Corporation presented the final results of its conceptual design work on transporters for handling canistered spent fuel and wastes in the underground repository 33
- . . . A 50% conceptual design review was held with Stearns-Roger Engineering Company on December 13 to 15 34
- . . . All Boeing consulting services on the OWI Program Control System were completed in December 41
- . . . On December 4, NWTs Program public affairs responsibilities were transferred from OWI to DOE-HQ 53

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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)

During December, LETCO met separately with OWI, Louisiana State University (LSU), Texas Bureau of Economic Geology (TBEG), and U.S. Geological Survey (USGS) representatives for brief reviews of the program plan that LETCO is formulating for the next phase of the evaluation of the Gulf Coast salt domes. The program plan, as well as a draft report on the results of the reconnaissance survey, is expected to be submitted to OWI on January 16, 1978.

DOE-Headquarters, who has responsibility for all activities in the area of public affairs and state coordination, has been contacted and requested to arrange reviews by appropriate state officials of both the draft report and the proposed exploratory plan being prepared by LETCO.

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

General

A general internal review of the LSU study was held on December 15 with Grover Murray, LSU consultant and eminent authority in the geology of the U.S. Gulf Coast and associated salt dome basins.

On December 19, a meeting was held with representatives of LETCO to review the status of ongoing activities, both at LSU and within the LETCO organization.

Geomechanics

Collection of field data from the tiltmeters over Vacherie and Rayburn's domes is continuing. Power hookups to one of the tiltmeters over Rayburn's dome will be made before January 1, 1978. The sensitivity of the most mature tiltmeter installation over Vacherie dome has been "tuned" to record ± 1 microradian of tilt. This capability should make the recording of earth tides possible.

M. Tumay has installed newly acquired soils testing equipment and will soon begin laboratory testing of soil samples collected at the tiltmeter sites over Vacherie. The mechanical properties of the soils will be obtained and used in the site-specific finite-element model of Vacherie dome for analyzing possible vertical movements.

Geohydrology

The description of well cuttings at three wells completed at Rayburn's dome is continuing. The details of the geology encountered were reevaluated in planning for additional wells during 1978.

The preparation of samples for microfossils, useful in correlating stratigraphic units at Vacherie, was completed for the four water wells drilled at that dome. This effort is expanding to include the shallower cores taken in the Quaternary investigation. The determination of the age of formations underlying the Quaternary deposits is important to the complete explanation of the history of salt solution and subsidence at Vacherie.

D. Alcott of LETCO visited the LSU offices to discuss details of the proposed thermal infrared survey of selected salt dome sites in Louisiana and to initiate contractual procedures.

C. Smith presented a paper by Smith, R. Barlow, and B. Hoda entitled "Groundwater Studies of Gulf Coast Salt Domes" at the fall meeting of the American Geophysical Union in San Francisco.

R. L. Thoms and Grover Murray (LSU consultant) visited W. H. Cameron, retired plant manager of the Winnfield Salt Mine (now flooded) in Winnfield, Louisiana, on December 6. The Winnfield salt dome is a member of the North Louisiana salt dome group that includes Vacherie and Rayburn's domes; therefore, its history is of direct significance to the interior Gulf Coast basin study. A more detailed report on the features of the Winnfield mine, particularly with reference to mine hydrology and gas blowouts, will be submitted at a later date.

R. L. Thoms held a telephone discussion with G. Thompson of the University of Arizona on dating brines found in salt domes. This matter will be further pursued early in 1978.

Regional geology

Work in the geochemistry laboratory continued with the analysis of salt samples from the Cote Blanche mine. Approximately ten additional samples were processed. R. E. Ferrell is reviewing the literature on the mineral stability of the various precipitates found in the banded salt layers. The student helpers are processing the completed salt sample data into the quantitative estimates of possible mineral abundances.

Gravity data for the Webster and Bienville parishes, Louisiana, recently purchased from Exploration Surveys, Inc., are being digitized, and the construction of inverse mathematical models of the gravitational effects of salt domes continues. Initial steps were taken in the preparation of the proposal for the acquisition of new and existing seismic data for Vacherie and Rayburn's salt domes and the surrounding areas of the North Louisiana basin.

Quaternary geology

All cored samples from the Quaternary and the underlying Tertiary at Vacherie dome have been processed, and final plates and exhibits are being prepared. Boring logs, soils laboratory data, downhole geophysical logs, color photographs, and similar data on each boring are being assembled as a topical report, and the supporting data are being filed at LSU. The first of the cored samples from Rayburn's dome were opened and are being processed.

During the report period, seismic refraction surveys to fill gaps in the shallow seismic information above the dome were made at Rayburn's dome by LSU crews using LSU Nimbus equipment. The results of these surveys are being processed through LSU computers using programs furnished by Harding-Lawson of Livermore, California. The overall results of the shallow seismic refraction surveys appear to be very good. A 13,000-fps-velocity layer (probably caprock) can be delineated to depths of more than 300 ft; a 6,000-fps layer (probably Cretaceous and Eocene) is detectable above the caprock; and a 1,500-fps layer (probably Quaternary) can be delineated at the surface. Borings are planned to determine the precise lithology corresponding to the seismically detectable strata. A three-dimensional plastic model is being prepared to illustrate the results of the seismic surveys.

Negotiations have been under way during the past month with LETCO in planning and preparing specifications for subcontracts for some 60 borings for the Rayburn's and Vacherie areas. Hopefully, specifications can be completed and contracts let in time for borings to begin in late January. These borings are part of the data collecting program scheduled for FY 1978.

C. R. Kolb spent a day at Rolla, Missouri, headquarters of the Topographic Division of USGS with Bill Mengle. Discussions centered on the USGS mapping of the Rayburn's and Vacherie areas at a 1:24,000 scale, using 5-ft contour intervals. Such data are of prime importance in tracing elevations of similar levels above the domes and in areas adjacent to them so that possible tectonic movement above the domes can be assessed. An additional objective is to correlate the Quaternary levels at the two sites with terrace levels along major streams so that the relative ages of the Quaternary levels can be established.

During the month, Roy Schroeder of the University of Utah was contacted concerning the possible use of the amino acid method of dating carbonaceous deposits in the Quaternary. This method permits the use of small quantities of material and has been successful in dating material up to 1 million years. Also, Bill Tanner of Florida State University was contacted concerning the possible use of the ionium-thorium method of dating. This method may permit dating of iron-cemented terrace materials between 100,000 and 2 million years old. Selected LSU geology students are processing samples of silty material from unusual deep sands found beneath the Quaternary at Vacherie for pollen analysis. These sands are thought to fill depressions formed in sinks that developed because of dissolution and collapse of the underlying salt. If pollen is found, the spores will be sent to an expert in Gulf Coast pollen studies for identification as to geologic age.

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

The draft report on phase one of the study was returned to this USGS office November 23 after review by T. F. Lomenick of OWI and P. R. Stevens, A. Clebsch, and M. S. Bedinger of USGS. Revisions to the report were made in response to the suggestions. The title was changed to "Geohydrology of the Northern Louisiana Salt Dome Basin Pertinent to the Storage of Radioactive Wastes - A Progress Report."

Work on data compilations for regional geohydrologic mapping is continuing, and a map of outcrop and subcrop patterns for all major units cropping out in the study area was prepared.

On December 15, R. L. Hosman and G. N. Ryals met in Jackson, Mississippi, with L. E. Carroon, E. H. Boswell, and C. A. Spiers, USGS, Jackson, Mississippi; J. E. Carr, USGS, Houston, Texas; P. R. Stevens, USGS, Reston, Virginia; and J. G. LaBastie, Jim Wallace, G. H. Fogle, and C. O. Durham of LETCO, Geologic Project Manager (GPM). The meeting was called by the GPM to present its work plan, which includes plans for test drilling at six candidate domes, and to coordinate their plans with the work objectives of USGS. Some of the test holes planned for the vicinities of the domes could possibly be in areas where test holes are needed for regional geohydrologic information and thus could serve a dual purpose. GPM representatives are to meet with Louisiana project personnel in January 1978 to discuss specific drilling plans.

1.1.1.4 Evaluation of the Potential of the East Texas Interior Salt Domes . . . E. G. Wermund, Texas Bureau of Economic Geology

The TBEG was notified of approval for the funding of its proposal submitted to DOE. The contract was effective as of October 1, 1977.

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 - Keechi, Whitehouse, and Bullard.

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 completion of the potentiometric maps on the Wilcox Group, the Carrizo Sand, and the Queen City Sand.

Planned accomplishments for the next report period are construction of net sand thickness maps on the following aquifers: Wilcox, Carrizo, and Queen City.

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 December.

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

The regional literature review of the Salina salt basin was completed. The results of this work, in the form of a preliminary draft of Volume I of the Stone & Webster report, was submitted to OWI on November 23, 1977, for review. The final draft version of this volume, as well as drafts of Volumes II and III, will be submitted by January 16, 1978. Volume II will recommend areas for further study and will contain the study plan for the next phase of studies of the investigation of the Salina salt basin; Volume III will consist of budget projections.

DOE-Headquarters, who has responsibility for all activities in the areas of public affairs and state coordination, was contacted and requested to arrange for review of Volumes I and II of the Stone & Webster report by the appropriate state officials.

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

A first draft of the USGS report entitled "Hydrologic Environment of the Silurian Salt Deposits in Parts of Michigan, Ohio, and New York," by S. E. Norris, was submitted to DOE and OWI for review and comment. This report summarizes the hydrologic environment of the Salina salt basin, insofar as existing data allow, and recommends areas within the basin for further evaluation in regard to their potential for the isolation of radioactive waste.

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

No activity has been reported for December.

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

R. J. Hite met with T. F. Lomenick (OWI) and Fred Conwell (Woodward-Clyde, Consultants) in Salt Lake City on December 12 to 14 to finalize plans

*This report covers activities from November through December 1977.

for the drilling program at the Salt Valley area. During this time, a conference was held with Director Don McMillan and other members of the Utah Geological and Mineral Survey to discuss their participation in the Paradox basin program. Separate meetings were also held with USGS personnel (including Ted Arnow, District Chief, Water Resources Division; Ed Guynn, Oil and Gas Operations, Conservation Division; and Jim Travis, Mining Operations, Conservation Division) to discuss the protection of fresh-water zones, drilling requirements on federal lands, and various problems concerning the protection of leasable minerals and responsibilities to lease holders in the area.

During December, the report by R. J. Hite entitled Subsurface Geology of a Potential Waste Emplacement Site, Salt Valley Anticline, Grand County, Utah was issued as USGS Open-file Report 77-761.

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

During the reporting period, activities in the Pierre Shale (South Dakota) consisted of refinement of the interpretation of the Landsat color-coded MSS 5/6 image. This ratio image is linearly proportional to vegetation cover density, and in other areas, the vegetation cover density was found to be adjusted to subtle aspects of lithology. Therefore, the map resulting from the interpretation of the color-coded MSS 5/6 image is believed to show surface lithologic variations and to suggest regional facies relationships.

This map was edited and drafted in December, and copies were sent to Rich Bretz, South Dakota Geologic Survey, and George Shurr, USGS. Both Bretz and Shurr have expressed interest in evaluating this image and can contribute to the interpretation from their extensive experience in western South Dakota.

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

Environmental geologic mapping continues, and 80 quadrangles have been completed. Twelve map units defined in terms of geologic processes, materials, and morphology have been identified. The areal distribution of these units must be understood in order to recognize areas of different geologic processes and rates of erosion.

A generalized regional soils map from south of the Canadian River to lat 33°N has been compiled. The map covers 31 Texas and New Mexico counties.

Linear features have been mapped on seven Landsat scenes covering the High Plains of Texas and eastern New Mexico. Black and white photo-mosaics (scale 1:24,000) have also been analyzed for linear elements.

Understanding the distribution of linear elements and their preferred orientations may influence understanding the development of drainage networks in the High Plains.

Joint patterns (~600 readings) were recorded at ten different areas. Initial comparisons of the joint-set azimuths with the orientation of the major basement structural feature suggest a strong relationship. Generally, the orientations of the escarpment faces and drainage segments are also roughly parallel to the joint sets, suggesting a relationship between streams and their valleys and the basement structure.

Three instrument station sites were confirmed - one is along Rita Blanca Creek south of Dalhart; one, within the Buffalo Lake Wildlife Refuge; and one, adjacent to Tubb Springs Canyon east of Palo Duro State Park. Instrument stations will be installed in late January or February 1978.

Two papers will be given during the next quarter. One paper will concern the methodology used in the Texas High Plains Remote Sensing and Shallow Stratigraphic Studies, and a second will present preliminary interpretations of the genesis of drainage systems on the Texas High Plains surface.

The Texas Water-Oriented Data Bank has provided for 55 recording stations on the High Plains precipitation, stream, and sediment load data along with length of record and estimates of data quality. Additional references concerning climate, stream flow, and Quaternary environments of the southwest have been located.

Preliminary contact with land owners in the areas of proposed instrument stations is 75% complete.

In the coming month, the selection of final instrument station locations and the leasing of these plots will be continued. Additional environmental geologic mapping will be field checked. Mapping of joint systems and areas of slope failure or mass movement within the Palo Duro Canyon will be continued.

Aerial photography surveys (1:80,000) of the project area are in progress.

Basin analysis . . . W. E. Galloway

Acquisition of the primary data base for basin analysis is essentially complete, and geologic synthesis is under way. Regional cross sections, combined with published information, indicate that 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. Facies architecture, potential resources, and hydrologic parameters vary significantly between these units, which both include and vertically bracket potential isolation sites.

Pre-Pennsylvanian. Correlation of Precambrian, Ellenburger, and Mississippian units within the Palo Duro basin is complete. Intersecting lithologic cross sections of the pre-Pennsylvanian sequence illustrate broad, facies patterns. Approximately the basal one-third of

the carbonate-dominated interval sandstone is confined to the base of the section. A structure map on the top of the Mississippian as defined by sample logs and filled out by correlation of geophysical logs is complete. The basement structure map for the Panhandle region is also complete. An isopach map of the total Mississippian is under construction.

Pennsylvanian. A structure map on a top Pennsylvanian datum is complete. Seven cross sections illustrating facies patterns within the Pennsylvanian section have been constructed. Sample logs provide basic data on lithologic type and can be used to calibrate geophysical log response. Two hundred sixteen wells penetrate the entire Pennsylvanian section, which consists of a narrow, northward-trending, central basinal sequence surrounded by fringing shelf-margin carbonates. Shelf facies include interbedded limestone and clastics, grading toward the surrounding granitic uplands into coarse granite wash and mudstone.

The Pennsylvanian section can be subdivided into lower and upper intervals consisting of 45% and 55% of the section, respectively. Depositional architecture and gross lithologic composition differ significantly in the two intervals. Limestone percentage and total limestone isolith maps of the lower interval define the poorly developed early Pennsylvanian shelf margin. A granite wash percentage map for the Palo Duro basin is complete and will be tied to generalized total granite wash maps that are being constructed to provide a picture of the distribution of these permeable units, which extend through the Pennsylvanian basin fill.

