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CNWRA PROGRAM MANAGER'S PERIODIC REPORT  
ON ACTIVITIES OF THE  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

FOR THE FISCAL REPORTING PERIOD  
September 2 - September 29, 1989  
PMPR No. 89-13

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CNWRA PROGRAM MANAGER'S PERIODIC REPORT  
ON ACTIVITIES OF THE  
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TITLE: Center for Nuclear Waste  
Regulatory Analyses

FIN: D1035-8

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CONTRACT NO: NRC-02-88-005

ESTIMATED BUDGET: \$42,550,000

SITE: 6220 Culebra Road  
San Antonio, Texas

PERIOD OF PERFORMANCE: 10/26/87 - 10/26/92

PERIOD OF THIS REPORT: 09/02/89 - 09/29/89

1. SUMMARY

1.1 Narrative Project Status and Technical Progress This Period

Staff efforts were directed primarily in the following areas:

1. Completion of the Division of High Level Waste Operations Plans for FY90-91 and the Overall Research Plan for FY90-91,
2. Actions that are needed to support further development and refinements in the Program Architecture (PA) and Program Architecture Support System (PASS),
3. Acquisition of staff and consultants (both for permanent positions and to assist in specific short-duration tasks); two permanent staff members were added this period,
4. Continuing development, revision, and implementation of Research Project Plans, and
5. Work on specific Element/Subelement activities, including development of the Fast Probabilistic Performance Assessment (FPPA) methodology, evaluation of potential rulemakings, and activities associated with technical positions.

The current status of Center staffing is indicated in the attached tables. The first table indicates the staffing plan, that is, the identification of areas of expertise and experience required to accomplish the long-term scope of work assigned under the contract, and associated FTE that are needed at particular times, as constrained by available resources. The second table provides the names of the individuals currently on the core Center professional staff. Note that the tables have been modified from the NRC-approved Staffing Plan of June 1989, to incorporate changes in the staffing plan that were reflected in the approved Division of High Level Waste Operations Plans and Overall Research Project Plan for FY-90-91. These rather significant revisions will be incorporated in the revised Staffing Plan which will be issued in the coming months.

Following submittal of the Division of High Level Waste Operations Plans and Overall Research Project Plan, a major NRC/CNWRA management meeting

was conducted September 12-13, 1989, at the NRC White Flint offices, to brief the staff and management on the content and format of these important planning documents. In addition, effective coordination and project control were maintained and augmented through frequent focused telephone conferences among NRC staff and Center staffs in both Washington and San Antonio. Key among the subjects addressed were: requirements for closing out FY89, Program Architecture development, ongoing and planned Research projects, and various Element-specific activities.

Major effort continued to be expended within the WSE&I Subelement, with assistance from the Element/Subelement Managers, on activities supporting further development of the Program Architecture (Sections 2, 4 through 6, 8, and 9). A briefing was provided to the NRC staff on the previously submitted revised Technical Operating Procedure on the development of Program Architecture (TOP-001-02). This TOP, together with its supporting attachments, provides detailed guidance on the conduct of regulatory analyses and the development of the Program Architecture relational database that will contain the results of those analyses. Activities continued in the Engineered Barrier Systems and Geologic Setting Program Elements in preparation for the "baselining" of Program Architecture. In addition, program Architecture Review Committee (PARC) activities continued for Sets 1 through 4 of the Regulatory Requirements to prepare these data (which are under development using the now-current procedures) for orderly transition to the new format and content requirements of the revised Program Architecture process and procedures.

The Center continued to (a) conduct evaluations and assessments of alternatives regarding process, procedures, format, and content of the Program Architecture and the Program Architecture Relational Database and (b) interact with the NRC cognizant Element Manager as the preferred alternatives began to be implemented. These activities are focused on baselining the Program Architecture and PASS (Chapter 2). Closure on these important matters entails the greatest near-term schedule risk for currently assigned tasks. Specific actions taken to date are noted in Chapter 2 of this report. Due to highest priority being assigned to Operation Plan preparation, this work slowed somewhat during this period. Effective utilization of Center, SwRI, and consultant staff who were not involved heavily in Operations Plan preparation minimized the impact.

In addition, the following actions continued, using the current (unrevised) Program Architecture process and procedures:

- \* Development of specific examples that will be used to baseline the Program Architecture (the Erosion and Substantially Complete Containment regulatory requirements).
- \* Continued development of Sets 1 through 4 of the Regulatory Requirements.
- \* Continued PARC actions on portions of Sets 1 through 4 of the Regulatory Requirements.
- \* Continued development of Regulatory Requirements for the remainder of 10 CFR Part 60 using TOP-001-04.
- \* Continued revision of Program Architecture Technical Operating Procedures, data input templates, and instructional materials.
- \* Continued development of new and improvement of existing PASS capabilities.
- \* Revision and redistribution of the procedure for the identification of Regulatory Topics and associated Regulatory Requirements.
- \* Discussions and feasibility/need evaluations of implementing the OS/2 technology in the development of the PASS.

The modified Application System (AS) and Application System Project Management Costing (ASPMC) software was fully implemented this period with the development of the Operations Plan schedules and budgets being generated, entered, and integrated for each of eight Program Elements. Further development and modification of work practices, and implementation of additional user training also took place, as needs were identified.

Refinements to the personal computer hardware and software configuration between the NRC and the Center offices in San Antonio, TX and Crystal City, VA continued at a low-priority (addressing critical needs, only), as dictated by staff demands to support Operations Plan and Program Architecture development activities.

Coordination continued among the Center and Institute computer facilities and support personnel, and the NRC-IRM staff.

The semi-annual report on the status of acquisition of technical documents and technical reviews was completed and transmitted to the NRC. The Technical Document Index (TDI) continues to be developed and used in the technical assistance and research activities of the Center.

Performance Assessment activities (currently under the WSE&I Element, Chapter 2) included vigorous recruitment efforts. Work continued on the performance assessment review strategy subtasks and the Performance Assessment Operations Plan was developed.

The research Project Plans for "Geochemical Analog of Contaminant Transport in Unsaturated Rock" and "Stochastic Analyses of Unsaturated Flow and Transport Through Fractured Rock for Large Scale Hydrogeologic Systems" projects were under development this period, with the former scheduled for completion October 5, 1989. Literature searches and related background work continued to support development of the Project Plans associated with these two projects. Revision of the Overall Research Project Plan for FY90-91 was completed.

Activities in the Geochemistry Research Project (Section 3) continued in accordance with the Project Plan. Computations continued with the modified EQ3/EQ6 code which now includes nonisothermal kinetic reaction path and Rayleigh gas fractionation. Initial preparation of clinoptilolite samples for use in ion-exchange experiments was completed, in accordance with modified TOP-005. The geochemistry staff supported the IWPE materials research program review this period, making presentations on the anticipated nature of groundwater in the vicinity of the proposed Yucca Mt. repository site and on the characteristics of the J-13 well water that is frequently used by materials researchers conducting studies related to that site.

Installation and evaluation of test apparatus for the Thermohydrologics Project continued this period (see Chapter 3). Significant effort was devoted to the evaluation of instrumentation for the Separate Effects Experiments. A wide range of possible instrumentation is being evaluated to assure that results achieved during subsequent testing are accurate and reliable. Resistivity, light-transmission, and heat-flux techniques for measuring or inferring the degree of saturation were evaluated this period. Acoustic and gamma-ray attenuation techniques are planned to be evaluated next period. Techniques for controlling the porosity of bead assemblages were also undertaken. Fusing the beads by "baking" them at temperatures near the softening temperature of the glass appears to be a promising technique. The literature survey continued this period.

A two-day working meeting on the Seismic Rock Mechanics Project was held at the Center to consider revisions to the content of the program which will be included in an update to the Project Plan (Chapter 3). The research effort is being extended to include instrumented field studies of the effects of dynamic events on underground structures and seismic effects on the

groundwater. A three-day review meeting was also conducted for J. Philip, the NRC Project Manager. Several trial runs have been conducted with the test apparatus for the Seismic Rock Mechanics Project. Evaluation of the UDEC and 3DEC codes continues.

A materials research coordination meeting involving the NRC, Cortest-Columbus, the Center, and SwRI staff was held September 26, 1989. Topics included test methods, sources of variability in results, and geochemical considerations (primarily groundwater compositions). Aspects of the IWPE program dealing with de-alloying of copper-based materials and long-term stability of candidate austenitic steels were also discussed with the new NRC Project Manager. IWPE test apparatus is now operational in the recently completed Building 57 research facility.

Quality Assurance surveillance of implementation of the key PA development guidance documents TOP-001-02 and TOP-001-03 continued this Period with 100% review of all inputs to the PA relational database (Section 4). Revisions to the Center Quality Assurance Manual also continued, based on audit results and lessons learned during implementation of Center Technical Operating Procedures. An internal audit of the implementation of the CQAM was conducted with no finding being made. Staff participated in the Observation Audits of the Sandia National Laboratories September 11-15, 1989, and REECO September 25-29, 1989. Two candidates have been interviewed for an opening on the Center QA staff; a hiring decision is pending.

Geological Setting Element (Section 5) activities on development of the Program Architecture continued to be intense this period; focusing on preparation of inputs to the "baselining" of the Program Architecture. The focus was on (a) refinement of Technical Review Components and development of Compliance Determination Methods and Information Requirements for the regulatory requirement dealing with "Adverse Condition--Extreme Erosion". Center and NRC staff met September 25-26, 1989, to discuss progress on this item.

Efforts continued on a high priority basis toward the acquisition of a geologist/engineering-geologist, three geochemists, tectonics/structural geologist, geophysicist, geostatistician, QA specialist with background in the earth sciences, performance assessment specialists, and two more geohydrologists as part of the core Center staff. These positions will be filled during the coming year. Numerous resumes were reviewed and additional personal contacts were made this period. Staff attended the technical sessions and conducted recruitment activities at the FOCUS '89 meeting in Las Vegas, NV September 18-21, 1989. In addition, field trips to the Nevada Test Site and Yucca Mt. and vicinity were conducted during this time frame.

Work on the Natural Resources technical position continued this period, utilizing the services of Center and subcontractor personnel. A letter report recommending additional literature to be used in this study was provided to the NRC.

The EBS Element continued its extensive involvement in Program Architecture (PA) development this Period (Chapter 6). The dominant PA activities were Program Architecture Review Committee (PARC) actions on items submitted by the other Elements and development of materials relevant to the Regulatory Requirement on "Substantially Complete Containment". Particular effort was devoted to development of Technical Review Components, Compliance Determination Methods, and Uncertainty Reduction Methods for the latter item. The specific status of these activities is reported in Chapters 2, 6, and 8.

As part of the Center's activities related to the potential rule making on "substantially complete containment", work continued on both the uncertainty evaluation methodology report and the elements of proof report.

Development of the EBS Performance Assessment Code (EBSPAC) continued this period. Three thermal analysis codes, ANSYS, SINDA, and TOPAZ3D, are being evaluated for potential use in generating the temperature fields within EBSPAC. A paper entitled "Probabilistic Performance Assessment Using A New Importance Sampling Scheme Based On An Advanced Mean Value Method" was presented at the FOCUS '89 conference in Las Vegas in September.

Two staff additions were made in the EBS area this period. Dr. N. Sridhar, an expert in corrosion metallurgy, joined the staff from Haynes Alloys, to work in the EBS Element and related IWPE research activities. Mr. C. Tschoepe, an experienced mechanical/materials engineer, transferred to the Center from another division of the Institute after providing extensive support over the past year.

Work continued on the Transportation Risk Study in accordance with the Operations Plan (Chapter 7). A focus during the past period was investigation of some of the calculational characteristics of the RADTRAN III code which is used to estimate risks associated with the transportation of radioactive materials. Items investigated included: (a) the imposition of regulatory limits (for both worker dose rates and levels of clean-up for spills), (b) constraints on the use of data sets for calculation of whole-body dose, cancer risk, and genetic effects risk, and (c) the treatment of missing data.

The SPAE/T Subelement staff was heavily involved in both the PARC and Program Architecture development activities (Section 8). Interviews were conducted for the position of Regulatory Analyst in the Washington Office of the Center. In addition, a crosswalk between the Format and Content Guide "table of contents" and 10 CFR Part 60.

RDCO Element staff worked extensively on preparation of Program Architecture database inputs on the Uncertainties, Elements of Proof, etc. associated with 23 separate Regulatory Requirements (see Section 9 for a detailed list). Acceleration of those items which will be used to support development of Technical Positions during FY90-91 continued. This includes work related to technical positions on repository design, retrievability, and extrapolation of data from short- to long-term applications. As part of the related work on compliance determination methodologies, NRC cognizant staff participated in a meeting at the Center on September 28, 1989, on the technical position regarding thermal load.

Significant Program Architecture Review work was also conducted within this Element and principal Center and subcontractor staff participated in Program Architecture training. Efforts at recruiting rock mechanics and mining engineering personnel continued, in accordance with the revised staffing plan.

Several actions of a management and administrative nature were also undertaken this period. Because none of these are directly or solely attributable to any particular Element/Subelement, they are not forward-referenced to other sections of this report.

1. Continued planning, coordination efforts, and discussions regarding preparation of Operations Plans, based on recent guidance from the NRC.
2. Continued work on a plan for bringing the Center practices for submittal of documents and correspondence into compliance with the provisions of 10 CFR Part 2.
3. Completed revisions to the Center Staffing Plan in accordance with the anticipated long-term scopes of work for the NRC-NMSS and NRC-RES program areas.

4. Continued work with an IMS coordinating group at the SwRI which includes all Center, SwRI, subcontractor, consultant, and vendor cognizant personnel.
5. Conducted several Conflict of Interest evaluations for prospective permanent, subcontractor, and consultant staff. Included in this activity was close coordination and preparation of justifications for use by the NRC Program Management, Contracts, and legal staff in their determinations regarding potential COI situations with prospective employees.
6. Continued planning for Internal Research and Development (IR&D) activities that will be funded out of a portion of the award fees earned by the Center.

1.2 Milestone Status and Significant Accomplishments This Period

The following table summarizes the status of all Element/Subelement milestones related to development of the Program Architecture.

<u>Milestone</u>	<u>Abbreviated Description</u>	<u>Date</u>	<u>Status</u>
E1	Element Activity via TOP-001-02 on Set 1	9/16/88	98%
P7	PARC Review of Set 1 Reg. Requirements	9/26/88	92%
I3	Integrate PARC Set 1 Data	9/27/88	82%
E2	Element Activity via TOP-001-02 on Set 2	9/30/88	96%
P8	PARC Review of Set 2 Reg. Requirements	10/11/88	92%
I4	Integrate PARC Set 2 Data	10/12/88	50%
E3	Element Activity via TOP-001-02 on Set 3	10/28/88	98%
P9	PARC Review of Set 3 Reg. Requirements	11/08/88	85%
I5	Integrate PARC Set 3 Data	11/09/88	20%
E4	Element Activity via TOP-001-02 on Set 4	11/11/88	95%
P10	PARC Review of Set 4 Reg. Requirements	11/21/88	80%
I6	Integrate PARC Set 4 Data	11/21/88	40%
I7	Integrated and "Certified" Data (Sets 1-4)	11/23/88	54%

Set up of equipment and apparatus for the Thermohydrologics and IWPE were completed in the Building 57 research facility. A materials research coordination meeting was conducted at the Center September 26, 1989.

The Center supported the NRC in the SNL and REECO Observation Audits.

Significant developments were made on the Regulatory Requirement "Adverse Condition--Extreme Erosion" (Chapter 5). A letter report was prepared and transmitted giving recommendations for the possible use of USGS-MMS OFR-88-373 in the Natural Resources Technical Position.

Significant developments were made on the Regulatory Requirement "Substantially Complete Containment" (Chapter 6). A paper entitled

"Probabilistic Performance Assessment Using A New Importance Sampling Scheme Based On An Advanced Mean Value Method" was presented at the FOCUS '89 conference in Las Vegas in September.

The uncertainty analysis of the databases and the first section of a sensitivity analysis using RADTRAN III were completed and submitted in draft form to the NRC.

The cross-walk between the Format and Content Guide "table of contents" and 10 CFR Part 60 was submitted to the NRC.

The RDCO Element had no specific milestones scheduled this period (Chapter 9).

### 1.3 Problems None.

### 1.4 Forecast for Next Period

Revision of the Division of High Level Waste Operations Plans and the Overall Research Project Plan will be the highest priority task during the next period.

Development of the Program Architecture and PASS will return to Priority 1 status following completion of the Operations Plans next period. Inputs in support of the "baselining" activity should be completed. Additional Program Architecture development workshops, involving the teaming of NRC and CNWRA staffs will be conducted, as necessary. NRC review and comment on the draft TOP-001-02 is expected to be completed, allowing final closure to be reached on the modifications to the process, Technical Operating Procedures, and supporting guidance for Program Architecture Development. Primary training of Center and support staff in the new procedures will continue. PASS development, as well as other Program Architecture development activities will continue consistent with the FY90-91 Operations Plan.

Performance Assessment activities currently being conducted under the WSE&I Element will be transferred to a separate Element next period. Work on the Performance Assessment Review Strategy and other approved tasks will continue in accordance with the Operations Plan. It is anticipated that an answer will be received regarding the employment offer for a senior Performance Assessment scientist and further recruitment will continue in this important area, under the CNWRA Operations Element.

