**RE/SPEC INC. TECHNICAL SUPPORT
TO THE REPOSITORY TECHNOLOGY PROGRAM**

**Summary of Activities for
September 1, 1988 Through June 30, 1992**

by
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June 1992

Work Performed Under Contract No. DE-AC02-89CH10378

**RE/SPEC Inc.
Rapid City, South Dakota**

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1.0 INTRODUCTION

This report presents a summary of all RE/SPEC Inc. technical support activities to the Repository Technology Program (RTP) from September 1, 1988, through June 30, 1992, under contract number DE-AC02-89CH10378. The RE/SPEC Inc. activities are grouped into the following categories: project management, project quality assurance (QA), performance assessment (PA), support of the Office of Civilian Radioactive Waste Management (OCRWM) through technical reviews and general assistance, participation in the Department of Energy (DOE) International Program, and code evaluation and documentation.

Project management activities include preparing weekly, monthly, and quarterly progress reports, monitoring spending, and interacting with DOE personnel on current and future projects.

Project quality assurance activities include audits, surveillances, and associated corrective actions as well as the preparation of quality assurance plans and procedures.

RE/SPEC Inc. supported the DOE OCRWM performance assessment integration by participating in the Performance Assessment Technical Integration Group (PA/TIG). The PA/TIG also assisted DOE in compiling data generated by the Yucca Mountain Project (YMP)-, RTP-, and OCRWM-sponsored organizations; assisted in reviews of QA procedures for planned PA sensitivity studies; and reviewed procedures required to ensure certification of applicable performance assessment codes for use in licensing.

RE/SPEC Inc. assisted DOE-CH in activities that included review, evaluation, and technical support. RE/SPEC also acted as a technical expert providing direction to the investigative activities in the interest of the OCRWM program on an as-needed basis. Reviews were conducted on system performance of the engineered and natural barriers.

RE/SPEC Inc. supported the Organization for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA) Stripa Project by participation in meetings of the Joint Technical Committee, Technical Subgroups, and various Task Forces. This included chairing and observing the activities of such groups, involvement as a technical expert, providing direction to the investigative activities in the interests of the OCRWM program, and reviewing the results of investigative activities. In addition, RE/SPEC Inc. provided technical support for the transfer and integration of technology from the Stripa Project to the candidate repository site and to the international cooperative activities.

RE/SPEC Inc. completed documentation of the computer codes SPECTROM-32, SPECTROM-41, and SPECTROM-55 in accordance with the standards provided by the Nuclear Regulatory Commission report NUREG-0856. RE/SPEC Inc. also revised and edited the *User's Manual for SQAMP: Software Quality*

Assurance Maintenance Program. The Software Quality Assurance Maintenance Program (SQAMP) was previously developed by RE/SPEC Inc. and is an integral part of computer code configuration management and change control.

2.0 PROJECT MANAGEMENT — CWBS 1.1.3.1.1

September 1988 Through April 1989

RE/SPEC received the Fiscal Year 1989 preliminary guidance letter on February 21, 1989, and the draft contract on March 16, 1989. The contract between RE/SPEC and DOE-CH was signed on April 21, 1989.

May 1989

The Management Plan was developed and sent to various individuals at DOE-CH on May 6, 1989. The Management Plan also included the Milestone Schedule/Plan, Cost Plan, and contractor Work Breakdown Structure (CWBS) Dictionary (Index and Element Definition). The Management Plan was sent as a controlled copy document and all appropriate individuals received any revisions.

The Notice of Energy RD&D Project was completed and sent on May 10, 1989, to the National Energy Software Center and copies were sent to Jerry Zimmer.

The Quarterly QA Summary/Monthly Report for September 19, 1988, through April 30, 1989, was submitted on May 19, 1989.

Effective May 22, 1989, the new Project Manager became William Coons and the Project Administrator became David Parrish of the Albuquerque office of RE/SPEC. Notice of this change was sent to Jerry Zimmer on May 19, 1989.

On May 25, 1989, Chapter 3 of the Management Plan was revised to reflect the new Project Manager and Project Administrator. Also on May 25, 1989, this new version of Chapter 3 as well as a Revision Record for the Management Plan were sent to all individuals who initially received the Management Plan.

June 1989

The Monthly Report for May 1989 was submitted on June 19.