Lower Permian. Five regional sections designed to illustrate facies relationships within the Lower Permian section have been completed. An isopach map of the Lower Permian interval (top Pennsylvanian to base of San Andres) is complete. The section can be subdivided into Wolfcamp and Leonard intervals on the basis of gross lithic composition. The underlying Wolfcamp consists of limestone, mudstone, and some sandstone; and the Leonard is characterized by dolomite and evaporites. A limestone percentage map is under construction to better define the poorly differentiated shelf and basin facies of the Lower Permian.

Upper Permian. Eleven lithologic cross sections and a regional structure map on the top of the Tubb Sand are complete. Details of the Tubb, one of several widespread terrigenous clastic beds within the carbonate- and evaporite-dominated sequence, are under examination. An isopach and paleogeographic map of the Tubb has been drawn, and 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 in a broad NNE trending belt. Similar facies analyses of other terrigenous-evaporite units that punctuate the salt section will be initiated to determine the permanence of this salt depocenter. Net salt thickness and distribution are difficult to determine in the main mixed salt-carbonate sequences because of imprecise log differentiation of evaporite-carbonate lithologies. Maps of the clastic intervals may thus provide a useful guide to the geometry of the salt basin.

An isopach map of the San Andres is complete. This unit thins dramatically (by 100%) into the Dalhart basin.

Triassic. Stratigraphic and sedimentologic studies of the Dockum Group already under way are being extended northward into the Panhandle. Comparison of the Dockum of the Palo Duro/Dalhart basins with the better known section to the south indicates depositional continuity within a major lacustrine basin.

Significant new results. Examination of shallow aquifer hydro-chemistry in the Panhandle shows development of sulfate waters above subcrop areas of evaporite-rich parts of the Permian section, indicating local discharge of deeper Paleozoic waters into shallow aquifers.

Salt solution zones within the Permian appear to be characterized by a distinctive response on the geophysical logs. Recognition of this response should be useful in delineating areas of significant salt solution.

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

During December, the report by G. W. Shurr entitled The Pierre Shale, Northern Great Plains: A Potential Isolation Medium for Radioactive Waste was issued as USGS Open-file Report 77-776.

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

New England and Canadian Shield crystalline rocks . . . H. W. Smedes, U.S. Geological Survey; L. B. Cobb, OWI

Compilation of attributes of crystalline rocks on a national scale is continuing by Smedes. D. E. Gable, USGS, has started studies and compilation of data on rates of uplift in crystalline rock terrain.

Regional studies. Data for approximately one-third of the area along the Wisconsin-Michigan border contracted for aeromagnetic surveys have been received. These data, compiled as contours at 1:62,500, are being analyzed by P. K. Sims, USGS.

Rock mechanics. S. F. Diehl, USGS, continued density measurements and strength tests on the Lucerne Granite of southeastern Maine.

Isotope studies. Z. E. Peterman, USGS, continued writing the manuscript, "Geochronology of the Archean." Analytical work is continuing on rocks from northern Wisconsin and parts of adjacent Michigan.

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

No activity has been reported for December.

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

Task 1: Full-scale heaters. Full-power testing of full-scale heater 3 was completed; this testing completes the power-on testing of the three full-scale heaters. The fifth, sixth, and seventh peripheral heaters are currently undergoing full-power tests. Power testing of the last three peripheral heaters will begin during the first part of January 1978.

Fabrication of the full-scale heater power-driver and monitor prototype chassis was completed, and the unit is ready for check out. Design of the remaining electronics chassis for the heater power racks will continue into the first weeks of January 1978.

Work on the computer tabulation and cross referencing of the assignment of all instrumentation devices to the computer and data loggers is approximately one-half completed and will continue through January 1978.

All data acquisition equipment associated with the data logger has been received. Final cabling and testing of this equipment will continue into January 1978.

Performance tests were completed for heater assembly 3 and also for six of the peripheral heaters. Guide tube assemblies were designed and detailed to permit the use of borescopes. The assemblies are now being fabricated. Testing of the high-temperature shrink tubing for power cable and heater termination has also been completed.

Drilling of eight geophysical holes was completed in addition to the 406-mm H-10 hole. All holes in the H-9 area of the extensometer drift were completed. Fifty percent of the drift wall has been photographed by VIAK, and television-camera logging of the 76- and 406-mm holes in the H-9 area was completed. Fracture mapping of the instrumentation shed was started and is continuing in the H-9 area.

Construction of the instrumentation shed was started, and work in the computer room, power room, and control room is progressing according to schedule.

Task 2: Time-scale heaters. The detailed design of the time-scale heater power-drivers and monitor chassis is continuing.

Formal documentation of all instrumentation assignments continues parallel with the tabulation for Task 1.

Final cabling and testing of the data acquisition equipment will continue into January 1978.

*This report covers activities from November 15 through December 15, 1977.

Modifications have been designed to permit simultaneous testing of four time-scale heaters (instead of one at a time), and the parts are being fabricated. Also, a decrepitation weighing system is being developed as a replacement for the previous decrepitation detection system design, which proved too cumbersome.

Drilling in the time-scale drift has been completed. Television logging of 127- and 27-mm holes was completed by Hagconsult of Sweden, and pressure tests were completed in extensometer holes 1 and 5.

Rock bolting and wire meshing were completed. Construction of the instrumentation shed is in progress.

Water in-flow measurements were made for the time-scale holes, and calculations are being made to determine the possible needs for the de-watering of the heater holes.

Task 3: Fracture hydrology. The inclined borehole SBH-1 was terminated at a depth of 384.88 m. Reflex Photobar measurement was made at 33 m, and reconstruction and photography of the core from this hole was completed. Drilling proceeded to 329 m in SBH-2, and the Photobar survey was made at a depth of 267 m. Core logging and photography for this hole are proceeding well.

All water table wells were completed, and water sampling is continuing as planned.

Task 4: Geophysical assessment of fracture system. Geophysical logging equipment was shipped to the Tennessee Valley Authority (TVA) geophysical group. The TVA acoustical velocity equipment was made compatible with the LBL logger.

Task 5: Material properties measurement. Plans for the first phase of material testing are almost complete.

Task 6: Water, mass transfer experiment. No activity has been reported for December.

Task 7: In Situ stress measurement. No activity has been reported for December.

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

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

No activity has been reported for December.

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

Thermal conductivities measured on three Jefferson Island Salt samples are represented in the following table:

Temperature (°C)	Thermal conductivity (W/m·°K)		
	J1H1 ^a	J1V1 ^b	J1V2 ^b
66	3.40	4.30	3.86
104	3.11	3.87	3.39
212	2.44	2.90	2.60
323	2.06	2.50	2.21

^aH indicates horizontal (conduction perpendicular to the core axis).
^bV indicates vertical (conduction along the core axis).

As much as 20% variation in values was obtained on these specimens. However, all samples showed a decrease in thermal conductivity with increasing temperature. One of the specimens, J1H1, was remeasured after coating the surfaces with silver paint; the resulting value was about 3% higher. The Pyroceram standards used in these tests were used in previous studies at temperatures exceeding 300°C. Since thermocouple changes are known to occur at such temperatures, the old standards were compared with new Pyroceram reference materials after completing these measurements. The reference was 4% higher indicating that the values shown in the table above are about 4% low. Consequently, the thermocouples in the old standards were replaced, and additional standards were prepared in order to eliminate this source of error in future experiments.

Additional salt cores of Jefferson Island, Weeks Island, Cote Blanche, and Avery Island were received from RE/SPEC, Inc. Thermal conductivity measurements will be made on these materials as soon as suitable specimens are prepared.

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

The principal objective of this project is to provide means for predicting thermal conductivity (K) of rocks from mineral composition,

water content, and texture, thereby taking account of natural variations without extensive laboratory measurements. Because of the extreme friability of shale, laboratory measurement of the K of shale is difficult. The available data for shale indicate that its K increases with quartz content and decreases with clay mineral content. However, because few experimentalists provide petrographic data on their samples, or measure samples both dry and water-saturated, or study the variation with porosity, these conclusions are difficult to quantify. This difficulty is apparent because shales generally (1) contain moderate proportions of clay minerals and quartz, (2) contain considerable amounts of adsorbed water, and (3) have moderate porosity. In view of these limitations, the approach being taken is to correlate the shale measurements that have been made with the data on sandstones and soils to try to obtain some uniformity of variation. Systematic relationships have been demonstrated for basalts, felsic igneous rocks, limestones, and sandstones, for K with mineral composition, water content, and porosity. The data for K of shales do not yield correlations easily; therefore, work continues on the problem.

The reduction of the K of shale by clay minerals is partly due to the low value perpendicular to the layering of the crystal structure (about 1×10^{-3} cal/cm·sec·°C) as compared to the value parallel to the layering (about 8×10^{-3} cal/cm·sec·°C). In addition, the size and number of pore spaces are important in reducing K ; if the pore spaces are very small and contain air, K may be drastically reduced because convection of the air cannot occur in pores smaller than the mean free path of the air molecules. This effect and that of preferred layering of clay flakes, which is normally parallel to the bedding, can reduce the value of K to 0.2×10^{-3} cal/cm·sec·°C, whereas K for some sandy shales can reach as high as 7×10^{-3} cal/cm·sec·°C.

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 December.

1.3.1.4 Thermophysical Property Measurements of Conasauga Shale and Jefferson Island Dome Salt . . . D. D. Smith, Y-12 Development Laboratory, UCC-ND

No activity has been reported for December.

1.3.1.5 Computing Support on Thermal Analysis Work for OWI . . . D. C. Elrod, G. E. Giles, 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. Three refinements added to the code were (1) the ability to handle nonlinear thermal properties, (2) a more general convergence criterion based on the normalized maximum heat residual for

the linear case, and (3) the capability of controlling the time-step size based on the maximum change in temperature. Most of the output features used in HEATING5 have been added to THAC-SIP-3D. These features include the output of the card images of the input data to facilitate in debugging of input data and the output in map form of the nodal configuration and the transient temperature distribution for the two-dimensional planes normal to either the z or the y axis. The transient temperature distribution is output at the exact times specified in the input data. The documentation for the code was begun.

HEATPLOT code . . . D. C. Elrod

The addition of the HOLES4 contour plotting package to HEATPLOT resulted in HEATPLOT depicting the border of the model incorrectly in many cases. Therefore, a separate subroutine was added to HEATPLOT to draw the border of the model when contour plots were generated.

HEATING5A code . . . G. E. Giles

A letter describing the differences between the HEATING5 and HEATING5A codes was distributed to HEATING5 users. The overlay version of the code was implemented, and related job control language procedures were implemented.

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

The second draft of ORNL/ENG/TM-7, "Temperature Increases in a Salt Repository Incurred from the Storage of Spent Fuel or High-Level Waste," was issued, including changes suggested from both in-house and OWI review. This draft is expected to be finalized and published as soon as possible.

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

No activity has been reported for December.

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. J. Serne, Battelle Pacific Northwest Laboratories (PNL)

Technical progress summary[†]

I. General - R. J. Serne. Samples of four "standard" rocks were sent to subcontractors. Instructions on Kd methodology and synthetic

*This report covers activities from November 15 through December 15, 1977.

[†]A detailed report may be requested.

ground waters were also sent so that interlaboratory comparisons can be performed. Upon arrival of the ^{237}Pu isotope material, all controlled sample program resources will be on hand.

Additional rock samples (massive anhydrite, halite, Culebra dolomite, and Magenta dolomite) were received from the Sandia Waste Isolation Pilot Plant (WIPP) program. After crushing and mixing, these samples will be distributed.

All paperwork for FY 1978 subcontracts with Adaptronics, Inc., Argonne National Laboratory (ANL), ORNL, Los Alamos Scientific Laboratory (LASL), Lawrence Livermore Laboratory (LLL), Lawrence Berkeley Laboratory (LBL), and Rockwell Hanford Operations (RHO) are being processed.

II. PNL Internal Research - J. Relyea, D. Rai, and R. J. Serne, "Collection and Generation of Transport Data." Desorption experiments for Am, Np, and I for eight minerals were completed. Four minerals are still being processed. Sorption experiments using controlled rock samples are being initiated.

Dissolution of plutonium compounds at 120 days shows that solution concentrations of plutonium have not changed from the 90-day data. Further plutonium adsorption experiments under controlled Eh and pH conditions are being deferred until plutonium speciation extraction discrepancies are resolved. The liquid extraction procedure used by Bondietti (ORNL) which separates Pu (III-IV) from Pu (V-VI) and Pu polymer appears to give erroneously high plutonium polymer contents for the standard solutions. Pu(IV) and Pu(VI) standard solutions remain as prepared with the exception that both had significant amounts of plutonium polymer. Information from the literature suggests that polymer formation should be insignificant at the acid concentrations used.

III. Argonne National Laboratory (ANL) - P. Ricket, M. G. Seitz, A. Friedman, and S. Fried, "Transport Properties of Nuclear Waste in Geologic Media." Batch adsorption experiments to determine the effect of brine concentration on K_d values continue. Test tube adsorption problems are being explored. Rock "test tubes" are being fabricated so that surface adsorption vs contacted surface area can be studied.

IV. Oak Ridge National Laboratory - R. E. Meyer, K. A. Kraus, and J. Johnson, "Systematic Study of Nuclide Adsorption on Selected Geologic Media." Using columns composed of celite and montmorillonite, adsorption functions were determined for Cs^+/Na exchange at low loadings of Cs over a range of NaCl concentrations. These results were then compared to those obtained by the batch method and found to agree.

Because ideal behavior for 2:1 exchange experiments has not been observed, investigations of loading effects for $\text{Sr}^{+2}/\text{Na}^+$ and $\text{Ca}^{+2}/\text{Na}^+$ exchange are being performed.

V. Lawrence Livermore Laboratory - L. D. Ramspott, Homer Weed, David Coles, and Don Jackson, "Studies of Radionuclide Availability and Migration at the Nevada Test Site." The high-pressure intact core K_d apparatus was fabricated, and experiments using volcanic tuff were started. Supportive batch K_d experiments are also in progress.