Work will continue in the Geochemistry, Thermohydrologics, Seismic Rock Mechanics, and Integrated Waste Package Experiments Projects in accordance with approved plans. Preparation of the Project Plan for research in the areas of stochastic modeling of fluid flow in the unsaturated zone will continue and comments are expected on the geochemical natural analogs project plan. Based on evaluation and response to the Peer review comments on the IWPE Project, recommendations for project changes will be made.

Implementation of Revision 1 of the Center Quality Assurance Manual, including development of appropriate Administrative, Technical, and Quality procedures, will continue and revisions will be considered (Section 4). Emphasis will continue on the oversight of the Program Architecture development and review activities. Center and SwRI quality assurance professionals will continue with Task 5 work, as requested by NRC, but no Observation Audits are anticipated next period.

The Geologic Setting Element activities will focus on further development of the Program Architecture Relational Database under the revised process, procedures, and data input templates (Chapter 5). Specific work will include the preparation of data and entry of such data on the appropriate input forms for the "Adverse Condition--Extreme Erosion". Technical assistance on the Natural Resources Technical Position will also continue, in

accordance with the revised work plan. Acquisition and equipping of facilities in which to perform GS technical work will continue next period. Staff acquisition efforts, including interviews, are anticipated to be intense in the areas noted in Chapter 5; these will be conducted under the CNWRA Operations Element during FY90-91.

Considerable effort will continue to be expended in the EBS Element with the further development of the Program Architecture Relational Database and related PARC activities (Section 6). Recruitment efforts for an electrochemist and another materials scientist will continue under the CNWRA Operations Element with interviews being conducted, as appropriate candidates are identified. Both technical assistance and Program Architecture work related to the Regulatory Requirement "Substantially Complete Containment" will be intense, in accordance with the approved Task 4 plan. Activities will continue in Task 6 regarding EBS performance assessment.

The Transportation Risk Study staff will continue work in accordance with the approved Operations Plan. R. Weiner and P. LaPlante will attend a seminar at Sandia National Laboratories on RADTRAN IV.

Activities in the SPAE/T Element will be conducted in accordance with the approved FY90-91 Operations Plan. Several of the activities previously resident in this Element will be transferred to other Elements next fiscal year.

Activities within the RDCO Element will focus on supporting development of the Program Architecture through activities on the PARC and the development of inputs to the relational database, primarily associated with portions of Set 1 and Set 3 (Section 9). Particular emphasis will be on those portions of the Program Architecture associated with technical positions that are under development during the next fiscal year. Recruitment will continue under the CNWRA Operations Element.

#### 1.5 Summary Financial Status

Table 1, below, indicates the financial status of the overall Center program in the context of "ceiling" and "allotted" funds established by the NRC. Table 2 displays planned and actual costs to date on both a per period and cumulative basis. In addition, variances are shown on both a dollar and percentage basis. These data do not include commitments in the amount of \$373,232. Similar data are presented for each Element/Subelement in the respective sections of this periodic report.

The preponderance of the variance is in the Research programs which were conditionally approved considerably later than originally planned. In addition, under-runs are occurring in the QA Subelement where Task 5 activities have not been as great as anticipated and in SPAE where proposed Task work has been rejected by the NRC and, therefore continues to be defined. Taking into account the commitments noted above, overall spending is \$355,534 (about 4%) under plan. No further changes to budget or schedule are recommended at this time.

Total	Funds		Adjustment		Revised
Negotiated	Allotted			to Complete	Subelement
Subelement	by NRC	Funds	Funds	Subelement	Subelement
<u>Ceiling</u>	<u>to date</u>	<u>Costed</u>	<u>Uncosted</u>	<u>(+ or -)</u>	<u>Ceiling</u>
\$10,484,147	\$10,484,147	\$9,104,289	\$1,379,858	-0-	-0-

CENTER CORE STAFF -- CURRENT PROFILE (09/29/89)

EXPERTISE/EXPERIENCE	
ADMINISTRATION	J. Latz, R. Adler, H. Garcia, W. Patrick, A. Whiting
DATA BASE MANAGEMENT AND DATA PROCESSING	S. McFaddin, M. Pape
ELECTROCHEMISTRY	N. Sridhar
ENGINEERING GEOLOGY/GEOLOGICAL ENGINEERING	
GEOCHEMISTRY	W. Murphy, R. Pabalan
GEOHYDROLOGY	R. Ababou, R. Green
GEOLOGY	J. Russell
GEOMORPHOLOGY	
GEOSTATISTICS	
HEALTH PHYSICS	J. Hageman
INFORMATION MANAGEMENT SYSTEMS	R. Johnson, R. Marshall
MATERIAL SCIENCES	P. Nair, H. Manaktala, C. Tschoepe
MECHANICAL, INCLUDING DESIGN & FABRICATION	
METEOR/CLIMATOLOGY	
MINING ENGINEERING	S-M. Hsiung
NUMERICAL MODELING	
PERFORMANCE ASSESSMENT	
QUALITY ASSURANCE	B. Mabrito
RADIOCHEMISTRY	
REGULATORY AND POLICY ANALYSIS	P. LaPlante, S. Spector
RELIABILITY	J. Wu
ROCK MECHANICS	A. Chowdhury
STRUCTURAL GEOLOGY	
SYSTEMS ENGINEERING	D. T. Romine
TRANSPORTATION	R. Weiner
VOLCANOLOGY/IGNEOUS GEOLOGY	

CENTER CORE STAFF -- HIRING PROFILE  
(BASED ON APPROVED FY90-91 OPERATIONS PLANS)

EXPERTISE/EXPERIENCE	FY 88	FY 89	FY 90				FY 91	FY 92	TOTAL REQUIRED	CURRENTLY OPEN (4TH QTR)
			1Q	2Q	3Q	4Q				
ADMINISTRATION	5	5	5	5	5	5	5	5	0	
DATA BASE MANAGEMENT AND DATA PROCESSING	1	2	2	2	2	2	2	2	0	
ELECTROCHEMISTRY (b) (a)			1	1	1	1	1	1	0	
ENGINEERING GEOLOGY/GEOLOGICAL ENGINEERING (b)				1	1	1	1	1	0	
GEOCHEMISTRY (b) (a)	2	2	3	5	5	5	5	5	0	
GEOHYDROLOGY (b) (a)		2	2	4	4	4	4	4	0	
GEOLOGY	1	1	1	1	2	2	2	2	0	
GEOMORPHOLOGY (b) (a)				1	1	1	1	1	0	
GEOSTATISTICS (b)				1	1	1	1	1	0	
HEALTH PHYSICS	1	1	1	1	1	1	1	1	0	
INFORMATION MANAGEMENT SYSTEMS	2	2	2	2	2	2	2	2	0	
MATERIAL SCIENCES (b) (a)	2	2	3	3	3	3	3	3	(g) -1	
MECHANICAL, INCLUDING DESIGN & FABRICATION			1	1	1	1	1	1	(g) -1	
METEOR/CLIMATOLOGY (b)				1	1	1	1	1	0	
MINING ENGINEERING	1	1	1	1	1	1	1	1	0	
NUMERICAL MODELING (b) (a)			1	1	1	1	1	1	0	
PERFORMANCE ASSESSMENT (b) (c) (d)		1	2	4	4	4	4	4	1	
QUALITY ASSURANCE (b) (a) (d)	1	2	2	2	2	2	2	2	1	
RADIOCHEMISTRY (b)				1	1	1	1	1	0	
REGULATORY AND POLICY ANALYSIS (f) (a) (d)	2	3	3	3	3	3	3	3	1	
RELIABILITY	1	1	1	1	1	1	1	1	0	
ROCK MECHANICS (b) (a)		1	2	3	3	3	3	3	0	
STRUCTURAL GEOLOGY (b) (a) (d)				1	1	1	1	1	0	
SYSTEMS ENGINEERING (b)	1	1	2	2	2	2	2	2	0	
TRANSPORTATION	1	1	1	1	1	1	1	1	0	
VOLCANOLOGY/IGNEOUS GEOLOGY (b)				1	1	1	1	1	0	
TOTAL REQUIRED	21	28	36	50	51	51	51	51	1	

Notes:

- (a) Interview scheduled next period.
- (b) Resumes being solicited.
- (c) Offer made.
- (d) Offer pending.
- (e) Offer accepted.
- (f) Position re-opened.
- (g) Negative number indicates early hire.

Staffing Summary

	Professional	Support	Total
Current	27	8	35
Planned This Date	28	8	36
Planned End of FY89	28	8	36
Previous Plan End of FY89	35	8	43

CENTER Composite Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PD COST	419,423	511,770	576,570	590,933	653,944	672,049	667,536	575,451	567,945	577,778	583,975	567,278	598,444	576,038	9,789,690
ACTUAL PD COST	364,234	406,981	371,630	418,872	419,505	453,624	451,790	495,768	456,234	568,497	478,950	521,026	549,021	609,595	9,104,288
VARIANCE, \$	55,189	104,789	204,940	172,061	234,439	218,425	215,746	79,683	111,711	9,281	105,025	46,252	49,423	(33,557)	685,402
VARIANCE, %	13.2	20.5	35.5	29.1	35.9	32.5	32.3	13.8	19.7	1.6	18.0	8.2	8.3	-5.8	7.0
ESTIMATED CUM COST	3,404,589	3,916,359	4,492,929	4,947,907	5,601,851	6,273,900	6,290,432	6,865,883	7,433,828	7,804,839	8,047,930	8,615,208	9,213,652	9,789,690	
ACTUAL CUM COST	2,902,795	3,309,776	3,681,406	4,100,278	4,519,783	4,973,407	5,425,197	5,920,965	6,377,199	6,945,696	7,424,646	7,945,672	8,494,693	9,104,288	
VARIANCE, \$	501,794	606,583	811,523	847,629	1,082,068	1,300,493	865,235	944,918	1,056,629	859,143	623,284	669,536	718,959	685,402	
VARIANCE, %	14.7	15.5	18.1	17.1	19.3	20.7	13.8	13.8	14.2	11.0	7.7	7.8	7.8	7.0	

NOTES: 1. All estimated and actual costs exclude award fee.

2. HLW estimates are taken from the May 16, 1989, Interim Spending Plan. TRS and Research estimates are taken from Year 2 Project Plans.

3. Cumulative variances include FY 1988 year to date cost experience.

4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.

5. Totals reflect costs since inception of Contract.

6. Period 12 Overall Research cumulative costs include the transfer of Research (3102) amounts. Ref: Mace ltr 01/18/89.

## 2. WASTE SYSTEMS ENGINEERING AND INTEGRATION

NRC Program Element Manager: Philip M. Altomare

NRC Program Subelement Manager: Philip M. Altomare

NRC Project Officer for  
Program Architecture: Michael P. Lee

CNWSRA Subelement Manager: Allen R. Whiting

Key Personnel: R. Adler, R. Johnson, J. Latz, W. Patrick, A. Whiting,  
T. Romine

Subcontractors/Consultants: None

### 2.1 Subelement Objectives

The FY1989 objectives are to (a) continue development and maintenance of the Program Architecture for the NRC-HLW program, (b) develop and sustain the Center's capability to perform systems engineering and integration for the overall program, (c) coordinate and integrate inputs to the Center 5-Year Plan, (d) develop technical capabilities and make necessary preparations to transfer performance assessment activities into the Center and (e) provide technical review of other NRC contractors, DOE and its contractors, other agencies, and affected parties.

### 2.2 Subelement Technical Status

Activities related to this Subelement continued to be predominantly associated with development and implementation of the intended integrating effect of this Operations Plan. These activities focused on applying the Center's systems engineering and integration concepts to the successful development of the Program Architecture (PA) and the overall NRC-HLW regulatory program.

Throughout this Period, limited pre-PARC and PARC work on Set 1, Set 2, Set 3, and Set 4 of the Regulatory Requirements was resumed. Efforts to finalize definitions, terminology and expectations of the process, procedures and products of Program Architecture continued to be aggressively pursued by the Center and the NRC during this period. Meetings, phone conferences, written and telecopied information were all utilized to aid in communication related to open items. Final resolution continues to occur regarding definitions, guidance, and schedule for the refinement of the Program Architecture process. A major step toward resolution occurred when a previously submitted draft of TOP-001-02 Rev. 1 titled "Program Architecture Relational Database Content and Development Instructions" (reference letter from A. Whiting to P. Altomare dated September 2, 1989) was briefed to the NRC by T. Romine on September 6, 1989.

Activities regarding development of the Regulatory Requirements, "Erosion" and "Substantially Complete Containment" consistent with the 22-step Program Architecture Process and TOP-001-02 Rev. 1 were pursued this period in preparation for "baselining" the system in October. Meetings were held in the Center offices in San Antonio between NRC and Center staff on September 25, 26, and 27 to assess progress on these efforts. Target dates for the submittal of the examples "Erosion" and "Substantially Complete Containment" is scheduled for the week of October 15.

In addition, work continued on development of Program Architecture and PASS consistent with the requirements of TOP-001-02 Rev. 1 with emphasis

on the refinement and extension of the relational database; systems requirements and definitions; and development of the hardware, software, and telecommunications specifications necessary to support it.

Major efforts on scoping, staffing, scheduling and resource loading, and integrating the Draft Operations Plans occurred during the early part of this period with the culmination represented by the submission of the draft Operations Plans for HLW and Overall Research on September 11, 1989. A briefing of those plans was presented to specific NRC HLW and Research staff on September 12 and 13 in the NRC White Flint offices. Subsequent to that briefing we have received conditional approval of the Operations Plans with comments to be incorporated in the final submittal. A final resolution meeting is scheduled for the week of October 16, 1989 in San Antonio.

Continuing this period were training sessions of Center Staff on IMS applications as they are implemented and used in CNWRA operations.

The Technical Document Index and review system continues to be expanded and utilized by Center staff, SwRI, and subcontractors who are providing Element-specific reviews as input.

The semi-annual report on the acquisition of technical documents in the Center and the technical reviews performed with a description for accessing them via PASS was delivered this period. Reference letter from A. Whiting to M. Mace dated September 28, 1989.

During this period in the area of Performance Assessment, the pursuit of staff continued, with several individuals being set up for interviews. Discussions on Conflict of Interest (COI) were initiated with the NRC relative to the applicant previously extended a job offer. Currently we are awaiting a COI opinion from the NRC. Also, continuation of work on performance assessment review strategy (PARS) was pursued with Dr. Ruth Weiner acting as the Center's focal point on Performance Assessment and input from R. Green, Center staff member. Extensive meetings with appropriate NRC staff are being held as the draft reports are being developed. The due date for the draft letter reports has been delayed at the request of the NRC Program Element Manager (reference letter from W. Patrick to M. Mace dated October 5, 1989).

#### 2.2.1 Narrative Technical Progress This Period

Activities under the Waste Systems Engineering and Integration (WSE&I) Operations Plan for this period included technical work in Task 1 (Develop and Maintain Program Architecture), Task 2 (Develop Technical and Analytical Capability), Task 4 (Evaluate and Develop Performance Assessment Methodology at the Center) and Operations Plan scoping in Tasks 1, 2, 3, 4, and 5.

##### 2.2.1.1 Task 1: Develop and Maintain Program Architecture

Major emphasis this period included continuing attempts to capture final definitions, guidance, and schedule for the refinement of the Program Architecture process and revising TOPS for further actions of the PARC and Element Managers consistent with the NRC needs and expectations for "baselining" the Program Architecture in the fall of 1989. This included finalizing the prioritization of efforts on Statutes/Regulations and Regulatory Requirements consistent with the December requirement of having all Regulatory and Institutional Uncertainties for 10 CFR Part 60 identified. Also, work continued on development of Program Architecture and PASS with emphasis on the refinement and extension of the relational database; systems requirements and definitions; and development of the hardware, software, and telecommunications specifications necessary to support it. These efforts were supported by the following:

1. Continuing to develop Regulatory Requirements, Uncertainty Reduction Methods, etc. for Sets 1, 2, 3, and 4 in developing the relational database of Program Architecture.

2. Developing, defining, and documenting the terminology and criteria for refining, updating, and expanding the relational database of the Program Architecture through refining the PA process, modifying TOPs and instructions based on the agreements reached in the May 18-19, 1989 meeting at Crystal City between the NRC and the CNWRA (reference the minutes of said meeting).

3. Prioritization of the Statutes/Regulations relative to planned effort consistent with WSE&I deliverables scheduled for the fall of 1989 and defined in the Center Operations Plans.

4. Continuation of activities with identified participants and schedules from the joint NRC/CNWRA team development of the Regulatory Requirement analyses of "Adverse Condition--Geochemistry," "Substantially Complete Containment," and "Erosion," and loading of the data into the Program Architecture Relational Database in support of the March 15, 1989 NRC/CNWRA meeting request and the fall "baseline" requirement reflected in the April 20, 1989 letter from R. Browning to J. Latz. These activities are consistent with the guidance received from NRC concerning replacing the Center's effort on "Adverse Condition--Geochemistry" with "Volcanism" (reference meeting minutes of July 20-21, 1989 meeting and letter from P. Altomare to A. Whiting dated August 15, 1989).

5. Continuing the development of a preliminary draft of the CNWRA Administrative Procedure for Task Control and its relationship to PA.

6. Continuing the development of "Erosion" and "Substantially Completed Containment" for "baselining" the 22-step Program Architecture Process and TOP-001-01 Rev 1.

7. Briefing to the NRC on the draft revised TOP-001-02 with associated attachments to reflect the refined PAD Process through Block 22 with the attendant logic diagrams and appropriate DW4 templates to capture the regulatory analysis data consistent with the refined PADP and the revised TOP philosophy agreed to in the May 18 and 19, 1989 meeting (reference briefing conducted by T. Romine in NRC White Flint offices on September 6, 1989).