July 1989

On July 7, RE/SPEC received a guidance letter for Fiscal Year 1989 and a contract Amendment to fund the contract through October 31, 1989.

William Coons coordinated with DOE-CH regarding the budget and scope of the Contract.

Fay Swenson read the different DOE Orders giving guidance on the requirements for submitting documents to Office of Scientific and Technical Information (OSTI) and National Energy Software Center (NESC).

The Monthly Report for June 1989 was submitted on July 17. Weekly highlights were started with the week of July 17.

August 1989

Fay Swenson coordinated with Mark Fornwall and Pam Gorman of the OSTI regarding submitting the Monthly Reports and Quarterly QA Summaries as part

of the reporting requirements for RE/SPEC. Pam Gorman worked with DOE-CH to eliminate these two items from the RE/SPEC submission requirements to OSTI.

The Monthly Report for July 1989 was submitted on August 15, and weekly highlights were sent on August 7, 11, 17, 28, and September 1.

On August 31, a memo regarding a drug-free workplace and a revised Project Records Index were distributed to RE/SPEC employees.

September 1989

The Monthly Report for August 1989 was submitted on September 15, and weekly highlights were sent on September 1, 8, 15, 22, and 29.

During the month, Fay Swenson started compiling and writing the technical progress report.

RE/SPEC received Amendment A002 to the Contract authorizing an additional \$34,450.49 for operating expenses. This Amendment was dated September 21.

October 1989

The Quarterly QA Summary/Monthly report for September 1989 was submitted on October 16; and weekly highlights were sent on October 6, 13, 20, and 27.

The Notice of Energy RD&D Project for Fiscal Year 1990 was submitted to the NESC and Jerry Zimmer on October 18.

Work continued on the Technical Progress Report for the time period September 19, 1988, through September 30, 1989.

November 1989

The Monthly Report for October 1989 was submitted on November 17, and weekly highlights were sent on November 3, 10, 17, and 22.

Work continued on the Technical Progress Report for the time period September 19, 1988, through September 30, 1989.

December 1989

The Monthly Report for November 1989 was submitted on December 18, and weekly highlights were sent for the weeks ending December 1, 8, 15, 22, and 29.

Work continued on the Technical Progress Report for the time period September 19, 1988, through September 30, 1989.

January 1990

William Coons and John Kasprovicz Department of Energy, Chicago, Repository Technology Program (DOE-CH/RTP) discussed the status of the guidance for Fiscal Year 1990 and précis of the Fiscal Year 1989 deliverables. This discussion was followed up with a memorandum to John Kasprovicz summarizing the status of the contract milestones.

The Monthly Report for December 1989 was submitted, and weekly highlights were sent for the weeks ending January 5, 12, 19 and 26.

Work continued on the Technical Progress Report for the time period September 19, 1988, through September 30, 1989.

February 1990

The progress report for January 1989 was submitted and weekly highlights were sent for the weeks ending February 2, 9, 16, and 23. Work continued on the Technical Progress Report for the time period September 19, 1988, through September 30, 1989.

March 1990

A supplemental guidance letter from Richard Baker (DOE-CH) was received March 27, 1990. A Fiscal Year 1990 guidance letter and new QA Requirements were received March 30, 1990. A final Field Work Proposal was prepared in response to the Fiscal Year 1990 guidance letter.

The progress report for February 1990 was submitted and weekly highlights were sent for the weeks ending March 2, 9, 16, 23 and 30.

April 1990

The Quarterly QA Summary and the Progress Report for March 1990 was submitted, and weekly progress reports were sent for the weeks ending April 6, 13, 20, and 27.

The *RE/SPEC Inc. Technical Support to the Repository Technology Program, Technical Progress Report for September 19, 1988 Through September 30, 1989* was submitted to John Kasprowicz (DOE-CH) and to OSTI, on April 18, in accordance with 4F of the Reporting Requirements Checklist.

An updated Notice of Energy RD&D Project was sent to the National Software Center, Technical Information Center on April 20, in accordance with 4F of the Reporting Requirements Checklist.

May 1990

The Progress Report for April 1990 and weekly progress reports for the weeks ending May 4, 11, 18, 25, and June 1, were submitted.

