MASTER

OFFICE OF WASTE ISOLATION
PROGRESS REPORT

OCTOBER 1977

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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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OFFICE OF WASTE ISOLATION
PROGRESS REPORT

OCTOBER 1977

C. D. Zerby, Director

Issued November 18, 1977

Edited by J. M. Asher
and R. C. Rhines

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

prepared for the
DEPARTMENT OF ENERGY
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HIGHLIGHTS

- . . . A design status review on the high-level-waste repository conceptual design was held with Stearns-Roger Engineering Company in Denver, October 17-19 29
- . . . The first Program Review Meeting using the equipment, formats, and procedures of the OWI Program Control System was held October 24 33
- . . . The finalized Statement of Work for the Spent Fuel Disposal System Study was issued 39
- . . . A vendor was recommended by the evaluation team as the subcontractor for the International Waste Repository Study 40
- . . . Draft regional and study area environmental survey plans for Mississippi, New York, and Ohio were published 41

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

General

During the reporting period, several meetings were held with representatives of Law Engineering Testing Co., the Geologic Project Manager (GPM) for the Gulf Coast salt domes. Every effort is being made to provide that organization with general background information related to our past research for the Office of Waste Isolation (OWI), as well as detailed information on topics of special interest to them.

Louisiana State University input to the NWTs Program annual progress report for FY 1977 has been finalized and forwarded to OWI as requested. Also, work is continuing on the LSU annual report to OWI, and this report is scheduled to be delivered to the printers within a few weeks.

Geomechanics

Results from the National Geodetic Survey's (NGS) precise leveling sub-subcontract work over Vacherie and Rayburn's salt domes have been received and are being incorporated into a number of phases of the LSU study.

Tiltmeters were serviced, and data were collected on October 14-15 for both Vacherie and Rayburn's domes. Solar recharging of batteries at two remote sites over Vacherie is apparently working well. Cassette recording of data and radio telemetry capabilities are being advanced rapidly. More detailed examinations of meteorological effects (e.g., temperature variations) on the tiltmeters are being performed.

The geotechnical field program on the mechanical properties of soils over Vacherie dome is complete, and the data are being analyzed. The core specimens collected at the tiltmeter sites are being used by both the geomechanics group and the Quaternary geology group.

The microseismic monitoring system is near completion, and arrangements have been made to install it over a South Louisiana salt dome with a working mine (and known seismic energy outputs, e.g., blasting). Five geophones will be placed down existing boreholes to the surface of the salt dome. After the system is checked out, it will be moved to one of the North Louisiana study domes. There the geophones will tentatively be installed in existing water observation wells.

Geohydrology

Three observation wells contracted at Rayburn's dome were completed in Wilcox sands at the southeast, southwest, and northwest flanks of the dome. Water samples were collected for analysis by the U.S. Geological Survey (USGS). Final copies of the geophysical logs of the wells, including dip meter logs, have been received. Microfossils are being collected from the Cane River section in one well to compare with microfossils already prepared from wells completed earlier at Vacherie dome. It is hoped that comparisons of microfauna will aid in determining the depositional environment during Cane River time. This work may help explain complex structural and stratigraphic problems revealed in drilling at Vacherie.

Based on the results of the three wells at Rayburn's dome, plans for the five remaining wells may require adjustments in locations in order to reach the desired objectives. For example, one of the completed wells (well R-1A) was expected to drill salt within 300 ft of the surface, based on interpretations from surface mapping and topographic relief at Rayburn's dome. However, the well was terminated at a depth of 1112 ft in Wilcox sand without drilling either salt or caprock. Shallow seismic surveys completed over Rayburn's dome by the Quaternary geology group will be reviewed before finalizing well locations for additional wells planned during FY 1978.

Coordination efforts between the geohydrology group and the salt core hole team (Subcontract 7362) are increasing. The knowledge gained in drilling both sediments and caprock in the water wells is being applied to planning for the core hole. Such past experience should be particularly helpful in developing plans to deal with possible zones of lost circulation and in anticipating tops of various critical stratigraphic units (i.e., caprock and salt). R. Barlow, who monitored drilling at the Vacherie water wells as a member of the geohydrology group, has now been assigned to the core hole team to assist with that effort.

Regional geology

Contouring has been completed on isopach residual maps for 15 stratigraphic intervals in the North Louisiana basin. These composite maps include both positive and negative residuals of the first order and third order, for a total of 30 maps. Interpretation of these maps is under way.

Seismic profiling data originally obtained from Atlantic Richfield Company (ARCO) was reprocessed by Geophysical Data Processing, Inc., in Houston, Texas; and the results were received in August 1977. Interpretation of the five ARCO profiles and the Petty-Ray profiles obtained in FY 1975 indicates that the depth of salt beneath the top of Vacherie salt dome is in the range of 16,000 to 18,000 ft. Further, the column of salt appears to be continuous to the parent salt at depth.

Preliminary interpretation of gravity data obtained from Cities Service and ARCO for Vacherie, Rayburn's, and Prothro domes confirms the elliptical shape of Vacherie and suggests that it is a much larger dome than either Prothro or Rayburn's. Further, irregularities in the gravity anomalies over Rayburn's and Prothro domes suggest that shallow irregularities in the configuration of the two domes - either overhangs or depressions in the upper surfaces - may be present.

The geochemistry section has been concentrating its efforts on finishing chemical analyses of salt samples collected from Cote Blanche salt mine, from surface waters, and from saline surface crusts from Rayburn's dome area. Approximately 25 to 30 salt samples have been analyzed for Mg, Na, Ca, Sr, and K by atomic absorption spectrophotometry. At present, all sulphate determinations have been completed by colorimetric methods (approximately 100 samples). Standardization for chloride analysis, which encompasses silver nitrate titration, is complete (approximately 50 samples finished). Alternative techniques for bromide, iodide, and chloride analyses are still being tested. R. L. Thoms and R. E. Ferrell, Jr., Battelle Pacific Northwest Laboratories, attended a conference on the Waste Isolation Safety Assessment Program (WISAP) at Seattle, Washington, September 19-23, and were able to evaluate and compare chemical techniques and methodologies with those of other laboratories.

Quaternary geology

This report covers progress on the Quaternary studies from approximately August 20 to October 20, a period of intensive field and office activity.

At Rayburn's dome, some 65 borings, sampled as continuously as possible, were completed under contract by Servitron, Inc., of Baton Rouge, Louisiana. All cores were sealed in foil and will not be opened for detailed laboratory examination until all the cores from Vacherie dome have been completely examined.

Field logs kept by LSU field geologists have been worked into preliminary sections along two subsurface sections, and some intriguing, complex geologic relationships are developing. Examination of the cores in the coming weeks should help clarify these relationships.

A network of seismic refraction profiles made under contract and completed during this reporting period by Harding-Lawson Associates of California is of considerable value in interpreting the geology at Rayburn's dome. Caprock, encountered at depths as shallow as 20 ft in the borings, is being tentatively identified to depths as great as 300 ft on the seismic profiles. Several borings are planned to correlate seismic-geologic-lithologic boundaries. Unfortunately, a difficult boundary to detect with the seismic refraction equipment is the base of the Quaternary. Additional seismic traverses are being planned for late October to fill gaps in the geologic information. These traverses are being made by LSU geologists using the newly acquired Nimbus seismic equipment.

Cores from all except 15 of the 81 borings made during the fiscal year at Vacherie have been opened, photographed, and analyzed in the Quaternary Studies Laboratory and the Soils Laboratory at LSU. Some of the results are being reported in the annual report; the remaining results are being worked into subsurface sections and related to newly acquired elevation data made at the site by the NGS. To date, all evidence from these borings indicates that the dome has been tectonically stable since the earliest of the Quaternary deposits were laid down (estimated at 200,000 years ago).

Plans are under way to run 10 miles of seismic refraction traverses above the dome to augment the data obtained from the cored borings. The first of these seismic traverses is scheduled for early November and will be made by LSU geologists.

Three 200-ft-deep borings were made at Vacherie during the reporting period to explore a unique fine, silty sand that occurs beneath much thinner gravel-bearing Quaternary deposits. The material is limited in lateral extent and is interpreted as an unusually deep Quaternary sequence or as pre-Quaternary material that may have filled surface depressions formed because of dissolution and collapse of the underlying salt. The three borings were cased with polyvinyl, and a wave-front analysis is being made of shocks emanating from shots set off from the bottom to the top of each of these borings. The results are being analyzed by a consultant from Harding-Lawson Associates of California and should help to delineate the size and shape of the depressions.

The material is extremely difficult to sample, and only a few inches of it was obtained when encountered in the original group of 81 borings made at the site. A specially devised sampling tube was used to resample the material during the last two weeks in September, and about 65% of the material was retrieved from the one boring that was sampled.

As an aid to interpreting the materials that lie within the depressions, samples of the material are being compared microscopically with samples from cores of the surrounding Tertiary sands.

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

On October 3-4, R. L. Hosman and C. A. Spiers (hydrologist, Mississippi District, assigned to the salt domes study) visited USGS offices in Denver to confer with personnel regarding techniques and services that might be useful in the planned test drilling program. A two-hole electrical log method described at the August 30-31 Oak Ridge meeting appeared encouraging for detailed geohydrologic studies at a salt dome, especially with regard to determining thickness and location of caprock. However, after discussion with Jeff Daniels, of the Geologic Division, a determination was made that the method in its present state of development is primarily effective in locating anomalies in an otherwise homogeneous mass. Because caprock is situated between salt and sediment, the mass cannot be considered homogeneous; therefore, considerable experimentation would be necessary to determine if the two-hole logging method could define the irregularities.

A visit was made to Warren Teasdale, of the Hydrologic Equipment and Services Unit, Water Resources Division, USGS, to discuss the availability of packer and geophysical logging services. According to Teasdale, the pneumatic packer that his group developed is not suitable for the depths that will be tested during test drilling for the salt domes study. He recommends a commercial hydraulic packer developed by Lynes, Inc., as being most adaptable to our needs. Geophysical logging equipment owned by USGS and located in Atlanta is available for use in the test drilling program. The services most likely to be used would be

electrical, gamma-ray/neutron, and caliper logs. The equipment also includes a sonic borehole televiewer that might prove valuable if holes are drilled through caprock.

Jim Wallace and David Pauls of Law Engineering Testing Company, the GPM, and Clay Durham (the geologic consultant who will serve as technical director) met with George Caldwell and R. L. Hosman on October 12 to discuss test drilling plans. Wallace and Pauls were shown a location map with tentative sites for 13 test wells ranging in depth from 2000 to 3500 ft. They felt that the number of wells was a logical amount for a regional study of the area involved. All wells and locations are designed to provide the information necessary for the regional geohydrologic study and possible digital modeling of the entire region.

The base-of-freshwater map of northern Louisiana is approximately 60% complete. Work is continuing on that map as well as on the data compilations necessary for the regional geohydrologic maps.

The last two test wells drilled at Rayburn's dome by the LSU Institute for Environmental Studies have been sampled using the USGS mobile laboratory. One of the wells drilled earlier at Vacherie remains to be resampled for analysis using ^{14}C dating, pending availability of manpower and necessary pumping equipment.

1.1.1.3 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 that show (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 following: (1) geologic horizon picks on all geophysical logs planned for regional evaluation of the basin; (2) structural contour maps on the top of the Midway group and the Carrizo Sand; and (3) completion of the geologic cross sections.

Planned accomplishments for the next report period are (1) structural contour maps on the top of the Wilcox group, Reklaw Formation, and Queen City Sand and (2) calculation of sand and clay thicknesses on approximately half of the geologic logs.

1.1.2 SALINA BASIN . . . R. B. Laughon

1.1.2.1 Appalachian Basin Remote Sensing . . . L. C. Rowan, U.S. Geological Survey

Image processing of northern New York test areas was completed. The tapes of the eastern portion of the area were played back, and after adjustments were made to maximize film density, base stable pin-registered prints were made. Tapes for the western area were received near the end of the month, and processing was initiated. Preparations for field work are occupying a major portion of the time.

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. P. Snyder, U.S. Geological Survey

Robert J. Hite, geologist in the Chemical Resources Branch, USGS, Denver, has been appointed as the Survey Coordinator for the Paradox Basin Waste Emplacement Studies Project.

No progress on the project has been made during October. The next scheduled activities are the actual location of the drill site in Salt Valley, Utah, and the awarding of the drilling and support contracts by Woodward-Clyde Consultants.

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

Analysis of Landsat frame E-5165-17030 (taken October 10, 1975), geometrically corrected and processed with a 2% linear stretch, has yielded some new facts on the structural geology of the northwest quadrant of the 2° Moab quadrangle. Several MSS bands of the Landsat frame clearly show a northeast-trending lineament set that extends through (i.e., controls) the incised meander pattern of a segment of the Green River and extends to the Uncompahgre uplift. The lineament set cuts the axes of Courthouse syncline and Salt Valley anticline and continues across Elephant Butte folds and Yellowcat dome.

It has been interpreted that the northeast-trending lineament set occurs in the area of a northeast-trending wrench-fault pattern but extends farther northwest to include a major lineament marked by the alignment of Tenmile Canyon and Thompson Wash, about 5 km southwest of Crescent Junction. Tenmile Canyon lineament marks the eastern termination of Tenmile graben and cuts Courthouse syncline and Salt Valley graben where previous structural mapping (P. Williams, USGS, 1964) indicates a major change in trend of the Salt Valley anticline. Tenmile

Canyon lineament has the earmarks of a right-lateral strike-slip fault. If the Landsat interpretation is confirmed by field investigations, an additional structure can be added to the map of Hite (1975) which is northwest of, and parallel to, the Yellowcat fault.