8. Continuing the development of Regulatory Requirement Topics for the remaining sections of 10 CFR Part 60 as per TOP-001-04.

9. Continuing to improve the communications link of the PASS system to the IBM 4381 by refining the software for the Version 2.0 mainframe implementation.

10. Providing Center end-user training on the PASS system on the IBM 4381 on PROFS and E-Mail.

11. Developing additional file maintenance capabilities for PASS and, in particular, developing the system maintenance process for updating the regulations and statutes text.

2.2.1.2 Task 2: Develop Technical and Analytical Capability

Major Milestone WSM-23 (Semi-Annual Report on the Status of Acquisition of Technical Documents and Technical Reviews Performed by the CNWRA) was delivered during this reporting period (reference letter from A. Whiting to M. Mace dated September 27, 1989). Additionally, the following activities were accomplished:

1. Continued refinement of the database and tracking system for document acquisitions and reviews including continued

indexing of the backlog of technical documents in the CNWRA library. Discussed the possibility of NRC document control sending the CNWRA the RIDS header information on diskettes to load into TDI. This is being coordinated with HLW. (Delivered the milestone report referenced above).

2. Supported the preparation of Operations Plans using ASPMC to load resources, schedules and budgets. Loaded the Work Breakdown Structure, Resources (per the latest staffing plan) and the Cost Elements for both the spending plans and the periodic reports in the ASPMC master file tables.

3. Continued weekly meetings with CCF, IBM, and IMS staff to coordinate CNWRA system development and implementation with NRC-IRM and IBM in Washington on the cluster controller status, network problem resolution, and software configuration control items.

4. Continued training sessions for selected Center staff on IMS applications as they are implemented in the CNWRA.

5. Continued pursuit of candidates for Center staff in Performance Assessment and Systems Engineering. Additional candidate interview times were established this period for Performance Assessment staff positions. Discussions on Conflict of Interest (COI) were initiated with the NRC relative to the applicant previously extended a job offer.

6. Started preparation of a PASS Users Manual.

2.2.1.3 Task 3: Coordinate and Integrate Input to Center 5-Year Plan

Continued scoping of FY90-91 Operations Plans in this task consistent with the new scope guidance received from the NRC in mid-June 1989.

2.2.1.4 Task 4: Evaluate and Develop Performance Assessment Methodology at the Center

Activities included submittal of the FY90-91 Operations Plans in this task consistent with the new scope guidance received from the NRC mid-June and discussed thru July and August. Also continuation of work on performance assessment review strategy (PARS) subtasks 1 and 2 was pursued.

2.2.1.5 Task 5: Technical Review

Completed development of FY90-91 Operations Plans in this task consistent with the new scope guidance received from the NRC in mid-June.

2.2.2 Milestone Status and Significant Accomplishments This Period

2.2.2.1 Task 1: Develop and Maintain Program Architecture

During this period, the following intermediate milestones were pursued. NOTE: With the acceptance of the Operations Plans, the following will be revised to more accurately reflect modified milestone definitions, schedules, and completion status.

<u>Milestone</u>	<u>Abbreviated Description</u>	<u>Date</u>	<u>Status</u>
E1	Element Activity via TOP-001-02 on Set 1	9/16/88	98%
P7	PARC Review of Set 1 Reg. Requirements	9/26/88	92%
I3	Integrate PARC Set 1 Data	9/27/88	82%
E2	Element Activity via TOP-001-02 on Set 2	9/30/88	96%
P8	PARC Review of Set 2 Reg. Requirements	10/11/88	92%

I4	Integrate PARC Set 2 Data	10/12/88	50%
E3	Element Activity via TOP-001-02 on Set 3	10/28/88	98%
P9	PARC Review of Set 3 Reg. Requirements	11/08/88	85%
I5	Integrate PARC Set 3 Data	11/09/88	20%
E4	Element Activity via TOP-001-02 on Set 4	11/11/88	95%
P10	PARC Review of Set 4 Reg. Requirements	11/21/88	80%
I6	Integrate PARC Set 4 Data	11/21/88	40%
I7	Integrated and "Certified" Data (Sets 1-4)	11/23/88	54%

2.2.2.2 Task 2: Develop Technical and Analytical Capability

Continued identification, accumulation, and entry of general information reviewed by Element Managers into the Library Management System and delivered WSM-23 Major Milestone on September 27, 1989. Submitted draft WSE&I and Performance Assessment Element Operations Plans for FY90-91 on September 11, 1989.

2.2.2.3 Task 3: Coordinate and Integrate Input to Center 5-Year Plan

Completed development of FY90-91 Operations Plans in this task consistent with the new scope guidance received from the NRC in mid-June. This task becomes part of the Center Operations Plan in FY90-91.

2.2.2.4 Task 4: Evaluate and Develop Performance Assessment Methodology at the Center

Completed development of FY90-91 Operations Plans in this task consistent with the new scope guidance received from the NRC in mid-June and discussion with the NRC counter parts. This task becomes a separate element activity in FY90-91.

2.2.2.5 Task 5: Technical Review

Completed development of FY90-91 Operations Plans in this task consistent with the new scope guidance received from the NRC in mid-June. This task becomes part of Center Operations Plan in 90-91.

2.2.3 Problems

None.

2.2.4 Forecast for Next Period

2.2.4.1 Task 1: Develop and Maintain Program Architecture

Major emphasis next period will involve revision and finalizing Operations Plans for FY90-91 and continued efforts towards finalization of definitions, guidance, and schedules for the refinement of the Program Architecture process and revising TOPS for further actions of the PARC and Element Managers consistent with the NRC needs and expectations for the Program Architecture in the fall of 1989. This will include continuing participation in "teaming" workshops of individuals within the NRC on "Erosion," "Igneous Activity," and "Substantially Complete Containment." Also, work will continue on development of Program Architecture and PASS with emphasis on the refinement and extension of the relational database; systems requirements and definitions; and development of the hardware, software, and telecommunications specifications necessary to support the agreed upon refined

PAPD and the modified TOP requirements. Specific activity directed toward this task will include:

1. NRC/CNWRA "teams" working with the Refined Program Architecture Development Process and the Revised Technical Operating Procedure (TOP-001-02 Rev. 1) necessary to implement it to meet the requirements of the fall deliverables.

2. Finalizing the NRC/CNWRA concurrence on the prioritization of Center efforts related to the Statutes/Regulations and Regulatory Requirements consistent with the fall 1989 deliverables and points beyond.

3. Finalizing a schedule and plan, with NRC participation, to conduct analyses of the three Regulatory Requirement topics to varying degrees: "Igneous Activity," "Substantially Complete Containment," and "Erosion," in support of the March 15 and July 20, 1989 requests and consistent with the Program Architecture "baseline" requirements.

4. Finalization of a schedule for the specification developments of the fall 1989 deliverables.

5. Continuing the redesign of the PASS system consistent with the May 18 and 19, 1989 agreements and producing database relationship diagram and flow charts for the operation of the modified system to match the processes. Confirm and/or evaluate software products and options for PASS for user interface and text management, as well as types of workstations, and submit to NRC options for how to best implement the PASS.

6. Continuing to develop Regulatory Requirements, consistent with the refined PAPD and the revised TOP-001-02, to the extent approved, for Sets 1, 2, 3, and 4 through Process Block 15 in support of Program Architecture and in a prioritized manner consistent with the final Operations Plans for FY90-91.

7. Continue developing Regulatory Requirement Topics for the remaining sections of 10 CFR Part 60 as per TOP-001-04.

8. Continuing to provide Center end-user training on the PASS system on the IBM 4381.

9. Work with the NRC as they develop a configuration control plan, and specify and execute computer tests to isolate problems and verify systems are working.

10. Continue to work on numbering schemes for PASS and new data records to handle logical relationships in REOP's, TRC's, etc. Work with regulatory analysts and task team members for training in new procedures and use of modified DW4 templates.

#### 2.2.4.2 Task 2: Develop Technical and Analytical Capability

The following activities are anticipated:

1. Continued refinement of the database and tracking system for document acquisitions, reviews, and indexing technical documents in the CNWRA library.

2. Continued expansion of liaison with DOE through NRC.

3. Continued pursuit of candidates for Center staff in support of Performance Assessment and System Engineering and Integration needs consistent with the Center Staffing Plan.

4. Train additional staff to use E-Mail and continue using PROFS via the line to White Flint.

5. Implement and train the staff to index correspondence and technical documents and commitment control through the PASS system.

6. Continued loading of technical documents in the index, entering abstracts and reviews for reference and status reporting in PASS, developing and continuing the Correspondence Index for the Center.

7. Providing training, orientation, and support of the group continuing to develop Regulatory Requirements, Elements of Proof, and other relational database fields for the PA and PASS consistent with TOP-001-02 Rev 1 and the 22-step Program Architecture Development Process.

8. Continuing the development of the ASPMC project management features and their interface to the SwRI accounting system.

9. Continued refinement of the Center LAN/workstation configurations for effective printing and plotting.

10. Continued implementation of additional capability to access NUDOCS using SMARTTERM to download the data.

11. Further implementation of the procedure for Center staff to access DIALOG.

12. Finalization of the Operations Plans for WSE&I for FY90-91 using AS and ASPMC.

2.2.4.3 Task 3: Coordinate and Integrate Input to Center 5-Year Plan

This task becomes part of the Center Operations Plan with the approval of the Operations Plans for FY90-91.

2.2.4.4 Task 4: Evaluate and Develop Performance Assessment Methodology at the Center

This task becomes an element activity with its own Operations Plan for FY90-91 with the approval of the Operations Plans for FY90-91.

2.2.4.5 Task 5: Technical Review

This task becomes part of the Center Operations Plan with the approval of the Operations Plans for FY90-91.

2.3 Element Financial Status

Table 1, below, indicates the financial status of the Element/Subelement program in the context of "ceiling" and "allotted" funds established by the NRC. Table 2 displays planned and actual costs to date on both a per period and cumulative basis. In addition, variances are shown on both a dollar and percentage basis. These data do not include commitments in the amount of \$4,910. Taking into account these commitments, costs are on-target with budgets. No changes to budget or schedule are recommended at this time.

Total Negotiated Subelement Ceiling	Funds Allotted by NRC to date	Funds Costed	Funds Uncosted	Adjustment to Complete Subelement (+ or -)	Revised Subelement Ceiling
\$1,652,941	\$1,652,941	\$1,570,286	\$82,655	-0-	-0-

WSE&I Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	63,749	40,166	55,030	71,774	79,636	80,988	88,649	81,131	81,472	89,437	85,908	85,170	109,585	99,447	1,549,908
ACTUAL PERIOD COST	26,223	40,165	14,073	73,637	63,906	74,958	74,351	90,267	89,269	73,254	90,679	82,575	104,912	135,871	1,570,287
VARIANCE, \$	37,526	1	40,957	(1,863)	15,730	6,030	14,298	(9,136)	(7,797)	16,183	(4,771)	2,595	4,673	(36,424)	(20,379)
VARIANCE, %	58.9	0.0	74.4	-2.6	19.8	7.4	16.1	-11.3	-9.6	18.1	-5.6	3.0	4.3	-36.6	-1.3
ESTIMATED CUMULATIVE COST	546,852	587,018	642,048	713,822	793,458	874,446	917,758	998,889	1,080,361	1,169,798	1,255,706	1,340,876	1,450,461	1,549,908	
ACTUAL CUMULATIVE COST	532,926	573,091	587,164	690,245	754,151	829,109	903,460	993,727	1,082,996	1,156,250	1,246,929	1,329,504	1,434,416	1,570,287	
VARIANCE, \$	13,926	13,927	54,884	23,577	39,307	45,337	14,298	5,162	(2,635)	13,548	8,777	11,372	16,045	(20,379)	
VARIANCE, %	2.5	2.4	8.5	3.3	5.0	5.2	1.6	0.5	-0.2	1.2	0.7	0.8	1.1	-1.3	

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NOTES: 1. All estimated and actual costs exclude award fee.

2. Estimates are taken from the May 16, 1989, Interim Spending Plan.

3. Cumulative variances include FY 1988 year to date cost experience.

4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.

5. Totals reflect costs since inception of Contract.

### 3. RESEARCH

NRC Program Element Manager: William R. Ott

NRC Project Officer for  
Geochemistry Task: George F. Birchard

NRC Project Officer for  
Thermohydrology Task: Linda A. Kovach

NRC Project Officer for Integrated  
Waste Package Experiments Task: Phillip R. Reed

NRC Project Officer for Seismic/Rock Mechanics Task: Jacob Philip

CNWRA Element Manager: Wesley C. Patrick (Acting Manager)

Key Personnel: B. Brady, F. Dodge, C. Freitas, S. Hsiung, D. Kana,  
F. Lyle, H. Manaktala, W. Murphy, P. Nair,  
R. Pabalan, J. Russell, B. Vanzant, A. Chowdhury  
R. Ababou, R. Green

Subcontractors/Consultants: Itasca, ABC, Inc., Ohio State University,  
University of Arizona, University of Texas-  
San Antonio

#### 3.1 Element Objectives

The broad objective of this Element is to develop and recommend a research program that will have optimal effect in identifying, characterizing, and contributing to the eventual resolution of issues and the reduction in the uncertainties and safety concerns associated with the long-term performance of a geologic repository. Specific research objectives for FY88-FY89 are to (a) obtain an understanding of geochemical mass transfer processes including sorption and matrix diffusion in both saturated and unsaturated, fractured, and porous tuff, (b) initiate a laboratory-scale study of repository thermohydrologics to provide a basis for evaluating calculational techniques, (c) undertake a laboratory study to evaluate potential corrosion mechanisms and parameters affecting corrosion failure modes for austenitic stainless steels and other DOE candidate materials exposed to conditions hypothesized to be present in a repository in tuff, and (d) investigate the effects of seismological events on both pre- and post-closure repository performances.

#### 3.2 Element Technical Status

##### 3.2.1 Narrative Technical Progress This Period

A major activity of the Center's staff in Period 13 was the preparation of the Operations Plans for Fiscal Years 1990 and 1991. The Operations Plans included a section on the Center's present and anticipated research projects. Laboratory experimental work in the Geochemistry, Thermohydrology, and Waste Package Research Projects was conducted in Building 57. Development of experimental procedures for the Thermohydrology Research Project separate effects experiments continued this period. Laboratory experiments were initiated for the Integrated Waste Package Experiments project in Building 57. The experimental facilities for the Seismic/Rock Mechanics project is set up in the high bay area within the Engineering and Material Sciences Division's Building 128. Currently the test facility is in operation.

Research Project Plans for "Stochastic Analysis of Unsaturated Flow and Transport Through Fractured Rock for Large-Scale Hydrogeologic Systems" and "Geochemical Analog of Contaminant Transport in Unsaturated Rock" research projects were under development in response to statements of work delivered to the Center from NRC. The status of the Project Plans as identified in the Overall Research Project Plan, is shown below.

<u>Project</u>	<u>Title</u>	<u>Revised Plan Completion Date</u>	<u>Approval Status</u>
Res. 1-Overall Program Plan		09/11/89	approved
Res. 2-Geochemistry		01/13/89	approved
Res. 3-Thermohydrology		05/12/89	approved
Res. 4-Seismic/Rock Mechanics		06/30/89	submitted to NRC
Res. 5-Integrated Waste Package		12/30/88	revision planned
Res. 6-Stochastic Analysis of Unsaturated Flow and Transport		SOW received	Project Plan development occurring under Res. 1 Project
Res. 7-Geochemical Analog of Contaminant Transport		10/5/89	submitted to NRC
Res. 8-Long Term Climatological Effects on Ground-Water Recharge and Site Hydrology		SOW received	Project Plan development pending

3.2.1.1 Research Project 1-Overall Program Plan

Based on the NRC guidance in the letter dated August 1, 1989, the Center prepared and submitted a FY90-91 Overall Program Plan for Research. The plan incorporates the effort required for the development of the project plans for the anticipated new starts for FY90 and describes the Center's approach to developing and maintaining a strong research capability at the Center. It outlines a plan to develop focused research projects in support of reducing technical uncertainties arising from regulatory concerns for the licensing of the HLW repository.

In Period 13, Research Project Plans for "Stochastic Analysis of Unsaturated Flow and Transport Through Fractured Rock for Large-Scale Hydrogeologic Systems" and "Geochemical Analog of Contaminant Transport in Unsaturated Rock" research projects were in the process of preparation in response to statements of work delivered to the Center from NRC. R. Ababou and W. Murphy, respectively, are the designated leaders in preparation of these two research project plans. A major activity of Dr. Murphy during Period 13 was identification, review, and preparation of background information to support the "Geochemical Analog of Contaminant Transport in Unsaturated Rock" Research Project Plan. He also interviewed candidates for Center staff positions in the Performance Assessment, Geologic Setting, and Research Program Elements. A major activity of R. Ababou during Period 13 was the identification, review, and preparation of background information to support the "Stochastic Analysis of Unsaturated Flow and Transport Through Fractured Rock for Large-Scale Hydrogeologic Systems" Research Project Plan.

3.2.1.2 Research Project 2-Geochemistry

W. Murphy and R. Pabalan gave presentations on the nature and use of groundwater from J-13 well to representatives of the Center, Cortest, and the NRC who met at the Center to review the Integrated Waste Package Experiments Research Project activities. R. Pabalan presented the results of his study on "Preliminary Evaluation of Technical Operating Procedures for the Preparation of Synthetic J-13 Well Waters." W. Murphy, R.