William Coons and Paul Gnirk received copies of a memorandum from Ralph Stein (DOE-HQ) to Hillary Rauch (DOE-CH) dated May 25, 1990. The memorandum provided additional programmatic guidance to the Repository Technology Program regarding RE/SPEC's PA support task. Six subtasks were identified.

June 1990

The Progress Report for May 1990 and weekly progress reports for the weeks ending June 1, 8, 15, 22, and 29 were submitted.

July 1990

William Coons coordinated with John Kasprowicz (DOE-CH) and Choon Quan (DOE-CH) regarding cost estimates submitted for the evaluation of Alternative

Licensing Strategies (ALS). He also discussed technology transfer with Barry Gale (DOE-HQ), Joanne Lowry (DOE-HQ), and John Kasprowicz.

The Progress Report for June 1990 and weekly progress reports for the weeks ending July 6, 13, 20, 27, and August 3 were submitted.

August 1990

On August 22, William Coons and Ken Ley (RE/SPEC) met with Ralph Stein (DOE-OCRWM), Steve Gomberg (DOE-HQ), John Kasprowicz (DOE-CH), and Don Alexander (DOE-OCRWM) to discuss the fact that written guidance to support SSE/ALS had been received by RE/SPEC Inc., but the requested funding for the additional activities had not, putting RE/SPEC in an overspent condition. The matter was then pursued by DOE-CH and DOE-HQ.

On August 27-28, 1990, Ken Ley met in Chicago, Illinois, with John Kasprowicz (DOE-CH) and David Dashevsky (DOE-RTTD) regarding the sequence of events relating to RE/SPEC's over-expenditures and the funding levels for the six new identified tasks.

The Progress Report for July 1990 was submitted, and weekly progress reports were sent for the weeks ending August 3, 10, 24, and 31.

September 1990

On September 27, RE/SPEC Inc. received guidance from David Dashevsky (DOE-CH) regarding authorization for domestic travel. This policy has been implemented. Travel requests for the month of October were compiled and sent to John Kasprowicz (DOE-CH) the first week of October.

The Progress Report for August 1990 was submitted and weekly progress reports were sent for the weeks ending September 7, 14, 21, and 28.

October 1990

The Progress Report for September 1990 was submitted, and weekly progress reports were sent for the weeks ending October 5, 12, 19, 26 and November 2. An updated Notice of Energy RD&D Project was sent to the NESC, as was required on a yearly basis as specified in 4F of the Reporting Requirements Checklist (RRC). According to 4B of the RRC, other documents requiring a yearly update were the Milestone Schedule/Plan and the Cost Plan.

Domestic travel requests for November were sent and conditional approval was received from John Kasprowicz. Ken Ley will travel to Rapid City in December for audit participation with DOE.

November 1990

On November 12, William Coons, Critz George, and Tom Feldman met with Russ Dyer (DOE-YMPO), Jerry Boak (DOE-YMPO), U. Sun Park (SAIC-YMPO) and Albin Brandstetter (SAIC-YMPO) at RE/SPEC Inc. in Albuquerque, New Mexico, to discuss guidance on the contract.

The Progress Report for October 1990 was submitted, and weekly progress reports were sent for the weeks ending November 2, 9, 16, 23, and 30.

December 1990

The Progress Report for November 1990 was submitted, and weekly progress reports were sent for the weeks ending December 7, 14, and 21. Since there was no activity to report, the preparation of weekly activity reports was discontinued.

January 1991

The Monthly Report for December 1990 was submitted.

All milestones shown on the Milestone Logs and Milestone Schedule and Status Reports were inactive and therefore were dropped from future Monthly Reports. The current milestones for Fiscal Year 1991 were included in Monthly Reports when Fiscal Year 1991 guidance was received.

February 1991

The Monthly Report for January 1991 was submitted.

March 1991

The current projected funding for Fiscal Year 1991 was a total of \$300,000, which includes \$200,000 for international work and \$100,000 for the activities related to performance assessment. To reserve funds for obligated travel to support the Joint Technical Committee (JTC) in June and the Sealing Task Force in September, routine support work was suspended.

William Coons met with Richard Lark (DOE-CH), Critz George, Ken Ley, and Tom Feldman to review the status of RE/SPEC's Fiscal Year 1991 guidance and anticipated budget requirements submitted for Fiscal Year 1992. William Coons was requested by Richard Lark to investigate some of the funding and plans for Stripa I, II, and III overview reports.