The remainder of the northeast-trending lineament set could be interpreted as the geomorphic representation of the structural response to a southwest-northeast direction of stress, parallel to the direction of compressive stress that resulted in the folding and diapiric development of the salt anticlines. During the development of the fracture or joint system represented by these lineaments, the direction of relative release of strain would thus have been to the northwest and southeast.

1.2.2 PERMIAN BASIN . . . T. F. Lomenick

No activity has been reported for October.

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

1.2.3.1 Pierre Shale . . . T. F. Lomenick

Pierre Shale remote sensing . . . L. C. Rowan, U.S. Geological Survey

The major activities this month have been (1) a short reconnaissance field trip to the South Dakota study area, (2) completion of the color-coded 5/6 ratio image, and (3) analysis of this ratio image. The field party included Gary Raines and George Shurr, USGS, and Richard Bretz, South Dakota Geological Survey, who visited Pierre Shale outcrops south of Rapid City on the flank of the Black Hills and along the breaks of the Cheyenne from Bridger to Cherry Creek. They also examined outcrops of the overlying Fox Hills Formation.

The Bridger-to-Cherry Creek area is an area of very subtle inter-fingering black shale and calcareous shale facies of the Pierre Shale. Another noteworthy feature is the presence of calcite-filled fractures in the calcareous shale; in places, the calcite veins are 8 cm thick and can be traced for at least 40 m. In one area visited, these fractures were very common, with spacing between fractures that ranged from a few centimeters to at least 10 m. The significance of these fractures is not known at this time.

While on this field trip, a light aircraft was used for observing the geomorphic and vegetation characteristics of the various lithologies. Also, various geomorphic features were observed and photographed which are suggestive of faults or fractures that range in length from several kilometers to, in one case, tens of kilometers.

Analysis of the color-coded Landsat 5/6 ratio has resulted in a map of the major formation changes within the area. Also, this ratio image shows a west-to-east change in the Bridger area that could be related to the facies change from black shale to calcareous shale. This image also shows a decrease in vegetation density along the Cheyenne River at Oahe Reservoir which is like the vegetation density of the black shale facies. This suggests a facies change from calcareous shale back to black shale along the Cheyenne River at Oahe Reservoir.

A subtle northwest-trending anticline in the Pierre Shale in Meade and Butte counties is well displayed in this ratio image. What might be a major fault at least 20 km long on the southwest flank of this anticline is seen on this ratio image and is also seen as a distinct linear geomorphic feature from a light aircraft. The anticline could not easily be seen from the light aircraft.

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

Rock mechanics. Samples from the Lucerne Granite of southeastern Maine are being tested in the laboratory and compiled for an open-file report by F. T. Lee and S. F. Diehl. Static tests and sonic velocities are being determined in addition to the measurements for density and point-load tensile strength already made.

Isotope studies. Z. E. Peterman completed preparation of the paper he was invited to present as the "Distinguished Lecture" for the Geological Society of America annual meeting in early November.

Coordination. H. W. Smedes visited I. W. Marine and colleagues at the Savannah River Plant for conferences on topics of mutual interest in the field of waste management. During October, Smedes also visited personnel of OWI in Oak Ridge, with special emphasis on the computer Geologic Data Management System. Field trips were made to gain familiarity with the geology of the Knoxville and Atlanta regions. Smedes provided general information on the Crystalline Rocks and Basement Studies Programs to J. B. Lyons of Dartmouth College, who is on an Environmental Protection Agency advisory committee, and continued an exchange of ideas and plans with Paul Witherspoon's colleagues (Maura O'Brien) in preparation for a detailed conference to be held in Seattle at the annual meeting of the Geological Society of America.

Remote sensing (L. C. Rowan, U.S. Geological Survey). Field work in eastern Maine has provided data for a geologic interpretation of a major lineament. The lineament, referred to as the Orland lineament, extends in a N25E direction for at least 64 km, along the north side of the Lucerne pluton, from Orland to East Holden. It is manifested by strongly aligned landforms and drainage in a zone about 4/5 km wide.

The lineament is entirely within the Ordovician-Silurian Bucksport Formation, consisting of thin-bedded, disharmonically folded calcareous metasilstone with minor interbeds of phyllite. Foliation strikes about N25E and dips very steeply east. The eastern edge of the lineament is bordered by a zone of evenly layered hornfels contacted by the Lucerne Granite. The western border of the lineament is marked by older, high-grade units; mylonitized Bucksport Formation; or (especially in the northern area) less closely jointed, less-deformed Bucksport rocks.

Although the lineament is evidently related to the locally intensive mylonitization, it would be incorrect to say that the lineament is fault controlled. Instead, the lineament landforms appear to be controlled by close, regular cross-jointing and clean foliation cleavage. These structures were susceptible to glacial plucking and scouring along

a zone of relatively weakly metamorphosed calcareous metasilstone. Preglacial solution weathering may have figured significantly in the strike-aligned drainage.

Two hypotheses of the origin of the lineament structure are presently being considered. The first hypothesis is that the intrusion of the Lucerne pluton baked steeply dipping, but otherwise undeformed, Bucksport beds into their present configuration, but buckled and shattered the beds beyond the aureole, with the deformation rather abruptly dying out beyond the narrow zone presently defined by the lineament. The presence of a similar lineament (unexamined) on the southeast side of the pluton supports this hypothesis. The second hypothesis is that the hornfels is actually a baked mylonite that marks the remnant edge of a major shear zone exploited by the Lucerne pluton during intrusion. This hypothesis, originally suggested by David Wones, would mean that the lineament structure is a shattered zone bordering what remains of a central sheared zone. Presumably, a similar border zone existed on the east side of the central shear zone but was obliterated by the intrusion. A large road cut in the Bucksport, which exhibits this symmetrical structure on a small scale, was observed during field work.

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

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

On August 25, 1977, a major shift in emphasis in the Studies for Geologic Storage of Radioactive Waste in the Southeast occurred. In line with new program directions from OWI, tasks that were applicable to salt investigations were emphasized. Other work was deemphasized or deferred.

Technical progress

Research applicable to radioactive waste storage in the rock types of interest irrespective of the specific site includes several studies. Progress in these studies is discussed below.

1. In the Parametric Study of Geologic and Hydrologic Performance Characteristics, most calculations have been made preparatory to constructing graphs.
2. On the contract to Document and Evaluate the Damage to Mines, Wells, and Underground Facilities Due to Earthquakes, most U.S. data on earthquakes and on nuclear detonations have been collected. Initial attempts have been made to establish contact with Japanese, Chinese, and European earthquake institutes.

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*This report covers activities for August and September 1977.

3. In the Study of Membrane Phenomena, the design of the testing machine is complete. Various designs of the experiments are being evaluated.
4. In the Studies of the Applicability of Methods of Measuring Rock Stress and Fracture Closure with Depth, discussions have been held with several consulting firms on the hydraulic fracturing tests to be performed at the Savannah River Plant (SRP). With the new program direction, the number of holes in which hydraulic fractures will be made has been reduced from four to two.
5. In the Study of Fracture Closure with Depth in Crystalline Rock, the planned deepening of one of the existing borings at SRP from 2000 to 5000 ft to explore the decrease of fractures with depth has been deferred.

Additionally, proposals by geologic consulting firms to review the literature and existing knowledge of host rocks in the Southeast were received and evaluated. Contracts for these reviews are expected to be awarded since preparation work has already begun and since completion of the reviews will comprise a plateau of knowledge that will require considerable discussion by state geologists and others before work begins. Plans to do field work immediately following those reviews have been deferred.

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

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

Borehole cables were purchased for hole-to-hole electrical measurements, and computer modeling of these measurements is continuing. A contract has been awarded to Simplec of Dallas, Texas, for the development of a borehole acoustic source, which is to be used for hole-to-hole acoustic measurements.

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

Temperature sensing disks were fabricated and tested using the TCFCM thermal conductivity system. These disks consist of 1/8-in.-thick nickel plates of the same diameter as the sample and reference disks, with a radial hole provided for the insertion of a thermocouple. Normally, temperatures are measured by thermocouples embedded in slots cut into the surfaces of the sample and reference material. Embedding the

thermocouple is an intricate, time-consuming operation that must be performed with each sample studied. Use of the temperature sensing disks completely eliminates this time-consuming procedure.

If there are no errors in the measurement of the temperatures in a test stack, the thermal conductivity of a sample is as follows:

$$k_s = \frac{\Delta X_s}{2\Delta T_s} \left(\frac{k_1 \Delta T_1}{\Delta X_1} + \frac{k_3 \Delta T_3}{\Delta X_3} \right),$$

where

k = thermal conductivity (cal/cm·sec·°C);

ΔT = temperature differential (°C);

ΔX = thickness (cm);

$s, 1, 3$ = subscripts referring to the sample, top, and bottom reference materials in the test stack, respectively.

Studies show that the normal occurrence of error in the measurements, either with embedded thermocouples or with the sensing disks, can be minimized by careful surface preparation and by closely matching the thickness and conductivity of the reference and sample material. Tests were run with both temperature sensing methods using Pyroceram vs Pyroceram and shale vs Pyroceram at sample temperatures up to 200°C. The thermal conductivities determined with the sensing disks were within 7% of the values determined with the embedded thermocouples.

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

The thermal properties of inorganic sediments (or soils) are useful in providing lower-limit values for sandstones and shales, which can be considered as merely consolidated sediments of appropriate composition. Their thermal conductivity is affected by grain-size distribution, mineral composition, and water content. Available data from measurements at room temperature on sediments at about 0.65 solidity (0.35 porosity) are summarized in the following table.

Grain size	Thermal conductivity (10 ⁻³ cal/cm·sec·°C)			
	Dry		Saturated	
	Kaolin ^a	Quartz	Kaolin ^a	Quartz
Gravelly sand	0.5 ^b	1	3-4 ^b	7
Sandy silt	0.5	1	4	6
Silty clay	0.2	0.4	3	4

^aIncludes illite and montmorillonite.

^bSamples rich in mafic minerals, not kaolin.

For all size distributions, the kaolin-rich sediments, whether dry or saturated, have a lower thermal conductivity than the quartz-rich ones because of the higher conductivity of quartz. The coarser sediments conduct better than the finer ones because of the smaller number of interfaces per unit length.

The presence of organic matter in soil will reduce the conductivity. The thermal conductivity of peat is 0.1 dry and 1.0 saturated.

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

A draft report on the hybrid transfer program SALTY has been completed and transmitted to OWI for comments.

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 October.

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

Development work continued on the THAC-SIP-3D heat conduction program. Various input/output user convenience features similar to those in HEATING5 are being added.

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

OWI and Engineering Division comments on the draft report comparing the thermal effects in a spent fuel repository loaded at 60 kW/acre with those in a high-level-waste repository loaded at 150 kW/acre were received and are being incorporated into the final draft.

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

A two-dimensional cylindrical far-field model of a 2000-acre repository with a power loading of 150 kW/acre has been developed for the burial of high-level waste in a salt repository. A transient calculation for the time interval from 0 to 2500 years is being made to predict the time-temperature history throughout the repository and to predict the maximum thermal uplift.

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. The Task 5 (now designated Task 4) Information Meeting on Nuclide Migration was held at Battelle in Seattle, September 20-23. The following work is continuing.

1. The annual technical report is in preparation.
2. The Nuclide Migration Information Meeting Report is in preparation.
3. The annual technical summary for the NWTs Program annual progress report is in preparation.
4. The program for standard geological materials is under way.
5. The FY 1978 form 189s are being reviewed, and changes of work scope are being considered.

II. PNL Internal Research - J. Relyea, D. Rai, and R. J. Serne, "Collection and Generation of Transport Data." Sorption K_d experiments on Tc, Sr, Cs, Am, and I are continuing, and desorption experiments were initiated on 12 minerals. Three-month equilibration supernatant samples have been taken on pure systems of PuO_2 , Pu(OH)_4 , $\text{PuO}_2(\text{OH})_2$, and contaminated Hanford soils in the continuing study to determine (1) the total concentration of Pu in solution at equilibrium, (2) the kinetics of Pu mineral formation, and (3) the nature of Pu compounds in contaminated soils. X-ray diffraction and scanning electron microprobe examinations were performed.

Using the controlled potentiostat, study will continue on the sorption of Pu(III), Pu(IV), and Pu(VI) and the effects of pH and Pu concentration on the distribution coefficient with several minerals.

III. Argonne National Laboratory (ANL) - P. Rickett, M. G. Seitz, A. Friedman, and S. Fried, "Transport Properties of Nuclear Waste in Geologic Media." Column filtration and batch adsorption-desorption studies using rock materials and rock-equilibrated solutions were continued for the isotopes Cs, Np, Am, and Pu.

Comments on the draft report were reviewed, and a final report is being prepared.

Sherman Fried visited PNL on September 16 to discuss ongoing nuclide migration studies.