Pabalan, and J. Russell met with G. Birchard at the Center where they discussed the status of the Center's present Geochemistry Research Project and potential future sorption modeling and experimental activities. It is anticipated that the Center will receive a Statement of Work prepared by G. Birchard for sorption investigations.

Initial preparation of geochemistry experiment materials was accomplished using clinoptilolite samples from Grant County, New Mexico. These samples were hand-ground in a mortar and pestle, and were sieved several times to produce at least 250 grams of clinoptilolite powder. Homoionic Na-clinoptilolite was prepared from the clinoptilolite powder according to Technical Operating Procedure No. 005. The procedure involved equilibrating the clinoptilolite samples with 1 molar sodium chloride solutions at 25 degrees Celsius over several days to exchange the cations in the zeolite for sodium in the solution. The final composition of the homoionic clinoptilolite will be determined by chemical analysis. The Homoionic Na-clinoptilolite will be used as starting material in ion-exchange experiments.

W. Murphy performed computations with the EQ3/6 codes which he had previously modified to incorporate nonisothermal kinetics and Rayleigh gas fractionation calculation capabilities.

#### 3.2.1.3 Research Project 4-Thermohydrology

In Period 13, a resistivity probe commonly used to determine moisture content has been monitored for stability in bead mixtures of different saturations. The insertion of the probe apparently causes local disturbances in the media which give erroneous readings. Therefore, the probe has been embedded in a static mixture and has been monitored over time. The saturation level has been decreased by withdrawal of water and the stabilization of the probe's response is awaited. It appears that the time response of the media to stabilization is not rapid and the probe continues to monitor changes in the media. The resistivity of the fluid is very sensitive to a multitude of variables and the use of a resistivity probe does not appear promising. However, use of resistivity probes has not been totally discounted.

Scoping experiments have been conducted to study the use of light transmission through the media as a way to determine saturation levels. The initial data from trials is very promising. A light source of constant intensity is directed through the glass bead media at different percentages of saturation. The intensity measured using a photodetection device appears to be proportional to the saturation. The glass bead media, due to the spherical geometry, refracts most of the light when dry, but as water is added, it transmits light increasingly well. A curvilinear relationship was found to exist and is being investigated for application with respect to separate effects models.

Another technique investigated for possible use employs a heat-flux measuring device. A single thermistor can be used to measure the rate of heat change within the media. A current is run through the resistor to provide very low levels of local heating. The rate of heat decay can be measured and may be related to saturation levels. The heat flux is a function of the heat transfer coefficient of the media which will change as saturation levels change. A two-thermistor device might allow local monitoring of the temperature rise in the local environment to determine if any influence occurs and to limit that influence. It may also allow measurement of the heating rate as well as heat decay.

Plans have been made to use a simple laboratory configuration for investigating the change in acoustic velocities in the media as a function of saturation level. Currently, an investigation of the

application of gamma ray attenuation from single and multiple sources to the measurement of local saturation levels has been made. The gamma ray attenuation methods and acoustic velocity methods would require precise planar positioning.

Trial runs have been performed to make a fused bead matrix in an attempt to control bead structure/pore volume. This may be useful in the separate effects as it would remove some uncertainty with regard to the physical aspects of bead models. The soda lime glass melts at 1841 degrees Fahrenheit and softens at 1283 degrees Fahrenheit. Although 1500 degrees Fahrenheit has been used to fuse the beads, non-uniform melting occurred because of heat transfer problems. The temperature was lowered to 1300 degrees Fahrenheit and the "baking" time was increased. This appears to give a evenly distributed fusing of the beads with limited reduction in the pore volume.

The literature report document is projected to be completed by the end of October. It will contain an Introduction/Summary describing current state-of-the-knowledge in thermohydrological research from the perspective of the Center's project. It will be followed by individual document reviews organized into discrete categories, where possible. The reviews consist of approximately one page of text with an opposing page showing some relevant figures where possible. Structure of the reviews are as follows: (a) a problem description; (b) the method of solution; (c) the major conclusions; (d) the perceived importance of the work with respect to thermohydrology; and (e) a keyword listing. The document will be oriented towards application of relevant published material to the thermohydrology projects' objectives.

M. Lewis attended the Focus '89 conference in Las Vegas, where discussions were held on current directions of research in the thermohydrology and related areas. Attendance at the meeting allowed gaps in the current approaches to be better understood. Key researchers at the national laboratories were identified and experimental techniques and experiences with instrumentation were discussed.

#### 3.2.1.4 Research Project 4-Seismic/Rock Mechanics Studies

The major activities related to seismic rock mechanics research project that took place during this reporting period include: (a) a research group meeting for the preparation of the revised project plan for the seismic rock mechanics research project, (b) a visit to the Center by J. Philip of NRC-RES, (c) the construction and operational demonstration of seismic rock mechanics experimental apparatus, (d) the qualification study of computer codes, and (e) the tuff specimens acquisition effort.

A two-day working-meeting of the seismic rock mechanics research group was held at the Center on September 14 and 15, 1989. The primary participants at this working-meeting were B. Brady (Itasca), S. Hsiung (CNWRA), D. Kana (SwRI), and A. Chowdhury (CNWRA). The purpose of this meeting was to update the format and conduct technical discussions for the preparation of revised project plans for the seismic rock mechanics research project to include (a) instrumented analog field studies for dynamic effects on underground openings and (b) seismic effects on the groundwater. The revised project plan will include seven tasks, and the project duration will be extended through FY94.

J. Philip of NRC-RES visited the Center on September 18, 19, and 20, 1989 to review the progress of seismic rock mechanics research project and to discuss the future activities of the project. The pertinent activities included:

- o Review of the example problems for qualification study of computer codes.
- o Demonstration of run of computer code UDEC in IBM personal computer PS/2 to analyze example problem.
- o Demonstration of operational run of seismic rock mechanics experimental apparatus.
- o Visit of the laboratories being developed and used for CNWRA research projects.
- o Discussion on tuff specimens acquisition from Apache Leap, Arizona, for experimental work of seismic rock mechanics research project.
- o Access to CNWRA computer network by NRC-RES.
- o Identification of topics for future research projects.
- o Submission of revised project plan for seismic rock mechanics research project.

The parts of the seismic rock mechanics research project experimental apparatus have been assembled at the Dynamics Laboratory at SwRI during this reporting period. Several demonstration experimental runs were made during the visits of this laboratory by M. Silberberg, J. Bunting, J. Philip, G. Birchard, P. Reed, J. Pearring, J. Buckley, and C. Abbate of the NRC. Additional work on this apparatus and associated instrumentation are underway. The qualification study on the UDEC and 3DEC codes is continuing.

The efforts for the acquisition of tuff specimens from Apache Leap are continuing. A trip report by M. Lewis, B. Vanzant, and F. Dodge based on their preliminary survey trip to Apache Leap on August 16-18, 1989 has been submitted to the NRC during this reporting period. D. Evans of the University of Arizona visited the Center on September 25, 1989 and participated in discussions concerning the acquisition of tuff specimens from Apache Leap.

A list of 22 references from Seismic Rock Mechanics Research Task 1 Report, Critical Assessment of Seismic and Geomechanics Literature Related to a High-Level Waste Underground Repository (CNWRA 89-001) has been sent to the Copyright Office and Library of Congress for determination of the copyright ownership of these references. Figures and/or tables from these references have been included in Task 1 Report and permissions from the authors of copyrighted references are needed prior to publishing this Task 1 Report as a NUREG.

#### 3.2.1.5 Research Project 5-Integrated Waste Package Experiments

A research efforts coordination meeting was held at CNWRA on September 26, 1989, to review in depth the waste package related research sponsored by the NRC-RES at various organizations, viz. CNWRA, CORTEST-Columbus, and NIST. Those present during the technical presentations included H. Manaktala, P. Nair, R. Pabalan, W. Murphy (CNWRA), F. Lyle, R. Mason (SwRI), M. Silberberg, G. Birchard, P. Reed (NRC-RES), J. Bunting, R. Weller, K. Chang (NRC-NMSS), J. Beavers (CORTEST-Columbus), and W. Brown (NRC-NMSS/PMDA). Topics reviewed included methods used at CORTEST and CNWRA in conducting electrochemical tests on candidate HLW canister materials, variability in the data obtained, possible causes of the variability and

additional tests to be performed to resolve some of the differences between CORTEST and CNWRA observations, lab formulation of synthetic J-13 well water for corrosion tests, and likely water composition in the unsaturated tuff in the Yucca Mountain at the proposed repository horizon. NIST representatives were not present at the meeting, however, their research activities, in the areas of growing microbes for corrosion testing and development of high temperature pH measurement devices, were reviewed by G. Birchard and P. Reed respectively.

P. Reed was also provided a review of the IWPE tasks related to experimental studies of: (a) de-alloying of copper-based canister materials for the HLW canister, and (b) long-term stability (low temperature sensitization) of candidate austenitic materials for the waste canister. Discussions with P. Reed also covered the CNWRA-EBS activities to be initiated during FY90, funded by NRC-NMSS, in the areas of wastefrom (spent-fuel and borosilicate glass) characterization and leaching studies.

A tour of the CNWRA research facilities (geochemistry and waste package labs), Chemistry Division, Materials Science & Metallurgy Division, and hot-cell facilities was conducted for M. Silberberg, G. Birchard and P. Reed (NRC-RES) on September 27, 1989.

### 3.2.2 Milestone Status and Significant Accomplishments This Period

Experimental setup work has been completed for three projects in the Building 57 research facility.

A research coordination meeting was held at the Center on September 26, 1989 to review all the ongoing NRC-RES supported research activities in the materials area.

### 3.2.3 Problems

None.

### 3.2.4 Forecast for Next period

Based on an assessment of the IWPE peer review comments, and the review meeting on September 26, 1989, a revised technical direction recommendations for the IWPE project will be developed. The procedures for the development of synthetic J-13 water will be reviewed by the Center technical staff for implementation.

## 3.3 Element Financial Status

Table 1, below, indicates the financial status of the Element/Subelement program in the context of "ceiling" and "allotted" funds established by the NRC. Table 2 displays planned and actual costs to date on both a per period and cumulative basis. In addition, variances are shown on both a dollar and percentage basis. There are outstanding subcontractor commitments totalling \$134,878 related to these projects. Under-runs result primarily from delayed approvals of these projects. No changes to budget or schedule are recommended at this time.

### Overall

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$396,726	\$396,726	\$350,519	\$46,207	-0-	-0-

Outstanding Subcontractor Commitments - \$29,931

Geochemistry

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$352,378	\$352,378	\$299,751	\$52,627	-0-	-0-

Outstanding Subcontractor Commitments - \$13,399

Thermohydrology

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$266,584	\$266,584	\$251,085	\$15,499	-0-	-0-

Outstanding Subcontractor Commitments - \$2,373

Seismic Rock Mechanics

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$675,270	\$675,270	\$582,376	\$92,894	-0-	-0-

Outstanding Subcontractor Commitments - \$44,969

Integrated Waste Package

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$576,774	\$576,774	\$467,522	\$109,252	-0-	-0-

Outstanding Subcontractor Commitments - \$44,206

OVERALL Research Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	14,074	6,381	14,880	16,061	13,464	14,556	15,736	6,056	7,473	7,473	7,237	7,797	8,978	8,742	321,238
ACTUAL PERIOD COST	2,043	10,003	1,501	6,552	4,056	3,129	8,900	13,886	3,400	3,265	5,879	10,006	13,568	30,364	350,519
VARIANCE, \$	12,031	(3,622)	13,379	9,509	9,408	11,427	6,836	(7,830)	4,073	4,208	1,358	(2,209)	(4,590)	(21,622)	(29,281)
VARIANCE, %	85.5	-56.8	89.9	59.2	69.9	78.5	43.4	-129.3	54.5	56.3	18.8	-28.3	-51.1	-247.3	-9.1
ESTIMATED CUMULATIVE COST	41,222	47,603	62,483	78,544	92,008	106,564	122,300	128,356	135,829	143,302	150,539	158,336	312,496	321,238	
ACTUAL CUMULATIVE COST	2,824	12,827	14,328	20,880	24,936	28,065	36,965	50,851	54,251	57,516	63,395	73,401	320,155	350,519	
VARIANCE, \$	38,398	34,776	48,155	57,664	67,072	78,499	85,335	77,505	81,578	85,786	87,144	84,935	(7,659)	(29,281)	
VARIANCE, %	93.1	73.1	77.1	73.4	72.9	73.7	69.8	60.4	60.1	59.9	57.9	53.6	-2.5	-9.1	

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- NOTES: 1. All estimated and actual costs exclude award fee.
2. Estimates are taken from Year 2 Project Plan submitted on 12/15/88.
3. Cumulative variances include FY 1988 year to date cost experience.
4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.
5. Totals reflect costs since inception of Contract.
6. Period 12 cumulative costs include the transfer of Research (3102) amounts. Ref: Mace ltr 01/18/89. (Estimated \$145,182 - Actual \$233,186 F/Y 88).

GEOCHEM Research Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	48,621	22,875	40,318	15,887	30,975	48,441	33,685	29,761	32,527	25,358	25,358	27,719	25,358	27,129	505,682
ACTUAL PERIOD COST	8,006	44,057	23,131	13,759	30,837	12,895	13,638	22,935	30,285	15,946	15,265	20,741	19,826	16,875	299,751
VARIANCE, \$	40,615	(21,182)	17,187	2,128	138	35,546	20,047	6,826	2,242	9,412	10,093	6,978	5,532	10,254	205,931
VARIANCE, %	83.5	-92.6	42.6	13.4	0.4	73.4	59.5	22.9	6.9	37.1	39.8	25.2	21.8	37.8	40.7
ESTIMATED CUMULATIVE COST	120,291	143,166	183,484	199,371	230,346	278,787	312,472	342,233	374,760	400,118	425,476	453,195	478,553	505,682	
ACTUAL CUMULATIVE COST	19,561	63,618	86,749	100,508	131,345	144,240	157,878	180,813	211,098	227,044	242,309	263,050	282,876	299,751	
VARIANCE, \$	100,730	79,548	96,735	98,863	99,001	134,547	154,594	161,420	163,662	173,074	183,167	190,145	195,677	205,931	
VARIANCE, %	83.7	55.6	52.7	49.6	43.0	48.3	49.5	47.2	43.7	43.3	43.0	42.0	40.9	40.7	

NOTES: 1. All estimated and actual costs exclude award fee.

2. Estimates are taken from Year 2 Project Plan submitted on 01/12/89.

3. Cumulative variances include FY 1988 year to date cost experience.

4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.

5. Totals reflect costs since inception of Contract.

THERMO Research Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	0	38,962	46,887	40,670	40,670	40,670	50,293	47,859	25,198	39,355	40,425	37,747	41,368	44,284	327,621
ACTUAL PERIOD COST	0	32,485	8,961	11,900	17,754	9,600	2,581	19,813	21,339	10,055	15,828	32,715	36,702	31,344	251,086
VARIANCE, \$	0	6,477	37,926	28,770	22,916	31,070	47,712	28,046	3,859	29,300	24,597	5,032	4,666	12,940	76,535
VARIANCE, %	0	16.6	80.9	70.7	56.3	76.4	94.9	58.6	15.3	74.5	60.8	13.3	11.3	29.2	23.4
ESTIMATED CUMULATIVE COST	0	38,962	85,849	126,519	167,189	207,859	258,152	306,011	331,209	163,797	204,222	241,969	283,337	327,621	
ACTUAL CUMULATIVE COST	0	32,485	41,446	53,355	71,109	80,709	83,290	103,103	124,442	134,497	150,325	183,040	219,742	251,086	
VARIANCE, \$	0	6,477	44,403	73,164	96,080	127,150	174,862	202,908	206,767	29,300	53,897	58,929	63,595	76,535	
VARIANCE, %	0	16.6	51.7	57.8	57.5	61.2	67.7	66.3	62.4	17.9	26.4	24.4	22.4	23.4	

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- NOTES: 1. All estimated and actual costs exclude award fee.
2. Estimates are taken from Year 2 Project Plan submitted on 05/12/89.
3. Cumulative variances include FY 1988 year to date cost experience.
4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.
5. Totals reflect costs since inception of Contract.

SEISMIC Research Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	76,260	49,207	57,429	55,621	55,323	50,323	52,323	53,175	48,805	51,066	39,726	37,719	37,719	36,076	585,420
ACTUAL PERIOD COST	33,857	34,198	26,314	43,906	27,680	62,364	12,312	25,133	28,643	43,774	34,249	32,066	30,077	51,804	582,376
VARIANCE, \$	42,403	15,009	31,115	11,715	27,643	(12,041)	40,011	28,042	20,162	7,292	5,477	5,653	7,642	(15,728)	3,044
VARIANCE, %	55.6	30.5	54.2	21.1	50.0	-23.9	76.5	52.7	41.3	14.3	13.8	15.0	20.3	-43.6	0.5
ESTIMATED CUMULATIVE COST	301,792	350,999	408,428	464,049	519,372	569,695	622,018	675,193	723,998	775,064	473,906	511,625	549,344	585,420	
ACTUAL CUMULATIVE COST	129,856	164,054	190,368	234,274	261,954	324,318	336,630	361,763	390,406	434,180	468,429	500,495	530,572	582,376	
VARIANCE, \$	171,936	186,945	218,060	229,775	257,418	245,377	285,388	313,430	333,592	340,884	5,477	11,130	18,772	3,044	
VARIANCE, %	57.0	53.3	53.4	49.5	49.6	43.1	45.9	46.4	46.1	44.0	1.2	2.2	3.4	0.5	

NOTES: 1. All estimated and actual costs exclude award fee.