Via telephone communication, William Coons spoke with Richard Lark (DOE-CH) concerning the availability and sources for funding Stripa overview reports and support for Principal Investigators. William Coons informed Lark that:

- The source of overview funding is the JTC (funds planned and available).
- He had a discussion with Bengt Stillborg (SKB) regarding supplementing Steve Alcorn's funding and the possibility of obtaining a small increase of \$25,000.

In March, Steve Alcorn assisted William Coons with preparation of the RE/SPEC budget estimate for Fiscal Year 1992.

In a memo to John Kasprowicz (DOE-CH) dated April 2, 1991, RE/SPEC's Project Administrator position was changed from John Osnes to Critz George.

As per Ken Ley's conversation with John Kasprowicz on March 22, 1991, the preparation of weekly activity reports did not resume, as stated in the guidance

letter, due to a substantially decreased level of effort. Also, the distribution of the Monthly Report was to be:

John Kasprowicz - original
David Dashevsky - 2 copies
Gordon Giarrante - cost reports
John Chapman
RTTD Project Control Specialist
Russell Dyer
Martin Hanson
Steve Brocoum

April 1991

The Progress Report for March 1991 was submitted.

May 1991

The Progress Report for April 1991 was submitted.

June 1991 Through August 1991

No activity.

September 1991

The August 1991 Progress Report was prepared and submitted.

October 1991

The September 1991 Progress Report was prepared and submitted.

November 1991 Through June 1992

February 24, 1992, a letter was received from Jerry Zimmer (DOE-CH) with closeout requirements for the contract. No additional funding was provided.

Ralph Wagner prepared a closing report entitled *Summary of Activities for September 1, 1988 through June 30, 1992*.

3.0 PROJECT QUALITY ASSURANCE — CWBS

1.1.3.1.2

September 1988 Through April 1989

Paul Senseny received the Quality Assurance Specification for Rock Mechanics Analyses and Laboratory Testing from Richard Baker on September 28, 1988, and the Preliminary Quality Assurance Specifications on January 18, 1989.

A controlled copy of the Quality Assurance Manual was sent to Richard Baker (DOE-CH) on February 22, 1989. Controlled copies of the Quality Assurance Manual, Quality Assurance Procedures Manual, and Software Quality Assurance Program was sent to Antanas Bindokas (DOE-CH) and William Kehew (DOE-RTTD) on February 27, 1989. Revision 8 to the Quality Assurance Procedures Manual was sent to William Kehew and Antanas Bindokas on April 26, 1989.

Antanas Bindokas and Ken Ley were at the RE/SPEC offices in Rapid City to discuss the RE/SPEC Quality Assurance Program on March 27–28, 1989.

Donald Stroup attended the International Waste Quality Assurance Conference in Las Vegas, Nevada, April 2 through 5, 1989. Speakers at the conference reviewed latest developments and requirements in setting up QA programs.

May 1989

The Quality Assurance Plan was developed and a draft copy was sent to Ken Ley on May 8, 1989, for his review.

Ken Ley advised Donald Stroup that the draft Quality Assurance Plan was acceptable and that RE/SPEC would receive formal approval of the plan after submitting a controlled copy to DOE.

June 1989

The Quality Assurance Plan was revised to show the new Project Manager and Project Administrator and was submitted to DOE for approval on June 8.

A copy of the RE/SPEC Inc. Quality Assurance Manual was sent to Ken Ley on June 27.

July 1989

Donald Stroup conducted general QA tasks, and answered comments from DOE-CH on the Quality Assurance Program Plan.

August 1989

Donald Stroup answered DOE-CH review comments to the RE/SPEC Quality Assurance Plan.

September 1989

Ken Ley and John Kasprowicz (DOE-CH), discussed an increase in the QA budget for Fiscal Year 1990. Also, Ken Ley made arrangements with DOE-CH for a QA surveillance at both RE/SPEC offices the week of October 23 through 27.

Donald Stroup maintained QA records regarding this contract.

October 1989 Through November 1989

No activity.

December 1989

On December 27-28, Ken Ley and Don Stroup performed a Fiscal Year 1990 Quality Assurance Surveillance. No findings were reported.