IV. Oak Ridge National Laboratory - R. E. Meyer, K. A. Kraus, and J. Johnson, "Systematic Study of Nuclide Adsorption on Selected Geologic Media." Batch, column, and axial filtration K_d experiments using montmorillonite are continuing. Comments on the draft report were reviewed, and a final report is being prepared.

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*This report covers activities from September 15 through October 15, 1977.

[†]A detailed report may be requested.

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." Equipment checkout of the single-pass leaching, static K_d , and high-pressure intact-core equipment continued. Options for several field studies were investigated, and discussions were held with the USGS to assess the possibility of using some of their facilities. A draft FY 1978 proposal was prepared. Comments on the draft report were reviewed, and a final report is being prepared.

VI. Rockwell Hanford Operations - G. S. Barney, M. Brutzeck, and R. A. Deju, "Kinetics and Reversibility of Radionuclide Sorption Reactions with Geologic Media." Batch K_d 's on salt, basalt, quartz monzonite, and argillite with associated ground waters are being performed for ^{137}Cs , ^{90}Sr , ^{106}Pu , and ^{241}Am . Accelerated "weathering" experiments on the latter three rocks are in progress. Comments on the draft report were reviewed, and a final report is being prepared.

VII. Adaptronics, Inc. - M. F. Whalen and A. N. Mucciardi, "Statistical Investigation of the Mechanics Controlling Radionuclide Sorption." Data from PNL's batch K_d experiment were statistically analyzed by linear regression and adaptive learning networks. It appears that predictive K_d relationships can be structured from knowledge of geologic media characteristics and solution composition. A draft final FY 1977 progress report is being prepared.

VIII. Lawrence Berkeley Laboratory - John Apps, Sidney Phillips, and John Neil, "Theoretical and Experimental Evaluation of Waste Transport in Selected Rocks." A summary report of the thermodynamic data of solid phases and aqueous species of Pu, Np, Am, and Cm was prepared, as well as a summary report on the available literature on radionuclides. A plan to study the rate and character of penetration of dilute actinide solutions into rock wafers was drafted.

IX. Oak Ridge National Laboratory - C. W. Francis, M. Reeves, and E. A. Bondietti, "Soil Chromatograph K_d Values." Soil chromatographic experiments using soils and crushed shale are being performed for several nuclides. Computer modeling of chemical interactions under unsaturated flow regimes continues. Comments on the draft report were reviewed, and a final report is being prepared.

X. Sandia Laboratories - T. E. Hinkebein, R. L. Schwoebel, R. G. Dosch, and R. E. Cohen, "Microstructural Interactions of Geologic Media with Waste Radionuclides." No activity has been reported for October.

XI. Los Alamos Scientific Laboratory - D. C. Hoffman, K. Wolfsberg, B. Erdal, R. Vidale, and E. Norris, "Laboratory Measurements of Radionuclide Distributions." A draft final FY 1977 report, including pertinent information performed independently on the Nevada Test Site (NTS) Radionuclide Migration Project, was prepared.

Batch K_d 's on crushed alluvium and bentonite with NTS ground water were obtained for Sr, Ba, Cs, Co, Y, Eu, Ce, Sb, U(VI), I, Mo, Nb, and Ru.

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

Work has proceeded on schedule, and cross-section sets for both brine and water mixtures have been completed. Also, a series of test cases has been performed to check the cross sections and the computational model. The critical masses calculated with the computational model have generally been within 10 to 15% of the reference experimental calculated values.

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

A 189c program and budget proposal reflecting a major change in the emphasis of NFRP has been submitted to DOE. The project is entitled "Release Rates of Reactor Products from Stored Fuel Elements, Synthetic Uraninite, and Natural Reactor Ore." The primary objectives of the project are (1) to identify and quantify the release of radionuclides from irradiated UO_2 fuel elements and synthetic and natural uraninite (UO_2) minerals under conditions of geologic storage or disposal and (2) to correlate these measurements with the behavior of radionuclides observed in the Oklo natural reactor system. The principal processes that influence radionuclide release rates and are to be studied in this project are the solid diffusion of radionuclides in the host UO_2 and the dissolution of the UO_2 matrix. Under certain storage or disposal conditions, these can become the rate-limiting processes in the transport of reactor products to the biosphere. The program also calls for the completion of the Oklo radionuclide migration studies.

Most of the components for a device with which to equilibrate aqueous solutions with solids (such as uraninite) under conditions of controlled temperature, pH, and Eh have been received. Machining and assembly of the components have been started.

Twelve samples from a group of Oklo samples received through the French CEA have been submitted for thin-section fabrication. Examination of these sections should help determine conditions for the uraninite solubility experiments and should provide additional information on the physical setting of the Oklo phenomenon.

Lead isotopic analyses of Oklo samples have been initiated. These analyses should indicate the extent of lead redistribution between the reactor zones and the remainder of the ore body because lead in the reactor zones is the decay product of uranium with anomalous isotopic abundances; whereas uranium in the rest of the body is of normal isotopic composition. Reconnaissance samples of ore adjacent to, and distant from, the reactor zone have been selected for initial analyses. The high natural abundance of lead and the possibility of contamination during chemical separation require very clean analytical procedures. A microchemical separation technique is being tested for ~2-mg-sized samples, which should add only 3 to 5×10^{-11} g of the contaminant lead. In addition to this contamination problem, the mass fractionation of lead on the mass spectrometer must be monitored closely, and fractionation factors for our normal analytical procedures are being determined.

1.3.2.4 Near-Field Waste/Rock Interaction . . . D. M. Roy, G. W. Brindley, J. V. Biggers, G. J. McCarthy, W. B. White, S. Lomarneni, and B. Scheetz, Pennsylvania State University

Salt consolidation and brine migration

Hot-pressed samples of salt are being prepared with two different grain-size aggregates, 100 and 400 μm , and with three densities - 85%, 95%, and 100% - of theoretical. Test bars with 6- x 6-mm cross sections will be used to determine strength, using a 4-point-bend test fixture.

The compaction behavior was also investigated at room temperature, by pressing salt disks 1/2 in. in diameter by 1/8 in. thick in a tungsten carbide die, using various pressure levels. The salt was divided into two batches - the first batch was pressed "as is," and the second batch was dried for 12 hr at 110°C prior to pressing. This data combined with the hot-pressing data should lead to a deformation map for this particular salt. Next month's work will include studies of the effect of brines on consolidation.

Shale-waste compatibility

This month's efforts have been directed toward the preparation of a comprehensive statement of the results that were obtained during the first five months of this work. Because of the interruption in funding, all personnel were transferred, and support equipment was shut down; however, personnel have now been reassigned, and the equipment is being made operational.

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

On October 1, Roger W. Klaffky was assigned to this project. For the past three years, he has been conducting a study of thermally stimulated currents in irradiated aluminum oxide, using the electron accelerator employed for the rock salt radiation damage studies.

No new data were acquired during this report period. Problems with the electron accelerator delayed the completion of any of the planned irradiations. Consequently, much of the time was devoted to accelerator repairs. Also, vacations and attendance at the ORNL-sponsored "International Conference on Defects in Insulators" accounted for a large amount of time.

Analysis of radioluminescence and thermoluminescence data acquired in the past was started. Although the analysis has just begun, some qualitative results can be given. All natural rock salts studied to date exhibit radioluminescence during electron irradiation. The emission is most intense immediately after the irradiation is started and diminishes thereafter until it reaches a more-or-less constant value. When the irradiation is terminated, the luminescence disappears immediately (i.e., phosphorescence is not observed). The emission contains at least one broad band with peak intensity in the 2.3- to 2.4-eV region and another below 3.0 eV.

An irradiation of 7×10^8 rads causes the radioluminescence to decrease by roughly one-half. Considering the large number of defects produced by this irradiation, including colloid particles, the observed reduction in luminescence appears to be rather small. This suggests that the radiation-induced defects do not strongly influence the total number of luminescence processes. It is hoped that the luminescence measurements will provide information on the different types of processes entered into by the very large number of ionization pairs produced by irradiations in the range of 10^8 rads.

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

Investigation is continuing of the hydration of CaSO_4 in NaCl brines and the effect of MgCl_2 concentrations to 30 wt % on the solubility of CaSO_4 in NaCl-saturated brine.

Stewart attended the WISAP Task 5 Information Meeting in Seattle, September 20-23, and afterward prepared a summary letter. On September 26 at a meeting in Denver, he planned the efforts of his USGS branch on the Paradox basin rocks so that they would coordinate with other USGS efforts.

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

Efforts for October were focused on narrowing some of the broader-sized fractionations to determine if certain characteristics - such as expandable mixed-layered clays - are being masked. Presently, additional data are available for the 2- to 4- μm , $<2\text{-}\mu\text{m}$, and $<4\text{-}\mu\text{m}$ size fractions, which join the four previous cuts to give a clearer picture of the diagenetic processes that have occurred. Additionally, glycolation and heating analysis are in progress to determine the expandable mixed-layer clay percentages that occur in the western and northern limits of the Conasauga Shale project boundaries.

Argon isotopic analyses have been completed on additional sets of 0.2- to 2- μm and $<0.2\text{-}\mu\text{m}$ fractions of Conasauga Shale samples. Potassium analyses of these samples have been delayed; therefore, no new potassium-argon ages are reported. Work has continued on the use of rising current elutriation as a means of separating the silt-size fractions of the shale into narrow size ranges. The method appears to work well except for problems of incomplete disaggregation of the shale particles. Definition of a treatment that will provide adequate disaggregation without severe physical or chemical disruption of the particles is being attempted.

Preparation of samples for $^{18}\text{O}/^{16}\text{O}$ analyses continues. Vitrinite reflectance measurements are nearly completed.

1.3.3 ROCK MECHANICS . . . J. E. Russell

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

The RE/SPEC efforts regarding the OWI Program primarily involve rock mechanics analyses. Along this line, RE/SPEC is performing numerical simulations of repository concepts, conducting a materials testing program, and doing in situ experimentation.

During this report period, a report entitled "Case History Rock Mechanics Examination of the Jefferson Island Salt Mine: III. Evaluation of Laboratory Specimen Dimensions on the Uniaxial Strength and Deformation Characteristics of Dome Salt," written by Randall G. Stickney, was submitted to OWI for review.

Phase 1: Repository concept analysis and evaluations

Task 3A: Continuation of quasi-static and creep tests on bedded and dome salt. Last month the remainder of salt core from Avery Island (AI), Louisiana, was expended. A field crew is presently at AI performing various tasks in preparation for the in situ heater experiment. A request for additional core samples from AI has been made; the field crew indicated a possibility of obtaining and shipping either unoriented blocks of 4-in.-diam specimens by the end of October.

In the interim, three simultaneous long-term tests are being conducted on Jefferson Island salt at three mean stress [$\sigma_m = 1/3 (\sigma_1 + \sigma_2 + \sigma_3)$] levels, namely, 1500, 2500, and 3500 psi. These three tests are expected to last 40 days, which is substantially longer than previous creep tests.

Considerable effort is being expended on the development of a viscoplastic constitutive creep law with mean stress and temperature dependence. Collectively, data obtained to date are being examined and compared with published data. It is hoped that constants needed in such a formulation can be obtained from experimental data presently on hand.

Task 4: Design, fabrication, and implementation of additional creep apparatus. Assembly of the main frames for the creep machines has been completed onsite at Ragsdale Brothers, Denver. All machine fabrication is complete, and the components have been painted. All of the assembled apparatuses, including intensifiers, are scheduled for shipping on October 28. The next phase of fabrication involves finalizing the hydraulic control systems. Hydraulic systems have been designed and drafted, and most of the components have been purchased.

The data logger/acquisition system has arrived. Initial interaction between the computer system and programmer has been successful. Acoustic coupling, magnetic tape logging, and signal conditioning for data logging are in progress.

Task 5: Parametric scoping study of the global temperature fields around high-level-waste repository facilities. Subsequent to completion of the global thermal analyses for the 3000-ft-deep repository in a granitic medium, the repository depth has been changed to 1000 ft. In

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*This report covers activities from September 16 through October 15, 1977.

prior analyses, gross thermal loadings of 50, 100, and 150 kW/acre were considered for both spent fuel and high-level waste. For the 1000-ft-deep repository, only the 150 kW/acre loading has been considered. Peak temperature rises of 260°F and 200°F occurred for the spent fuel and high-level waste, respectively. Temperature field perturbations (within the limits of the depths considered) are at most 10%. The variations observed are due to the proximate surface and the imposed convective boundary condition. A report is being prepared which compares results from both the 1000-ft-deep and 3000-ft-deep repositories. In addition, a temperature scaling technique is being used to evaluate temperature distributions in other rock types, such as shale and limestone.

Task 6: Parametric scoping of the potential for global thermal fracturing and global plastic flow around high-level-waste repository facilities. Thermoelastic analyses have been completed for the 1000-ft-deep repository located in granite for the thermal loadings discussed under Task 5. The maximum vertical surface displacements were 23.5 in. at approximately 1000 years for the ten-year-old spent fuel and 8.2 in. at approximately 600 years for the ten-year-old high-level waste.

Failure potential analyses have been completed for two initial in situ stress states represented by the value K (lateral/vertical earth pressure). The two initial in situ stress states consisted of a gravitating medium and $K = 2$. In addition, a brief study investigated the effect of varying K with depth in order to represent more realistically in situ field conditions. Critical areas are seen in the shaft pillar and at the outer perimeter of the repository, where the largest thermal gradients exist.