2. Estimates are taken from Year 2 Project Plan submitted on 06/29/89.

3. Cumulative variances include FY 1988 year to date cost experience.

4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.

5. Totals reflect costs since inception of Contract.

IWPE Research Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	21,901	30,185	30,185	30,112	34,490	34,059	35,952	36,542	37,723	35,952	37,723	35,952	38,903	40,674	516,429
ACTUAL PERIOD COST	17,845	(8,279)	17,799	29,862	19,439	15,114	36,780	61,055	29,403	38,518	25,983	54,245	20,461	64,534	467,522
VARIANCE, \$	4,056	38,464	12,386	250	15,051	18,945	(828)	(24,513)	8,320	(2,566)	11,740	(18,293)	18,442	(23,860)	48,907
VARIANCE, %	18.5	127.4	41.0	0.8	43.6	55.6	-2.3	-67.1	22.1	-7.1	31.1	-50.9	47.4	-58.7	9.5
ESTIMATED CUMULATIVE COST	57,977	88,162	118,347	148,459	182,949	217,008	252,960	289,502	327,225	363,177	400,900	436,852	475,755	516,429	
ACTUAL CUMULATIVE COST	62,608	54,329	72,128	101,990	121,429	136,543	173,323	234,378	263,781	302,299	328,282	382,527	402,988	467,522	
VARIANCE, \$	(4,631)	33,833	46,219	46,469	61,520	80,465	79,637	55,124	63,444	60,878	72,618	54,325	72,767	48,907	
VARIANCE, %	-8.0	38.4	39.1	31.3	33.6	37.1	31.5	19.0	19.4	16.8	18.1	12.4	15.3	9.5	

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NOTES: 1. All estimated and actual costs exclude award fee.

2. Estimates are taken from Year 2 Project Plan submitted on 12/29/88.

3. Cumulative variances include FY 1988 year to date cost experience.

4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.

5. Totals reflect costs since inception of Contract.

#### 4. QUALITY ASSURANCE

NRC Program Element Manager: Mark S. Delligatti

NRC Program Subelement Manager: Mark S. Delligatti

NRC Project Officer for External QA Task: James E. Kennedy

CNWRA Subelement Manager: Bruce E. Mabrito

Key Personnel: Bruce E. Mabrito, Robert E. Engelhardt,  
Thomas C. Trbovich, Robert D. Brient, Michael R. Gonzalez

Subcontractors/Consultant: William M. Bland, Jr., P.E., John H. Doyle

##### 4.1 Subelement Objectives

Objectives pursued in FY1989 are to (1) support development of the Program Architecture for the NRC-HLW program, (2) develop and sustain the Center's technical and analytical capabilities in the technology of quality assurance, (3) provide appropriate inputs to the Center 5-Year Plan, (4) develop and implement the Center Quality Assurance Manual and (5) provide information assessments, and audits of the programs of other NRC contractors, DOE and its contractors, other agencies, and affected parties, based on NRC direction.

##### 4.2 Subelement Technical Status

The QA Subelement Operations Plan includes specific tasks associated with each objective noted above which are integrated into the overall Center program. In support of the Program Architecture WSE&I deliverables, the Quality Assurance Subelement monitors the quality of other Element work.

###### 4.2.1 Narrative Technical Progress This Period

###### 4.2.1.1 Task 1: Support Development and Maintenance of Program Architecture

During this reporting period, the Center Director of Quality Assurance (the QA Subelement Manager) continued to participate in major Center Program Architecture (PA) discussions and assisted in the application of quality assurance and quality control principles to the Program Architecture development. This included oversight of the controlled distribution of Draft Technical Operating Procedure-001-02 which was rewritten to incorporate significant changes in the process and content of the Program Architecture based on comments from the NRC and the Center. Both controlled and uncontrolled copies of TOP-001-02 were distributed: the controlled copies to those persons performing PA work and delivering a product, and the uncontrolled copies to those who are reviewing and commenting up the TOP. Because of work on the Center's Operations Plans, the QA Group did not receive new Program Architecture products to review from the Program Architecture Review Committee (PARC), however, the QA Director was able to review two RR packets remaining from the earlier period and have them entered into the mainframe after shipment of the Ops Plans. The Center QA Group will continue to check 100% of the PARC output and provide input to those Technical Operating Procedures which direct Program Architecture actions next period.

###### 4.2.1.2 Task 2: Develop Technical and Analytical Capabilities

The Director of Center QA continued to work as Secretary to the Center Conflict of Interest Management Committee in obtaining

the documentation required by Center Administrative Procedure AP-001, and documenting the COI Management Committee actions. The COI Management Committee considered COI-related information on eight individuals whose qualifications met the Center needs during the period and to date a total of 117 personnel have been approved by the Center COI Management Committee. A COI/Qualification folder drawer has been set up with all COI/Qualification actions captured in that Center area. In a related but separate matter, Center QA has devised a set of Certification of Personnel Qualification forms which are being reviewed by SwRI Legal Counsel and Center management. After they are approved, the forms will provide the basis for Center Directors to certify the qualifications of personnel and the document will reside in the already established COI/Qualification folders and be available for review.

The QA Subelement Manager read the pertinent professional, trade, and programmatic publications and documentation that were circulated through the Center this period in addition to American Society for Quality Control publications.

B. Mabrito attended a Southern Methodist University seminar on vendor certification September 28-29, 1989 in Houston, Texas. The purpose was to determine if methods and systems used by other industries to obtain, qualify and retain vendors may be applicable to the Center. A separate trip report was written which details the seminar and some of the points which may be utilized by the Center.

The San Antonio section of the American Society for Quality Control toured an area fabrication company to learn of the controls they utilize to ensure quality production. The Center Quality Assurance Director is chairman of the local ASQC section.

#### 4.2.1.3 Task 3: Provide Input to 5-Year Plan

Discussions were held with R. Adler on the Center Five-Year Plan task during the period and the parameters for input from the Center Directors and Element Managers have been established. More work on the Center Five-Year Plan will take place next period.

#### 4.2.1.4 Task 4: Develop and Implement Center QA Program

During Period 13, implementation of the Center QA Manual continued and an internal QA audit on the remaining four active sections of the Center QA Manual proceeded utilizing specific project activities as the basis for evaluation. The internal audit was completed and no findings were issued. The internal audit report will be distributed to the Center Directors and Element Managers next period.

#### 4.2.1.5 Task 5: Develop External Program Information/Audits

This task continued in Period 13, as directed by the NRC, with the Sandia National Laboratory Audit Observation Team work accomplished from September 11-15, 1989 in New Mexico. Robert E. Engelhardt represented the Center on the NRC Audit Observation Team and provided the follow up report as required by the Task Operations Plan which was processed through the Center. Center participation in a second NRC Audit Observation Team occurred late in the period when Thomas C. Trbovich worked the REECo audit September 25-29, 1989. At the direction of Mr. James Kennedy, the Center QA Group made preparations for additional reviews of Department of Energy Quality Assurance Program Plans and for Audit Observation Team participation. Center participation in NRC Audit Observation Teams will continue next fiscal year, however it appears none will occur next period.

4.2.2 Milestone Status and Significant Accomplishments This Period

4.2.2.1 Task 1: Support Development and Maintenance of Program Architecture  
None planned.

4.2.2.2 Task 2: Develop Technical and Analytical Capabilities

Additional personnel were cleared through the Center COI Management Committee, including the Center's Advisory Board members. Two individuals were interviewed for the Center QA position. Both are under consideration for the position, as are other qualified individuals.

4.2.2.3 Task 3: Provide Input to 5-Year Plan

Preliminary work with R. Adler took place during the period in anticipation of milestone development next period.

4.2.2.4 Task 4: Develop and Implement Center QA Program

An internal audit of the Center was completed this Period with Robert E. Engelhardt of the SwRI QA Department performing the Lead Auditor activities. The audit report will be issued to Center Management next period.

4.2.2.5 Task 5: Develop External Program Information/Audits

Period 13 activities included work on the Sandia National Laboratory Audit Observation Team (R. Engelhardt) and the follow up report. Also during the period work on the REECo Audit Observation Team (T. Trbovich) took place and the report will be issued next period. Mr. James Kennedy continued the bi-weekly NRC staff conference calls involving Center QA personnel and key NRC NMSS QA staff during the period.

4.2.3 Problems

None.

4.2.4 Forecast for Next Period

4.2.4.1 Task 1: Support Development and Maintenance of Program Architecture

Quality Assurance at the Center will focus on documenting the continuing development and maintenance of the Program Architecture. QA reviews being performed by the Program Architecture Review Committee will continue to be documented. The revised TOPs will be reviewed for QA implications and be approved when judged to be in compliance with QA requirements. New TOPs and QAPs will receive appropriate QA input before they are published by the Center. The quality control work of checking each product from the PARC will continue and personnel from the SwRI Quality Assurance Department will be utilized in that process if required.

4.2.4.2 Task 2: Develop Technical and Analytical Capabilities

Information and insights gained from the Center's representatives to the NRC Audit Observation Teams will be integrated into the day-to-day activities of the Center QA Program. Work will continue with the Center's Conflict of Interest Management Committee. A decision will be made on the individual who is to be named to the Center QA position.

4.2.4.3 Task 3: Provide Input to 5-Year Plan

Work will begin and input will be provided to R. Adler on the Center Five-Year Plan.

4.2.4.4 Task 4: Develop and Implement Center QA Program

The Center will refine the Decision Support System which is detailed in the CQAM. The CQAM will be modified to reflect the

"lessons learned" in the area of Program Architecture and other Center activities. The Center QA and programmatic controls will be applied to products of the Center throughout the Period.

4.2.4.5 Task 5: Develop External Program Information/Audits

Close coordination will be maintained with Mr. Kennedy and his NRC personnel in preparation for additional work assignments of reviewing DOE Quality Assurance Program Plans and Audit Observation Team work. The Center will provide Quality Assurance reviews of the DOE QA Program Plans for those organizations identified by the NRC as they are received.

4.3 Subelement Financial Status

Table 1, below, indicates the financial status of the Element/Subelement program in the context of "ceiling" and "allotted" funds established by the NRC. Table 2 displays planned and actual costs to date on both a per period and cumulative basis. In addition, variances are shown on both a dollar and percentage basis. These data do not include commitments in the amount of \$3,058. The observed under-run results from delay in the DOE audit schedule. Any monies remaining at the end of FY89 are anticipated to be carried over to complete the planned work during FY90. No changes to budget or schedule are recommended at this time.

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$541,160	\$541,160	\$435,074	\$106,086	-0-	-0-

QA Subelement Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	25,670	26,218	42,027	50,965	62,239	54,268	50,644	53,229	24,825	23,809	27,686	27,973	26,580	18,855	502,639
ACTUAL PERIOD COST	12,249	26,219	29,578	15,800	17,060	23,858	23,334	23,737	32,387	19,015	19,543	16,915	23,711	27,395	435,075
VARIANCE, \$	13,421	(1)	12,449	35,165	45,179	30,410	27,310	29,492	(7,562)	4,794	8,143	11,058	2,869	(8,540)	67,564
VARIANCE, %	52.3	0.0	29.6	69.0	72.6	56.0	53.9	55.4	-30.5	20.1	29.4	39.5	10.8	-45.3	13.4
ESTIMATED CUMULATIVE COST	186,164	212,382	254,409	305,374	367,613	421,881	299,682	352,911	377,736	401,545	429,231	457,204	483,784	502,639	
ACTUAL CUMULATIVE COST	136,523	162,742	192,320	208,120	225,180	249,038	272,372	296,109	328,496	347,511	367,054	383,969	407,680	435,075	
VARIANCE, \$	49,641	49,640	62,089	97,254	142,433	172,843	27,310	56,802	49,240	54,034	62,177	73,235	76,104	67,564	
VARIANCE, %	26.7	23.4	24.4	31.8	38.7	41.0	9.1	16.1	13.0	13.5	14.5	16.0	15.7	13.4	

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- NOTES: 1. All estimated and actual costs exclude award fee.
2. Estimates are taken from the May 16, 1989, Interim Spending Plan.
3. Cumulative variances include FY 1988 year to date cost experience.
4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.
5. Totals reflect costs since inception of Contract.

## 5. GEOLOGIC SETTING

NRC Program Element Manager: David Brooks

NRC Project Officer for Task 1: John Trapp

NRC Project Officer for Tasks 2 and 4: Tin Mo

NRC Project Officer for Subtask 4.1: William Ford

NRC Project Officer for Task 3: Jeff Pohle

CNWRA Element Manager: John L. Russell

Key Personnel: M. Board, A. Brown, R. Hart, M. Logsdon, L. Lorig,  
J. Russell, W. Murphy, R. Pabalan, M. Miklas, R. Ababou  
R. Green

Subcontractors/consultants: Itasca Consulting Group, Inc., Adrian Brown  
Consultants, Inc.

### 5.1 Element Objectives

The objectives are to (1) support development of the Program Architecture for the NRC-HLW program, (2) develop and sustain the Center's technical and analytical capabilities in technical areas relevant to the geologic setting, (3) provide appropriate inputs to the Center 5-Year Plan, and (4) support the development of regulatory guidance documents such as technical positions and rules, (5) provide technical assistance in the form of reviews and analyses, and (6) support SCP and Study Plan reviews.

### 5.2 Element Technical Status

A major activity of the Geologic Setting Program Element during Period 13 was the development of the Center's draft Operations Plans for Fiscal Years 1990 and 1991. Other activities of this Program Element were in: Task 1 - development of the Program Architecture, Task 2 - development of the Center's technical and analytical capabilities, Task 3 - supporting development of the Center's 5-Year Plan, and Task 4 - supporting development of technical reports/positions and rulemaking activities. Activity in Task 2 included supporting Geologic Setting investigations by major efforts in recruitment.

J. Russell, W. Murphy, R. Pabalan, R. Green, R. Ababou and B. Everett of the Center staff, and M. Miklas and J. Erwin of the SwRI staff performed work at the Center on the Geologic Setting Program Element during Period 12. M. Miklas primarily performed work on Task 1. B. Everett's work activities were in Tasks 1 and 2. W. Murphy and R. Pabalan conducted work for the Geologic Setting Program Element primarily in Tasks 1 and 2.

J. Russell performed work for the Research Program Element in support of recruitment of professional staff and management of Research projects. He also managed the Thermohydrology Research Project and Geochemistry Research Project and conducted certain technical activities for these projects. W. Murphy and R. Pabalan primarily worked on the Geochemistry Research Project. In addition to performing work for the Geologic Setting Program Element, R. Green became familiar with the activities of the Center and the NRC in performance assessment, particularly the activities related to hydrology and geohydrology. R. Ababou continued development of a Research Project Plan for "Stochastic Analyses of Unsaturated Flow and Transport Through Fractured Rock for Large-Scale Hydrogeologic Systems" and contributed

greatly to the identification of computer hardware and software necessary to support the Center's activities in performing scientific and engineering computations and computer graphics. W. Murphy developed a draft Research Project Plan for "Geochemical Analog of Contaminant Transport in Unsaturated Rock," in addition to Geologic Setting Program Element activities.

The major work during the period was the development of the Geologic Setting Program Element components of the Center's FY90 and FY91 Operations Plans using a computer-based project management system to schedule anticipated Geologic Setting Program Element activities and to determine the quantity and availability of resources (including personnel) to accomplish activities. All members of the Center staff performing work for the Geologic Setting Program Element contributed significantly to the development of the Operations Plans.

#### 5.2.1 Narrative Technical Progress This Period

##### 5.2.1.1. Task 1: Support Development and Maintenance of Program Architecture

Work on development of the Program Architecture was primarily on the Regulatory Requirement designated "Adverse Condition--Extreme Erosion" which was selected to be used as an example for input of required information onto DisplayWrite 4 (DW4) templates which were developed to correspond to the revised Technical Operating Procedure for Program Architecture development. Work on the "Adverse Condition--Extreme Erosion" Regulatory Requirement included revision of, and entry of data onto appropriate templates. C. Purcell traveled to Las Vegas where he attended the Focus '89 Meeting and worked with M. Miklas and J. Russell on the "Adverse Condition--Extreme Erosion," in particular on refinement of Technical Review Components and development of Compliance Determination Methods and Information Requirements. Center staff met with NRC staff on September 25 and 26 in San Antonio to discuss the progress on development of Program Architecture input for the "Adverse Condition--Extreme Erosion" Regulatory Requirement and the anticipated product to be delivered to the NRC in October 1989.

M. Miklas, J. Erwin, B. Everett, and J. Russell comprise the SwRI/Center Staff team which provided the Geologic Setting Program Element input into Program Architecture development throughout Period 13. Dr. Jimell Erwin, a Chemical Engineer on the SwRI staff, assisted in development of Program Architecture logic and data for the "Adverse Condition--Geochemical Processes" Regulatory Requirement.

##### 5.2.1.2 Task 2: Develop Technical and Analytical Capabilities

Identification and acquisition of literature (including maps and unpublished reports) related to ongoing investigations, technical issues, compliance assessment methodologies, and other information pertinent to the HLW program were conducted during the reporting period. Professional publications which are pertinent to the geologic setting aspect of HLW geologic repositories were ordered for the Center and logged into the Center's Technical Document Library.