January 1990

Ken Ley and William Coons met with DOE-RTTD personnel in Chicago, Illinois (John Kasprowicz, John Adachi, and Richard Baker) with respect to the impending QA audit/surveillance of contract activities and the QA level assignments for the Fiscal Year 1990 guidance.

February 1990

Don Stroup conducted a QA surveillance of the Software Design Control Program at the RE/SPEC Inc. Rapid City office. He reported that the Software Quality Assurance Plan and procedures that pertain to configuration management need to be updated.

March 1990

Don Stroup conducted a QA surveillance of the Software Design Control Program at the RE/SPEC Inc. Rapid City office. He reported that the Software Quality Assurance Plan and procedures that pertain to configuration management need to be updated.

The Software Quality Assurance Plan and procedures that apply to configuration management were updated as a result of Don Stroup's surveillance of the Software Design Control Program.

April 1990

William Coons held a series of telephone conferences with John Adachi (DOE-CH) for the purpose of coordinating a schedule for a QA surveillance of the RE/SPEC Inc. Albuquerque and Rapid City Operations. The quality assurance surveillance was conducted on April 25-26, 1990, by John Adachi (DOE-CH). Areas surveyed were training records, maintenance records, and software activities. The surveillance was monitored by John Kasprowicz (DOE-CH) and Choon Quan (DOE-HQ). No findings were noted. Observations in the area of training documentation were noted.

Don Stroup conducted a QA surveillance of document handling at the RE/SPEC Inc. Office in Rapid City. He found no discrepancies.

May 1990

The RE/SPEC Inc. Quality Assurance Procedures were updated with the following:

- *RE/SPEC Inc. Quality Assurance Procedure QAP-01, Rev. 3 for Developing Activity Plans, Procedures, and Special Work Instructions*
- *RE/SPEC Inc. Quality Assurance Procedure QAP-20, Rev. 0 for Management Assessments*
- *RE/SPEC Inc. Quality Assurance Glossary, Rev. 1.*

Don Stroup met with Ken Ley in the Rapid City Office where they conducted an internal QA pre-audit conference.

June 1990

Ken Ley and Don Stroup conducted a quality assurance audit of the Rapid City and Albuquerque offices of RE/SPEC Inc. during the week of June 4–8. No findings were noted but three general observations were sited.

Don Stroup sent out the following documents for internal review:

- *RE/SPEC Software Quality Assurance Plan RSI/SQAP-01, Revision 1*
- *RE/SPEC Quality Assurance Procedure QAP-04, Revision 3, for Software Design Control.*

July 1990

The *Quality Assurance Management Assessment* for the Rapid City Office was completed on July 20.

August 1990

No activity.

September 1990

Ken Ley and Don Stroup conducted a surveillance of RE/SPEC Inc. procedures, plans, special work instructions, software quality assurance, and nonconformance and corrective actions. No deficiencies were found.

A meeting was convened to rectify the problems of RE/SPEC Inc. software quality assurance plans and procedures that presently do not meet the requirements of RW214 Rev. 3 (QARD). Attending the meeting were Ken Ley, Don Stroup, Gary Callahan, Natalie Eslinger, Kirby Mellegard, Joe Ratigan, and Darrell Svalstad.

October 1990

Don Stroup revised Quality Assurance Procedures 16 – *Engineering Analysis and Laboratory Software Control*, 18 – *Acquired Software Control* and 20 – *Managements Assessments*.

November 1990

The DOE Quality Assurance Audit scheduled for December 3-7 was cancelled.

December 1990 Through February 1991

No activity.

March 1991

Ken Ley traveled to Golder Associates with Richard Lark (DOE-CH) for a meeting regarding QA activities on their subcontract to RE/SPEC, and held discussions with respect to quality assurance activities on the continuation of their Site Suitability Evaluation and Alternative Licensing Strategy work.

Ken Ley traveled to Chicago, Illinois, and had meetings with John Kasprowicz (DOE-CH) and Richard Lark (DOE-CH) regarding the quality assurance activities for the RE/SPEC and Golder contracts.

Ken Ley and Don Stroup traveled to Golder Associates with John Kasprowicz (DOE-CH) to conduct a QA audit of their subcontract activities. No findings were issued.

April 1991

Don Stroup completed an acceptance review of the site suitability and alternative licensing work performed by Golder Associates.