A report is in preparation in conjunction with the thermal report which compares the results from the 1000-ft-deep and 3000-ft-deep granitic repository models.

1.3.3.2 Displacement Discontinuity Modeling* . . . Michael Hardy, University of Minnesota.

In the previous monthly report, it was noted that the creep model originally used in the displacement-discontinuity-based models had been replaced by an alternative form that better accounted for the effect of a load reversal on the calculated pillar creep. Computer runs completed during the past month indicate that there is little difference between results from the old vs the revised models providing there is not a sudden decrease in load, such as occurred at the experimental area of Project Salt Vault after the thermal loading ceased.

During the week of October 3-7, C. M. St. John visited three potash mines in Saskatchewan. The object of this visit, which was arranged by OWI, was to gather data for model correlation studies and to become familiar with data collection techniques and ground conditions.

The problem of combining the displacement discontinuity method or a boundary integral equation method with an explicit finite-difference model was considered during the past month. Informal discussions have

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*This report covers activities from September 16 through October 15, 1977.

been held with R. Hofmann and D. E. Maxwell, of Science Applications, Inc., to determine the most appropriate means of achieving the desired coupling. Also during the report period, a brief summary of the work accomplished during the year was completed for inclusion in the NWTS Program annual progress report.

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

No activity has been reported for October.

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

The first sample is presently being tested. No serious problems were encountered in preparing this sample, although many minor preparation techniques were resolved. The granite blocks were finished by a commercial quarry in Minnesota and were then instrumented in the laboratory.

The ten strain gauges and four dial indicators are being monitored prior to drilling the 6-in. hole. The technique of instrumenting the hole will be practiced on a block of granite that has a 6-in. hole in the same location as that of the salt block. This technique should eliminate the initial test problems and provide better data.

The rough finishing of the samples has left a fairly large supply of salt that is being saved for possible future testing on the smaller testing machine. The smaller pieces of salt were not returned from Minnesota.

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

The objective of this program is to measure the thermal properties, thermal expansion, thermal conductivity, and heat capacity of rocks containing water. These measurements will be made with confining pressures to 0.2 GPa and temperatures to 725°K. The pore pressure will also be varied to determine its effect on the thermal properties.

The program started September 1, 1977. During September, design work and equipment procurement were initiated.

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

An organizational meeting of the three designated data centers that were most qualified to contribute to the preparation of a Salt Properties

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*This report covers activities from August 8 through October 21, 1977.

[†]This report covers activities during September 1977.

[§]This report covers activities from September 15 through October 15, 1977.

Data Handbook was held at the National Bureau of Standards on September 15. Attendees were J. L. Haas and D. B. Stewart, of the National Center for Thermodynamic Data of Minerals, USGS; G. J. Janz, of the Molten Salts Data Center, Rensselaer Polytechnic Institute; Y. S. Touloukian, of the Center for Information and Numerical Data Analysis, Purdue University; J. E. Russell, of OWI; and L. H. Gevantman, of the Office of Standard Reference Data, National Bureau of Standards.

The discussion centered on the assignment of the data evaluation effort for the handbook, using an altered version of an outline suggested by Russell. Briefly, the assignments decided upon were as follows:

1. The National Center for Thermodynamic Data of Minerals, USGS, will be responsible for the geological data.
2. The Rensselaer Molten Salts Data Center will subcontract with R. Tomkins, of the New Jersey Institute of Technology, to do the chemical data using the facilities of the National Center for Thermodynamic Data of Minerals.
3. The Purdue Center for Information and Numerical Data Analysis will do the physical properties data.

In addition, Russell supplied a list of chemicals that should be taken into account because they affect salt properties when present as impurities.

A revised proposal that reflects the areas of effort agreed upon has been received from Touloukian. Similar proposals are expected from Haas, Tomkins, and Janz. Upon receipt and acceptance, the Office of Standard Reference Data will activate the handbook project.

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

Permeability measurements were completed on a series of type I Portland cement/Kingston fly-ash pastes. The samples had a water-to-solids (w/s) ratio of 0.485, with 0 to 40% of the cement being replaced with fly ash. The permeability values ranged from 4.5×10^{-5} darcy to 1.5×10^{-4} darcy, with no apparent correlation to the fly-ash content. The specimens were cured 28 days at 22°C in saturated lime water and then dried 24 hr at 110°C prior to making the measurement. All measurements were made using the Hassler Cell technique with nitrogen gas as the permeability fluid.

Compressive strength measurements were made on a set of 28-day-cured mortars prepared as controls for the fly-ash studies. The specimens contained type I Portland cement, with 0 to 40% of the cement replaced with Ottawa sand and with a w/s ratio of 0.485. They were cured at ambient temperature after being coated with Protexo Cote. The compressive strength varied as follows: $Y = 27.5 - 0.42 X$, where Y is the compressive strength and X is the sand (in weight percent) present in the samples.

The differential thermal analyzer and dilatometer of the thermal analysis system have been installed and are being checked.

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

During the month, the work on the effect of water-reducing admixtures on the properties of the cement slurry, hardened pastes, and mortars has progressed in several areas. Measurements of compressive strengths of long-term-cured cements with admixtures are continuing. Weight-loss measurements at 110, 200, and 900°C have also been obtained at intervals of one day, three days, and one, two, three, and four weeks for these pastes in order to determine the adsorbed or pore water and chemically bound water contents as a function of time. These data are being analyzed. Modifications are being made to the Brookfield viscometer so that the viscosities of slurries can be measured. The electrical double layer formed near the surface of solids in contact with an electrolyte in solution usually results in a potential difference at the solid-liquid interface. This surface potential is affected by the introduction of additional electrolytes or surfactants into the solution. Measurements of the surface potential (zeta potential) are being made in an effort to obtain a more thorough understanding of the role of surfactant admixtures in determining the properties of cement slurries and to enable quantitative comparisons between the effects of various types of admixtures.

An effort is continuing in an attempt to establish the validity of the assumption that high pressures can be applied to the "average pressure" term in Darcy's equation. This assumption has been shown to be valid for the pressure range up to 350 psi, at which continuing permeability measurements are being made. Establishment of the validity of this assumption up to 800 psi is being attempted. The Hoek-Franklin cell for radially restrained permeability measurements has been modified to conform to the availability of jacketing materials for the sample containment. This modification is complete, and trial experiments have been initiated.

Density, surface area, and weight-loss measurements are continuing on the cement compositions that have been cured under accelerated conditions. Preliminary results indicate that the samples of types I and V cement pastes cured at 55°C contain more chemically bound water than their room-temperature-cured counterparts.

The cement-rock interface studies have involved scanning electron microscope (SEM) characterization of 90-day-cured shale-cement samples compared with 3-day-cured samples (both cured at 2500 psi and 85°C). These studies indicate that, initially, very little chemical interaction is taking place at the cement-shale interface. However, after prolonged treatment, interaction does occur, and some degree of bonding is present. Efforts will be directed toward a determination of the quality of this bond in the present types of sample, as well as some new configurations and types of materials.

Cement paste and mortar chemical shrinkage studies at atmospheric pressure are continuing; these studies reveal significantly different effects between mortar and paste. The existing high-pressure apparatus does not seem to be sufficiently accurate for the measurements required at elevated pressures; thus, modifications of this apparatus are being designed.

1.3.4.3 Investigation of Salt Transport in Vertical Boreholes and Brine Invasion into Freshwater Aquifers . . . R. M. Knapp and A. L. Podio, University of Texas at Austin

No activity has been reported for October.

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

Program management

A summary of technical progress for the NWS Program annual progress report was written and is under internal review.

Tasks 1 and 2 (Methods and Concepts and Disruptive Events Analysis) have been combined into one task, which is now designated Task 1. The previous Tasks 3 and 4 are now labeled Tasks 2 and 3 and have been re-named as shown below.

Task 1: Release scenario analysis - Jess Greenborg and J. A. Stottlemire. Tasks 1 and 2 from the FY 1977 program have been combined for FY 1978. A second draft of a discussion paper, "Safety Assessment Methods for Geologic Isolation," was completed and is under internal review. The first draft of a report describing the results of the Task 2 workshop held in July was completed and is under internal review.

Task 2: Waste form release rate data - D. J. Bradley and R. P. Turcotte. Purchase requisitions are being prepared for the autoclaves (for the high-temperature/-pressure studies of doped and high-level waste) and for the combination glove-box/open-face hood (for the static and anoxic doped leach experiments).

Because of waste disposal problems in the hot cell that is to be used for the spent fuel leach studies, these experiments will not be started for another week or two.

A form 189 from Lawrence Livermore Laboratory concerning temperature and flow-rate studies of actinide-doped waste glasses has been received and is being reviewed. A form 189 for the low-level-waste leaching program has been submitted by Brookhaven National Laboratory.

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*WISAP = Waste Isolation Safety Assessment Program.

[†]This report covers activities from September 15 through October 15, 1977.

Leaching tests were started on the final series of doped-glass beads that contained ^{99}Tc , thus completing that section of work on schedule.

Task 3: Release consequence analysis - J. R. Raymond and J. K. Soldat. Calibration and verification cases are being run to test the Davis Finite-Element Three-Dimensional Model. Currently, a model run using the Long Island data set (a large, 2035-node, three-dimensional case that has been run elsewhere) is being attempted. Work is continuing on a report describing the model and on a users' manual.

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

No activity has been reported for October.

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

Field activities for the tests in Conasauga Shale at Oak Ridge, Tennessee, were curtailed for much of the month pending arrival of a drill rig to be used for the central heater holes. However, during the final week of October, rapid progress was made toward completion of the required drilling. Accordingly, installation, completion, and "turning on" of the heaters are expected to take place in November. A portion of the mineralogic analyses has been completed, and additional thermal expansion measurements were performed (as reported below).

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

Drilling for the central heater holes commenced on October 24 and progressed through the end of the month. One heater hole was completed to total depth, and drilling on the second hole is under way. This drilling will complete site preparation and will permit completion of instrument installation.

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

X-ray diffraction was used to detail the mineralogies of the diverse lithologies present at the site. The carbonate in the limestone proved to be relatively pure calcite, but the limestone was impure to the extent that almost all samples contained detectable amounts of quartz and oligoclase. As would be expected, the siltstones consist primarily of quartz and feldspar with lesser amounts of clay minerals and calcite. In the shales, the dominant sheet silicate mineral belonged to the chlorite group, with illite usually present in lesser amounts and montmorillonite absent. The remainder of the shale was composed of quartz, feldspar, and calcite in varying proportions. No pyrite was noted in any of the samples. Thermal expansion measurements have been carried out on limestone samples to assess whether the lithologic complications are of concern in modeling the mechanical response of the formation. In contrast to the behavior already reported for shale, the limestone expands monotonically to 600°C. Therefore, the bedding must be considered in attempting to model the situation that actually exists at the site.

2.1.1.2 Dome Salt In Situ Tests

Activities on the Avery Island heater experiment in Louisiana continued, with more progress being made both in the field and on the shop fabrication work. Construction of the underground control room in the mine is well under way, and equipment fabrication in the ORNL shops is approximately 80% complete.

The first of two planned shipments of equipment is scheduled for early November. This shipment will include all major electrical equipment needed for the electrical subcontractor's work in the mine.

Field operations . . . L. L. Van Sambeek, RE/SPEC Inc.

The actual field work for the Avery Island in situ heater experiment has begun. In early October, the drilling equipment was moved underground to the site, and the construction of a control shack was begun. The control shack is framed in, and the finishing aspects of insulating and enclosing are expected to be finished within the month.

Actual drilling will not begin until the approval of the electrical sub-subcontract is obtained. Approval is expected by mid-November, which should allow a December 1, 1977, drilling start date. At this time, estimates indicate that the experiment can be completely installed by March 1978 if the December 1 drilling initiation date is met.

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

Equipment fabrication continued in the ORNL shops. Job completion has been delayed because of (1) the late arrival of the thermocouple materials, (2) manpower shortages (particularly in the carpentry and welding trades), and (3) a general schedule slip due to a change in project management. However, these problems should be alleviated by early November.

The heater canisters have been completed and are being installed with the skin thermocouples. Three of these canisters will subsequently be packaged for shipment, and the fourth canister (spare canister "D") will undergo a two-week power test prior to packaging. The pieces for the three sleeves have been fabricated and are at the Engineering Technology Division Shop at Y-12 for final instrumentation (strain gages, thermocouples, etc.) and assembly. In fact, sleeve "C" has been completed and is ready for packaging. Peripheral heater sleeves are being fabricated and should soon be packaged. Also, the insulation cans have been completed and are being packaged. Fabrication of the peripheral thermocouple sleeves is slow because the tubing must be slit on a planer and then deburred at a rate of approximately one tube per day. The heat flux meter is undergoing calibration and is scheduled for completion soon. The backfill tubes have been sandblasted and wrapped for shipment. The closure measuring tools have been fabricated and assembled and are being calibrated before packaging.

The instrumentation panels are nearly complete - awaiting only the return of the data loggers before final checkout and packaging. The

data loggers have been shipped to Accurex for interfacing and should be returned by mid-November. The final testing and packaging of the electrical panels are pending receipt of a shipment of meter relays. The load test buggy is complete. Truck shipment pricing has been obtained for transportation from Oak Ridge to Avery Island, packing lists for each crate have been drafted, and final planning is under way.