The Geologic Setting Program Element provided input for revision of the Center's staffing plan which established, as a high priority, the acquisition of an engineering geologist, geologist, volcanologist, tectonics/structural geologist, geomorphologist, meteorologist/climatologist, radioisotope geochemist, three additional geochemists, geostatistician, QA specialist with a background in the earth sciences, performance assessment specialists with backgrounds in geochemistry and/or hydrology, and two additional geohydrologist as full-time employees. These individuals will be tasked to conduct work for the GS, QA, Performance Assessment, WSE&I (Program Architecture development), and the Research

Elements. John Russell reviewed resumes, applications, and COI questionnaires obtained from a large number of geoscientists expressing interest in employment and entered pertinent information regarding the applicants into a computer data base. A large number of telephone calls was also made to solicit applications by qualified individuals. Announcements of employment opportunities were placed in professional journals, including the American Geophysical Union's EOS and the American Geological Institute's Geotimes. Arrangements were made to recruit at the annual meetings of the Geological Society of America, Gulf Coast Association of Geological Societies, and the American Geophysical Union's winter meeting. J. Russell distributed job announcements for Center positions at the Focus '89 Meeting in Las Vegas where he interviewed individuals interested in full-time employment and consulting work.

J. Russell, M. Miklas, and C. Purcell attended the Focus '89 Meeting on Nuclear Waste Isolation in the Unsaturated Zone. The meeting was held on September 18-21, in Las Vegas. A number of excellent presentations on a variety of topics pertaining to the Geologic Setting of a HLW repository in the unsaturated zone were attended. In addition, M. Miklas participated in a field trip to Yucca Mountain, G-Tunnel, the Climax facility, the Sample Management Facility, and other areas of interest on the Nevada Test Site. J. Russell and C. Purcell made a field trip on September 21, to the Crater Flat area to investigate the geomorphology of the area. They were unable to drive an automobile across Crater Flat to the western margin of Yucca Mountain because erosion, caused by water flowing in a channel ("arroyo"), had dissected the gravel road making it impassable. They examined the eastern flank of Bare Mountain and Miocene volcanic units at the type section of the Crater Flat Tuff.

Certain members of the Center's Washington Office staff attended the Yucca Mountain Site Team weekly meetings at Rockville. Attendance and reporting of activities at these meetings were conducted as Geologic Setting Program Element activities.

5.2.1.3 Task 3: Support Development of Center 5-Year Plan

A meeting initiating Geologic Setting Program Element activity to develop input for the Center's 5-Year Plan was attended by J. Russell and work to develop the input was conducted by him.

5.2.1.4 Task 4: Support to Technical Reports/Positions and Rulemaking Activities

Technical assistance work was accomplished to support the development of the Natural Resources Technical Position. The work was performed by the Center, including its subcontractors, Itasca Consulting Group, Inc. and Adrian Brown Consultants, Inc., and by R. Wright, a consultant to the Center. This technical assistance work was briefly discussed with H. Lefevre on September 26, when he was at the Center in San Antonio. A letter report giving recommendations for the possible use of USGS-MMS, Open File Report 88-373 (Working Paper) was delivered to NRC on September 15.

5.2.1.5 Task 5: Review SCP and SCP Modifications

No activity occurred for Task 5 in Period 12.

5.2.2 Milestone Status and Significant Accomplishments This Period

5.2.2.1 Task 1: Support Development and Maintenance of Program Architecture

Significant development of Program Architecture input for the 10 CFR Part 60.122 Adverse Conditions--Extreme Erosion was accomplished.

5.2.2.2 Task 2: Develop Technical and Analytical Capabilities

Approximately 15 applications of individuals with academic training and experience in the geosciences were received for the Center's career opportunities.

5.2.2.3 Task 3: Support Development of Center 5-Year Plan  
No milestones were scheduled.

5.2.2.4 Task 4: Support to Technical Reports/Positions and Rulemaking Activities

Center activities associated with providing technical assistance to NRC supporting development of the Natural Resources Technical Position were conducted during the period. A letter report giving recommendations for the possible use of USGS-MMS, Open File Report 88-373 (Working Paper) was delivered to NRC on September 15.

5.2.2.5 Task 5: Review SCP and SCP Modifications  
None.

5.2.3 Problems  
None.

5.2.4 Forecast for Next Period

5.2.4.1 Task 1: Support Development and Maintenance of Program Architecture

Program Architecture modification, development and maintenance will be conducted with appropriate consideration of guidance from the WSE&I Subelement and the NRC. Program Architecture development will consist of continuation of input of data and preparation of a deliverable documenting input for the "Adverse Condition--Extreme Erosion"

5.2.4.2 Task 2: Develop Technical and Analytical Capabilities

A major activity for Task 2 during Period 1 of FY90 will include continuation of recruitment of highly qualified Center staff with the specializations noted in Section 5.2.1.2 It is anticipated that the best candidates for these positions will be brought to the Center on recruiting/interview trips in the next Period.

5.2.4.3 Task 3: Support Development of Center 5-Year Plan  
Initiation of activity associated with this task

is presently planned for Period 1, FY90.

5.2.4.4 Task 4: Support to Technical Reports/Positions and Rulemaking Activities

A major activity of Period 1, FY90 will be assisting in developing the technical and regulatory bases for the NRC's proposed Natural Resources Technical Position.

5.2.4.4 Task 5: Review SCP and SCP Modifications

It is anticipated that Geologic Setting Program Element activities associated with supporting NRC's review of the SCP will continue in Period 13, upon request by NRC. The SCP review activities may include involvement at technical meetings between the NRC and DOE where the NRC's technical review of the SCP is discussed.

5.3 Element Financial Status

Table 1, below, indicates the financial status of the Element/Subelement program in the context of "ceiling" and "allotted" funds established by the NRC. Table 2 displays planned and actual costs to date on both a per period and cumulative basis. In addition, variances are shown on both a dollar and percentage basis. These data do not include commitments in the amount of \$58,517. Taking into account these commitments, Element costs

are on-target for the remainder of the year (currently about \$30,000 above planned). No changes to budget or schedule are recommended at this time.

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$1,459,903	\$1,459,903	\$1,232,424	\$227,479	-0-	-0-

GS Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	31,435	70,910	56,930	66,382	124,335	124,825	115,991	63,922	62,660	61,931	58,633	58,265	57,223	55,289	1,231,731
ACTUAL PERIOD COST	73,081	70,910	68,214	69,555	59,949	58,979	84,144	69,083	31,968	75,014	51,136	62,641	97,012	63,610	1,232,425
VARIANCE, \$	(41,646)	0	(11,284)	(3,173)	64,386	65,846	31,847	(5,161)	30,692	(13,083)	7,497	(4,376)	(39,789)	(8,321)	(694)
VARIANCE, %	-132.5	0.0	-19.8	-4.8	51.8	52.8	27.5	-8.1	49.0	-21.1	12.8	-7.5	-69.5	-15.1	-0.1
ESTIMATED CUMULATIVE COST	475,315	546,225	603,155	669,537	793,872	918,697	813,808	877,730	940,390	1,002,321	1,060,954	1,119,219	1,176,442	1,231,731	
ACTUAL CUMULATIVE COST	385,482	456,392	524,606	578,889	638,838	697,817	781,961	851,044	883,012	958,026	1,009,162	1,071,803	1,168,815	1,232,425	
VARIANCE, \$	89,833	89,833	78,549	90,648	155,034	220,880	31,847	26,686	57,378	44,295	51,792	47,416	7,627	(694)	
VARIANCE, %	18.9	16.4	13.0	13.5	19.5	24.0	3.9	3.0	6.1	4.4	4.9	4.2	0.6	-0.1	

NOTES: 1. All estimated and actual costs exclude award fee.

2. Estimates are taken from the May 16, 1989, Interim Spending Plan.

3. Cumulative variances include FY 1988 year to date cost experience.

4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.

5. Totals reflect costs since inception of Contract.

## 6. ENGINEERED BARRIER SYSTEM

NRC Program Element Manager: Jerome R. Pearring

NRC Project Officer for Tasks 1-4: Kien C. Chang

CNWRA Element Manager: Prasad K. Nair

Key Personnel: R. Adler, B. Brady, H Manaktala, P. Nair, W. Patrick,  
A. Whiting, Y. Wu

Subcontractors/Consultants: Systems Support, Inc.

### 6.1 Element Objectives

Objectives pursued in FY1989 are to (1) support development of the Program Architecture for the NRC-HLW program, (2) develop and sustain the Center's technical and analytical capabilities in technical areas relevant to engineered barriers, (3) provide appropriate inputs to the Center 5-Year Plan, (4) develop technical reviews of technical documents related to the EBS, (5) conduct technical review of DOE's Site Characterization Plan and associated documents, and (6) develop methodologies for evaluating DOE compliance with regulatory requirements in the area of engineered barriers.

### 6.2 Element Technical Status

During this reporting period the FY90-91 EBS Program Element Operations Plan was completed and submitted to the NRC. The plan incorporated the tasks outlined by NRC in the guidance documents provided to the Center and the discussions held with the staff. The EBS Program Element Operations Plan includes several activities proposed by the Center staff and has outlined the priorities for the various activities. The major activities in the EBS Element for FY90-91 include two topics for rulemaking, i.e., Substantially Complete Containment and Greater-than-Class C waste. Also, three technical positions are planned.

A EBS program review meeting, based on the proposed FY90-91 EBS Operations Plan was held at the Center on September 27, 1989. The attendees at the meeting included; J. Bunting, R. Weller, J. Pearring, and K. Chang from NRC and P. Nair and H. Manaktala from the Center.

#### 6.2.1 Narrative Technical Progress This Period

##### 6.2.1.1 Task 1: Support Development and Maintenance of Program Architecture

The status of the three regulatory requirements (E-3, E-4, & E-5) associated with the EBS and its performance, is given below.

E-3 -- No activity this period

E-4 -- This RR is being used as one of two examples to demonstrate the implementation of the Program Architecture process steps. This effort provides a treatment of the identified Uncertainty in the regulation on "Substantially Complete Containment." This is also the subject of an ongoing rulemaking effort. The Program Architecture process steps undertaken for E-4 are 1, 2, 3a, 3b, 4b, 10, 15a, and 13-22 (as applicable). Process steps 1, 2, 3a, 3b, 4b, 10 and 15a have been completed. Uncertainty Reduction Methods and the Technical Review Components have been developed.

A review meeting was held at the Center on September 27, 1989 to review the completeness of the RR1002 (E-4) Program Architecture development. The meeting was attended by the NRC and Center staff. The Center staff presented the details of the process undertaken to develop the necessary information and analysis required for each of the

Program Architecture process steps. The Technical Review Components were reviewed for their technical content, and the depth and detail requirements. The need to remain generic to the extent possible was expressed. The site specific information/data should be generated by the applicant.

E-5 -- No activity this period.

6.2.1.2 Task 2: Develop Technical and Analytical Capabilities

Literature review of waste package materials continued this period. The paper "Probabilistic Performance Assessment Using a New Importance Sampling Scheme Based on an Advanced Mean Value Method", authored by Y.-T. Wu and P. Nair, was presented at the FOCUS '89 meeting held in Las Vegas on September 18-21, 1989. The EBS staff attending the conference were P. Nair, Y.-T. Wu, and H. Manaktala. H. Manaktala participated in the U. S. Department of Energy conducted tour, on September 21, 1989, of the Nevada Test Site (NTS) with visits to the Climax Spent Fuel Test Facility, G-Tunnel with unwelded and welded tuffs, and Yucca Mountain--the proposed site of the HLW repository. A trip report is under preparation.

Dr. Narasi Sridhar, currently with Haynes Alloys, has accepted a position with the Center in the area of Material Science/Corrosion. Dr. Sridhar has a PhD in metallurgy from the University of Notre Dame. Dr. Sridhar is a recognized expert in the area of corrosion of metals. He has to his credit several publications in refereed journals, special publications and books. He is an active participant on three NACE committees and the chairman of one. He is expected to join the Center staff by early December this year.

Mr. Emil (Chuck) Tschoepe, a mechanical engineer in the Engineering and Material Sciences Division at SwRI, has accepted a position in the mechanical/materials engineering area at the Center. He has worked as a support staff from SwRI for about a year in the area of analysis of regulatory requirements. He is an active participant in the development of the "Substantially Complete Containment" rulemaking activity. Mr. Tschoepe has a MS in mechanical engineering with about eleven years of valuable experience in testing structural/material components to evaluate performance. His activities at the Center will also include support to the RDCO element. His transfer to the Center will be effective October 1, 1989.

6.2.1.3 Task 3: Provide Input to the Center 5-Year Plan  
No work performed this period.

6.2.1.4 Task 4: Develop Technical Reviews  
**Uncertainty Evaluation Methodology Report**

Efforts continued to review existing uncertainty evaluation methodologies that are applicable to the EBS performance assessment. The information is being compiled for the purposes of writing a report related to the potential rulemaking regarding "substantially complete containment."

**Elements of Proof Report**

Pertinent reports, technical papers, and relevant materials are being obtained and reviewed for the preparation of the report.

6.2.1.5 Task 5: Technical Review of DOE SCP Documents  
No activities this period.

6.2.1.6 Task 6: Develop Compliance Assessment Methodology

**FPPA Methodology Development**

A fast Monte Carlo methodology was developed and documented in a paper titled: "Probabilistic Performance Assessment Using A New Importance Sampling Scheme Based On An Advanced Mean Value Method" coauthored by Y. Wu and P. Nair. The newly developed sampling technique has been demonstrated to be highly efficient relative to the standard Monte Carlo methods and can be used to confirm or improve the fast probability performance assessment (FPPA) results. The FPPA method, supplemented with the fast Monte Carlo method, is suitable for providing quick and cost-effective "what if" answers to different assumptions to assist in decision making and computationally feasible solutions to complex problems.

**EBSPAC Code Development**

The development of EBSPAC for EBS performance assessment continued. The EBSPAC code is envisioned to have a modular structure with a central driver. The key components of the code include: (1) the probabilistic analysis module, (2) the process module which currently contains several corrosion models (based on the computer code CONVO), (3) a module for linking external computer codes, and (4) a database for managing performance models and parameters. During the last period, the integration of the probabilistic analysis module and the CONVO process module was completed. This experience will be useful in the future for integrating external codes.

In the EBSPAC framework, well-developed external codes based on established technology will be used to define waste package initial and boundary conditions. Currently, three thermal analysis codes are being evaluated by the Center. These three codes are ANSYS, SINDA and TOPAZ3D. It is anticipated that one thermal code will be selected for estimating the EBS long-term temperature field.

A letter report was prepared and submitted to NRC on the "Status of Compliance Assessment Methodologies". This report was identified as the EBS Major Milestone [49] in the EBS Operations Plan.

6.2.2 Milestone Status and Significant Accomplishments This Period

Significant effort was directed toward the submission of the EBS Program Element Operations Plan for FY90-91.

6.2.2.1 Task 1: Support Development and Maintenance of Program Architecture

A presentation was made to the NRC staff on the status of the regulatory requirement E-4 through Program Architecture 22-step process. This includes the development of the "Substantially Complete Containment" uncertainty and its associated uncertainty reduction methods. Additionally, the technical review components were developed.

6.2.2.2 Task 2: Develop Technical and Analytical Capabilities

A paper on the probabilistic performance assessment of the EBS was presented at FOCUS '89 conference at Las Vegas. P. Nair, Y.-T. Wu, and H. Manaktala attended the conference. Dr. Narasi Sridhar has accepted a position at the Center in the EBS section. Mr. E. Tscheope has joined the EBS staff as of October 1, 1989.

6.2.2.3 Task 3: Provide Input to the Center 5-year Plan  
None planned.

6.2.2.4 Task 4: Develop Technical Reviews

Work on the "Substantially Complete Containment" activity continued. Progress was made according to the task program plan developed in FY89.

6.2.2.5 Task 5: Technical Review of DOE SCP Documents  
None planned.

6.2.2.6 Task 6: Develop Compliance Assessment  
Methodology

Activities in modelling, debugging and code structure developments continued this reporting period. Milestone [49] activities were completed and a report prepared.

6.2.3 Problems  
None.

6.2.4 Forecast for Next Period

Support any additional activities necessary for the EBS FY90-91 Operations plan resulting from NRC staff review.

6.2.4.1 Task 1: Support Development and Maintenance of  
Program Architecture

Participation in PARC reviews of Regulatory Requirements assigned to the EBS Element by the WSE&I Subelement will continue. Development of E-4 based on the revised Program Architecture procedures and support of the analyses to carry the "Substantially Complete Containment" assessment through the 22-process steps will be completed and a report will be submitted to the NRC.

6.2.4.2 Task 2: Develop Technical and Analytical  
Capabilities

Continue review of literature and information on materials-related programs.

6.2.4.3 Task 3: Provide Input to the Center 5-Year Plan  
Provide preliminary input to the 5-Year plan.

6.2.4.4 Task 4: Develop Technical Reviews

Continue the approved work for the feasibility study for resolution of the uncertainty associated with "Substantially Complete Containment."

6.2.4.5 Task 5: Technical Review of DOE SCP Documents

Continue to provide support to the NRC on the review of the SCP, as requested.

6.2.4.6 Task 6: Develop Compliance Assessment

Continue the planned development of EBSPAC.

### 6.3 Element Financial Status

Table 1, below, indicates the financial status of the Element/Subelement program in the context of "ceiling" and "allotted" funds established by the NRC. Table 2 displays planned and actual costs to date on both a per period and cumulative basis. In addition, variances are shown on both a dollar and percentage basis. These data do not include commitments in the amount of \$83,377. Spending is on target for the established budgets. No changes to budget or schedule are recommended at this time.