VI. Rockwell Hanford Operations - G. S. Barney, M. Brutzeck, and R. A. Deju, "Kinetics and Reversibility of Radionuclide Sorption Reactions with Geologic Media." Work began to determine whether or not certain radionuclides are irreversibly sorbed on basalt, granite, and argillite. The crushed rock, loaded with radionuclides from the initial sorption equilibration measurements, was equilibrated again with radionuclide-free ground water, and the desorption K_d was measured. Two additional equilibrations with unspiked ground water were performed, and the K_d values for each were compared to those obtained from the original equilibration. Values of K_d for desorption equilibrations should be approximately equal to the K_d for initial sorption if the reaction is reversible. If the sorption reaction is irreversible, the K_d for desorption will be greater than that for sorption. Taking into account a large error for the desorption K_d values, the data indicate that sorption of ^{137}Cs on granite and argillite may be irreversible, as well as the sorption of ^{106}Ru on granite. Strontium-85 sorption appears to be reversible for each rock type. The data for actinide sorption-desorption are difficult to interpret, and a portion of the actinides in solution probably precipitated during the sorption measurements as hydroxides. Therefore, the measurements made may be measuring the solubility of these precipitates rather than the equilibrium sorption-desorption reactions of actinide ions with the rock surfaces. Further sorption-desorption measurements with actinides will be made using concentrations of actinides low enough to prevent precipitation.

Other crushed rock samples with sorbed radionuclides were equilibrated with 0.1 M solutions of NaNO_3 , KNO_3 , $\text{Ca}(\text{NO}_3)_2$, and $\text{Mg}(\text{NO}_3)_2$ to determine whether or not the radionuclide could be desorbed by ion exchange.

The sorbed ^{137}Cs in basalt and argillite can be desorbed by exchange with K^+ . Strontium-85 is desorbed by each of the four cations from the three rock types. However, these cations will not displace ^{106}Ru from any of the rock types. In fact, sorption of ^{106}Ru appears to be greater in the presence of these salts. Again, the actinide data are difficult to interpret.

VII. Adaptronics, Inc. - A. N. Mucciardi and Elsie Orre, "Statistical Investigation of the Mechanics Controlling Radionuclide Sorption." Adaptive learning networks and clustering techniques are being performed on available PNL data to evaluate similarities and differences between minerals that have been used in batch K_d experiments.

VIII. Lawrence Berkeley Laboratory - John Apps, Sidney Phillips, and John Neil, "Theoretical and Experimental Evaluation of Waste Transport in selected Rocks." Various test cases involving reaction between gabbro and sodium bicarbonate type ground water are being simulated using the FASTPATH code. Other similar codes are also being studied.

Work continued on the application of equilibrium thermodynamics to the ion exchange process and on the relation of equilibrium constants to K_d s. A method was outlined in which K_d s can be predicted as a function of concentration in multicomponent systems. In addition, the combination of ion exchange equilibrium constants was formalized, and laboratory

simulation of ion exchange in natural systems was reviewed. The first sections of a preliminary report are in preparation and will be submitted separately for review.

Cores 1-1/4 in. in diameter were taken from samples of altered and unaltered Umtanum Basalt, altered and unaltered Climax Stock quartz monzonite, and Eleana Shale. Wafers 0.5 cm thick were taken from the cores for later sorption/desorption studies. Portions of the core were sent to TerraTek for permeability measurements, to Micromeritics for multipoint specific surface area and porosity determination, and to the Earth Science Board at the University of California, Santa Cruz, for the preparation of microprobe mounts. Unaltered portions of the basalt, quartz monzonite, and shale were crushed to pass through a 60 μ sieve. Because these materials will be used in rock equilibration studies, they were also sent to Micromeritics for surface area determinations.

Small test columns were run on microgram samples of ^{237}Np , ^{233}U , ^{243}Am , ^{248}Cm , and ^{242}Pu to test a separation scheme using Dowex 50-X8 cation-exchange resin and different concentrations of HCl to isolate pure valence states and clean the tracer samples. NpO_2^+ , UO_2^{++} , Am^{3+} , Cm^{3+} , and Pu^{4+} can be isolated quite well. Some reduction of Pu to the trivalent state by the resin is evident, but a small amount of HNO_3 added to the HCl keeps most of the Pu as 4^+ . A large column was prepared and calibrated with microgram amounts of the five elements; about 1 mg of each element will be processed in the next two weeks.

About 1 mg of ^{243}Am has been separated from the ^{244}Cm contaminant by cation-exchange column using Dowex 50-X12 resin and ammonium α -hydroxyisobutyrate as eluant.

IX. Oak Ridge National Laboratory - C. W. Francis, M. Reeves, and E. A. Bondietti, "Soil Chromatograph K_d Values." During December, emphasis was placed on determining the hydrodynamic dispersion coefficient of Conasauga Shale in channel chromatographs. The calculations are based on the observation that as the shale is wetted, the movement of the water-front along the chromatograph is a function of the square root of time. Under these conditions, the longitudinal dispersion coefficient is not dependent on pore water velocity. Thus, the coefficient can be calculated from the concentration profiles along a chromatograph using the appropriate Boltzmann transformations. The first experimental set showed that the dispersion coefficient ranges from 10^{-7} to 10^{-5} m^2/sec . These data are also being used to calculate diffusivity. These coefficients, diffusivity and dispersivity, will be used in the coupled-equations model to determine selectivity coefficients, which, in turn, will be compared to selectivity coefficients determined by batch techniques.

X. Sandia Laboratories - 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 - D. C. Hoffman, K. Wolfsberg, B. Erdal, R. Vidale, and E. Norris, "Laboratory Measurements of Radionuclide Distributions." Thin sections were prepared from Climax Stock granite and from Eleana Shale from the Nevada Test Site (NTS). The thin

sections were examined by optical microscopy to determine grain size, original mineralogy, and alteration phases. The major minerals found in the Climax Stock were quartz, plagioclase, K-feldspar, biotite, and opaques. Minor minerals were sphene, zircon, apatite, and tourmaline. Average grain diameters were 0.4 to 0.8 mm. The minerals found in the Eleana Shale include quartz, sericite, chlorite, albite, carbonate (siderite), and pyrophyllite. The average grain size was 1 to 10 mm.

Uncertainties about source ground waters that might be present in granite formations necessitated synthesis in the laboratory. Pulverized granite was shaken with deionized water and with alluvial ground water at room temperature and at 70°C. Alluvium is being similarly treated as a control. Samples will be withdrawn at various times for analyses. Already noted is the fact that the pH of deionized water in contact with granite increased from 5.7 to 9.5 in two days. Water from wells in contact with fractured granite in this area is also being obtained.

Three pieces of Climax Stock granite (about 5 lb each) were reduced in size with hammers in a Braun Chipmunk apparatus and finally in a pulverizer with the plates set at ~ 1 mm. Each material was graded by sieving into the following size fractions expressed in microns: >500; 355 to 500; 250 to 355; 180 to 250; 150 to 180; 106 to 150; and <106. The >500- μ fractions were repulverized but not regraded. Later the 106- to 150- μ , 150- to 180- μ , and 180- to 250- μ fractions from one sample were recombined to make a standard for surface area and particle size determinations. As an interlaboratory calibration, surface area analyses of duplicate samples of crushed granite and alluvium are being made at LASL and LLL.

The in-house capability for monitoring changes in concentration of the major cations during the course of either batch or column measurements of K_d s was developed. Atomic adsorption spectrophotometric techniques are being used on the solutions containing the tracers before and after sorption measurements are performed. Both flame and flameless methods are used. The elements for which analyses are made are Na, K, Si, Ca, Mg, and Fe.

Experiments were conducted to ascertain the best method for introducing Pu tracer into the ground water to be used in the K_d determinations. Pu(IV) tracer in 3M HCl solution has been dried in various types of centrifuge tubes and then contacted with the ground water. Polypropylene tubes give the best recovery, about 60%, and will be used. Introduction of Pu tracer in 3M HCl volumes of 0.1% of total volume of ground water resulted in pH changes of 8.2 to 3.6, which would possibly change the results of subsequent K_d measurements. These solutions will be contacted with the materials to see if the original pH is reestablished. Careful investigation of these parameters appears to be important.

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 were completed. In the previous reporting period, critical mass calculations were made for water and brine mixtures of various actinide oxides for several nuclear waste types and ages. In this reporting period, granite and salt mixtures of

the actinide oxides for the same waste types and waste ages were treated. In addition, critical mass calculations of uranium oxide were extended to a waste age of 100,000 years for all four mixture compositions. A rough draft of the report summarizing this work is 60% complete.

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

No activity has been reported for December.

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. Scheetz, and J. M. Bind, Pennsylvania State University

Salt consolidation and brine migration

A four-point bend apparatus has been adapted to an Instron Machine and calibrated in order to measure the bend strength of hot-pressed bars of salt. Samples of various porosity and grain sizes were produced in a reproducible manner and tested in strength. Although more data are needed to draw specific conclusions, some trends can be detected, such as the increase of the strength with increased density and a decrease of the grain size.

All theoretical equations for the deformation maps of salt have been chosen. New equations or modifications were added when the previously proposed models were inadequate. Constants specific to NaCl were also selected in the literature, and programming is under way. This progress should soon produce the first theoretical maps.

Shale-waste compatibility

Of the various waste forms, spent unprocessed fuel (SURF) rods seem to be of the most immediate interest in view of current national policy discussions. The compatibility of SURF, especially its principal constituent (UO_2), with the shale repository rock has been moved to top priority.

A set of hydrothermal runs to test reactions between UO_2 and five reference shales was set up. This initial set of experiments is being conducted at 300°C so that reactions will most likely occur in the initial one week reaction period. Similar experiments will be conducted for longer periods of time at 200°C .

Similarly, the interaction of two phases that were identified as forming in SURF are being hydrothermally treated with selected clay minerals to test for reactions. These phases are Cs_2MoO_4 and SrZrO_3 . These experiments are being conducted at 200°C for a one month period.

CsOH is also being reacted with the selected clay minerals in order to determine the possible formation of pollucite. The amounts of CsOH are adjusted in such a way that 100% and 25% of the silicon from the various minerals will be used in pollucite formation.

X-ray diffraction methods, particularly the Gandolfi camera (which permits powder diffraction photographs from very small crystals), were used to identify the sodium analog of weeksite, $\text{Na}_2(\text{UO}_2)_2(\text{Si}_2\text{O}_5)_3 \cdot 4\text{H}_2\text{O}$.

Sodium, potassium, and rubidium wecksites exist; however, cesium wecksite was not synthesized. Further characterization measurements on these materials are under way.

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)

During this report period, the major effort was reduction and analysis of data obtained by irradiating synthetic NaCl with 1.5-MeV electrons at 75, 100, 125, 150, 175, 200, 250 and 300°C at dose rates approximately 2.5×10^8 rads/hr. Some preliminary results from this data set were reported last month. In addition, several of the measurements were repeated using improved electron beam steering and sample temperature measurement techniques.

The analysis has proceeded to the point that some quantitative results can be given, particularly for F-center formation in synthetic NaCl. Above 100°C and at dose rates of 2.5×10^8 rads/hr, the F-center vs dose curves separate into two stages. The first stage is roughly approximated by a saturating exponential. The second stage is linear with minor but apparent deviations. For example, in samples irradiated at 150°C the first stage saturates at approximately 1.5×10^{17} F-centers/cm³ for an accumulated dose of approximately 1.0×10^8 rads. In contrast, at 300°C the saturation F-center concentration is only 1.5×10^{16} F-centers/cm³ at a dose of 7.0×10^7 rads. The second or linear stage shows similar differences. At 150°C, the slope of the linear region corresponds to an F-center formation rate of 1.8×10^8 F-centers cm⁻³ rad⁻¹. However, at 300°C, the second-stage linear portion is horizontal (i.e., the formation of additional F-centers is not observed). Colloid particle formation at this temperature also is not observed.

Sufficient data are now available on undeformed synthetic NaCl, irradiated between 100 and 300°C to doses of 7×10^8 rads, to make some comparisons with the Jain and Lidiard* theory for defect and colloid formations in salt. To do so, the data must be corrected or scaled for differences in dose rate. The Jain and Lidiard computations used data obtained at dose rates approximately four times those used in these measurements. Also, the present measurements are being made at dose rates many times those expected in repositories. Thus, the need for an understanding of dose rate effects becomes apparent. The first-stage saturation levels obtained in these studies at 150°C are approximately one-third those expected on the basis of the Jain and Lidiard considerations. The appearance of a finite-slope, nonnegligible second stage is not included in their model. An important point is that this finite second stage has not been observed in natural rock salt (e.g., from drill hole 7, irradiated at 150°C). Therefore, these new results support the contention that radiation damage formation in natural rock salt is different from that in synthetic crystals.

*Jain, Uma and Lidiard, A. B., "The Growth of Colloidal Centres in Irradiated Alkali Halides," Phil. Mag., 35: 245-259 (1977).

The analysis of these data is continuing. Also, some improvements are being introduced to remove any possible discrepancies. An example of such an improvement is a procedure to correct for overlap of the F-center and colloid absorption bands.

1.3.2.6 Geochemical Interactions and Characterizations . . . D. B. Stewart, U.S. Geological Survey

No activity has been reported for December.

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

Evaluation of x-ray and potassium/argon analyses continues. Processing of samples for $^{180}/^{160}$ analyses continues. Quartz is being isolated from the bulk and also from the 0.2- to 0.63- μ m fraction and illite from the less than 0.2- μ m fraction.

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

An apparatus to determine the rate of water loss from core specimens of halite subjected to a thermal gradient is being designed and constructed. In initial tests, a gradient of $\sim 5^\circ/\text{cm}$ is expected to be established between the two faces of a core 15 cm in diameter and 10 cm long by the use of a heater over the upper face while maintaining the lower face near room temperature. Any water evolved will be swept from each face by two streams of dry air which will be passed through drying tubes that can be weighed. The rate of water removed will be compared to predictions based on various measurements of the movement of brine inclusions in single crystals.

In another series of experiments being planned, an attempt to directly observe the movement of brine inclusions along grain boundaries will be made using polished polycrystalline salt specimens. Either a modified commercial microscope hot-stage will be used to establish the thermal gradient, or a similar apparatus will be designed and constructed locally.

1.3.3 ROCK MECHANICS . . . J. E. Russell

W. C. McClain and J. E. Russell attended a review meeting of rock mechanics subcontractors involved with numerical modeling at the University of Minnesota on December 8 and 9. Subcontractors represented were RE/SPEC Inc., the University of Minnesota, and Science Applications, Inc., (SAI).

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

During this report period, several studies were completed, and the technical reports summarizing these studies will be transmitted to OWI for review in the next report period. Specifically, these studies include (1) fabric analyses of various underformed and deformed laboratory specimens, (2) the thermoelastic behavior of a conceptual repository in a granitic medium under various thermal loadings, and (3) selected analytical solutions to approximate the thermoelastic behavior of repository concepts.

RE/SPEC personnel attended the OWI rock mechanics review meeting held at the University of Minnesota in Minneapolis on December 8 and 9. Results from work efforts of the past year were presented, and the general discussions included delineation of future modeling and laboratory experimentation.

Task 1: Mine stability studies. This task involves a parametric analysis of room closures for representative room and pillar configurations. A matrix of parameters is being developed, and a sensitivity analysis is being performed to determine an adequate finite-element representation.