2.1.2 DESIGN STUDIES . . . P. D. Fairchild

Final documents were received in October for the OWI Quality Assurance (QA) Plan and for the design of the canister emplacement hole drill, thus completing the subcontractor's work. Draft reports on the study of nondestructive assay (NDA) techniques were received and are currently under internal OWI review. The Cask Scoping Study will be concluded early in FY 1978, and Sandia Laboratories has begun preparation of their final report. The FMC Corporation canister transporter project will continue into FY 1978 and therefore will continue to be reported.

2.1.2.1 Canister Transporter . . . M. Wallis, FMC Corporation; M. K. Preston, Engineering Division, UCC-ND

The FMC Corporation, Engineered Systems Division, has continued with the conceptual design of waste transporters to handle high-level-waste canisters and canistered spent fuel elements. A design review meeting was conducted at FMC in San Jose, California, on October 26-27, with UCC-ND Engineering Division and OWI personnel in attendance. The contract for an increase in scope to cover the horizontal burial conceptual study and additional shielding calculations by Los Alamos Technical Associates (LATA) has been approved by DOE and issued to FMC.

FMC has progressed with the conceptual study for a burial cask and operating mechanism for the purpose of carrying, inserting, and retrieving waste canisters in the horizontal mode of burial in the mine pillars. In addition, transporter concepts for vertical burial are being expanded to provide more detail regarding materials, equipment, actuators, and shielding. Design has continued on the two-canister spent fuel transporter, which is nearly complete. Reduced-size drawings are being prepared which depict the operating sequence. The two-canister cask was reviewed by LATA for adequacy of shielding and design.

The installation cycles for high-level waste (HLW), intermediate-level waste (ILW), and cladding waste (CW) have been evaluated on the basis of first filling the outermost panels of the repository and then working inward toward the shafts. This analysis plus an economic analysis have identified the need for a two-canister capacity transporter that will handle all the HLW and CW and some of the ILW. After several years of repository operation, two additional ILW transporters will be required. These will be smaller machines, which will transport all-steel casks because neutron shielding is not required and because the gamma shielding is minimal compared to that needed for spent fuel or HLW. The all-steel construction will simplify cask manufacture.

2.1.2.2 Canister Emplacement Hole Drill . . . M. K. Preston, Engineering Division, UCC-ND

Foster-Miller Associates of Waltham, Massachusetts, has completed the study on the availability of commercial drilling equipment for a repository. The Foster-Miller final report^{*,†} has been issued with the recommendation that an auger drilling rig with air circulation bailing (removal of drilled salt fragments) be used on a crawler frame. This report completes the contract with Foster-Miller.

2.1.2.3 Cask Scoping Study . . . P. D. Fairchild

The Cask Scoping Study is intended to provide preliminary information on cask availability and, more particularly, on the total procurement schedule for new casks - including design, licensing, testing, and manufacturing (although neither cask ownership nor shipping arrangements is necessarily viewed as a repository responsibility). Sandia Laboratories has furnished OWI a summary of the cask procurement plan for review. They are currently working on other aspects of their final report. A review meeting is scheduled for November 2 to discuss the contents of the final report and to discuss the implication of cask design variations on the receipt/unloading interfaces at the repository.

2.1.2.4 Study of Nondestructive Assay Techniques . . . P. D. Fairchild

Two reports that cover (1) existing nuclear assay equipment and (2) recommendations in the area of nuclear assay measurements for the repository have been received and are under internal OWI review. Final revisions and formal report issuance are expected in November.

2.1.2.5 Quality Assurance Plan for OWI . . . P. D. Fairchild

Copies of the OWI proposed QA Manual have been forwarded to DOE-ORO for review and approval; copies have also been distributed within OWI. Usage of the manual is pending DOE review and approval of certain delegated QA responsibilities as well as formal approval of the QA policy statement by the president of UCC-ND. A DOE/OWI meeting is planned for review of the implications of this type of National Regulatory Commission QA Program (10 CFR 50, Appendix B).

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^{*}Foster-Miller Associates, Inc., Emplacement Hole Drill, Evaluation and Specification Study, Volume I, prepared for Union Carbide Corporation, Nuclear Division, Office of Waste Isolation, Y/OWI/SUB-77/22324/1 (Sept. 30, 1977).

[†]Foster-Miller Associates, Inc., Emplacement Hole Drill, Evaluation and Specification Study, Volume II - Appendices, prepared for Union Carbide Corporation, Nuclear Division, Office of Waste Isolation, Y/OWI/SUB-77/22324/2 (Sept. 30, 1977).

2.2 Repository Projects

S. C. Matthews

2.2.1 CONCEPTUAL DESIGN OF NWTS REPOSITORIES 1 AND 2

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

A meeting was held October 17-19 at SRENCO to review the conceptual design status. In-depth reviews of the waste transporter concepts and the mine ventilation design status were conducted; also, discussions of the low-level-waste facility, the canistered waste facility, and licensing design bases took place. A design review meeting at the 50% completion point is scheduled for December 13-15 in Oak Ridge. SRENCO will forward all available design materials to UCC-ND and DOE on November 21. During October, design memos regarding canister size, waste volumes, and handling rates were issued by SRENCO and approved by OWI.

Kaiser presented the Planning Study design to OWI/UCC-ND/DOE personnel in Oak Ridge on September 27 and participated in a conceptual design status review on September 28-29. Topics discussed were the (1) shaft and shaft pillar study, (2) electric vs diesel mine equipment study, (3) mine/earthquake study, (4) alternative site arrangements, (5) dry vs wet processing, (6) handling rates and flexibility, and (7) transporter alternatives. The next review meeting will be at Kaiser on November 9-10, and major topics will include finalization of the mine layout concept and the waste handling philosophy.

The approximate percentage of completion for Repository 1 (SRENCO) is 44%, and for Repository 2 (KE), 52%.

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

General design efforts continued throughout the month. The work breakdown schedule for Underground Facilities was reviewed, and several revisions were made to reflect the tasks remaining to complete the design activities in this area. Woodward-Clyde Consultants (WCC) has produced preliminary drafts of reports in support of SRENCO's design efforts. These reports include (1) a review of applicable mining methods, (2) a selection of shaft sinking methods, (3) a study of the canistered waste repository capacity, and (4) an evaluation of alternative canister storage methods. These reports will be reviewed by OWI prior to the issuance of final reports.

A meeting was held October 17-19 in Denver with DOE, OWI, UCC-ND, and SRENCO personnel to review the project status. On October 25, SRENCO met with WCC personnel in Denver to review the status of their work orders and to develop a program for completing this effort.

SRENCO has continued to develop the far-field thermal analysis computer studies. Some minor problems in the setup of the model have resulted in a delay of this analysis. All work on both the near- and far-field thermal analyses is anticipated to be completed during November.

A final selection of the preferred concept for the waste transporter system was made after the review of several different concepts. The final report summarizing this effort will be issued during November. At the request of DOE/OWI, SRENCO will continue to develop more-detailed design descriptions of the preferred transporter system concept.

Approval was received to continue with the additional occupational exposure and health physics studies. Energy Incorporated will perform the bulk of these studies, assisted by information currently being developed by SRENCO.

The Planning Study has been revised in accordance with the comments received from DOE and OWI and will soon be issued in the final form.

General conceptual design efforts will continue during the next month, and the occupational exposure and health physics studies will be initiated by Energy Incorporated. The far- and near-field analysis effort will continue during November.

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

Kaiser Engineers' technical effort continued in the areas of thermal and nuclear analyses, mining, estimating summary for the Planning Study report, and final editing and publishing of the Planning Study reports.

A field trip was made to the Federal No. 2 Mine, Bula, West Virginia, to examine their computerized system for sensing and recording safety conditions underground.

Mining engineers, accompanied by DOE and OWI personnel, also made field tours and inspection trips to the Cayuga Salt Mine, Ithaca, New York; the Retsof Salt Mine, Retsof, New York; and the Detroit Salt Mine, Detroit, Michigan, to examine mining methods and equipment. Deep potash mines in Canada were also inspected by KE, OWI, and DOE engineers to observe mine maintenance problems and mining machine productivity. The mines visited were the Rocanville Division Mine of the Potash Corporation of Saskatchewan; the Alwinal Mine of Potash of Canada, Ltd.; and the Central Canada Potash Corporation Mine. Trip reports are in preparation.

The majority of studies in progress during September has continued through October. These studies include (1) investigating the feasibility of storing two, three, and four BWR assemblies in a single canister with consequent reduced handling and burial hole quantities; (2) examining the possibility of combined low-level-waste (LLW) and spent fuel handling in a single surface building; (3) developing mine layouts that minimize the number of shafts and improve ventilation routing at the mine level; (4) developing automated methods of canister unloading and handling in the waste handling surface facility; (5) performing a literature search on earthquake effects on deep mines; (6) investigating salt disposal alternatives; (7) reducing salt storage costs; (8) reducing mine ventilation air quantity; (9) developing a transporter that carries canisters horizontally but emplaces vertically; (10) determining the economies possible with various types of on-site power generation; and (11) performing hand calculations to obtain correlation with Project Salt Vault experimental results on mine closure.

Tentative study results indicate that (1) four BWR assemblies can be stored in one canister; (2) a mine layout with the shaft pillar extending to one side of the burial panels like a panhandle provides the best mine configuration when mine development, traffic flow, and ventilation are considered; (3) on-site steam should be generated by leased boilers to achieve minimum capital cost; and (4) partial on-site power generation by permanent turbines would result in lowest life-cycle cost. A design status review meeting is scheduled for November 9-10 to discuss recent design decisions and to study work in progress which has not yet reached the decision stage.

2.3 OWI Facilities

S. C. Matthews

No activity has been reported for October 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 salt, granite, and shale 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. All work under the initial contract scope was completed by September 30, 1977.

The final GEIS submittal, which was based on this work and which describes the preconceptual repository designs for various fuel cycles in salt, granite, and shale and identifies the effluents anticipated from

these designs, was delivered to PNL on September 30, 1977. These preconceptual designs described repositories capable of handling the waste forms and projections defined by OWI* for three fuel cycles: total recycle, uranium-only recycle, and the spent unprocessed fuel cycle. Technical documents describing the analytical and design efforts performed in support of this GEIS have been delivered in working draft form by each of the subcontractors. In addition, preliminary cost estimates have been prepared for surface facility construction, shaft construction, mine construction and operation, and waste handling operations.

During the past month, each of the subcontractors responded to an OWI request for proposals to expand these studies to include repository designs in basalt for each of the three fuel cycles and to analyze the impact of a set of waste forms and their associated projections that have recently been supplied by PNL.† In addition, this expanded effort will deal with several questions associated with ground-water flow into the repository area. This effort will (1) define the impacts of increased host rock temperatures on the inflow in the granite, shale, and basalt repositories, (2) analyze techniques to handle the inflow, and (3) analyze its influence on possible nuclide migration. Finally, this effort will result in a conversion of the working drafts of the technical documents supporting the GEIS into final technical reports.

These proposals have been reviewed, and contracts are being negotiated. The negotiated contract completion date is expected to be March 1978.

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*Kisner, R. A.; Marshall, J. R.; Turner, D. W.; and Vath, J. E.; OWI Waste Projections and Source-Term Data for FY 1977, Office of Waste Isolation/Union Carbide Corporation, Nuclear Division, Y/OWI/TM-34, in preparation.

†"Waste Packaging Descriptions for Impact Statement on Commercial Radioactive Waste Management," letter from C. M. Unruh, Battelle Pacific Northwest Laboratories, to C. D. Zerby, Director of OWI, Sept. 28, 1977.

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

All information required for the first Program Review Meeting was prepared on schedule. This preparation included (1) an update of the network diagram and the Work Breakdown Structure/Program Responsibility Matrix, (2) the creation of a Program Master Schedule, (3) 58 Department Work Authorizations, (4) 171 Task Work Authorizations, (5) 62 Department Schedules, and (6) 195 Department and Task Budget charts. A total of 436 35-mm slides was prepared and now forms the principal planning data base for the OWI Program. The Program Master Network and Schedule, along with geologic maps, organization charts, and facility renditions, were displayed in the control room. The necessary projection equipment and equipment console were received and assembled during the month prior to the review meeting.

The first Program Review Meeting using the Program Control System was held October 24. A review was presented of the Program Control System - its status and future plans; the program assumptions and guidelines; the Program Statement of Work; Technical and Management Plans; the major scheduling conflicts and risk areas; and the overall FY 1978 and Life-Cycle Budgets. Following these presentations, each department head reviewed selected activities in his area of responsibility using the prepared slides to describe the activities.

The baseline data are currently being upgraded to incorporate modifications that were suggested during the meeting.

3.2 Program Planning

J. E. Vath

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

The OWI Program Plan was further revised to reflect the program status as of October 1 and to incorporate work authorizations and schedules developed for the Program Control System.

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

Waste projection data memos 13 and 14 were issued this month to OWI project managers in support of heat transfer and waste canister shielding studies. The power and energy from uranium and plutonium from the spent fuel [in metric tons of heavy metal (MTHM)] were included in memo 13. Memo 14 contained tables of photon spectra, radioactivity, and structural material composition for cladding waste.