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$1,405,466	\$1,405,466	\$1,169,666	\$235,800	-0-	-0-

EBS Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	51,006	79,232	55,908	42,707	54,609	59,241	54,087	55,036	58,151	49,916	51,395	39,787	42,389	37,942	1,142,990
ACTUAL PERIOD COST	73,085	79,231	81,711	46,010	111,552	54,068	55,682	32,619	36,414	51,104	48,625	43,302	62,110	85,523	1,169,666
VARIANCE, \$	(22,079)	1	(25,803)	(3,303)	(56,943)	5,173	(1,595)	22,417	21,737	(1,188)	2,770	(3,515)	(19,721)	(47,581)	(26,676)
VARIANCE, %	-43.3	0.0	-46.2	-7.7	-104.3	8.7	-2.9	40.7	37.4	-2.4	5.4	-8.8	-46.5	-125.4	-2.3
ESTIMATED CUMULATIVE COST	496,276	575,508	631,416	674,123	728,732	787,973	808,374	863,410	921,561	971,477	1,022,872	1,062,659	1,105,048	1,142,990	
ACTUAL CUMULATIVE COST	394,885	474,116	555,827	588,667	700,219	754,287	809,969	842,588	879,002	930,106	978,731	1,022,033	1,084,143	1,169,666	
VARIANCE, \$	101,391	101,392	75,589	85,456	28,513	33,686	(1,595)	20,822	42,559	41,371	44,141	40,626	20,905	(26,676)	
VARIANCE, %	20.4	17.6	12.0	12.7	3.9	4.3	-0.2	2.4	4.6	4.3	4.3	3.8	1.9	-2.3	

NOTES: 1. All estimated and actual costs exclude award fee.

2. Estimates are taken from the May 16, 1989, Interim Spending Plan.

3. Cumulative variances include FY 1988 year to date cost experience.

4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.

5. Totals reflect costs since inception of Contract.

7. TRANSPORTATION RISK STUDY

- NRC Program Element Manager: John Cook
- NRC Program Subelement Manager: Russell R. Rentschler
- CNWRA Subelement Manager: John P. Hageman
- Key Personnel: R. Weiner (P.I.), P. LaPlante, J. Buckingham (SwRI)
- Subcontractor/Consultant: A. Greenberg

7.1 Subelement Objectives

The overall objectives of the Transportation Risk Study (TRS) are to (1) update the currently available information on the subject, (2) provide a supplement to and revise risk estimates, which will cover the transportation of all radioactive materials by all transportation modes, (3) review and assess the available computational methodologies related to probabilistic risk assessment, (4) assess the risk of transporting radioactive materials, and (5) provide a Final Report which will project the acquired data and transportation statistics through the year 2005. The current emphasis of the study is to collect and implement information as set forth by the Operations Plan.

7.2 Subelement Technical Status

7.2.1 Narrative Technical Progress During This Period

7.2.1.1 Task 1: Completion of Overview and Scoping

R. Weiner continues to serve as a Program Committee Member for Transportation and Risk Assessment for the International High-Level Radioactive Waste Management Conference to be held in Las Vegas, NV, April 8-12, 1990. The information and resources regarding transportation continues to be augmented and updated on a regular basis.

7.2.1.2 Task 2: Evaluation and Assessment of Data, Models, and Codes - Recommendations and Uncertainty and Sensitivity Analysis

7.2.1.2.1 Subtask 2.1: Evaluation of Data and Databases

After an evaluation of the available databases it was determined that only the SAND84-7174 database will be used in the TRS and complete tables comparing extrapolated 1975 and 1982 data with 1985 projections were generated. Both of these items were discussed in a presentation given to the NRC, in White Flint on August 16, 1989. Further data and literature on radioactive materials transportation associated with medical use are being investigated.

7.2.1.2.2 Subtask 2.2: Evaluation of Models and Codes

Some underlying characteristics and assumptions of RADTRAN III were investigated. The results of these investigations are given below.

**Regulatory Limits**

RADTRAN III calculates risk with the assumption of compliance with applicable regulations. There are two primary areas where RADTRAN III imposes regulatory limits. The first is the dose rate limits imposed on shipments of radioactive material to limit exposure to workers and the public. Packages are designated "exclusive use" if:

- o a package transportation index (TI) is >10
- o the package surface dose rate is > 20 microsieverts/hr (uSv/hr) (or 200 mrem/hr), or
- o the total shipment TI is > 50

If designated "exclusive use," the shipment must also meet the applicable limits:

- o surface dose not > 100 uSv/hr (1000 mrem/hr)
- o vehicle surface dose not > 20 uSv/hr (200 mrem/hr)
- o 2 m from vehicle dose of < 1 uSv/hr (10 mrem/hr)
- o Crew dose rate < 0.2 uSv/hr (2 mrem/hr)

If the shipment exceeds these criteria, the code will automatically set the value to the regulatory limit [the surface dose < 100 uSv (1000 mrem/hr) is not checked]. This explains why incident-free dose results for a high activity Co-60 shipment reach a ceiling when the number of packages were increased above 3 (in cases where the amount of material shipped was such that after 3 packages, regulatory limits were exceeded).

Another regulatory criterion used in RADTRAN III is the cleanup level for an accident, where package contents are released. Although the RADTRAN III manual states that this variable (CULVAL) must be specified by the user (pg. 90 of the User's Manual), S. Neuhauser confirmed that no regulatory cleanup limits currently exist for individual nuclides, thus a default of 0.2 uCi/m<sup>3</sup> is used. This default originated from an EPA guidance document for cleanup of plutonium. Currently, the EPA has no regulations for radionuclide cleanup levels. There are some acceptable contamination levels in the NRC Regulatory Guide-1.86, but they cannot be used since our tests of the RADTRAN III code found that it will not accept user supplied cleanup values. There is a possibility the problem can be resolved by a small alteration in the code. This will be discussed with Sandia in the near future.

The cleanup level is important because of quarantine provisions if the amount of material deposited from an accident exceeds the allowable level. Thus, the modeled ingestion, resuspension, and groundshine risks will not increase proportionally with the amount of material shipped, and thus available for release in an accident, if the quantity of material is great enough to cause deposition in excess of the cleanup value. If the material in the scenario is designated as a non-dispersible material then the results for cloudshine, groundshine, ingestion, and resuspension will be zero.

#### **Dose to Risk Conversions**

RADTRAN III will calculate results as whole body dose (person-rem), as cancer risk, or as genetic effects risk based on individual organ doses. The user does not have the capability to select one or the other within a specific pre-defined data set. A pre-defined data set can be viewed as a data input "skeleton" that already contains data for a particular scenario. The user must choose such a data set to modify in order to run a customized scenario. Some data sets are setup to calculate whole body dose results (UNIT), while others are set up for cancer, and still other data sets for genetic effects risk calculated from organ dose (NON-UNIT). The manual does

not mention that certain data sets correspond to a particular output. C. Erickson of Sandia noted the following data set categories:

<u>UNIT</u>	<u>NON-UNIT</u>
Spent Fuel	Cs, Sr Capsules
LSA	Contaminated soil
LWR Fuel	National Assessments
Metallic Spent Fuel	Vitrified Waste
PuO	
State Examples	
TRU	

With this information, the user can select the data set that corresponds to the results desired, and modify that data set to run a customized scenario. By testing some of the "data sets", some differences were noted. For instance, the LSA data set, only uses 4 accident severity categories while all the others use 8. This may have some effect on the results since we were not able to duplicate the LSA "data set" results by using another data set in which we entered the same information. Therefore, we will not use the LSA data set. Since S. Neuhauser indicated the code is consistent within UNIT and NON-UNIT data sets, the obvious test was to enter the same data into two different "data sets" from the same category (UNIT or NON-UNIT) and see if the results agreed. The test produced identical results as expected. This shows that we can enter our own data into RADTRAN III, and obtain consistent results.

#### Missing Data

One of the tasks that was necessary before running scenarios was to obtain the proper input data. A significant portion of the input data is generic information on physical and chemical characteristics of individual nuclides. Since the information within the RADTRAN III data sets was considered to be acceptable, one task involved extracting the applicable data and tabulating it to a usable form. Following data extraction we noticed a number of zeros in certain places. For instance, in the National Assessments data set for NUREG-0170 the rem to Ci conversion factors for organ dose are less than 50% complete. In addition, the data for food transfer fraction, and soil transfer fraction are also about 50% complete. A communication with S. Neuhauser indicated that the zero values are representative of areas where they could not find, or did not calculate specific data values. In our scenarios appropriate values will be entered for missing values when data is available.

7.2.1.2.3 Subtask 2.3: Uncertainty and Sensitivity Analysis Evaluation of RADTRAN III by conducting several verification exercises continues.

7.2.1.3 Task 3: Analysis of Regulations Governing Radioactive Materials Transportation NRC comments on the preliminary draft of Chapter 2 of the TRS (the analysis of transportation regulations) were received. Response is being prepared.

7.2.1.4 Task 4: Discussion and Analysis of Transportation Alternatives It was determined that the material for Chapter 6 "Alternative Analyses" will be included in Chapters 4 and 5. This change was discussed with the Subelement Project Manager.

- 7.2.1.5 Task 5: Analyses of Radiological Effects of Radioactive Materials Transportation
  - 7.2.1.5.1 Subtask 5.1: Radiological Effects and Risk Analysis of Normal Transportation  
R. Weiner has begun to scope the material for Chapter 4.
  - 7.2.1.5.2 Subtask 5.2: Radiological Effects and Risk Analysis of Transportation Accidents  
R. Weiner has begun to scope the material for Chapter 5.
  - 7.2.1.5.3 Subtask 5.3: Security and Safeguards Considerations  
Review of regulations on transportation of "Special Nuclear Material" continues. A. Greenberg has begun work on revision of the material presented in Chapter 7 of NUREG-0170.
  - 7.2.1.5.4 Subtask 5.4: Radiation Dose and Risk Analysis  
Construction of scenarios for representative shipments continues (see preceding discussion of RADTRAN III).
- 7.2.1.6 Task 6: Analysis of Non-Radiological Impacts of Radioactive Materials Transportation, and Consideration of Human Factors  
No action to date. Consideration of Human Factors is unfunded.
- 7.2.2 Milestone Status and Significant Accomplishments This Period
  - 7.2.2.1 Task 1: Completion of Overview and Scoping  
No milestones scheduled.
  - 7.2.2.2 Task 2: Evaluation and Assessment of Data, Models, and Codes - Recommendations and Uncertainty and Sensitivity Analysis
    - 7.2.2.2.1 Subtask 2.1: Evaluation of Data and Databases  
No milestones this period.
    - 7.2.2.2.2 Subtask 2.2: Evaluation of Models and Codes  
No milestones this period.
    - 7.2.2.2.3 Subtask 2.3: Uncertainty and Sensitivity Analysis  
The uncertainty analysis of the databases and the first section of a RADTRAN III sensitivity analysis have been submitted as a draft to NRC.
  - 7.2.2.3 Task 3: Analysis of Regulations Governing Radioactive Materials Transportation  
Comments were received on the draft of Chapter 2.
  - 7.2.2.4 Task 4: Discussion and Analysis of Transportation Alternatives  
No milestones scheduled.
  - 7.2.2.5 Task 5: Analysis of Radiological Effects of Radioactive Materials Transportation  
The draft of Chapter 3 was submitted to NRC.

- 7.2.2.5.1 Subtask 5.1: Radiological Effects and Risk Analysis of Normal Transportation  
No milestones scheduled.
- 7.2.2.5.2 Subtask 5.2: Radiological Effects and Risk Analysis of Transportation Accidents  
No milestones scheduled.
- 7.2.2.5.3 Subtask 5.3: Security and Safeguards Considerations  
No milestones scheduled.
- 7.2.2.5.4 Subtask 5.4: Radiation Dose and Risk Analysis  
No milestones scheduled.
- 7.2.2.6 Task 6: Analysis of Non-Radiological Impacts of Radioactive Materials Transportation, and Consideration of Human Factors.  
No milestones scheduled.
- 7.2.3 Problems  
None.
- 7.2.4 Forecast for Next Period
  - 7.2.4.1 Task 1: Completion of Overview and Scoping  
Continue development of Chapters 4 and 5 for input to Chapter 1.
  - 7.2.4.2 Task 2: Evaluation and Assessment of Data, Models, and Codes - Recommendations and Uncertainty and Sensitivity Analysis
    - 7.2.4.2.1 Subtask 2.1: Evaluation of Data and Databases  
Work on data tables for Appendix A continues.
    - 7.2.4.2.2 Subtask 2.2: Evaluation of Models and Codes  
R. Weiner and P. LaPlante will attend a seminar at Sandia National Laboratories on RADTRAN IV. RADTRAN access through TRANSNET, running representative scenarios, will continue during the coming periods. Sensitivity analysis of RADTRAN III and IV will continue.
    - 7.2.4.2.3 Subtask 2.3: Uncertainty and Sensitivity Analysis  
J. Buckingham will continue the sensitivity analysis during the coming periods. R. Weiner and P. LaPlante will continue the RADTRAN analysis of representative shipments.
  - 7.2.4.3 Task 3: Analysis of Regulations Governing Radioactive Materials Transportation  
Response to NRC comments will be completed during the coming period.
  - 7.2.4.4 Task 4: Discussion and Analysis of Transportation Alternatives  
No actions planned.
  - 7.2.4.5 Task 5: Analysis of Radiological Effects of Radioactive Materials Transportation

7.2.4.5.1 Subtask 5.1: Radiological Effects and Risk Analysis of Normal Transportation  
 Comments on the Overview of Radiological Effects, Chapter 3, are awaited.

7.2.4.5.2 Subtask 5.2: Radiological Effects and Risk Analysis of Transportation Accidents  
 No actions planned.

7.2.4.5.3 Subtask 5.3: Security and Safeguards Considerations  
 The regulatory aspects of Security and Safeguards of the TRS will continue to be reviewed in the upcoming periods.

7.2.4.5.4 Subtask 5.4: Radiation Dose and Risk Analysis  
 No actions planned.

7.2.4.6 Task 6: Analysis of Non-Radiological Impacts of Radioactive Materials Transportation, and Consideration of Human Factors  
 Work on Non-Radiological Impacts of transporting radioactive material will begin during the next period.

### 7.3 Subelement Financial Status

Table 1, below, indicates the financial status of the Element/Subelement program in the context of "ceiling" and "allotted" funds established by the NRC. Table 2 displays planned and actual costs to date on both a per period and cumulative basis. In addition, variances are shown on both dollar and percentage bases. These data do not include commitments in the amount of \$300. Budgets are on target. No changes to budget or schedule are recommended at this time.

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$474,438	\$474,438	\$376,682	\$97,756	-0-	-0-

TRS Subelement Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	15,925	6,587	20,865	12,648	14,974	19,808	21,741	19,836	21,987	22,467	25,701	28,953	29,626	31,213	439,555
ACTUAL PERIOD COST	17,695	10,597	19,931	16,988	8,856	16,238	23,497	29,086	17,313	10,598	16,279	23,173	10,200	12,616	376,682
VARIANCE, \$	(1,770)	(4,010)	934	(4,340)	6,118	3,570	(1,756)	(9,250)	4,674	11,869	9,422	5,780	19,426	18,597	62,873
VARIANCE, %	-11.1	-60.9	4.5	-34.3	40.9	18.0	-8.1	-46.6	21.3	52.8	36.7	20.0	65.6	59.6	14.3
ESTIMATED CUMULATIVE COST	163,149	169,736	190,601	203,249	218,223	238,031	259,772	279,608	301,595	324,062	349,763	378,716	408,342	439,555	
ACTUAL CUMULATIVE COST	161,310	171,907	191,838	208,826	217,682	233,920	257,417	286,503	303,816	314,414	330,693	353,866	364,066	376,682	
VARIANCE, \$	1,839	(2,171)	(1,237)	(5,577)	541	4,111	2,355	(6,895)	(2,221)	9,648	19,070	24,850	44,276	62,873	
VARIANCE, %	1.1	-1.3	-0.6	-2.7	0.2	1.7	0.9	-2.5	-0.7	3.0	5.5	6.6	10.8	14.3	

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NOTES: 1. All estimated and actual costs exclude award fee.

2. Estimates are taken from the Year 2 Project Plan submitted on 04/04/89 (Revision 1).

3. Cumulative variances include FY 1988 year to date cost experience.

4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.

5. Totals reflect costs since inception of Contract.

8. SPECIAL PROJECTS AND ANALYTICAL EVALUATIONS, INCLUDING TRANSPORTATION

NRC Program Element Manager: Mark S. Delligatti

NRC Program Subelement Manager: Mark S. Delligatti

CNWRA Subelement Manager: John P. Hageman

Key Personnel: R. Adler, J. Hageman, S. Spector, R. Weiner,  
P. LaPlante

Subcontractors/Consultants: A. Greenberg, J. O'Brien, D. Field

8.1 Subelement Objectives

The FY 1989 objectives are to (1) support development of the Program Architecture for the NRC-HLW program, (2) develop and sustain the Center's technical and analytical capabilities in technical areas relevant to special study areas that will include legal, socioeconomic, institutional, environmental, and policy analyses, (3) develop Strategic Plan inputs and the Center 5-Year Plan based on the NRC-HLW Program Architecture and inputs from the other Elements/Subelements of the Center program, (4) monitor and assess the potential impacts of nuclear related Federal legislation and other relevant national technical/policy developments, and (5) provide policy options to streamline the HLW repository licensing process. Concentration on these objectives has continued in accordance with priorities indicated by the NRC.

8.2 Subelement Technical Status

The Subelement activities have been distributed over the five tasks as detailed in the following paragraphs.