Task 2: Near-field studies. The near-field studies involve a parametric analysis of emplacement drillhole closures and the loadings generated on emplacement sleeves. Consideration will be given to various backfill materials in the annulus between the drillhole wall and sleeve. No progress has been made on this task to date.

Task 3: Far-field studies. This task is primarily concerned with analysis of bedded salt models with consideration of quasi-static plastic behavior and anisotropies of shale and other materials situated above the bedded salt horizon. In conjunction, regional ground-water flow will be considered in the nonsalt members. A finite-element heat transfer code including advection has been developed.

Task 4: Quality assurance studies. Simulation of the bench-scale experiments being conducted at the South Dakota School of Mines and Technology along with comparisons with the commercially available finite-element code ANSYS will be included in this task. In this period, finite-element models of the bench-scale experiments were generated, and the ANSYS user's manuals were obtained from Control Data Corporation.

Task 5A: Laboratory studies - F. D. Hansen. At the review meeting in Minneapolis, comprehensive experimental data were presented. The presentation included the results of all salt tested to date at RE/SPEC Inc. Considerable discussion took place concerning the results with particular emphasis placed on verification of the creep law models used by the modelers at RE/SPEC, SAI, and the University of Minnesota. One

*This report covers activities from November 16 through December 15, 1977.

of the recommendations was that modelers, particularly SAI and the University of Minnesota, submit a matrix delineating certain tests necessary for verification of their creep models. In the meantime, triaxial compressive strength and triaxial creep tests are continuing on Avery Island salt to complete a test matrix prescribed by RE/SPEC Inc.

The RE/SPEC field crew procured seven pieces of NX core drilled from the floor in the proximity of the heater experiments at Avery Island (AI), Louisiana. Each piece is approximately 8 in. long; drilling was accomplished by using a brine solution to remove the cuttings. This core, along with the core available from an unoriented block, should be sufficient to complete the test matrix as outlined for the determination of the baseline material properties of AI salt. Sections of this core will be forwarded to the Oak Ridge National Laboratory for thermal conductivity tests.

Fabrication of the hydraulic control panels is being performed by Pilot Industries of Minneapolis. Final technical drawings of the hydraulic layout were sent to Pilot on December 15, and delivery of the panels is expected in mid-February. Electrical circuit controls to drive the loading systems are being designed. In addition, a prototype of the lateral servo-control electrical circuits with limit switches is nearly complete.

Task 5B: Fabric analyses - N. L. Carter. Halite specimens, ERDA #9 and AI, were analyzed for initial preferred orientations of the crystal a-axes by measuring orientations of cleavages induced during the sample preparation process. The ERDA specimen contains a few opaque impurities at grain boundaries but is a fairly clean halite consisting dominantly of small, equant grains averaging about 0.15 mm in size with fewer larger grains averaging about 4 mm. This specimen is a bedded salt from southeastern New Mexico which appears to have recrystallized, probably by annealing, and many of the salt grains contain negative crystals. The specimen of domal salt from AI is much coarser in grain size with grains ranging from 5 to 10 mm in diameter. Inclusions of anhydrite occur along grain boundaries of this specimen. As a result of the coarser size of the AI specimen, four thin sections were necessary for determinations of the orientations of 100 crystals; whereas only two thin sections were required for 92 grains in ERDA #9. Evidence of effects of plastic deformation were lacking in both specimens.

The ERDA bedded salt specimen has a very weak orientation and if consideration is given to undersampling of grains whose a-axes (poles to cleavages) are inclined to the vertical core axis (vertical in the lower hemisphere projections) at angles near 45°, the fabric may be regarded as virtually random. This orientation is in marked contrast to the Lyons, Kansas, bedded salt whose preferred orientation is very strong with an a-axis maximum parallel to the core axis.

The fabric of AI domal salt is stronger than that of ERDA #9 and is remarkably similar to the fabric of Jefferson Island domal salt. Again, considering the undersampled area at about 45° from the core axis, a concentration of a-axes parallel to the core axes and in a girdle nearly normal to it is found. As reported in a RE/SPEC draft

report,* this fabric is not so strong as that expected from earlier work on domal salt but is significant. The ERDA #9 fabric is about that expected for a bedded salt but is not found in Lyon's salt. In any case, the fabrics so determined should have a marked effect on the mechanical properties, a correlation that will subsequently be made in this study.

1.3.3.2 Displacement Discontinuity Modeling[†] . . . C. M. St. John,
University of Minnesota

Code development during this reporting period was largely confined to updating the two-dimensional displacement discontinuity model, SALT2. The model now incorporates the analytical solutions for exponentially decaying heat sources and the revised treatment of the creep law. A version of this model is being used to assess the significance of disposing of radioactive waste of differing ages.

A review meeting attended by representatives from OWI and subcontractors contributing to the OWI rock mechanics program was held at the University of Minnesota on December 8 and 9. Presentations concerning the current status of laboratory and numerical model investigations were made and provided a background for discussions relating to future work in these areas.

1.3.3.3 Explicit Finite-Difference Modeling . . . Ronald Hofmann,
Science Applications, Inc.

No activity has been reported for December.

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

No activity has been reported for December.

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 December.

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

The data centers have selected and assigned staff to work on all salt properties of interest. In some areas, the initial literature search is almost complete, and data extraction is expected to begin in the near future.

*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).

[†]This report covers activities from November 16 through December 15, 1977.

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

In plugging holes that penetrate salt formations with cementitious grouts, brines must be used in the preparations to prevent dissolving the salt out of the walls of the holes by any water present in the mix. A program was initiated to determine the effect of salt on the physical characteristics of the resulting mixes (saltcretes). The initial specimens contained 28.8 wt % of NaCl, 44.7 wt % of Type I Portland Cement, and 26.5 wt % of H₂O. After curing in Protexo Cote for seven days, the compressive strength of 2-in. cubes was 10.5 MN/m². As a comparison, a neat cement paste with a water-to-cement (w/c) ratio of 0.485 has a seven-day compressive strength of about 30 MN/m². However, the saltcrete was quite liquid indicating that it could be made with much less water. This use of less water would improve the resulting physical properties. Additional specimens were prepared with lower water content and will be tested after appropriate curing times.

The thermal conductivity of the seven-day saltcrete specimen was 1.06, 0.949, 0.511, and 0.460 W/m·°K at 66, 104, 212, and 323°C, respectively. As a comparison, the neat cement paste (w/c ratio of 0.485) has a conductivity of about 0.4 W/m·°K at 125°C or less than half that of the saltcrete. On the other hand, the permeability of the specimen to nitrogen was 3.8×10^{-5} darcy or about the same as that of a neat cement paste.

Permeability measurements were completed on concrete specimens containing Cencron fly ash. These were 28-day cured specimens in which 10 to 40% of the cement had been replaced with Cencron fly ash. The permeability ranged from 1.8×10^{-4} darcy to 4.8×10^{-4} darcy with no apparent relationship to the fly-ash concentration.

Specimens were painted with two coats of Protexo Cote to prevent water evaporation during the curing period. Recent tests showed that wrapping specimens in plastic sheeting such as Saran Wrap or Para-film-M was just as effective as the Protexo Cote. The effectiveness of Para-film-M was further demonstrated by placing an Ascarite-filled bag made from the material in a >90% RH cabinet for one week. Essentially no water penetrated the bag. Considerable time will be saved in the future by using the plastic sheeting.

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

Study of the effect of water-reducing admixtures on rheological properties of cement slurries continues. For this study, the zeta potential determination of β -wollastonite (β -CaSiO₃) as a standard calcium silicate for reference continued by means of the microelectrophoresis technique. Several additional experiments were conducted in order to establish the influence of the original impurities in the water on the measurements. In these experiments, deionized water, 0.2% saturated Ca(OH)₂ solution, and tap water were used. The zeta potential in tap

water was not changed remarkably by addition of the admixture M-2. The surfactant was apparently consumed not only by the dissolving species from the β -wollastonite, but also by the original impurities in the water used. The effect of the dissolving species is expected to be more significant in the cement-water system than in the β -wollastonite water. In addition, the effect of the original water impurities should not be so large in the practical cement-water systems because of the lower water-to-solids (w/s) ratio and the higher cement compound solubilities.

The procedures used to jacket the samples used in the Hoek-Franklin high-pressure permeability cell have been undergoing careful review in an effort to insure a good seal. Other permeability measurements continue at low pressures.

Chemically combined water is used to determine the degree of hydration of a cement, and pore water or physically sorbed water is used as a measure of sample porosity. Gravimetric measurements for the determination of sorbed water and chemically-bound water are typically slow and tedious. Comparisons are being made between results of the "static" gravimetric method and the "dynamic" thermogravimetric analysis method. The total weight losses for these samples are within $\frac{1}{2}\%$ of each other (which reflects the constancy expected) as controlled by the original w/c ratio. Additional samples are being run in an effort to determine the best procedure for precise determination of the weight losses at the lower temperature.

A set of experiments was completed that evaluated the effect of the size and geometry of the samples used for compressive strength measurements. These data would seem to indicate that careful control over sample preparation and handling of the 28- x 50.8-mm pasty cylinders should produce compressive strength data that are as reliable as those obtained on the larger 50.8-mm cubes, having standard deviations in the 6% range.

Early-stage chemical shrinkage of cement paste is expected to have a major influence on its later performance. In order to evaluate the influence of the addition of fly ash to cement paste on chemical shrinkage, pastes containing fly ash were compared with pastes containing the same amount of sand. Some runs of the pastes containing sand have been completed. Because the distribution of the results is large, additional checking is necessary in regard to the efficiency of the removal of bleeding water and to the homogeneity of the sand. Therefore, comparison has not yet been made of the results from neat pastes with those from pastes containing fly ash.

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. Twelve contracts are in preparation for the geologic consultants group; seven positions remain to be filled. A series of internal

*WISAP = Waste Isolation Safety Assessment Program.

[†]This report covers activities from November 15 through December 15, 1977.

PNL meetings were held to discuss refinement of the statistical aspects of the repository simulation analysis computer code. Plans to acquire site-specific geologic/geophysical data for the proposed salt repository in southeastern New Mexico and the proposed basalt repository in south-central Washington are being developed with the help of Sandia and Rockwell personnel.

Task 2: Waste Form release rate data - D. J. Bradley and R. P. Turcotte. A meeting was held with P. Columbo, R. Neilson, and A. Weiss of BNL to finalize the leaching program of low-level transuranium wastes for FY 1978. The program will concentrate on leaching characteristics of incinerator ash solidified in concrete, bitumen, urea-formaldehyde and resin polymers. A Program and Budget Proposal form 189 is being prepared and should be sent to PNL by the end of December.

The spent fuel studies began using the same procedure, leach solutions, and sampling techniques that were used in the actinide-doped leach studies started in FY 1977. These leach solutions are listed as follows:

1. salt brine, WIPP site natural salt brine, 80% saturated;
2. synthetic high-ionic strength ground water (30 meq/lCaCl₂);
3. synthetic high-ionic strength bicarbonate ground water (30 meq/lNaHCO₃);
4. synthetic high-ionic strength ground water (30 meq/lNaCl); and
5. deionized water.

Task 3: Release consequence analysis - J. R. Raymond and J. K. Soldat. Work continued on documentation for the Davis Finite-Element Hydrologic Model conversion to the PDP 11/45 computer and on conversion of the dose models and GETOUT to the 1100/44 computer.

Conversion of PATHS and a smaller companion program LOCQAR to the 1100/44 computer continued. Conversion of the interactive BASIC version of PATHS to interactive FORTRAN was completed except for specifying the control card generation scheme for Calcomp plotting. With the exception of the minor part of control card generation for plotting, the interactively generated output files have been obtained on the UNIVAC 1100/44 and checked against those generated from the original BASIC version of the PATHS program. The delay in the control cards for plotting is a UNIVAC system problem that will be corrected by January 1, 1978. Conversion of the smaller LOCQAR program to interactive FORTRAN is presently under way. Specifically, this program uses one of the interactively generated files from PATHS to enable rapid calculation of the outflow quantities for contaminant location/outflow distributions.

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. The software development on the borehole plotting package (this package includes a major improvement that enables plotting of multiple adjacent boreholes) is complete. The program has been debugged and is operational using borehole data for Northern Louisiana previously compiled by M. B. Kumar of Louisiana State University (LSU). However, the necessary maps have not been obtained from Kumar to convert the borehole northings and eastings into latitude-longitude locations. (This problem was mentioned in the November progress report.) In order to display and analyze the Kumar data, the borehole profiles are being plotted independently along constant northing lines in each of the parishes. These profiles use all boreholes in the vicinity of the constant northing line. Because the exact location of the boreholes is not known, an exact projection of the data on the actual northing line can not be produced.

II. Structure contour mapping on formation tops. The depth of formations in the North Louisiana borehole data is being extracted and prepared for structure contour mapping. The initial technique for contouring the depth data consists of interpolating the data onto a grid system that is then contoured with an existing software program. Both a planar and quadratic interpolation can be done using the Thiessen triangulation technique for determining neighborhood adjacency relationships. Since the exact latitude-longitude of the boreholes is not known, each parish is being handled independently using the northing and easting coordinates as if they were a true cartesian coordinate system. These preliminary maps may be distorted because of inadequacy in the conversion methods. When final maps are produced using the correct borehole locations, the results can be compared with the few existing structure contour maps for specific geological strata in the Northern Louisiana area.

III. Stratigraphic sections. The development of the first phase of the stratigraphic section display program was completed. Test runs are being made on the Kumar Louisiana data to find errors in the interpolation, spatial projection, and plotting software. A problem has arisen in the spatial interpolation for the deeper geological strata because of insufficient data points caused by borehole depth variability and missing borehole total depths on the data file.

As described in the November progress report, the interpolation technique involved the construction of Thiessen networks among the boreholes. Several bugs were found in this software and removed. Several improvements are being planned for the cross-section program such as shading each geological unit according to a user-selected rock symbol. Also, lithologic notation may be plotted within each layer to identify the rock type. Vertical grid lines are being plotted to show the spatial resolution used in the analysis, and the TOPOCOM elevation data is being

considered as a source of ground-level elevations to be used in constructing the upper ground surface for the cross-sectional plot. If the resolution of this data is sufficient, a software plot will be written to calculate the elevation along the user-defined cross-section line.

IV. TOPOCOM ground-elevation processing. A task is under way to process the TOPOCOM tapes so that FORTRAN-readable elevation files will be available for any area in the continental United States. The software for this task was finished, and ten different test areas are being run. The previous extraction of elevation data from the raw TOPOCOM tapes for Michigan was very difficult and time consuming. The Texas and Louisiana areas will be among the first run through this system.