Work continued on the preparation of the report Y/OWI/TM-34, entitled "OWI Waste Projection and Source-Term Data for FY 1977." This report will document the data supplied this year to OWI subcontractors, particularly to those (Science Applications, Incorporated; Dames & Moore; and Parsons, Brinckerhoff, Quade & Douglas, Inc.) who were involved in the support of the generic environmental impact statement (GEIS) for waste management. The report is undergoing OWI internal review.

Pacific Northwest Laboratories' (PNL) waste descriptions and projections for the GEIS arrived for review this month, and a cursory examination of their data package has been completed. The PNL nuclear power forecast is lower than that of OWI [at year 2000, OWI is using 480 GW(e) compared to 400 GW(e) from PNL]. After adjusting for this difference, agreement between the PNL and the OWI projections was found to be within 11% (PNL high) on the number of spent fuel assemblies and metric tons of high-level waste (after density correction).

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

The purpose of the Waste Inventory Study is to (1) survey existing commercial nuclear facilities to determine actual waste produced (excluding spent fuel and high-level waste), including the character, form, and generation rates of the wastes, and (2) develop projections of future waste production through the year 2000 based on assessments of waste treatment and packaging technology that is presently available or expected to be developed. The selected vendor is preparing the Statement of Work and the Pricing Proposal for this study.

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

No activity has been reported for October.

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 Cask Scoping Study and 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 at RHO on October 19 to review the current status of these studies and to discuss future work. A draft outline for the HLW canister report was presented by the RHO personnel and discussed. The lack of information about waste forms and waste characteristics was identified as a major problem in the Waste Packaging Study (Sect. 3.3.1.2). This information will eventually be supplied by the Waste Acceptance Criteria and Waste Inventory Studies, but pending the generation of the information by the above studies, the Waste Packaging Study will have to proceed on the basis of generic waste forms.

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

An objective of the High-Level-Waste Canister Envelope Study is to establish canister acceptance criteria that will assure that the waste canisters are compatible with all handling equipment and environments from the waste solidification process until emplacement in the federal geologic repository. To accomplish the objective, all constraints (size, weight, waste heat density, etc.) imposed by the handling equipment and environments must be identified for their impact on waste canister design. Five firms have been engaged to provide technical assistance in the development of canister acceptance criteria.

Science Applications, Incorporated (SAI)

Science Applications, Incorporated, has completed their study and has concluded that the transportation phase of the high-level-waste disposal problem does not impose more restrictive design constraints on the waste canister than do other portions of the canister life cycle, such as filling, interim storage, and final geological storage. However, the canister configuration within the shipping cask and the shipping cask space envelope can significantly influence the amount of high-level waste that can be shipped per cask.

Battelle Columbus Laboratories (BCL)

A review of the potential canister materials problems and limitations was conducted by BCL. They conclude that the greatest threat to canister integrity is failure by stress corrosion cracking (SCC) of a sensitized, stressed type 304L stainless steel canister in interim water storage at the fuels reprocessing plant. The sensitized condition and residual stress arise from the in-can melting process for converting the calcined waste to glass. Their suggested process sequence for the filling and storage of the canister to minimize this problem recommends a canister material more immune to SCC than the reference type 304L stainless steel, together with the use of the continuous ceramic melting process, which is less thermally severe than the in-can melting process for producing glass.

The sequence suggested by BCL is as follows:

1. Convert the high-level liquid waste to glass or calcine by an appropriate method, preferably the continuous ceramic melter.
2. Use an Inconel 600, Incoloy 800, or Incoloy 825 canister.
3. Mechanically lock and seal-weld the lid; inspect. Be sure the outside surface is clean and free of oxide films, crevices, overfills, and undercuts.
4. Store in water for the interim period at the fuels reprocessing plant.
5. At the end of the interim period, overpack with a carbon steel sleeve overpack of the medium-wall thickness to provide retrievability from geologic storage.
6. Place in geologic storage.

Kaiser Engineers, Inc. (KE)

Kaiser Engineers, Inc., conducted the canister handling and structural analysis study. The objective was to identify the constraints on canister design which might be imposed under normal and abnormal operating conditions. The following conclusions were reached in the study:

1. Type 304L stainless steel is limited by Sect. VIII, Div. 2, of the ASME* Boiler and Pressure Vessel Code to a maximum service temperature of 800°F. In certain abnormal events, temperature excursions are expected to be as high as 1100°F. Whether or not this eliminates the use of 304L needs to be determined by a more detailed analysis of the abnormal events and possible failure modes.
2. The maximum internal pressure that the 12-in.-diam schedule-40 canister can resist without exceeding its allowable code stress limit is 800 psi. For a temperature of 650°F and a conservatively estimated internal pressure of 100 psi, the stress limit will not be exceeded. However, quenching the canister in water for cooling results in stresses exceeding allowable material limits. Also, accidental dropping of canisters onto a concrete cell floor from 20 ft above results in structural damage that might compromise the integrity of the canister. The canister is able to resist impacts resulting from both the operating-basis earthquake and the safe-shutdown earthquake of the maximum acceleration of 0.125 *g* and 0.25 *g*, respectively, without structural failure.

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*ASME = American Society of Mechanical Engineers.

3. For normal operating conditions, the following alternative canister dimensions are found satisfactory:
  - a. 8-in. diam $\times$ 10-ft long $\times$ 3/8 in.
  - b. 8-in. diam $\times$ 16-ft long $\times$ 3/8 in.
  - c. 12-in. diam $\times$ 10-ft long $\times$ 3/8 in.
  - d. 12-in. diam $\times$ 16-ft long $\times$ 3/8 in.
  - e. 24-in. diam $\times$ 10-ft long $\times$ 3/8 in.
4. A 24-in. diam $\times$ 16-ft-long canister will exceed allowable code stress limits during a lifting operation and will require reinforcement of the bottom shell. Using different materials for the canister top and shell will result in high thermal stress at the weld junction and is not recommended.

TRW Defense and Space Systems Group (TRW)

The TRW Defense and Space Systems Group of Redondo Beach, California, performed the heat transfer studies for the HLW canister in interim storage at the fuel reprocessing plant and in geologic storage. The calculations were based on a 10-ft-long canister 80% filled with 10-year-old pressurized-water-reactor waste. The thermal constraints were that no more than 1% of the salt exceed 200°C (392°F). These interim thermal criteria may need to be modified for pitches (distances between canisters) of the magnitude discussed below. The maximum allowable centerline temperature was limited to 200°C for the calcined waste form and to 800°C for glass. The maximum allowable container temperature was 350°C. The major parameters investigated were canister diameter and the pitch.

For the glass waste form, the permissible canister diameter increases with pitch. Up to a pitch of about 48 ft, the canister diameter is constrained by the 25% salt temperature criterion. For pitches greater than 48 ft, the canister diameter is constrained by the allowable temperature for the canister material (350°C). At the 48 ft pitch, the maximum allowable canister diameter is approximately 17 in., excluding overpack, with a corresponding heat load of approximately 5 kW.

For the calcined waste form, the canister diameter also increases with pitch and is constrained by the 25% salt temperature criterion up to a pitch of about 40 ft. For pitches greater than 40 ft, the canister diameter is constrained by the maximum allowable waste centerline temperature (700°C). At the 40 ft pitch, the maximum canister diameter is approximately 10.5 in., excluding overpack, with a corresponding heat load of about 4 kW.

Nuclear Services Corporation (NSC)

Nuclear Services Corporation began a study to identify applicable codes and standards for the design and fabrication of the high-level-waste canister. The bases for the study were agreed upon by RHO and NSC.

RHO is currently evaluating and integrating the results of these studies to identify the interactions and trade-offs involving thermal, mechanical, and material problems that are important in establishing canister acceptance criteria.

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

Three technical service contracts are planned for this study in FY 1978. The transportation contract is scheduled to begin in early November 1977. The objective of this contract is to perform engineering studies of shipping enclosures and modes of transportation to define constraints on the size and weight of transuranic radioactive waste containers. This effort is being coordinated with the Transportation/Logistics Study. The corrosion contract is also scheduled to begin in early November 1977. Its objective is to identify major metallurgical and environmental factors and assess their impact on the reliability of the transuranic and cladding waste primary container material, using the container life cycle as a basis. The contract for codes and standards is scheduled to begin in early January 1978. The objective of this contract is to identify existing or proposed codes, standards, and/or regulations that will govern the design, fabrication, testing, and inspection of radioactive transuranic waste containers.

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

Work continues on the development of an overall Transportation/Logistics program plan, with the individual tasks being identified and organized under six functional groups. Within the transport program, these groupings are (1) planning and coordination, (2) environmental assessments, (3) risk evaluation, (4) cask design, (5) cask fabrication and testing, and (6) cask licensing. The program plan will show when these different functional activities must be initiated and completed for each waste type in order to have a viable transport system in place by CY 1985.

The final draft of the Rocky Flats' report "Low-Level TRU Waste System Analysis" was received and reviewed. PNL is preparing the final draft of their report entitled "Potential Problems in Nuclear Waste Transportation through Year 2000." Allied-General Nuclear Services has drafted two sections of their report, which will consider equipment design and licensing, facility-equipment interfaces, and cask fleet problems. A report is being prepared at ORNL which will describe all logistic modeling capabilities being used or planned. During October, the section describing the Low-Level TRU Waste Logistics Model was completed. This model is currently dimensioned for 12 waste generators, 6 disposal sites, and 28 years. The nuclear data base at ORNL was updated to reflect the information contained in Nuclear Assurance Corporation's final report (Y/OWI/SUB-77/42500).

The Spent Fuel Shipping Schedule program is now operational. Spent fuel discharge projections from now to the year 2000 are available for both pressurized-water reactors (PWR) and boiling-water reactors (BWR). The program determines the number of spent fuel movements from 30 regions of the country via truck and rail; it also indicates the number of casks needed each year. Information is based on the assumptions that (1) backlogged reactor fuel is worked off within a specified time period (e.g., five years), (2) the most economical mode of transport is used, and (3) partial cask loads of spent fuel are not shipped. Specific shipping routes and costs will be added shortly. Detailed routing information and rates are being gathered.

Contact was made with the Federal Railroad Administration (FRA) to discuss the availability of one of their computer models that might have applicability in our logistics work. FRA's Office of Rail Systems and Information Analyses has developed a computer program that models the railroad network throughout the United States. The code contains approximately 14,000 individual rail links. Each of the 60,000 railroad freight stations is either on a link or at the junction of two links. For each of the links in the network, the model identifies the owner, the number of tracks, the type of signaling system, the maximum and average speeds over the link, the density of cargo tonnage moved in previous years, and the length of the link. Access to this data base will provide general routing patterns, track conditions, transmit times, potential bottlenecks, and possibly mapping capabilities and should provide a great deal of flexibility in developing logistics programs. The General Services Administration (GSA) will provide the costs for shipping materials by truck or rail from any origin to any destination.

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

Several details on the Statement of Work, Pricing Proposal, and conference notes that were received from Bechtel were discussed by phone with D. B. Crandall, Bechtel. After some minor modifications, the Statement of Work, Pricing Proposal, and conference notes were considered to be fully acceptable. The Statement of Work document from Bechtel was converted into the standard UCC-ND format for such a document and transmitted to UCC-ND Purchasing.

An action plan detailing the justification, scope, work packages, deliverable items, schedule, etc., was prepared and is undergoing internal review.

3.3.4 ECONOMIC STUDY . . . H. N. Rosenberg

The initial program planning meeting to discuss the scope of the economic study, establish ground rules for the TRW study plan, and establish the borderline between the costing studies covered by this contract and any future effort involving pricing studies was held at TRW's McLean Facility on September 30. TRW presented the study plan at a meeting held October 21 at OWI. The study plan divides the TRW effort into eight major

tasks and fifteen subtasks. It identifies the approximate level of effort to be devoted to each subtask and presents the proposal schedule to meet the contractual completion dates.

The TRW effort for October was expended on the items described below.

1. Definition of the qualitative flow model - This effort was initiated and completed prior to the delivery of the study plan.
2. Definition of the quantitative physical flow model - This effort was initiated subsequent to the completion of the qualitative flow model. The task was completed during October, and the results are scheduled to be reviewed at a meeting during the first week of November.
3. Definition of the set of cost elements - A candidate list was provided to OWI on October 11. A revised list, incorporating OWI suggestions, has been issued.
4. Literature search for pertinent cost estimates - Documents provided by OWI plus additional documents available from the open literature were reviewed by TRW personnel to determine availability and quality of information. This effort was completed during the third week of October.
5. Validation of the literature search information - The data provided by the review of the documentation were compared, gaps were identified, and recommendations as to acceptance of the data were made. This material will be reviewed with OWI the first week of November.
6. Development of the Cost Estimation Model Specification - Work was initiated during October, and a completed model specification has been prepared. This specification will be reviewed with OWI in early November.

During November, the engineering cost estimates will be finalized, and work will be initiated on computer programming of the cost model as defined in the model specification.

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

The requests for proposals on this study were mailed to potential vendors on October 5. Proposals are due at OWI by November 10, 1977.

3.3.6 INTERNATIONAL WASTE REPOSITORY STUDY . . . H. M. Noritake and R. A. Kisner

The evaluation team selected a vendor as the subcontractor for this study, and they were subsequently notified of their selection by UCC-ND Purchasing. A revised Statement of Work detailing the requirements for this study was prepared and transmitted to the selected vendor for their use in preparing the Pricing Proposal.