May 1991 Through August 1991

No activity.

September 1991

Ken Ley and Don Stroup performed a close-out audit of the contract at the RE/SPEC Inc. Office in Rapid City, South Dakota. No discrepancies were found.

October 1991

Ken Ley finalized completion of the Quality Assurance Program Plan at the RE/SPEC Inc. Albuquerque Office. He also reviewed and finalized the QA audit report.

November 1991 Through June 1992

No activity.

4.0 PERFORMANCE ASSESSMENT INTEGRATION SUPPORT — CWBS 1.1.3.2.3

The DOE OCRWM implemented performance assessment through the PA/TIG. This group advised the Performance Assessment Program Oversight Group (PA/POG) regarding technical capabilities for performance assessments.

The PA/TIG had the responsibility for writing the Performance Assessment Management Plan (PAMP) and reviewing the Performance Assessment Strategy Plan (PASP).

The PA/TIG was established in November 1988 when a Performance Assessment Integration meeting was convened by Donald Alexander at DOE Headquarters. At that time the structure of the integration effort was established. The roles of the PA/POG and PA/TIG were defined, and six working groups were established. The working groups were instructed to initiate development of Fiscal Year 1989 work plans for the DOE-HQ Performance Assessment participants. During the remainder of calendar year 1988, the PA/TIG met several times with the working groups and established work plans in a common format.

The PA/TIG organized and coordinated the efforts of the Performance Assessment Status Review Group (PA/SRG). The purpose of the PA/SRG was to visit DOE-HQ and YMP participants to obtain in-depth information regarding project status and organizational capabilities. Six engineers from the Rapid City office of RE/SPEC were trained to be part of the PA/SRG. They wrote an activity plan and special work instruction for implementing status reviews. The activity plan included a checklist of items that were committed to by the Site Characterization Plan. Reference to this list provided a basis for assessing the completeness of the performance assessment program in terms of meeting formally documented commitments.

September 1988 Through December 1988

No activity.

January 1989 Through April 1989

Support of the PA/TIG began in January 1989. On January 25-26, the PA/TIG met with Working Group 3 at the offices of Science Applications International Corporation (SAIC) in Las Vegas, Nevada. On February 9, the PA/TIG met with Working Group 2 at the offices of Roy F. Weston in Washington, DC.

The PA/TIG also met with DOE-HQ Performance Assessment participants to compile information regarding PA capabilities. The meetings were held on the following dates:

- February 28 through March 1 at the University of California-Berkeley, Berkeley, California
- March 13 at the United States Geological Survey, (USGS) Denver, Colorado
- March 14 at Lawrence Berkeley National Laboratory, Berkeley, California
- March 15 at Sandia National Laboratories (SNL), Albuquerque, New Mexico
- March 28 at Lawrence Livermore National Laboratory (LLNL), Livermore, California
- March 29 at Pacific Northwest Laboratory (PNL), Richland, Washington
- March 30 at Pacific Northwest Laboratory, Richland, Washington
- April 12 at Los Alamos National Laboratory (LANL), Los Alamos, New Mexico

The PA/TIG met with the YMP Technical Project Officers on April 20, 1989.

Paul Gnirk met with other members of the PA/TIG to review Performance Assessment Integration activities with the PA/POG on the following dates:

- February 15-17 at SAIC, in Las Vegas, Nevada
- April 18 at Weston, in Washington, DC

On April 26, 1989, Paul Gnirk met with Antanas Bindokas at DOE-CH on PA activities.

Paul Gnirk participated in the Performance Assessment Environmental Impact Statement (PA/EIS) Discussion Group meetings beginning on February 8. He also attended meetings on March 22, April 19, and April 25.

An external memorandum on the subject "The Interrelationships Among the NWPA, the NWPA Amendments, the Siting Guidelines, the SRR, and the EIS" was provided to the PA/EIS Discussion Group on February 7.

Paul Gnirk provided the Discussion Group with suggested revisions to the Siting Guidelines in a memorandum dated April 14, 1989, on the subject "Suggested Revisions to the Siting Guidelines (10 CFR Part 960) Pursuant to the Provisions of the Nuclear Waste Policy Amendments Act of 1987."