V. Geographic digitization software. Three different efforts are under way to improve the digitization system used for geographic and geological data input. The first effort consists of improving the existing Tektronix digitization system on the PDP-10 time-sharing computer. The second effort consists of transferring this Tektronix system to the MODCOMP II minicomputer as described in the November progress report. The third effort involves the development of new Oak Ridge Interactive Digitization System (ORIDS) software to drive the high-resolution digitizer table and video projection system that was recently installed on the MODCOMP II. This third system will increase the throughput of both digitized and edited data by a factor of ten. Specifications have been written by P. R. Coleman for data management software to be used in the new ORIDS system to provide direct access to storage/retrieval capabilities. Improvements were also made to the map projection software in the Tektronix digitization system previously mentioned. These improvements will allow the use of any standard parallels and zone definitions in three of the most commonly used map projections.

VI. ORIDS assembly language software. The test software for the video projection system and the interface software between the MODCOMP II and the video display generator were completed and debugged. When this software was used with the video projector, a hardware error was found in the character generator used to create ASCII characters on the screen. Personnel from Aydin Controls, Inc., corrected this hardware problem (see section below describing hardware).

Data bases

I. North Louisiana borehole data base. Processing continued with the borehole data compiled by M. B. Kumar, LSU, in attempting to calculate latitude-longitude locations from the northings and eastings supplied with the data. These attempts have not been successful; therefore, attempts are being made to obtain the original maps on which the borehole sites were placed. Once these maps are acquired, digitization of the locations of the actual boreholes will be relatively simple. In the meantime, the northings and eastings are being used as if they were true linear cartesian coordinates. Because each parish has a different origin, parishes cannot be combined at this point. Another problem with the data has been the

lack of borehole total depth; therefore, the thickness of the last formation in each borehole is impossible to determine. One solution to this problem is to end the analysis at the next-to-last geological strata.

II. Vacherie site. All of the detailed data on the Vacherie salt dome area has been digitized, and data bases have been created containing detailed information on topography and land use features. Overlay plots are being made in order to perform final editing on the data and to test its accuracy since the original base map was of an unknown map projection. The software is also being set up to make color-shaded plots of the different variables in this data base. The log system established to keep track of and monitor the large number of OWI data bases has been completed, and all files are stored on dec tape on the PDP-10.

III. U.S. county and state outline data base. The Tektronix digitization system was used during the slack period of the Christmas holidays to complete the U.S. state and county data base for all fifty states. In addition to the digitization, errors have been corrected during the last couple of months in certain polygonal county boundaries that were simply not connected or had not been closed properly. Versatec plots are being made of the digitized data to allow the filtering of excess data points, correction of erroneous points, and joining of boundaries that cross successive maps.

IV. Restricted geographical areas. The UCC-ND Computer Sciences Division is involved in a project with the Energy Division at ORNL that involves the acquisition of "wilderness areas", including those currently proposed by the Forest Service. This data, along with other information involving rare and endangered species, may be useful to OWI in determining exclusion regions in terms of siting waste repositories. This information will be digitized from base maps supplied by the Forest Service and DOE.

Hardware

The video projector, which was returned in November from the factory, had two final problems, which have been corrected by personnel from Aydin Controls, Inc. The first was a hardware memory problem that resulted in incorrect character generation, and the second was an electronic stability problem associated with grounding of the high voltage section of the equipment. The 30-day acceptance tests associated with the high resolution digitizer have been completed, and the equipment has been accepted. Detail specifications were written and approved to purchase a color-image processing system that will be connected to the MODCOMP IV. This system, purchased by the National Uranium Resource Evaluation (NURE) Grand Junction project, will be useful in processing OWI geologic and geographic data bases. In providing for this new equipment, several problems associated with air conditioning and provision of sufficient space are being solved. Proposals and specifications for four additional hardware items needed in the ORIDS system were written. These four items included communications interfaces, control console terminals, a refresh video monitor for the projection system, and a diagnostic data scope. These items will reduce the need for acquiring additional peripheral equipment and will increase the uptime of the total system significantly.

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

During December, field installation and start-up were accomplished at the second of the Conasauga near-surface heater experiments. Installation of the heaters at both sites has now been completed, and both heating sequences have been initiated. The application of air pressure to the heater holes at both sites was found to be necessary to maintain acceptable heater temperatures. Installation of a backup heater without metallurgy test coupons at Site 1 and the probable difficulty of extracting the heater from the crooked heater hole at Site 2 casts doubt on whether useful metallurgical data will be obtained from the test.

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

Installation of the two heater experiments in the Conasauga Formation was completed during early December. Turn-on dates for the two experiments were November 29 and December 6, respectively. The median plane of the heated portions of the heaters (5 ft from the bottom) is being held at 385°C. The heater hole at Site 1 is presently pressurized to about 10 psig essentially because of gases generated within the cavity. Of the 10 psig, 1 to 2 psig is due to compressed air added to stabilize the cavity pressure and to ensure a stable heater temperature profile. The heater cavity in Site 2 is pressurized at about 20 psig with compressed air. Air flow rates into Sites 1 and 2 are less than 0.5 cfm and 1.5 cfm, respectively. The result of the two different pressurizations is that Site 1 has water and steam present in the heater cavity; Site 2 does not. The following table summarizes the heater profiles of Sites 1 and 2 as well as the temperature in the shale 2 ft from the heater centerline. The thermocouple locations are measured from the bottom of the heater.

Heater Temperature Profiles (Data as of 12/20/77)

<u>Thermocouple Location (ft.)</u>	<u>Site 1 (°C)</u>	<u>Site 2 (°C)</u>
12.3	98	148
9.7	119	284
7.5	357	339
5	385	384
2.5	334	401
0.3	114	318
5 (in shale 2 ft from heater)	100	150

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

Considerable progress was made during the month toward getting a computer program on-line to model the mechanical response of the rock adjacent to the heater sites. Differential thermal analysis (DTA) and differential scanning calorimeter (DSC) analyses were completed on a large number of samples from core recovered this past summer. This work confirms the preliminary results previously reported regarding the degree of weight loss with heating and the presence of endothermic and exothermic reactions at elevated temperatures. Preparation of samples for detailed mineralogic determinations and gas evolution analyses was also completed during the month.

2.1.1.2 Dome Salt In Situ Tests

Activities on the Avery Island in-mine experiment in Louisiana continued on schedule both in the field and on equipment fabrication and packaging at Oak Ridge. Some drilling was performed to obtain additional core samples for the laboratory support program. Analytical support work was also initiated. A scheduling review meeting was held in preparation for the major drilling and installation activities, which will begin the week of January 9, 1978.

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

During December, activities for the installation of an in situ heater experiment at the Avery Island Mine centered around scheduling and pre-drilling activities in the mine.

On December 8, Leo L. Van Sambeek attended a meeting in Oak Ridge to schedule the installation. Current projections are that the first of the three sites will be drilled and ready for heater installation by February 15, 1978, and that the second and third sites will be drilled by March 8 and March 29, respectively. Arrangements were also made for shipments of the remaining hardware to be supplied by OWI with expected delivery in January 1978.

Predrilling activities in the mine included completion of the control shack, completion of the initial phase of the electrical work, and equipment preparation. A limited amount of core sample drilling for the laboratory was also performed, and the core was returned to RE/SPEC in Rapid City.

Thermal simulations of the Avery Island heater experiments were initiated using finite-element methods. Preliminary thermal properties were obtained through OWI and are being used to parametrically assess the importance of convective heat losses. Additional core samples were forwarded to OWI for further thermal conductivity measurements.

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

Equipment fabrication continued in the ORNL shops. The peripheral thermocouple sleeves were completed, and the thermocouples are being installed. The corrosion samples were cataloged by the Metals and Ceramics

*This report covers activities from November 16 through December 15, 1977.

Division and packaged for shipment to Avery Island. Also, the heater sleeves were completed at the Y-12 Engineering Technology Division Shop, crated, and placed in the experimental gas-cooled reactor (EGCR) staging area.

The one item remaining to essentially complete the work at Oak Ridge is receipt of the data loggers and their subsequent installation and check-out in the control panels. The instrument panels are complete and are awaiting return of these data logger units.

A meeting of OWI, Engineering Division, and RE/SPEC personnel was held on December 8 to discuss progress to date and future field activities. A tentative schedule for making the second shipment to Avery Island by mid-January was set, and field installation of equipment was scheduled to begin in mid-February.

2.1.2 DESIGN STUDIES . . . P. D. Fairchild

In December, both the Canister Transporter Design Study and the Cask Scoping Study progressed toward conclusion. An oral presentation on the transporter conceptual design work by FMC took place December 13 in Oak Ridge. The FMC final report draft was received in early December, and the technical review was completed by the end of the month. The final report draft on the Cask Scoping Study is due at OWI in January 1978.

2.1.2.1 Canister Transporter . . . E. G. St. Clair, Engineering Division, UCC-ND

FMC Corporation, Engineered Systems Division, completed the conceptual designs of the waste transporters for handling canistered spent fuel elements and high-level waste (HLW) canisters. Draft copies of their report, "Conceptual Designs of Radioactive Waste Canister Transporters," were received and reviewed by OWI and Engineering Division personnel. A presentation by the FMC design team and Los Alamos Technical Associates was held on December 13. Also, representatives of Kaiser Engineers and Stearns-Roger [architect-engineers (A-E) for the repository conceptual designs], Sandia Laboratories (Waste Isolation Pilot Plant Project), and DOE-ORO attended the meeting. With the exception of the final report revision, all work under this contract is completed.

2.1.2.2 Cask Scoping Study . . . P. D. Fairchild

Sandia Laboratories is drafting its final report, which is scheduled to be forwarded to OWI in January 1978. A discussion meeting was held on December 14 in Oak Ridge to coordinate results from the Cask Scoping Study, the repository conceptual design effort, and the Transportation/Logistics Study (see Sect. 3.3.2). The discussions focused on the current receipt/unloading approaches assumed for the conceptual design, the reference cask(s) designs assumed by the A-E, and the assumed unloading sequence and time cycles. A point of mutual agreement seemed to be that a new spent fuel cask should be designed which would take advantage of the "aging" of the spent fuel (existing casks are based on short-cooled spent fuel destined for reprocessing). Conclusions from these interface discussions will be incorporated in the forthcoming study report.

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.

An intensive indoctrination to DOE cost-estimating procedures, formats, etc., was held for both A-Es on November 30 to December 1 in Oak Ridge. Special emphasis was placed on use of the standard cost code of accounts and UCC-ND cost-estimating computing software.

An in-depth 50% design review was held December 13 to 15 with SRENCO, and progress was determined to be satisfactory. A similar in-depth design review is planned for Kaiser in February 1978.

The approximate percentage of completion for Repository 1 (SRENCO) is 55%, and for Repository 2 (KE), is 58%.

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

A 50% design review meeting was held at OWI on December 13 to 15 with DOE, UCC-ND, OWI, SRENCO, and subcontractors' personnel in attendance to receive comments on the review material submitted by SRENCO.

The overall design effort on the project was determined to be satisfactory. During December, the major design activities were performed in development of final drawing lists and a review of the conceptual design report requirements. These lists and report requirements will be the basis for the development of a schedule for the completion of the project.

Detailed drafting of drawings for the final conceptual design of the Underground Facilities continues. Existing mining facilities are being reviewed as they pertain to types of accidents that have occurred in hoisting systems. Woodward-Clyde Consultants, in support of design efforts of the Underground Facilities, is developing final reports of its design activities. These reports are due in February 1978. Woodward-Clyde and SRENCO personnel reviewed the status of Woodward-Clyde activities in a meeting at the SRENCO offices on December 20.

Final concepts for the conceptual design in the canistered waste area are being made. Systems and component lists are being prepared from which cost estimates will be made for the final Cost Estimate. Structural design of the Canistered Waste Facilities continues.

The design of the Low-Level Waste Facility is essentially completed, and systems and components lists are being developed for the final Cost Estimate.

Energy Incorporated continues its work in the area of Occupational Exposure and Health Physics Studies and has also initiated accident analysis studies.

A draft of the Quality Assurance (QA) Plan for Titles I, II, and III was prepared and is being reviewed by OWI and DOE prior to issuance in final form.

Design of the canistered waste transport system is progressing according to the design schedule. Development of a complete system not only for transporting and disposing of waste but also for drilling holes and setting sleeves for canister burial (using the same equipment with some modifications) is intended.

The UCC-ND estimating program has been received for use in the final Cost Estimate and is in operation on SRENCO computer facilities.

During January 1978, efforts to finalize design concepts will continue in all areas, and activities supporting the final Cost Estimate will be emphasized. Also, internal review of the QA Plan for Titles I, II, and III will 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 layout, documenting design decisions, and preparation of conceptual design drawings.

The effort on preparation of conceptual design decisions (CDDs) continued and has been substantially completed during the month. Also, design drawing preparation continued based on CDDs as written. A facility site plan and building layout for process and support buildings are well advanced. Mine development planning for the 5-year retrieval basic design is well advanced, and the 25-year retrieval mine planning was initiated. A preliminary evaluation of noise levels generated by mine supply and exhaust fans and the resultant effect on occupied areas was performed with the result that noise levels, although high, are within the Occupational Safety and Health Administration (OSHA) limit of 90 dB(A).

The time-motion study for receiving and handling spent fuel canisters, as well as the development of equipment to handle the various operations, is well advanced; the system can receive and handle as many as 100 canisters per 3-shift day as now designed and is limited by the mining rate. Design or operational modifications could presumably be incorporated to increase throughputs of canisters, although such modifications are not within the present scope of work planned.

Kaiser Engineers personnel attended a meeting at Oak Ridge for familiarization with the procedures and formats for the computerized cost estimating to be used for the final conceptual design report estimate. Two other meetings in Oak Ridge were attended by KE personnel. The first meeting on December 13 was an FMC presentation of their transporter concept design, and the second meeting on December 14 was a discussion with engineers from Sandia Laboratories on a study that they are finalizing on future spent-fuel-assembly shipping cask requirements and their interface with NWTS Repository 2. During the shipping cask meeting, a description of the NWTS Repository 2 design concept and limitations on receiving and unloading shipping casks were presented. Mutual agreement was reached on the following two points: (1) dry shipping and handling are preferred and (2) present shipping cask designs must be replaced with a new standard cask design for canistered fuel.

Orientation meetings were held with heat transfer consultants C. F. Bonilla, V. E. Schrock, and C. Tien to acquaint them with a general facility description and the thermal analysis performed by KE. The consultants were also given recommended thermal models and asked to indicate their interest in providing closed-form solutions to any part of the models.

The next design status review meeting is scheduled for February 14-16, 1978, at Oak Ridge. Drawings for this review meeting will be mailed from Oakland no later than January 26, 1978.

2.3 OWI Facilities

S. C. Matthews

No activity has been reported for December 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 were

initiated which emphasize the generation of preconceptual repository designs in basalt and an analysis of a set of waste forms defined by PNL.