8.2.1 Narrative Technical Progress This Period

8.2.1.1. Task 1: Support Development of Program Architecture

S. Spector continued to review and comment on the revised Program Architecture Technical Operating Procedure - TOP 001-02 and its supporting attachments. He attended a briefing at the NRC and traveled to San Antonio to participate in working sessions on both procedural format and system functions. The status of Program Architecture development is given in the attachment. J. Hageman and S. Spector also began participating in the twice-weekly PA Analysts meetings.

8.2.1.2 Task 2: Develop and Sustain Technical and Analytical Capability

R. Adler, S. Spector, and R. Weiner conducted interviews with two candidates for the vacant regulatory analyst position. One candidate was interviewed in the San Antonio Office. S. Spector and P. LaPlante attended weekly Yucca Mountain Project staff meetings and reported to Center staff. J. Hageman and the Washington staff assisted in final preparation of the FY90/91 Special Projects Operations Plan. B. Adler, S. Spector, R. Weiner, and P. LaPlante each attended portions of the 13th ACNW Meeting.

8.2.1.3 Task 3: Develop 5-Year Center Plan and Strategic Plan

R. Adler conducted a meeting with all Directors and Element Managers regarding development of planning documents.

8.2.1.4 Task 4: Monitor Nuclear Waste Related Federal Legislation and Assess Impact on Regulatory Policy

One Pertinent Information Summary was prepared and distributed internally on September 15, 1989. A review of the Federal Registers was made and updates to regulatory changes were provided to staff.

8.2.1.5 Task 5: Provide Policy Options to Streamline the Licensing Process

J. Hageman, R. Weiner and A. Greenberg developed a second "crosswalk" between all of 10 CFR Part 60 and the Format and Content Regulatory Guide (FCRG).

8.2.2 Milestone Status and Significant Accomplishments this Period

8.2.2.1 Task 1: Support Development of Program Architecture

None this period.

8.2.2.2 Task 2: Develop and Sustain Technical and Analytical Capability

None this period.

8.2.2.3 Task 3: Develop 5-Year Center Plan and Strategic Plan

None this period.

8.2.2.4 Task 4: Monitor Nuclear Waste Related Federal Regulations

One pertinent Information Summary was issued.

8.2.2.5 Task 5: Provide Policy Options to Streamline the Licensing Process

The 10 CFR Part 60 to FCRG crosswalk was completed and transmitted to the NRC.

8.2.3 Problems

None this period.

8.2.4 Forecast for Next Period

8.2.4.1 Task 1: Support Development of Program Architecture

The reporting of activities under each of these tasks will be addressed, if at all, under different categories in a new format for FY-90 and beyond, and will become a WSE&I-controlled task.

8.2.4.2 Task 2: Develop and Sustain Technical and Analytical Capability

Based on the August 9, 1989 meeting, with J. Linehan, M. Delligatti, and Center staff, the Center incorporated comments on the Environmental/Socioeconomic Task into the FY90/91 Special Projects Operations Plan activity to develop a Draft Environmental Impact Statement Review Plan.

8.2.4.3 Task 3: Develop 5-Year Center Plan and Strategic Plan

Procedure for analyzing program risks will be developed and submitted under a different Center element next period.

8.2.4.4 Task 4: Monitor Nuclear Waste Related Federal Regulations

This task will not appear in the FY90/91 Special Projects Operations Plan.

8.2.4.5 Task 5: Provide Policy Options to Streamline the Licensing Process

This task will not appear in the FY90/91 Special Projects Operations Plan.

8.3 Subelement Financial Status

Table 1, below, indicates the financial status of the Element/ Subelement program in the context of "ceiling" and "allotted" funds established by the NRC. Table 2 displays planned and actual costs to date on both a per period and cumulative basis. In addition, variances are shown on both a dollar and percentage basis. These data do not include commitments in the amount of \$1,500. The observed variances result primarily from tasking the staff to Program Architecture development activities outside of this Subelement.

Total Negotiated Subelement <u>Ceiling</u>	Funds Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	Adjustment to Complete Subelement <u>(+ or -)</u>	Revised Subelement <u>Ceiling</u>
\$1,499,841	\$1,499,841	\$1,363,982	\$135,859	-0-	-0-

ATTACHMENT  
SPECIAL PROJECTS AND ANALYTICAL EVALUATIONS, INCLUDING TRANSPORTATION

<u>I.D.</u>	<u>PARC Date</u>	<u>Status</u>
RR050 (B-1)	6/29/89	PARCed and input to mainframe.
RR051 (B-2)	12/20/88	RR was input to mainframe.
RR052 (B-3)	9/27/89	PARCed and input to mainframe.
RR053 (B-4)	6/29/89	PARCed and input to mainframe.
RR054 (B-5)	6/22/89	PARCed and input to mainframe.
RR074 (B-6)	7/19/89	PARCed and input to mainframe.
RR055 (E-7)	9/20/89	Submitted for PARC review, by S. Spector.
RR056 (E-8)	4/1/89	PARCed and placed in mainframe.
RR61 (B-12)	9/27/87	Submitted for PARC review.
RR062 (B-13)	9/28/89	Submitted for PARC review.
RR063 (B-14)	7/11/89	PARCed and input to mainframe.
RR064 (B-15)	7/11/89	PARCed and input to mainframe.
RR065 (B-16)		Currently being developed by J. Hageman and M. Muller.
RR066 (B-17)	7/11/89	PARCed and input to mainframe.
RR067 (B-18)	8/10/89	sent to PARC.
RR068 (B-19)	8/13/89	PARCed and input to mainframe.
RR069 (B-20)	9/25/89	PARCed and input to mainframe.

RR070           6/19/89 PARCed and input to mainframe.  
B-21)

RR071           Under revision by J. Hageman and R. Weiner.  
(B-22)

RR072           Under revision by J. Hageman and J. O'Brien, submitted to PARC.  
(B-23a)

RR073           Combined with B7, B8, B9, B10, B11 to make new RR (RR073).

RR076           Under revision by J. Hageman and J. O'Brien, submitted to PARC. NOTE:  
B-23           was split (B-23b) because it has DOE requirements and NRC requirements  
                  mixed within 10 CFR Part 60.52.

SPAE/T Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	40,598	16,604	60,952	74,753	87,791	89,195	91,019	91,350	123,485	123,557	125,662	128,671	125,094	124,998	1,622,473
ACTUAL PERIOD COST	28,385	16,603	13,272	43,145	35,813	60,244	70,073	80,300	101,403	110,097	80,486	79,649	90,401	62,936	1,363,982
VARIANCE, \$	12,213	1	47,680	31,608	51,978	28,951	20,946	11,050	22,082	13,460	45,176	49,022	34,693	62,062	258,491
VARIANCE, %	30.1	0.0	78.2	42.3	59.2	32.5	23.0	12.1	17.9	10.9	36.0	38.1	27.7	49.7	15.9
ESTIMATED CUMULATIVE COST	512,600	529,204	590,156	664,909	752,700	841,895	779,656	871,006	994,491	1,118,048	1,243,710	1,372,381	1,497,475	1,622,473	
ACTUAL CUMULATIVE COST	507,644	524,247	537,519	592,580	628,393	688,637	758,710	839,010	940,413	1,050,510	1,130,996	1,210,645	1,301,046	1,363,982	
VARIANCE, \$	4,956	4,957	52,637	72,329	124,307	153,258	20,946	31,996	54,078	67,538	112,714	161,736	196,429	258,491	
VARIANCE, %	1.0	0.9	8.9	10.9	16.5	18.2	2.7	3.7	5.4	6.0	9.1	11.8	13.1	15.9	

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- NOTES:
1. All estimated and actual costs exclude award fee.
  2. Estimates are taken from the May 16, 1989, Interim Spending Plan.
  3. Cumulative variances include FY 1988 year to date cost experience.
  4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.
  5. Totals reflect costs since inception of Contract.

9. REPOSITORY DESIGN, CONSTRUCTION, AND OPERATIONS

NRC Program Element Manager: Jerome R. Pearring

NRC Project Officer for Tasks 1-4: John Buckley

CNWRA Element Manager: Asadul H. Chowdhury

Key Personnel: A. Chowdhury, S. Hsiung, L. Lorig, T. Brandshaug,  
J. Daemen

Subcontractors/consultants: Itasca

9.1 Element Objectives

The objectives pursued in FY1989 are to (a) support development of the Program Architecture for the NRC-HLW program, (b) develop and sustain the Center's technical and analytical capabilities in technical areas relevant to the design, construction, and operations of both surface and underground facilities that are associated with a high-level nuclear waste repository, (c) provide appropriate inputs to planning activities and to the Center 5-Year Plan, (d) support the NRC in evaluating the DOE demonstration of compliance with regulatory requirements in the area of repository design, construction, and operations, and (e) perform a technical review of selected sections of DOE's Site Characterization Plan and associated documents.

9.2 Element Technical Status

Activities related to this Element for this period are predominantly in: Task 1 - support development of the Program Architecture, Task 2 - development of the Center's technical and analytical capabilities, Task 4 - develop compliance assessment methodology, and the preparation of the draft Operations Plan for FY90 and FY91 relevant to the RDCO Element. This Element also provided input for technical position preparation activities associated with thermal loads, retrievability, and short-term data extrapolation to long-term results for repository seals and near-field rock properties.

A. Chowdhury, and S. Hsiung of the Center staff, and T. Brandshaug of Itasca, performed work on the RDCO Program Element during Period 13. T. Brandshaug performed work on Task 1 and on the technical position on thermal loads. This reporting period, he visited the Center twice to attend: (a) Program Architecture training and (b) NRC/CNWRA meeting on the technical position on thermal loads. S. Hsiung conducted work in Tasks 1, 2, 4 and the draft Operations Plan for FY90 and FY91; he also worked on the Seismic Rock Mechanics Research Program Element. A. Chowdhury performed work on Tasks 1, 2, 3, and 4, and draft Operations Plan for FY90 and FY91, and worked on the Seismic Rock Mechanics Research Project. He also performed work in support of recruitment of professional staff. During this reporting period, J. Pearring, J. Buckley, and C. Abbate of NRC visited the Center for status review of CNWRA FY89 RDCO Program Element efforts, technical discussion for the technical position on thermal loads, and discussions on FY90 RDCO overall efforts.

9.2.1 Narrative Technical Progress This Period

9.2.1.1 Task 1: Support Development and Maintenance of Program Architecture

In support of the Program Architecture development, efforts were continued by this Element. This effort included CNWRA staff, and Itasca personnel participation in the analyses of Regulatory Requirements based on the parsed texts from the various regulations in the

Program Architecture Support System (PASS) database. The primary focus was the requirements of 10 CFR Part 60, Subpart E.

The development and maintenance of Program Architecture relevant to the RDCO Element involve twenty three Regulatory Requirements: RR1(E-36), RR2(E-2), RR3(E-50), RR4(E-1), RR34(E-34), RR35(E-35), RR37(E-37), RR80(E-44), RR81(E-45), RR82(E-46), RR83(E-47), RR84(E-48), RR85(E-49), RR86(E-51A), RR87(E-52), RR88(E-38), RR89(E-39), RR90(E-40), RR91(E-41), RR92(E-42), RR93(E-43), RR94(E-51B), and RR96(E-51C).

Personnel involved in regulatory analysis during this period included: A. Chowdhury, S. Hsiung, (CNWRA), and T. Brandshaug (Itasca).

A Program Architecture and database training based on TOP-001-02 Rev. 1 was conducted at the Center on September 11, 1989. T. Brandshaug, S. Hsiung, and A. Chowdhury attended this training session. During this reporting period, the RDCO and EBS elements jointly worked on the development of the Program Architecture on the Regulatory Requirement RR1002 (E-4), dealing with thermal loads following the Center's revised Technical Operating Procedure TOP-001-02 Rev. 1.

The status of RDCO Program Element efforts on Program Architecture in FY89 was reviewed by J. Pearring, J. Buckley, C. Abbate (NRC) and A. Chowdhury (CNWRA) during this reporting period. This review activity was carried out during a meeting at the Center on September 28, 1989. A meeting report is being prepared for submission to the NRC, including a Program Architecture status report. This meeting also reviewed the status of FY90 overall efforts of the CNWRA RDCO Program Element.

9.2.1.2 Task 2: Develop Technical and Analytical Capability

Identification and acquisition of technical literature related to RDCO activities were carried out during this period. Indexing and documenting newly received documents were carried out on an ongoing basis.

During this reporting period, the work for the preparation of the draft Operations Plan for FY90 and FY91 was carried under this task.

A. Chowdhury performed work in support of recruitment of professional staff in the areas of rock mechanics, mining engineering, and performance assessment.

9.2.1.3 Task 3: Support Development of Center 5-year Plan

During this period, A. Chowdhury performed work for the development of the Center 5-Year Plan, including attendance at the Center 5-Year Planning Meeting on September 28, 1989.

9.2.1.4 Task 4: Develop Compliance Determination Methodology

The technical position preparation activities associated with thermal load, retrievability, and short-term data extrapolation to long-term results for repository seals and near-field rock properties were performed under this task. A meeting to discuss the technical position on thermal load was held at the Center on September 28, 1989. J. Pearring, J. Buckley, and C. Abbate (NRC); A. Chowdhury, and S. Hsiung (CNWRA); and T. Brandshaug (Itasca) attended the meeting.

9.2.1.5 Task 5: Technical Review of DOE SCP

No work performed this period.

9.2.2 Milestone Status and Significant Accomplishments This Period.

- 9.2.2.1 Task 1: Support Development and Maintenance of Program Architecture  
No milestones were scheduled.
- 9.2.2.2 Task 2: Develop Technical and Analytical Capability  
No milestones were scheduled.
- 9.2.2.3 Task 3: Support Development of Center 5-Year Plan  
No milestones were scheduled.
- 9.2.2.4 Task 4: Develop Compliance Determination Methodology  
No milestones were scheduled.
- 9.2.2.5 Task 5: Technical Review of DOE SCP  
No milestones were scheduled.

9.2.3 Problems  
None.

9.2.4 Forecast for Next Period

The development of Program Architecture and technical positions on thermal loads and waste retrievability, development of Program Architecture on other Regulatory Requirements relevant to RDCO, development of the Center 5-Year Plan, and development of a revised project plan for Seismic Rock Mechanics Research Project will continue during the next period. The forecast for the three tasks of RDCO is given below.

9.2.4.1 Task 1: Prelicensing Activities

Support will be provided for the NRC/DOE Prelicensing technical exchange meeting on Exploratory Shaft Facility (ESF).

9.2.4.2 Task 2: Regulatory and Technical Guidance Development

Activities will concentrate on providing assistance in the development of technical positions on thermal loads and waste retrievability.

9.2.4.3 Task 5: Support Development and Maintenance of Program Architecture

The Program Architecture activities for the next reporting period (Period 1, FY90) will primarily concentrate on Regulatory Requirements dealing with thermal loads and waste retrievability. Program Architecture activities will also continue for other Regulatory Requirements relevant to RDCO.

### 9.3 Element Financial Status

Table 1, below, indicates the financial status of the Element/Subelement program in the context of "ceiling" and "allotted" funds established by the NRC. Table 2, displays planned and actual costs to date on both a per period and cumulative basis. In addition, variances are shown on both a dollar and percentage basis. These data do not include commitments in the amount of \$42,628. Spending is on target. No changes to budget or schedule are recommended at this time.

Total Negotiated Subelement <u>Ceiling</u>	Funds		Adjustment		Revised Subelement <u>Ceiling</u>
	Allotted by NRC <u>to date</u>	Funds <u>Costed</u>	Funds <u>Uncosted</u>	to Complete Subelement <u>(+ or -)</u>	
\$1,182,666	\$1,182,666	\$1,004,920	\$177,746	-0-	-0-

RDCO Element Status Cost Report, Year 2

ITEM	13	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
ESTIMATED PERIOD COST	30,184	68,158	67,983	60,859	55,438	55,675	57,416	37,554	43,639	47,457	58,521	51,525	55,621	51,389	1,044,004
ACTUAL PERIOD COST	62,653	68,156	66,576	47,627	22,483	62,128	46,495	27,850	34,412	117,852	75,000	62,999	40,043	26,723	1,004,920
VARIANCE, \$	(32,469)	2	1,407	13,232	32,955	(6,453)	10,921	9,704	9,227	(70,395)	(16,479)	(11,474)	15,578	24,666	39,084
VARIANCE, %	-107.6	0.0	2.1	21.7	59.4	-11.6	19.0	25.8	21.1	-148.3	-28.2	-22.3	28.0	48.0	3.7
ESTIMATED CUMULATIVE COST	357,769	425,927	493,910	554,769	610,207	665,882	698,298	735,852	779,491	826,948	885,469	936,994	992,615	1,044,004	
ACTUAL CUMULATIVE COST	319,502	387,658	454,234	488,935	511,418	573,546	620,041	647,891	682,303	800,155	875,155	938,154	978,197	1,004,920	
VARIANCE, \$	38,267	38,269	39,676	65,834	98,789	92,336	78,257	87,961	97,188	26,793	10,314	(1,160)	14,418	39,084	
VARIANCE, %	10.7	9.0	8.0	11.9	16.2	13.9	11.2	12.0	12.5	3.2	1.2	-0.1	1.5	3.7	

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- NOTES: 1. All estimated and actual costs exclude award fee.
2. Estimates are taken from the May 16, 1989, Interim Spending Plan.
3. Cumulative variances include FY 1988 year to date cost experience.
4. Period 1 actuals reflect NRC-approved adjustments of management and technical support costs.
5. Totals reflect costs since inception of Contract.