Another contribution to the Discussion Group was provided in a memorandum dated April 17 on the subject "Reference Package No. 7: With respect to post-closure impact assessment, what is the appropriate timeframe that needs to be

considered?" Revisions to Reference Packages 7 and 8 were delivered to the Discussion Group on April 27 in a memorandum on the subject "Revisions/Additions to Package Nos. 7 and 8."

RE/SPEC developed a draft version of a *Licensing and Compliance Division Implementing Line Procedures Manual* [1989] for internal review at DOE-HQ. The procedures were developed by Donald Stroup to provide administrative and training controls within the Licensing and Compliance personnel division. The resulting internal review comments were addressed by Donald Stroup in February and March 1989.

Donald Stroup responded to a request by the PA/TIG to review the Quality Assurance Program used by the University of California-Berkeley, Department of Nuclear Engineering. The purpose of the review was to assess whether the Quality Assurance Program met the requirements of the present DOE Quality Assurance Program for performance assessment calculations to be performed by the University of California-Berkeley, Department of Nuclear Engineering personnel. As a result of the review, Donald Stroup provided William Lee with QA materials and procedure development information for the development of a Quality Assurance Plan and procedures for forthcoming performance assessment calculations. The resulting draft copies of the "Quality Assurance Plan and Procedures Manual" were reviewed and review comments were provided to William Lee.

May 1989

Paul Gnirk provided review comments to Antanas Bindokas on the Draft Quality Assurance Procedure entitled *PA Test Case Procedures* [1989]. He also assisted DOE personnel in preparing for the briefing of the Nuclear Waste Technical Review Board on PA activities.

On May 30, Paul Gnirk attended a meeting at DOE-HQ to discuss the draft briefing paper on the Environmental Impact Statement scoping calculation.

June 1989

On June 1, Paul Gnirk briefed Antanas Bindokas at DOE-CH/RTP on the recent activities of the PA/TIG and plans for future activities. He also reviewed sets of test-case problems from Working Groups 1, 2, and 3 for total repository system, engineered barrier system, and natural system performance.

Paul Gnirk attended a meeting of the Nuclear Waste Technical Review Board with the State of Nevada and DOE-YMP on June 26-27 in Las Vegas, Nevada. Paul Gnirk and David Parrish participated in the PA/TIG meeting held at the offices of SAIC in Las Vegas, Nevada, on June 28. This meeting entailed (1) a review of the Engineered Barrier Systems (EBS) test-case problems for the Performance Assessment Calculational Exercise in Fiscal Year 1989 with Tom Pigford of the University of California-Berkeley and (2) a discussion of plans for development of the Performance Assessment Implementation Plan with Bob Wilems (Rogers & Associates Engineering Corporation) and U-Sun Park (SAIC). Paul Gnirk, David Parrish, and John Osnes participated in the meeting between the PA/TIG and

Working Groups 1, 2, 3, and 7 on June 29 for purposes of finalizing the sets of test-case problems for the Performance Assessment Computational Exercise in Fiscal Year 1989 and the associated QA and reporting requirements discussing the function of Working Group 7. The meeting was held at the DOE in Las Vegas, Nevada. Paul Gnirk prepared various memoranda for the PA/TIG concerning meetings of the PA/TIG with Working Groups 1, 2, 3, and 7.

July 1989

On July 6, Paul Gnirk (RE/SPEC) attended a meeting at DOE-HQ in Washington, DC, convened by Jeff Kimball, on approaches to the site suitability analysis for the Yucca Mountain Site.

On July 12 at DOE-CH, Paul Gnirk gave a briefing to Antanas Bindokas on the past, present, and future activities of the PA/TIG.

On July 18 at DOE-HQ in Washington, DC, Paul Gnirk attended (1) the Repository Regulatory Compliance Working Group Workshop and (2) the PA/TIG meeting with Donald Alexander. Paul Gnirk reviewed (1) the draft model validation strategy as prepared by the DOE-HQ Validation Oversight Group and (2) the Fiscal Year 1989 work plan for Performance Assessment Working Group 7 as prepared by Kenneth Krupka of Battelle-PNL.