Meetings were held with the three participating subcontractors during the week of November 14 to define a detailed list of interface milestones and to establish an integrated project schedule. A draft project plan was prepared describing in detail the interactions among the various tasks required to accomplish this expanded effort and the scheduling of these tasks. This project plan is being reviewed by OWI and the participating subcontractors.

The physical properties of a generic basalt host rock were defined so that thermal analyses, thermomechanical stress analyses, and hydro-geologic studies may be performed. A preliminary generic basalt stratigraphy has been specified. Employing these data, temperature profiles were generated that reflect the burial in basalt of waste from three fuel cycles: spent unprocessed fuel cycle (SURF), U and Pu recycle, and U-only recycle. A-E design efforts concentrated on repository facilities for waste from SURF.

Several data packages describing the PNL waste descriptions and projections were received by OWI. These data packages were analyzed, and the data were compiled in the proper format for repository design activities.

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

The accumulation of basalt host rock data was completed, and the preparation of the technical support document describing these data was initiated. For the basalt host rock, baseline thermal properties, hydro-logic properties, extraction ratios, generic stratigraphy, and preliminary estimates of the ground-water flow rates have been prepared. These data indicate that basalt will react somewhat like granite to the stresses imposed on it by the waste products.

For basalt host rock, final design thermal loadings of 190 kW/acre were determined using a computer model based on the finite-element method and checked by the boundary-element method. These data were submitted to SAI and PBQ&D on December 6.

After a detailed review of readily available codes and computer facilities, existing D&M codes and commercial computer facilities were selected for use in the ground-water modeling efforts in which thermal effects are taken into account.

Revising, reviewing, and editing previously submitted D&M technical draft reports continues. These reports will later be upgraded with data gathered during the present analytical efforts.

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

The rock properties and stratigraphic data for the basalt host formation compiled by D&M were employed to initiate basalt preconceptual repository designs. These initial efforts include location of an appropriate horizon for mining activities; sizing of the various required shafts, definition of the appropriate procedures for sinking the shafts in the

generic stratigraphies, and initiation of subsurface designs for the SURF cycle. Conventional drill and blast mining techniques previously suggested for shale and granite appear to also be appropriate for the basalt repository. Using these techniques, mining advance rates would be comparable to those in granite.

For basalt repositories, few, if any, changes are anticipated to be required in the design of the surface facilities as established for the other host rock repositories. The excavated rock handling system to be used for the granite design appears to be the most likely candidate for a basalt design because of the similarity in behavior in the handling of the two rocks. Mine master plans, mining and placement schedules, mine partial plan, and section drawings were completed for the placement of wastes from the SURF cycle into a basalt repository for the 5- and 25-year retrievability options. Because of the many similarities between granite and basalt, mining schedules were prepared for the SURF cycle using the same advance rate as in the granite studies.

Mining ventilation and storage ventilation requirements for SURF-cycle wastes in basalt for 5- and 25-year retrievability have also been established. Work was initiated on adapting the ventilation flow diagrams developed for the other rock types to basalt.

Basic mine drawings for the SURF-cycle option of the PNL alternate packaging data were prepared from which mechanical/electrical preconceptual design will be developed. Mine master plans and partial plans as well as their respective mining and placement schedules are being prepared. Special attention has been given to the techniques of handling and storing drums of PNL specified low-level wastes (LLW) that have activity levels requiring some degree of shielding. However, for the two reprocessing fuel cycles, the subsurface receiving stations for LLW are being designed to handle the higher activities. Evaluation of the requirements for surface and subsurface handling and storage procedures for 30-in.-diam intermediate-level waste (ILW) canisters was begun. Also, the impacts that variable waste packages will have on handling within a common shaft and at the receiving station underground are being evaluated. The surface facilities designs for the SURF cycle will be similar to those for the OWI waste packaging; however, the facilities for the reprocessing wastes are complicated by the variation in waste packaging considered in the PNL data set.

A review of the costing information compiled for salt, granite, and shale repositories was undertaken to determine its applicability to the study in basalt. The results of the investigation indicate that the costing figures for granite should be used as a base from which to evaluate costing information for basalt. On the basis of further analysis, variations and similarities in costing between granite and basalt were established.

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

Preliminary basalt physical properties data supplied by D&M were incorporated into SAI heat transfer models. Validation of the two-dimensional representation of heat transfer in the basalt repository was

completed through a comparison of results from these two-dimensional models with results from more complex three-dimensional models. Temperature profiles in the vicinity of the storage rooms and buttress pillars, in the immediate vicinity of a waste canister, and in the far field were generated. These data were sent to D&M for use in thermomechanical stress calculations to determine acceptable areal thermal loadings.

During the storage of radioactive waste in a host rock with lower thermal conductivity such as basalt or shale, a particular concern is the possibility that thermal constraints might be exceeded, for example, those associated with waste retrievability (e.g., a maximum desirable canister temperature) or with waste form stability (e.g., a maximum desirable waste temperature). Parametric calculations were performed analyzing these temperatures as a function of (1) the average areal heat load, (2) the canister radius, (3) the backfill material in the annulus around a canister emplaced in a hole, and (4) the canister heat load itself. Maximum waste and canister temperatures display a strong dependence on each of these parameters. Using the acceptable areal thermal loading determined by D&M (190 kW/acre), acceptable maximum canister thermal loads were determined for the reference glass waste canister to be 1.2 kW/canister during the retrievable period and 1.8 kW/canister after retrievability is no longer required. These maximum thermal loads are based on a maximum allowed canister temperature of 375°C and waste (glass) temperature of 500°C. The result of particular interest may be that delaying backfill around a canister can result in significant reductions in the maximum temperatures of the canister or waste.

The complete PNL data package was received and reviewed. The package contains a description of the waste types with the packaging configurations to be considered, a definition of the radioactive species associated with the various wastes, and initial waste projections data. Sufficient data were received, processed, and distributed to support the repository designs.

From an analysis of the PNL data package, waste acceptance considerations are being prepared for these packaging arrangements. The delineation of ILW and LLW into several categories of surface dose rates led to a parametric study of forklift shielding requirements for handling the various LLW and ILW drums and boxes. Initial results indicate that the forklift operator may have to be shielded by an equivalent of 2 to 8 cm of lead in order to maintain an operational dose rate of less than or equal to 0.25 millirad/hr when handling these PNL assumed wastes.

Normal operational radioactive releases are being analyzed for a repository in basalt using OWI waste projections and for a repository in salt using PNL-supplied waste projections. Data were developed describing a mine fire development when combustible wastes have been allowed into the repository (an alternative scenario evaluated by PNL in the GEIS). These data were supplied to PBQ&D so that they may analyze the fire/ventilation system interaction. Other airborne releases are being determined using the accident scenarios previously developed for the OWI-supplied waste package.

Data were received from D&M estimating the amounts of water inflow, including chemical composition, that might be expected for repositories located in the various host rocks. These data are presented as a function of time and temperature. These data form the baseline for the canister

integrity and nuclide migration analyses that were initiated. In addition, liquid radioactive waste treatment systems are being defined to handle the water inflow during the operational phase should that water become contaminated.

A detailed review of the SAI volumes, as well as selected portions of the PBQ&D and D&M volumes, of a draft technical support document was initiated. This review, coupled with the report specifications that were prepared, should accomplish better uniformity and more comprehensive documentation of the generic studies.

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, and D. G. Shaner

A schedule/procedure covering the normal cycle of events required for a Program Review Meeting was developed and issued to OWI departments. A procedure for processing Program Control System (PCS) slide masters and updating department slide carousels was developed for use by schedule and control personnel.

Updated drafts of PCS Instructions prepared by Boeing were received, reviewed, and finalized. Work began on incorporating OWI review comments into the detailed OWI Management and Technical Plans that were drafted in September. Finalization of that documentation was deferred until the Program Control Center was installed and operating.

The Work Breakdown Structure/Responsibility Matrix, OWI Program Schedule Tree (scheduling hierarchy diagram), and Life-Cycle Budget wall displays for the control room were updated.

All work under the Boeing contract for program control consulting services was concluded in December, approximately two months in advance of the original schedule.

3.2 Program Planning

J. E. Vath

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

DOE comments on the OWI Program Plan were received, and responses to the comments as requested by DOE-ORO were prepared. An alternate repository schedule that allows time for review by DOE, the Nuclear Regulatory Commission (NRC), and other organizations was prepared for DOE-HQ. Revision of the OWI Program Plan to reflect recent changes was started, and the revised Plan will be issued early in CY 1978.

The preparation of an FY 1980 budget and spring planning projection for the OWI program is under way based on guidelines provided by DOE-ORO.

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

The final draft of 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 was reviewed this month. However, because final editing and review are yet to be completed, the publication date will be in early February 1978.

Work continued on the development of the source-term data library and its associated retrieval code PLOTLIB. The PLOTLIB user's manual is undergoing review and should become available in January 1978.

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

The contract for the Waste Inventory Study was signed by UCC-ND and the successful bidder and transmitted to DOE-ORO for approval.

3.2.4 CURRENT ACTIVITY ON ALTERNATIVE FUEL CYCLES . . . R. A. Kisner and W. H. Pechin

No activity has been reported for December.

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.

A meeting was held on December 8 at OWI with R. E. Smith and E. L. Moore of RHO to discuss the draft report "Commercial Waste Packaging Studies, Task 2, High-Level-Waste Canister Acceptance Criteria Study." This meeting provided an opportunity for a discussion of some of the technical constraints on canister size, particularly the temperature and heat transfer constraints. OWI Technical Support Section personnel described the current status of work on heat transfer and rock mechanics. This report will be revised to incorporate OWI comments, and a final version will be issued by March 31, 1978. R. E. Smith spent part of December 9 at OWI reviewing the five-year program plan that he is preparing for HLW and spent fuel canisters.

3.3.1.1 High-Level-Waste Canister Envelope Study . . . E. L. Moore, Rockwell Hanford Operations

A draft interim report entitled "Commercial Waste Packaging Studies, Task 2, High-Level-Waste Canister Acceptance Criteria Study" was issued for comment during the report period. The report covers the results of four technical studies completed in support of the development of HLW canister acceptance criteria. A fifth technical study, which is a review of industry codes and standards for determining application to the design and fabrication of the HLW canister, continued. The review is approximately 90% complete. A draft report, "Spent Unreprocessed Fuel Package Acceptance Criteria for Storage in a Salt Repository," is being prepared for submission to OWI by December 31.

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

Major efforts during this report period were directed toward the preparation of a revised status report to be issued to OWI for comment and the collation of information relating to technology and alternatives for packaging, transportation, and storing commercial transuranic (TRU) waste.

The status report presents information pertaining to present and suggested practices for packaging and transporting non-high-level wastes. Preliminary acceptance criteria were developed based on the best available information.

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

Comments were received and incorporated in the draft of ORNL-5362, "Radioactive Waste Transportation Systems Analysis and Program Plan." The report documents the results of the waste transportation systems analysis and presents the long-range transportation program plan describing the activities necessary to provide a transport system to service NWTs facilities in 1985. The report provides an introduction to the scope of work, the development of the program, a listing and discussion of the programmatic concerns, a detailed program plan, and a discussion of other existing programs. A bar-net chart was included so that the flow of work and interaction among the programs could be readily seen.

The final draft of Y/OWI/SUB-77/42513, entitled "Current Status and Future Considerations for a Transportation System for Spent Fuel and Radioactive Waste," by Allied-General Nuclear Services (AGNS) was received for review.

Negotiations were begun with the Rocky Flats Plant* for work on TRU waste shipping packages. L. B. Shappert and D. W. Turner met with R. J. Merlini on December 15 and 16 to outline the scope of work to be performed,

*Rockwell International, Atomics International Division, Rocky Flats Plant, Golden, Colorado.

to develop the desired work format, and to establish desired commitment dates. Rocky Flats will be submitting a proposed work plan to accomplish the goals that were discussed.

A rough draft of ORNL/TM-6192, "Logistics Models for the Transportation of Radioactive Waste and Spent Fuel," was submitted to OWI. This report, written by D. S. Joy and B. Holcomb, provides a detailed description of the Low-Level-Waste Logistics Model, the Spent Fuel Logistics Model, the Spent Fuel Shipment Program, and the Nuclear Reactor Data Base. The two models are first outlined in a general description; then the mathematical model, data requirements, and organization of output are discussed. A sample problem is included for each model.

The Spent Fuel Logistics Model was used to develop transportation data in support of the OWI Economic Study (see Sect. 3.3.4), which is being performed by TRW, Inc., under an OWI subcontract. The problem dealt with spent fuel shipping costs from nuclear reactors to a repository via one of four away-from-reactor (AFR) sites.* Rail shipments were considered for all possible combinations between the AFR and repository sites. The necessary program modifications were made to the logistics model to incorporate the needs of the spent fuel economics study, and the data have been submitted to OWI for review and transmittal to TRW.

The first rate quotations were received from the General Services Administration (GSA), who was not able to supply overweight truck rates; therefore, another source is being sought to supply this information. The first group of rates was plotted and showed a linear progression associated with distance. Later, GSA was requested to provide truck and rail rates from 23 geographic regions to additional destinations. A response is expected in the early part of January 1978.

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

The audit of the successful bidder was completed, and a copy of the final contract was submitted to the bidder for signing.

A letter providing the Peer Review Group with preliminary information regarding this study is in preparation and will be sent to the designated committee members shortly.

3.3.4 ECONOMIC STUDY . . . H. N. Rosenberg, OWI; F. P. Mertes, TRW, Inc.

A review meeting with TRW and DOE was held at OWI on December 2. During this meeting, progress on each of the tasks was reviewed. In addition, a revised copy of the cost-estimation model specification was delivered to OWI for review and comment. This revised model specification included a detailed description of test case runs and data base organization. Progress was discussed, and comments were received on the following tasks:

1. definition of quantitative physical flow model,
2. validation phase for literature search, and
3. development of methodology for pricing study.

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

At this meeting, ground rules were established for the pricing study, which had just been initiated as an increment to the existing contract. TRW described a candidate pricing methodology that used varying discount rates for individual portions of the facility complex in order to properly account for the effect of inflation in the general case. Because of the preliminary nature of the data, a decision was made to simplify the methodological procedure.

On December 13, a meeting was held at Germantown, Maryland, during which a presentation was made by the DOE-HQ Uranium Enrichment Division on the procedures used to calculate the prices charged for enrichment of uranium by DOE. The information briefing was extremely well organized and proved most useful to the progress of the pricing study.

A briefing was also given at DOE-HQ on December 21 by a Savannah River Laboratory representative on AFR costs. AFRs are new items that will be considered in the pricing portion of the study but that were not within the original scope of the cost-estimating model development. These data are being incorporated into the cost data base.