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

Draft regional and study area plans, along with an extensive introduction and a synopsis of regulatory requirements, were published as Volume I of environmental survey plans for the states of Mississippi, New York, and Ohio. (The Volume II documents will be the locational plan for each state.) NUS and OWI staff presented these documents to state agency personnel for their review at meetings held on October 26, 28, and 31 in Mississippi, New York, and Ohio, respectively. In each case, reviews will be performed, and the subsequent comments will be provided. In Mississippi, members of the state legislature were also present at the meeting.

The comparable Volume I documents for the states of Utah and Texas are in the final stages of publication and are expected to be presented to state agency personnel on November 2 and 8, respectively. For Texas, there will be two separate planning documents - one corresponding to possible study areas in the Gulf Interior region and the other corresponding to the Permian region.

The study area plan for Louisiana is in preparation and will be available for presentation to the state agencies during November, along with the entire Volume I document for Louisiana.

Copies of these planning documents will be made available to appropriate leaders in the state legislatures, and thereafter, copies will be made available for review by technical experts and environmental groups in each region. Transmittal to these public reviewers should occur within one to two weeks after presentation to the state agencies. Lists of potential reviewers are being prepared by NUS and reviewed by OWI. State agency and public review comments will be incorporated later during preparation of the final plans. Volume II of the environmental survey plans for all of the above-mentioned states (which will include plans for the locational surveys) is in preparation. A partial working draft of possible locations in the Permian region within Texas was submitted to the NUS Technical Advisory Board for its meeting on October 14. Drafts of these plans are expected to be available in November for OWI review.

Efforts toward outlining (1) criteria for environmental site suitability, (2) the draft environmental impact statement, and (3) the environmental report were discussed at the NUS Technical Advisory Board meeting.

4.1.2 DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT FOR MANAGING RADIO- ACTIVE WASTE FROM COMMERCIAL REACTORS AND POST-FISSION OPERATIONS IN THE LWR FUEL CYCLE . . . A. S. Quist

Activities for October are reported in Sect. 2.4.

4.1.3 REGULATORY PROJECT MANAGERS

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

NUS, as Regulatory Project Manager (RPM) for bedded salt formations, and OWI personnel participated in two meetings with key state agencies in Albany, New York, and Columbus, Ohio. The purpose of these state meetings was (1) to introduce the RPM project and personnel to the state agencies and (2) to establish lines of communications for subsequent environmental data gathering using the states' files as necessary.

Progress is continuing in the preparation of regional reconnaissance reports for the Permian and Salina basins characterizing the environmental setting. The primary activity in all technical tasks was the acquisition and review of available information on the regions. The preparation of standardized base maps was begun, and task reports were started for ground-water hydrology, demography, and socioeconomics. The meteorological characterization was expanded to include paleoclimatology, and the associated draft sections of the regional reports were completed.

Administrative procedures governing project activities within NUS Corporation were completed. R. Shoup, OWI Project Manager, participated in a status review meeting at NUS in Rockville, Maryland, on October 26.

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

An accelerated rate of regional environmental characterization data collection has been initiated during the past month in the Gulf Interior dome salt formations. On October 11, the RPM (Bechtel Corporation) and an environmental scientist from Bechtel were introduced to state officials in a meeting at Baton Rouge, Louisiana. A brief presentation was made by the RPM to initiate the formal collection of data from state agencies and to elicit their full cooperation in this effort. Bechtel's environmental scientist remained in Louisiana from October 11 to 20 to collect the basic data required for the environmental characterization. A similar introductory meeting took place in Jackson, Mississippi, on October 26. The data collected will be used to prepare the regional characterization report described in the OWI draft plan provided for this task.

The regional characterization report to be prepared by the RPM will also include a separate section describing the geological and ground-water hydrological characteristics of the region. The geology and ground-water hydrology evaluation is now in progress. The results of this sub-task will be made available to the RPM environmental report personnel during December for use in completing the regional characterization report.

Descriptive specifications for the environmental disciplines involved in the environmental baseline surveys that are required to characterize confirmatory locations have been prepared and used to obtain proposals from potential sub-subcontractors. The RPM has completed the proposal evaluations and is proceeding to establish a definitive data collection and analysis plan and to obtain the necessary DOE concurrence for the required sub-subcontractors.

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*This report covers activities from September 24 to October 21, 1977.

Contract work in the Paradox basin area is similar to that in the Gulf Interior dome salt formations. Therefore, during regional environmental characterization and area studies, similar environmental, geologic, and hydrologic data will be collected in both regions. Formal data collection in Utah will be initiated after an introductory meeting in Salt Lake City on November 2, 1977. Meanwhile, a low-level effort in data collection from available published government sources has been under way. An RPM environmental scientist, specializing in Utah studies, will attend the November 2 meeting and will remain in Utah to collect the data required for the regional characterization report.

4.1.4 ENVIRONS MONITORING PROGRAM . . . W. A. Goldsmith, OWI; J. J. DiNunno, NUS Corporation

A generic design of radiological and meteorological monitoring systems for a commercial waste repository was completed. Components and interfaces for these systems were described for the preconstruction, construction, operation, decommissioning, and postdecommissioning phases of a repository. A draft report was received and reviewed by OWI in September 1977; a final report is in preparation and will be issued in November 1977.

4.1.5 ENVIRONMENTAL IMPACTS OF DISPOSAL OF MINED ROCK . . . W. A. Goldsmith, OWI; J. J. DiNunno, NUS Corporation

NUS Corporation has provided descriptions of the physical, social, and economic environments existing at seven reference locations. The environmental impacts of various options for disposal of waste mined rock were evaluated for these reference locations. A draft report of findings was received and reviewed by OWI in September 1977; a final report is in preparation and will be issued in November 1977.

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

Thirty-two existing computer models have been reviewed and evaluated for use in assessing potential radiological impacts of a commercial waste repository. Emphasis was directed at the capability of a code to model the various environmental transfer processes that are of primary importance in a radiological assessment. A draft report of findings was received and reviewed by OWI. A final report will be issued in November 1977.

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

The draft report outlining the important parameters that might be measured and the available instrumentation that could be used to obtain information for a monitoring program for the decommissioned phase of a waste repository is being reviewed by OWI.

4.2 Safety, Risk, and Hazard Studies

4.2.1 OUTLINES OF CONTENTS OF SAFETY ANALYSIS REPORTS FOR REPOSITORIES . . . C. S. Sims, OWI; J. A. Franco, EnviroSphere Company

In FY 1977, SRI, International, and Battelle-Columbus Laboratories prepared two format guides for the contents of the safety analysis report (SAR) for a waste repository. EnviroSphere reviewed these guides in light of licensing requirements and current NRC regulations and prepared a single format guide incorporating some features of each of the previous guides. They also proposed a schedule for the development of the SAR and made recommendations for work needed to meet the schedule. A draft report describing the above results was completed and received by OWI for comment in September. EnviroSphere will meet with OWI on November 4 to discuss comments on the draft. A final report will be issued in November 1977.

4.2.2 AS-LOW-AS-REASONABLY-ACHIEVABLE STUDIES . . . R. L. Shoup, OWI; R. P. Sullivan, NUS Corporation

The objective of the as-low-as-reasonably-achievable (ALARA) studies was to identify references containing discussions of ALARA criteria which may be pertinent to the design and operation of a repository and to evaluate the possible impacts on the OWI Program.

R. Schlegel of NUS Corporation visited OWI on October 11 to discuss OWI responses to the NUS draft report entitled "As-Low-As-Reasonably-Achievable (ALARA) Studies Relative to the NWTs Program." The comments were resolved, and a final report was received near the end of October.

4.2.3 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 and environmental reports. B. Suta and R. White of SRI, International, visited OWI on October 21 to review OWI comments on the SRI draft report entitled "Annotated Risk Assessment Bibliography for Geologic Isolation of Nuclear Wastes." The final report is due at OWI in November.

4.3 Nuclear Regulatory Commission Licensing Requirements

A. S. Quist

No activity has been reported for October.

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)

With the advent of the new fiscal year, some activities at HARC were cut back because of reduced funding; however, work continued in all areas. Output includes the completion of "Results of Research on the Social Impacts of Nuclear Waste Isolation Being Conducted by the Battelle Human Affairs Research Centers," a review paper for use by HARC researchers in waste management. In addition, several papers were completed in draft form and are being submitted for OWI review and comment.

Harc staff attended two of the three NRC workshops for state officials regarding the determination of site-suitability criteria for nuclear waste repositories. Randy Smith attended the first of these in Denver, September 19-21; and Hank Schilling attended the second, in New Orleans, September 25-27. In addition, Hank Schilling attended the American Law Institute/American Bar Association course on Nuclear Energy Law in Washington, D.C., September 29 through October 1. He also attended a presentation by OWI and its subcontractors (NUS, Bechtel, and HARC) to Louisiana state officials in Baton Rouge, October 11.

The primary output next month will be the preparation of a detailed plan for completing ongoing work during FY 1978. Also, the demographic projection model and an additional case study should then be available for OWI review.

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

The review of source materials continued, with special emphasis being placed on studies of local, state, and federal efforts to mitigate the negative social and economic impacts of military and energy facilities. The draft papers currently being written focus on community impacts that occur during the time period between the designation of candidate sites and the start of construction. The papers will describe the conflict between interests at each stage of the siting process, with the goal being to determine not only how, but when, facility sponsors can best respond to the needs and concerns of groups within affected communities.

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

The bibliography has been completed and is being typed in draft form. Composed of several hundred references drawn from the social sciences as they relate to conflict resolution, the bibliography covers the basic literature concerning conflict resolution, community power, decision making, and the nuclear power issue. The report outline has been compiled in final form, and three chapters have been drafted. The draft report, including the bibliography, is expected to be completed in mid-November.

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

A meeting with various staff members of Battelle HARC was held on October 18. Current work at HARC related to the OWI Program was discussed, and recent HARC reports were provided. The proposed outline for the state-of-the-art paper on public consultation in policy formation was discussed. Literature review on this topic is expected to be completed by early November; first drafts of several sections of the report are near completion.

5. PUBLIC AFFAIRS

I. N. Kaplan

No activity has been reported for October.

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

Company	Visitor	Date	Principal contact
Beak Consultants Ltd. 6870 Goreway Drive Mississauga Ontario, Canada 14V1L9	D. L. Lush	10/28	L. R. Dole
BGR, Stillewegs Hannover, West Germany	H. Albrecht	10/20-21	W. C. McClain
Boeing Engineering & Construction Company 102 Tulsa Road Oak Ridge, TN 37830	C. P. Black	10/3-4	D. G. Shaner
		10/10	D. G. Shaner
		10/12	D. G. Shaner
		10/19	D. G. Shaner
		10/21	D. G. Shaner
	R. B. Dixon	10/27	J. R. Palmer
		10/3-4	R. M. Jenkins
		10/6-7	R. M. Jenkins
		10/10-14	J. L. Ewing
		10/17-20	J. L. Ewing
	H. G. Stocking	10/27	J. R. Palmer
		10/28	D. G. Shaner
		10/3	M. L. Bennett
		10/6-7	M. L. Bennett
		10/10-14	M. L. Bennett
		10/17-21	M. L. Bennett
		10/25-26	M. L. Bennett
Brookhaven National Laboratory Department of Physics Upton, NY 11973	G. E. Fuller	10/14	G. H. Jenks
	R. W. Klaffky	10/14	G. H. Jenks
	P. W. Levy	10/19	G. H. Jenks
	K. J. Swyler	10/14	G. H. Jenks
Dames & Moore 134 Fairbanks Road Oak Ridge, TN 37830	J. R. Swaisgood	10/5	R. K. Kibbe
		10/21	R. K. Kibbe
		10/25	R. K. Kibbe
Dames & Moore 20 Harlem Avenue White Plains, NY 03755	A. E. Aikens, Jr.	10/25	R. K. Kibbe
Dames & Moore 6 Commerce Drive Cranford, NJ 07016	T. M. Gates	10/25	R. K. Kibbe
		10/31	R. K. Kibbe

APPENDIX A (continued)

Company	Visitor	Date	Principal contact
Energy Resources Conservation & Development Commission 1111 Howe Sacramento, CA 95825	M. T. Ringer	10/20	C. D. Zerby
FMC Corporation P. O. Box 5509 Rockville, MD 20855	K. B. Hinerman	10/19	A. L. Boch
Gilbert Associates, Inc. P. O. Box 1498 Reading, PA 19603	D. Ferrigno	10/11 10/12	K. K. Aydelotte J. M. Morrison
Gilbert Commonwealth P. O. Box 1498 Reading, PA 19603	C. Layland	10/11 10/12	K. K. Aydelotte J. M. Morrison
Isle of Wight Area Health Authority Newport, Isle of Wight England	G. L. Elderfield	10/6	C. D. Zerby
Law Engineering Testing Company 2749 Delk Road, S. E. Marietta, GA 30067	A. J. Glenn J. G. LaBastie	10/7 10/7	C. D. Zerby C. D. Zerby
Lawrence Berkeley Laboratory University of California Berkeley, CA 94720	C. A. Brown T. L. Simkin	10/13 10/13	W. C. McClain W. C. McClain
NUS Corporation 4 Research Place Rockville, MD 20850	O. E. Bassett R. L. Schlegel	10/17 10/11	A. L. Boch R. L. Shoup
Parsons Brinckerhoff Quade & Douglas Inc. One Penn Plaza New York, NY 10001	A. J. Angiola A. Gursoy R. J. Hill T. E. Hoover N. Secker	10/24-25 10/24-25 10/24 10/25 10/24-25 10/24 10/25	R. K. Kibbe R. K. Kibbe R. K. Kibbe C. E. Oldham R. K. Kibbe R. K. Kibbe C. E. Oldham