During December, effort was expended in the following areas:

1. Definition of quantitative physical flow mode - The ability to generate AFR-to-repository transportation cost by year for any flow alternative was computerized. This subprogram will be useful in rapidly developing the alternatives for the pricing study and will additionally be used for data input preparation for the cost-estimating model.
2. Engineering cost estimate - Work continued on establishing costs for baseline scenarios. These costs will be used for the cost-estimating study and as input for portions of the pricing study. Cost estimates were further broken down to obtain land costs and interest during construction. Work continued on the development of variation of repository construction costs as a function of receipt rate for spent fuel at the repository.
3. Computer programming - Design and development of programs making up the cost model continued. Software to be shared by several of the programs was coded first. About 80% of the FLOW MODEL has been coded and compiled; coding on the COST MODEL has also begun.
4. Collection of special cost data for use in pricing model - Work continued on collection of AFR costs that will be required for the pricing study but not for the original cost-estimating study. During the month, the AFR costs were analyzed in order to permit scaling of costs with variation in AFR size. Additionally, a second data source on AFR costs as estimated by the Savannah River Laboratory was received at the December 21 meeting in Germantown, Maryland.
5. Development of methodology for pricing study - The approach developed and presented at the December 2 meeting was updated and refined for the December 13 review meeting. Methodology was documented for the final review to be held on January 11, 1978, at OWI.

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

A bidder was selected for this study and is preparing a scope of work statement.

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

The technical review of the pricing proposal from the successful bidder was completed and transmitted to the UCC-ND Purchasing Division, who requested that OWI prepare an alternate estimate of a travel budget for this study. A preliminary estimate is being prepared.

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

The draft regional and study area environmental plans provided to state agencies in six states in October and November are being reviewed by state agency experts in those states. Letters briefly introducing the environmental planning program and requesting a review of the plans were sent to regional experts in each of the environmental disciplines (i.e., archaeology, ecology, land use, etc.) as available in the states of Utah, Texas, Ohio, Mississippi, and New York. Similar letters will be sent to regional experts in Louisiana.

Follow-up phone calls and transmittals of the plans for review and comment by these experts were completed in Utah and Ohio, with 23 and 14 copies, respectively, of the appropriate plans, being transmitted. Also, phone calls and transmittals are in process for Texas and Mississippi, where 17 and 7 experts, respectively, were sent copies of the plans. In addition, copies of the regional and study area plans were sent to an environmental coalition in Utah, Mississippi, Ohio, and Texas, giving these coalitions an opportunity to coordinate reviews with interested environmental organizations.

The environmental survey plan for a confirmatory location within a study area of the Permian basin in Texas was prepared as a working draft and submitted to OWI for review and comment. Outlines for environmental considerations relative to site selection and for the draft environmental impact statement (DEIS) are being organized for development by the multidisciplinary project team.

In January 1978, transmittals of the regional and study area plans for review by external reviewers in the six above-mentioned states are expected to be completed. Additionally, drafts of the locational plans are expected to be finalized for publication, and development of the DEIS plan will be in progress.

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 Regulatory Project Manager (RPM) for bedded salt formations, continued progress in the preparation of regional reconnaissance reports characterizing the environmental setting of the Permian and Salina basins. The primary activity in all technical tasks was the acquisition, review, and documentation of available information on the regions. Standardized base maps have been prepared, and initial drafts of regional reconnaissance report sections - background radiation, aquatic ecology,

terrestrial ecology, meteorology, air quality, land use, and demography - were completed by task leaders for project management review by NUS. Draft sections for hydrology and geology will be completed for project management review in early January 1978.

Planning for the procurement of long-lead meteorological monitoring equipment that will be required for the locational studies was initiated by NUS.

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

Gulf Coast Interior salt dome region

Regional characterization. Environmental, geologic, and ground-water hydrologic characterization continued. This activity has been performed according to the Office of Waste Isolation draft plans as far as the quantity and type of data available have permitted. Draft report material and maps for the geologic and ground-water hydrologic portions were completed for the three Gulf Coast states. The draft material for the balance of the sections is also in preparation and will be completed for Louisiana and Texas by the scheduled date, February 17, 1978. In some cases, a meaningful presentation of data for the Gulf Coast salt dome regional characterization necessitated the use of map scales larger and smaller than those recommended by OWI draft plans. Wherever possible, the regional report will follow the draft plans explicitly.

On December 7, permission to collect regional data in Mississippi was granted by state officials; this effort is under way. Because of the delay in Mississippi, the complete Gulf Coast salt dome regional characterization report will be submitted April 7, 1978 (seven weeks later than originally scheduled).

Area studies. The Regulatory Project Management contract schedule calls for submittal of the draft report of area studies to OWI by June 23, 1978. However, because of delays in the selection of suitable areas for study and consequent delays of initiation of work, this target date is jeopardized. Present projections do not indicate start dates early in 1978, and therefore, revision of the June 23, 1978, submittal date is expected. Geologic Project Manager (GPM) and OWI activities to define suitable areas are proceeding at different rates in Mississippi, Texas, and Louisiana; therefore, different schedules are expected to be established for each state. Area study in Louisiana could be initiated as early as February 1978, depending on the progress made by the Louisiana GPM.

Environmental baseline surveys. Fact-finding and direct-cost audits by Bechtel relative to a proposed sub-subcontract were completed, and U.S. government audits of the proposed sub-subcontractor's indirect costs are now in progress. Baseline surveys are contractually scheduled to start on July 14, 1978, after selection of proposed locations by OWI.

*This report covers activities from November 19 to December 23, 1977.

However, delays in area studies will probably result in the start of baseline surveys later than July 14, 1978. Present negotiations with the proposed sub-subcontractor will include consideration of possible delays in the start and completion dates of the survey.

Environmental report (ER) and environmental impact statement (EIS).
A minor effort was initiated to study proposed format and outline material and to develop RPM recommendations for suitable EIS and ER outlines. The preliminary draft EIS submittal date of September 1, 1979, and the ER submittal date of December 14, 1979, require that preliminary work be initiated during February 1978.

Paradox basin region

Regional characterization. The regional report for Utah covering geologic, ground-water, hydrologic, and environmental characterization will be submitted to OWI by February 17, 1978, as scheduled. Written text and maps are in preparation. The OWI draft plans have been followed explicitly where possible.

4.1.3 EVALUATION OF ENVIRONMENTAL DOSE MODELS . . . W. A. Goldsmith, OWI; J. A. Franco, Envirosphere Company

This project was completed in December. The final report evaluates currently existing environmental dose models and recommends the most appropriate ones for assessment of impacts of anticipated routine and accidental releases from a waste repository. The final report was received by OWI on December 14.*

4.1.4 POSTDECOMMISSIONING MONITORING OF A REPOSITORY . . . A. S. Quist, OWI; J. A. Franco, Envirosphere Company

The draft report describing a preliminary evaluation of the postdecommissioning monitoring of a waste repository in a rock salt formation was reviewed by OWI, and comments were transmitted to Envirosphere Company. The final report is expected to be published in early CY 1978.

*Mauro, J. J.; Michlewicz, D; and Letizia, A.; Evaluation of Environmental Dosimetry Models for Applicability to Possible Radioactive Waste Repository Discharges, prepared by Envirosphere Company for Union Carbide Corporation, Nuclear Division, Office of Waste Isolation, Y/OWI/SUB-77/45705 (September 1977).

4.2 Safety, Risk, and Hazard Studies

4.2.1 RISK ASSESSMENT BIBLIOGRAPHY STUDIES . . . R. L. Shoup, OWI; B. Suta, SRI International

The purpose of this bibliography is to provide part of a data base for preparation of safety analysis reports (SARs) and ERs. The final report was received by OWI in December.*

4.2.2 SAFETY ANALYSIS REPORT PREPARATION ACTIVITY

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

NUS staff met with personnel of Bechtel and OWI on December 13 in Oak Ridge to plan for the development (by May 1, 1978) of a working annotated SAR outline applicable to both bedded salt and dome salt repositories.

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

On December 13, a working review meeting was held at Oak Ridge to consider proposed SAR outlines and format. Personnel from OWI, Bechtel, and NUS participated. Available outlines from Battelle Columbus Laboratories, SRI International, and Envirosphere Corporation were compared with outlines for a fuel reprocessing plant and a uranium enrichment facility which were previously developed for Nuclear Regulatory Commission (NRC) SAR submittals. Chapter headings suitable for the waste repository purpose were agreed upon during the meeting. Bechtel and NUS will prepare and coordinate chapter subheadings for a follow-up working meeting to be held January 19, 1978. Further work, subsequent to agreement on subheadings, will include preparation of subheading content descriptions by March 30, 1978. The outline chapter headings are being developed to place emphasis on the features of the nuclear waste repository that are unique, but at the same time, to cover all relevant aspects included in outlines previously approved by the NRC.

On December 13 to December 15, the dome salt facility design sub-contract with Stearns-Rogers Corporation was reviewed at OWI in Oak Ridge. The Bechtel RPM/SAR Task Manager, H. D. Wills, attended this meeting and subsequently sent comments about the meeting to OWI. Bechtel will maintain close contact with the sub-subcontractors that are developing data necessary for the SAR preparation. Since the Title I facility design reports will not be completed until after the draft preliminary SAR submittal, major input will be collected during the facility conceptual design phase and updated later from the Title I progress reports. Major activities in the non-site-specific SAR preparation are planned during the last part of February 1978.

*Suta, B. E.; Mara, S. J.; Radding, S. B.; and Weisbecker, L. W.; Annotated Bibliography: Hazard Assessments for the Geologic Isolation of Nuclear Wastes, prepared by SRI International for Union Carbide Corporation, Nuclear Division, Office of Waste Isolation, Y/OWI/SUB-77/42508 (November 1977).

4.3 Nuclear Regulatory Commission Licensing Requirements

A. S. Quist

No activity has been reported for December.

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 (HARC)

A draft paper entitled "The Management of Social and Economic Impacts Anticipated with the Development of a Nuclear Waste Repository: A Preliminary Discussion" was prepared for OWI and external review. To indicate the scope of this paper, the chapter headings are presented below:

1. Overview
2. Description of Potential Impacts Associated with a Nuclear Waste Repository
3. Description of Federal Assistance Programs Available to Mitigate Impacts
4. Obtaining Federal Financial Assistance
5. Overview of Planning Strategies State and Local Governments May Use to Manage Social and Economic Impacts Associated with a Waste Facility
6. An Overview of the Planning Process Available to Local Governments for Managing Social and Economic Impacts
7. Summary

Because the federal government will be responsible for the development of a waste repository, the report is addressed to federal officials. Information on state and local impact management programs, as well as on potentially available federal programs, is presented to familiarize federal officials with the difficulties and complexities facing local and state governments as they attempt to manage social and economic impacts resulting from the development of a nuclear waste repository.

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

Rough drafts of the following papers describing probable short-term social and economic effects of the construction and operation of a nuclear waste repository were completed:

1. Participants and Stages in the Siting Process
2. Local Economic Effects (private sector)
3. Local Economic Effects (public sector)
4. Newcomers vs Existing Residents: Sociopolitical Implications

A series of papers has also been drafted which indicates possible methods for mitigating negative impacts associated with nuclear waste repositories. These drafts are as follows:

1. Developer Role in Impact Mitigation
2. Local Role in Impact Mitigation
3. State Role in Impact Mitigation
4. Federal Role in Impact Mitigation
5. Compensation by Auctions - A Critique

These nine draft papers will be edited in January 1978 and will lay the groundwork for the next stage of the research effort, which is to describe the longer-term regional development implications of the construction and operation of a high-level radioactive waste repository.

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

The draft report by the University of California, Berkeley, entitled "Resolving Community Conflict in the Nuclear Power Issue: A Report and Annotated Bibliography," which was transmitted to OWI in late November, is currently under review by OWI and HARC. Their comments are expected to be referred to the author in late January 1978.

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

Intermountain Consultants and Planners, Inc., completed additional draft sections of their state-of-the-art report and bibliography and transmitted the sections to OWI for review and comment.

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

The December monthly report was not received on schedule by OWI from the University of Washington.

5. PUBLIC AFFAIRS

I. N. Kaplan

On December 4, I. N. Kaplan and C. D. Zerby met with DOE personnel in Washington, D.C., to discuss and enact the transfer of NWTs Program public affairs responsibilities from OWI to DOE-HQ. Kaplan met with C. George of DOE-HQ on November 9 to 11 in Germantown, Maryland, to assist with scheduling of decision-process meetings between DOE and several states.

APPENDIX A
VISITORS TO THE OFFICE OF WASTE ISOLATION
DURING DECEMBER 1977

Company	Visitor	Date	Principal Contact
Battelle Memorial Institute 505 King Avenue Columbus, OH 47201	J. Batch	12/9	C. D. Zerby
	W. Pardue	12/9	C. D. Zerby
	M. Stark	12/9	C. D. Zerby
Battelle Pacific North- west Laboratories P. O. Box 999 Richland, WA 99352	W. B. Andrews	12/20	D. W. Turner
	A. J. Boegel	12/2	J. E. Vath
	L. L. Clark	12/2	J. E. Vath
	R. M. Fleischman	12/2	J. E. Vath
	R. Heineman	12/9	C. D. Zerby
	W. D. McCormack	12/2	J. E. Vath
	R. E. Rhoads	12/20	D. W. Turner
Bechtel Corporation 50 Beale Street San Francisco, CA 94119	M. K. White	12/2	J. E. Vath
	E. M. Miholits	12/13	W. A. Goldsmith
		12/14	S. C. Matthews
	N. A. Norman	12/13-14	W. A. Goldsmith
	H. D. Wills	12/12-13 12/14-15	W. A. Goldsmith S. C. Matthews
Boeing Engineering & Construction Company 102 Tulsa Road Oak Ridge, TN 37830	R. B. Dixon	12/9	D. G. Shaner
		12/21	D. G. Shaner
	H. G. Stocking	12/2	W. R. Musick
		12/6	D. G. Shaner
		12/8	D. G. Shaner
		12/15	W. R. Musick
Dames & Moore 134 Fairbanks Road Oak Ridge, TN 37830		12/21	D. G. Shaner
	T. M. Gates	12/13	R. K. Kibbe
		12/16	R. K. Kibbe
		12/19	R. K. Kibbe
	J. R. Swaisgood	12/13	R. K. Kibbe
		12/16	R. K. Kibbe
		12/19	R. K. Kibbe
		12/27	R. K. Kibbe
		12/30	R. K. Kibbe
Dynatech R/D Company 99 Erie Street Cambridge, MA 02139	R. P. Tye	12/6	W. A. Burnett

APPENDIX A (continued)

Company	Visitor	Date	Principal Contact
E. I. duPont de Nemours Louviers Building Newark, DE 19711	R. H. Cornwall	12/8	J. M. Morrison
E. I. duPont de Nemours Wilmington, DE 19898	L. F. Shafranek	12/8	J. M. Morrison
Energy, Inc. Idaho Falls, ID 83401	R. J. Breeding	12/13-15	S. C. Matthews
FMC Corporation 328 Brokaw Road Santa Clara, CA 95051	M. J. Cosgrove D. J. Giroux M. G. Wallis	12/13 12/13 12/13	P. D. Fairchild P. D. Fairchild P. D. Fairchild
Geraghty & Miller, Inc. 44 Sintsink Drive E. Port Washington, NY 11050	R. L. Stollar	12/13	R. B. Laughon
Hans/Meitner Institute D 1000 Berlin, Germany	F. Gruber	12/16	H. C. Claiborne
Kaiser Engineers Kaiser Center 300 Lakeside Drive Oakland, CA 94666	J. H. Bocks E. A. Dukleth F. V. Kahle R. K. Reynolds	12/1 12/13-14 12/1 12/13-14	C. E. Oldham S. C. Matthews C. E. Oldham S. C. Matthews
Law Engineering Testing Company 2749 Delk Road, S.E. Marietta, GA 30067	C. O. Durham G. H. Fogle J. G. LaBastie J. R. Wallace	12/14 12/14 12/14 12/14	R. B. Laughon R. B. Laughon R. B. Laughon R. B. Laughon
Los Alamos Scientific Laboratory Los Alamos, NM 87544	K. E. Apt R. I. Brasier G. A. Cowan	12/7 12/13 12/9	C. D. Zerby P. D. Fairchild C. D. Zerby
NUS Corporation 4 Research Place Rockville, MD 20850	P. D. Arrowsmith O. E. Bassett J. J. DiNunno T. R. Hincey B. N. Naft L. S. Robinson L. V. Stover E. R. Wiot	12/6 12/6 12/12 12/13 12/13 12/20 12/12 12/13	A. L. Boch A. L. Boch A. S. Quist R. L. Shoup R. L. Shoup R. L. Shoup A. S. Quist R. L. Shoup

APPENDIX A (continued)

Company	Visitor	Date	Principal Contact
RE/SPEC Inc. P. O. Box 725 Rapid City, SD 57709	L. L. Van Sambeek	12/8	P. D. Fairchild
Rockwell Hanford Operations P. O. Box 800 Richland, WA 99352	E. L. Moore R. E. Smith	12/8 12/8-9	W. H. Pechin W. H. Pechin
Sandia Laboratories P. O. Box 5800 Albuquerque, NM 87115	G. C. Allen A. W. Dennis J. M. Freedman R. E. Stinebaugh W. E. Wowak	12/14 12/13-14 12/14 12/13-14 12/13-14	P. D. Fairchild S. C. Matthews P. D. Fairchild S. C. Matthews S. C. Matthews
Science Applications, Inc. 114 Tulsa Road Oak Ridge, TN 37830	J. N. Baird L. D. Rickertsen R. E. Wilems	12/5 12/28 12/30 12/9 12/1 12/7 12/9 12/15 12/20 12/22	R. K. Kibbe R. K. Kibbe R. K. Kibbe R. K. Kibbe R. K. Kibbe R. K. Kibbe R. K. Kibbe R. K. Kibbe R. K. Kibbe R. K. Kibbe
Stearns-Roger Engineering Company 700 South Ash Denver, CO 80217	J. L. Brock D. A. Day D. W. Eichelberger V. G. Eschen J. H. Jones B. A. Nelson M. P. Pervich L. C. Rozelle M. A. Scheriff J. R. Smith C. R. Staadt R. B. Wrenshall	12/1 12/13-15 12/13-15 12/13-15 12/13-15 12/13-15 12/13-15 12/13-15 12/13-15 12/1 12/13-15 12/13-15	C. E. Oldham S. C. Matthews S. C. Matthews S. C. Matthews S. C. Matthews S. C. Matthews S. C. Matthews S. C. Matthews S. C. Matthews C. E. Oldham S. C. Matthews S. C. Matthews
Stone & Webster P. O. Box 2325 Boston, MA 02107	J. Briedis J. H. Peck	12/13 12/13	R. B. Laughon R. B. Laughon
TRW Energy Systems One Space Park Redondo Beach, CA 90278	S. Cohen	12/2	H. N. Rosenberg

APPENDIX A (continued)

Company	Visitor	Date	Principal Contact
TRW Energy Systems	E. R. Christie	12/2	H. N. Rosenberg
7600 Colshire Drive	F. P. Hayoz	12/2	H. N. Rosenberg
McLean, VA 22101	F. P. Mertes	12/2	H. N. Rosenberg
U.S. Department of Energy	R. Y. Lowrey	12/7	L. R. Dole
P. O. Box 5400			
Albuquerque, NM 87115			
U.S. Department of Energy	R. N. Ng	12/7	L. R. Dole
Washington, DC 20545			
Woodward-Clyde Consultants	E. O. Pitschel	12/13-15	S. C. Matthews
2909 W. 7th Avenue	D. W. Savory	12/13-15	S. C. Matthews
Denver, CO 80204			

APPENDIX B

TRIPS TAKEN BY OWI STAFF MEMBERS DURING DECEMBER 1977

Date	Place Visited	OWI Staff Member	Purpose of Visit
11/4	Washington, DC	I. N. Kaplan C. D. Zerby	To assist in the transfer of public affairs responsibilities from OWI to DOE-HQ.
11/9-11	Washington, DC	I. N. Kaplan	To assist DOE with the initial phases of their NWTs Program public affairs activities.
11/15	Jackson, MS	C. D. Zerby	To participate in briefing the Mississippi Governor's Energy Advisory Committee.
11/17-18	New Orleans, LA	C. D. Zerby	To participate in the Geologic Review Group meeting.
11/20-23	Williamsburg, VA	W. R. Andrews	To attend a conference on Essentials in Government Contracting.
11/28 - 12/2	Vienna, Austria	W. C. McClain	To assist, as a consultant for the International Atomic Energy Agency, in the preparation of a detailed program concerning the development of guides on site-confirmatory investigations for repositories of radioactive waste in geological formations.
11/29 - 12/1	Columbus, OH San Francisco, CA Seattle, WA	K. K. Aydelotte R. S. Lowrie	To evaluate potential subcontractors for the Waste Acceptance Criteria Study.
12/5-7	Albuquerque, NM	H. C. Claiborne L. R. Dole	To discuss safety analysis for the Waste Isolation Pilot Plant with WIPP personnel.

APPENDIX B (continued)

Date	Place Visited	OWI Staff Member	Purpose of Visit
12/6	Houston, TX	R. B. Laughon	To meet with Law Engineering Testing Company and their consultants for a technical review of the Gulf Coast Salt Dome Project.
12/8-9	Minneapolis, MN	W. C. McClain J. E. Russell	To attend the Rock Mechanics Review meeting at the University of Minnesota.
12/13	Germantown, MD	H. N. Rosenberg J. E. Vath	To discuss the Economic Study with DOE and TRW.
12/13-14	Salt Lake City, UT	T. F. Lomenick	To discuss the Paradox drilling program with Utah Geological Survey personnel.
12/15	Houston, TX	L. B. Cobb T. F. Lomenick	To review a drilling management proposal.
	Denver, CO	R. S. Lowrie D. W. Turner	To discuss the Rocky Flats Plant work on the Transportation/Logistics Study.

APPENDIX C
REPORTS GENERATED

The following reports were forwarded to DOE during December 1977:

Y/OWI/SUB-4091/6	<u>Borehole Cement and Rock Properties Studies: Progress Report for Period October 1, 1976, to September 30, 1977</u> , prepared by Pennsylvania State University under R&D subcontract 4091 with Union Carbide Corporation, Nuclear Division (September 30, 1977).
Y/OWI/SUB-77/42502	<u>Generic Description of Radiological and Meteorological Monitoring Program for Federal Repositories for Radioactive Wastes</u> , prepared by NUS Corporation under subcontract 86Y-42502V with Union Carbide Corporation, Nuclear Division (September 1977).
Y/OWI/SUB-77/42503	<u>Preliminary Environmental Assessments of Disposal of Rock Mined During Excavation of a Federal Repository for Radioactive Waste</u> , prepared by NUS Corporation under subcontract 86Y-42503V with Union Carbide Corporation, Nuclear Division (September 1977).
Y/OWI/SUB-77/42508	<u>Annotated Bibliography: Hazard Assessments for the Geologic Isolation of Nuclear Wastes</u> , prepared by SRI International under subcontract 86Y-42508V with Union Carbide Corporation, Nuclear Division (November 1977).
Y/OWI/SUB-77/45705	<u>Evaluation of Environmental Dosimetry Models for Applicability to Possible Radioactive Waste Repository Discharges</u> , prepared by Envirosphere Company, EBASCO Services, Inc., under subcontract 62Y-45705V with Union Carbide Corporation, Nuclear Division (September 1977).
Y/OWI/TM-47	<u>Geological Criteria for Radioactive Waste Repositories</u> , G. D. Brunton and W. C. McClain, Office of Waste Isolation, Union Carbide Corporation, Nuclear Division (November 28, 1977).

APPENDIX D
FUTURE ACTIVITIES

Date	Activity
January 17-19	Regulatory Affairs personnel to participate in WISAP program review and evaluation in San Francisco.
January 19-20	Regulatory Affairs personnel to conduct RPM working meeting on SAR outline development with RPMs in San Francisco.
January 24-25	A. S. Quist to review Battelle Human Affairs Research Centers' progress on socioeconomic studies at Seattle.
January 31 - February 1	W. A. Goldsmith to conduct a Bechtel RPM program review at San Francisco.
February 6	A 50% conceptual design review with Kaiser Engineers for NWTs Repository 2 (spent fuel in bedded salt) to be held in Oak Ridge.

APPENDIX E
SUBCONTRACTS NEGOTIATED DURING DECEMBER 1977

Subcontractor/Consultant	Subcontract Number	General Scope of Work
A. M. Piper	3745	Consultant for ground-water hydrology (renewal).
Louisiana State University	7362	Vacherie-Rayburn coring (extension of time).
K. S. Johnson	7414	Consultant for salt deposits (modification to subcontract for clerical services, reproduction, etc.).
Woodward-Clyde Consultants	89Y-22333C	Geologic Project Manager for Pierre Shale/Paradox Basin (definitive contract).

APPENDIX F

EMPLOYMENT LEVELS AS OF DECEMBER 31, 1977

	<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 December 1977.

OFFICE OF WASTE ISOLATION

January 1, 1978

Director
C. D. Zerby

DISTRIBUTION

Department of Energy (29)

J. J. Schreiber (20), OR
J. Ellis, GJ
T. B. Hindman, SR
C. D. Jackson, SAN
N. H. Mackay, AL
R. Nack, CH
W. K. Overbey, Jr., MERC
D. T. Schueler, Jr., NV
D. J. Squires, RL
G. Wehman, ID

ORGDP Administrative Offices (2)

C. J. Parks
R. A. Winkel

Oak Ridge National Laboratory (24)

C. F. Baes, Jr.
M. Bender
A. A. Brooks
D. D. Cannon
B. F. Crump
R. C. Durfee
D. E. Ferguson
C. W. Francis
R. M. Hill
R. M. Holmes
G. H. Jenks
J. S. Johnson, Jr.
W. E. Manrod
J. G. Moore
H. Postma
G. W. Renfro
L. B. Shappert
E. G. St. Clair (3)
J. A. Steed
I. L. Thomas
D. B. Trauger
J. R. Weir

Office of Waste Isolation (75)

W. R. Andrews
J. M. Asher
K. K. Aydelotte
M. L. Bennett

A. L. Boch
B. V. Brackney
G. D. Brunton
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

DISTRIBUTION (continued)

Technical

W. J. Wilcox, Jr.

Y-12 Plant (12)

J. M. Case
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)

NWTS Program Participants (51)

Argonne National Laboratory
Attn: A. M. Friedman
M. Steindler

Battelle Human Affairs Research
Centers
Attn: A. H. Schilling

Battelle Pacific Northwest
Laboratories
Attn: J. W. Bartlett
H. C. Burkholder
A. M. Platt
R. J. Serne
L. D. Williams

Brookhaven National Laboratory
Attn: P. W. Levy

Lawrence Berkeley Laboratory
Attn: J. A. Apps
P. A. Witherspoon

Lawrence Livermore Laboratory
Attn: L. B. Ballou
H. C. Heard
A. Holzer, Jr.
D. Isherwood
L. D. Ramspott

Los Alamos Scientific Laboratory

Attn: K. E. Apt
B. R. Erdal

Rockwell Hanford Operations

Attn: G. S. Barney
R. A. Deju
R. E. Smith
D. A. Turner
D. D. Wodrich

Sandia Laboratories

Attn: J. F. Cuderman
R. G. Dosch
J. M. Freedman
L. R. Hill
T. E. Hinkebein
R. K. Klett
L. W. Scully
W. D. Weart

Savannah River Laboratory

Attn: J. W. Crandall
H. J. Groh
F. D. King
I. W. Marine
W. C. Reinig

U.S. Geological Survey

Attn: J. D. Bredehoeft
J. Cleveland
G. Czamanske
G. D. DeBuchananne
W. W. Dudley, Jr.
J. Friedman
R. M. Hamilton
R. J. Hite
E. Jenne
J. C. Reed, Jr.
D. B. Stewart
R. I. Tilling
N. J. Trask, Jr.
W. S. Twenhofel
W. W. Wood

Consultants (10)

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

DISTRIBUTION (continued)

Consultants (continued)

J. B. Fussell
 S. Gonzales
 K. S. Johnson
 C. Killgore
 A. M. Piper
 R. F. Walters
 C. E. Weaver

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)

Adaptronics, Inc.
 Attn: A. N. Mucciardi

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

Pennsylvania State University
 Attn: D. M. Roy

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

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

Science Applications, Inc.
 Attn: R. Hofmann

TRW Systems and Energy
 Attn: E. R. Christie
 F. Mertes

University of Minnesota
 Attn: S. L. Crouch

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

Woodward-Clyde Consultants
 Attn: H. Ewoldsen

Geologic Review Group (6)

J. H. Crawford
 S. N. Davis
 F. A. Donath
 J. C. Frye
 E. F. Gloyna
 K. B. Krauskopf

American Association of
State Geologists Review Group (13)

H. R. Collins
 S. G. Conrad
 J. F. Davis
 C. S. Groat
 W. W. Hambleton
 V. E. Livingston, Jr.
 L. W. Lough
 D. T. McMillan
 D. N. Miller, Jr.
 W. H. Moore
 C. A. Ratté
 J. W. Rold
 A. E. Slaughter

DISTRIBUTION (continued)

Nuclear Safety Associates

J. A. Lieberman

Monsanto Research Corporation
Mound Laboratory

K. V. Gilbert

Department of Commerce
National Bureau of Standards

L. H. Gevantman

California Energy Resources
Conservation Development Commission

Attn: G. Simon

Atomic Energy of Canada, Ltd.*

Attn: E. Rosinger

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