APPENDIX A (continued)

Company	Visitor	Date	Principal contact
Sandia Laboratories P. O. Box 5800 Albuquerque, NM 87115	H. C. Shefelbine	10/25	J. E. Russell
	J. R. Wayland	10/25	J. E. Russell
Science Applications, Inc. 114 Tulsa Road Oak Ridge, TN 37830	J. N. Baird, Jr.	10/24	J. M. Asher
		10/28	R. K. Kibbe
	G. R. Bray	10/20	R. K. Kibbe
	C. W. Craven, Jr.	10/25	R. K. Kibbe
	L. D. Rickertsen	10/3	L. L. McCauley
		10/20	R. K. Kibbe
	M. J. Vasko	10/3	L. L. McCauley
	R. E. Wilems	10/10	L. L. McCauley
		10/12	R. K. Kibbe
		10/25	R. K. Kibbe
		10/27-28	R. K. Kibbe
S.C.K./C.E.N. Materials Science Department B-2400 MOL Belgium	A. Van Den Bosch	10/7	G. H. Jenks
S. M. Stoller Corporation 1250 Broadway New York, NY 10001	R. W. Kupp	10/27	J. M. Morrison
	L. Rutland	10/27	J. M. Morrison
SRI, International Menlo Park, CA 94025	B. E. Suta	10/21	R. L. Shoup
	R. K. White	10/21	R. L. Shoup
Stone & Webster Engineering Corporation 245 Summer Street Boston, MA 02108	J. Briedis	10/18	R. B. Laughon
	J. H. Peck	10/18	R. B. Laughon
TRW Energy Systems 7600 Colshire Drive McLean, VA 22101	H. L. Bell, Jr.	10/11-12	H. N. Rosenberg
	J. R. Gauthier	10/11-12	H. N. Rosenberg
	L. M. Green	10/11-12	H. N. Rosenberg
	F. P. Meltes	10/11-12	H. N. Rosenberg
U.S. Department of Energy Washington, D.C. 20545	W. W. Ballard	10/11	H. N. Rosenberg
	J. P. Thereault	10/11	H. N. Rosenberg
U.S. Geological Survey Mail Stop 954 Denver Federal Center Denver, CO 90225	H. W. Smedes	10/19	L. B. Cobb

APPENDIX A (continued)

Company	Visitor	Date	Principal contact
U.S. Geological Survey National Center Reston, VA 22092	G. D. DeBuchananne N. J. Trask	10/27 10/27	W. C. McClain W. C. McClain
U.S. Nuclear Regulatory Commission Washington, D.C. 20555	W. M. Grayson	10/28	L. R. Dole
University of Waterloo Department of Earth Science Waterloo Ontario, Canada N2L3G1	J. E. Gale	10/13	W. C. McClain
R. F. Walters 400 Insurance Building Wichita, KS 67202	R. F. Walters	10/21	R. B. Laughon
Wimborne D. C. Council Offices Furzehill Wimborne, Dorsiet United Kingdom	A. D. Linley	10/6	C. D. Zerby
Woodward-Clyde Consultants Three Embarcadero Center San Francisco, CA 94111	F. R. Conwell H. M. Ewoldsen S. R. Rinne	10/19 10/9 10/19	T. F. Lomenick J. M. Morrison T. F. Lomenick

APPENDIX B

TRIPS TAKEN BY OWI STAFF MEMBERS DURING OCTOBER 1977

Date	Place visited	OWI staff member	Purpose of visit
10/3	Rapid City, SD	J. E. Russell	To visit the South Dakota School of Mines and Technology and RE/SPEC Inc. to review their work in connection with their contracts with OWI.
10/4-6	Regina, Canada Saskatoon, Canada	J. E. Russell	To tour potash mines, to inspect continuous miner operation, to see shaft sinking operation, and to review the possibility of using rock mechanics data from these mines in verifying OWI's computer program.
10/10-11	Houston, TX	L. B. Cobb	To visit Law Engineering Testing Company and the U.S. Geological Survey to review FY 1978 program plans for East Texas Salt Domes.
10/11	Baton Rouge, LA	W. A. Goldsmith A. S. Quist	To attend a state agency meeting with OWI, NUS, and Bechtel personnel.
10/12-13	Washington, DC	A. S. Quist	To attend AIF Conference on Environmental Regulation of Nuclear Power Facilities.
10/12-14	Los Alamos, NM	S. C. Matthews	To participate in the Life Sciences Symposium on "Hazardous Solid Wastes and Their Disposal."
10/14	Rockville, MD	A. S. Quist	To review NUS progress on the environmental survey plans.
10/17	Marietta, GA	R. B. Laughon	To attend the progress review meeting with Law Engineering Testing Company.

APPENDIX B (continued)

Date	Place visited	OWI staff member	Purpose of visit
10/17-19	Morgantown, WV	G. D. Brunton	To attend the First Eastern Gas Shales Symposium.
	Denver, CO	S. C. Matthews	To visit SRENCO to review the status of the conceptual design for NWTS repository.
10/19	Richland, WA	R. S. Lowrie	To review the program with Rockwell Hanford Operations.
	St. Louis, MO	J. E. Russell	To attend the Scholarship Committee Meeting of the Society of Mining Engineers AIME Education Board as a Committee Member.
10/21	Pittsburgh, PA	A. L. Boch G. D. Brunton R. B. Laughon	To visit D'Appolonia Consulting Engineers as part of the Evaluation Team regarding RFP A-4266, management services for borehole plugging demonstrations.
10/24	Atlanta, GA	T. F. Lomenick	To meet with S. Gonzales and K. S. Johnson, OWI consultants, to discuss the salt report.
10/25	Aiken, SC	T. F. Lomenick	To meet with SRL personnel to discuss the FY 1978 program.
10/25-26	Santa Clara, CA	P. D. Fairchild	To discuss the conceptual design program for the transporter with FMC Corporation.
10/26	Jackson, MI	W. A. Goldsmith A. S. Quist	To attend a state agency meeting with OWI, NUS, and Bechtel personnel.
	Washington, DC	H. N. Rosenberg J. E. Vath	To meet with DOE and TRW regarding the Economic Study.

APPENDIX B (continued)

Date	Place visited	OWI staff member	Purpose of visit
10/27	Pittsburgh, PA	G. D. Brunton	To discuss borehole plugging demonstration contract with D'Appolonia Consulting Engineers.
	Rockville, MD	R. L. Shoup	To review NUS progress on Regulatory Project Manager contract.
10/28	Albany, NY	A. S. Quist R. L. Shoup	To attend a state agency meeting with OWI and NUS personnel.
10/30	Atlanta, GA	R. L. Shoup	To review J. W. Poston's progress on OWI projects.
10/31- 11/2	Austin, TX Baton Rouge, LA Marietta, GA	R. B. Laughon W. C. McClain	To discuss plans for work in the Gulf Coast salt domes with (1) Texas Bureau of Economic Geology, (2) Louisiana State University, and (3) Law Engineering Testing Company.
10/31	Columbus, OH	A. S. Quist R. L. Shoup	To attend a state agency meeting with OWI and NUS personnel.

APPENDIX C
REPORTS GENERATED

The following reports were forwarded to DOE during October 1977:

Y/OWI/INF-3/12

National Waste Terminal Storage Program Progress Report, September 1977, Office of Waste Isolation, Union Carbide Corporation, Nuclear Division (Oct. 19, 1977).

Y/OWI/SUB-77/16523/1

Geology-Hydrology of Avery Island Salt Dome, prepared by Jacoby and Company under subcontract 86Y-16523V with Union Carbide Corporation, Nuclear Division (July 1977).

Y/OWI/SUB-77/16523/2

Scoping Report of Various Salt Mines in the United States, prepared by Jacoby and Company under subcontract 86Y-16523V with Union Carbide Corporation, Nuclear Division (July 1977).

Y/OWI/SUB-77/22303/P6

Analysis of Transient History of Underground Excavations for Radioactive Waste Isolation, prepared by RE/SPEC Inc. under subcontract 89Y-22303 with Union Carbide Corporation, Nuclear Division (September 1977).

Y/OWI/SUB-77/22324/1

Emplacement Hole Drill Evaluation and Specification Study, Volume I, prepared by Foster-Miller Associates, Inc., under subcontract 89Y-22324 with Union Carbide Corporation, Nuclear Division (Sept. 30, 1977).

Y/OWI/SUB-77/22324/2

Emplacement Hole Drill Evaluation and Specification Study, Volume II, Appendices, prepared by Foster-Miller Associates, Inc., under subcontract 89Y-22324 with Union Carbide Corporation, Nuclear Division (Sept. 30, 1977).

Y/OWI/SUB-77/22328

Geologic Investigation of the Virgin River Valley Salt Deposits Clark County, South-eastern Nevada to Investigate Their Suitability for Possible Storage of Radioactive Waste Material as of September, 1977, prepared by Netherland, Sewell & Associates, Inc., under subcontract 89Y-22328V (September 1977).

APPENDIX C (continued)

Y/OWI/SUB-77/22330

Capabilities of the U.S. Domestic Transportation Systems for the Shipment of Radio-active Wastes, prepared by Nuclear Assurance Corporation under subcontract 89Y-22330V with Union Carbide Corporation, Nuclear Division (September 1977).

APPENDIX D
FUTURE ACTIVITIES

Date	Activity
November 2	W. A. Goldsmith and A. S. Quist to meet with Utah state officials in Salt Lake City to discuss Regulatory Project Manager activities and environmental survey plans for Utah.
November 8	W. A. Goldsmith, A. S. Quist, and R. L. Shoup to meet with Texas state officials in Austin to discuss Regulatory Project Manager activities and environmental survey plans for Texas.
November 8-9	C. S. Sims and A. S. Quist to attend Safety Assessment Meeting at DOE in Germantown, Maryland.
November 9-10	A status review to be held in Oakland, California, on Kaiser Engineers' spent fuel repository conceptual design. D. W. Turner and R. S. Lowrie to visit Allied-General Nuclear Services, Barnwell, South Carolina, for a program review meeting.
November 10-11	H. C. Claiborne, P. D. Fairchild, and W. C. McClain to attend DOE workshop on in situ testing to be held in Germantown, Maryland.
November 15	DOE-HQ personnel and C. D. Zerby to meet with Mississippi officials to obtain their input on their participation in the review process.
November 16-18	M. L. Bennett and K. K. Aydelotte to attend American Institute of Industrial Engineers' seminar on "Design to Cost/Life Cycle Costing," Washington, D.C.
November 17-18	W. C. McClain, P. D. Fairchild, and C. D. Zerby, OWI, and J. J. Schreiber, DOE, to attend a Geologic Review Group Meeting in New Orleans, Louisiana, to review work on the Gulf Coast Geologic Project.
November 18	NUS to submit Pricing Proposal on Waste Inventory Study.
November 21	DOE-HQ personnel and R. B. Laughon to meet with Ohio officials to obtain their input on their participation in the review process.

APPENDIX D (continued)

Date	Activity
November 22	A. S. Quist to review progress on environmental survey plans with NUS Corporation at Rockville, Maryland.
	R. E. Smith, RHO, to visit OWI to review progress of the Waste Container Studies.
November 28 - December 1	J. M. Morrison to attend Atomic Industrial Forum, Inc., Annual Conference in San Francisco, California.

APPENDIX E
SUBCONTRACTS NEGOTIATED DURING OCTOBER 1977

Subcontractor/Consultant	Subcontract Number	General Scope of Work
D. B. Wenner	4496	Consultant for Geologic Studies (renewal).
E. C. Jonas	7412	Consultant for Technical Support Studies.
Parsons Brinckerhoff Quade & Douglas, Inc.	62Y-45702C	GEIS Preconceptual Design Studies (Supplement I).
FMC Corporation	86Y-16538C	Waste Transporter Design (Supplement I).
Law Engineering Testing Company	89Y-22331C	Geologic Project Manager - Gulf Coast Salt Domes (de- finitive subcontract).
Woodward-Clyde Consultants	898Y-22333C	Geologic Project Manager - Pierre-Paradox Basins (modi- fication of letter subcon- tract).

APPENDIX F

EMPLOYMENT LEVELS AS OF OCTOBER 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
Public Affairs	1	1	2
Administration	4	4	8
Director's Office	1	2	3
Total	34	18	52

PERSONNEL CHANGES

<u>Name</u>	<u>Type</u>	<u>Department</u>	<u>Effective Date</u>
<u>Additions</u>			
D. P. Knee	New Hire	Administration	October 10
R. C. Rhines	New Hire	Administration	October 10
<u>Transfers and Terminations</u>			
R. Blumberg	Transfer	Facility Projects	October 1
D. B. Roe	Termination	Administration	October 1
C. R. Russell	Termination	Technical Projects	October 6

OFFICE OF WASTE ISOLATION
NOVEMBER 1, 1977

Director
C. D. Zerby

OWI-76-283 R11
11/1/77
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