On July 25 at the SAIC offices in Las Vegas, Nevada, Paul Gnirk attended a meeting of the Validation Oversight Group and the PA/TIG with Donald Alexander of DOE-HQ. On July 26-27, Paul Gnirk, John Osnes, and Tom Feldman attended meetings of the PA/TIG with Working Groups 1, 2, 3, and 7 at the DOE-YMPO offices in Las Vegas, Nevada. David Parrish attended the meeting on July 26, and Paul Gnirk prepared the agenda and the draft summary record of these meetings.

In July, Paul Gnirk reviewed the draft options paper by Jeff Kimball (DOE-HQ) entitled *Prioritization of Characterization Testing to Address Site Suitability*.

August 1989

Paul Gnirk completed memoranda to the PA/POG concerning recommendations on (1) replanning of the PA activities at DOE-YMP for Fiscal Year 1990 and Fiscal Year 1991 and (2) DOE-YMP technical representation to Working Group 7. Paul Gnirk reviewed the draft options paper by Jeff Kimball (DOE-HQ) entitled *Prioritization of Characterization Testing to Address Site Suitability*.

Tom Feldman hosted a PA/TIG Working Group 1 meeting at the RE/SPEC Albuquerque Office on August 15. Ten attendees from PNL, SNL, Battelle-OWTD, and RE/SPEC worked on the Total System Post-Closure Performance Assessment Problem activities for the Performance Assessment Computational Exercise for Fiscal Year 1990 (PACE-90).

On August 15 at the SAIC offices in Las Vegas, Nevada, Paul Gnirk (1) attended a PA/TIG meeting that included discussions with representatives of DOE-HQ and DOE-YMP concerning the short-term activities of Working Group 7 and (2) met with Ernest Hardin SAIC concerning the risk-benefit analysis to be performed on

the characterization of the Calico Hills member at the Yucca Mountain Site. On August 16, Paul Gnirk briefed Antanas Bindokas at DOE-CH concerning the activities of the PA/TIG. On August 17 at DOE-HQ, Paul Gnirk met with (1) Donald Alexander (DOE-HQ) and Steve Gomberg (DOE-OCRWM) concerning the activities of the PA/TIG during the month of August and (2) Ken Krupka (Battelle-PNL) concerning the near-term activities of Working Group 7.

On August 23-24, Paul Gnirk attended a meeting at the SAIC offices in Las Vegas, Nevada, for discussion of the risk-benefit analysis for characterization of the Calico Hills member at the Yucca Mountain site.

Paul Gnirk, Tom Feldman, John Osnes, David Parrish, and Steve Alcorn attended the PA/TIG meeting with Working Groups 1, 2, 3, and 7 in Las Vegas, Nevada, on August 30-31. Paul Gnirk prepared and distributed the meeting agenda. He also completed and distributed the summary record of this meeting.

Paul Gnirk (1) reviewed a draft of the Waste Isolation Pilot Plant (WIPP) Supplemental Environmental Impact Statement (SEIS), (2) met with Donald Alexander at DOE-HQ on August 8 and 9, (3) met with Donald Alexander and Jay Jones (DOE-HQ) on August 17 at DOE-HQ regarding both the presentation on September 14 and the dry run on September 6, and (4) prepared view graphs.

September, 1989

On September 6, Paul Gnirk and David Parrish attended a meeting at the SAIC offices in Las Vegas, Nevada, for the working group on Risk/Benefit Analysis of Alternative Strategies for Characterizing the Calico Hills Unit at the Yucca Mountain Site. On September 7, Paul Gnirk participated, with the Risk/Benefit Analysis Working Group, in a field trip to NTS/Yucca Mountain to visually inspect drillhole core and outcrops of the Calico Hills Unit. On September 8, Paul Gnirk met with Robert Levich (DOE-YMP) to discuss the transfer of Yucca Mountain site data from SNL to PACE-89/90 participants.

Paul Gnirk briefed Antanas Bindokas (DOE-HQ) and Richard Baker on the PA/TIG activities on September 13 at DOE-CH/RTP. On September 14 and 15, Paul Gnirk attended a meeting of the PA/TIG with Donald Alexander at DOE-HQ. During the week of September 11 through 15, David Parrish reviewed the characteristics of the Calico Hills Unit in support of the Risk Benefit Analysis Working Group.

On September 18, Paul Gnirk attended the PA/TIG meeting in Denver, Colorado, with senior DOE-HQ and DOE-YMP management. On September 21-22, Paul Gnirk, Tom Feldman, and Steve Alcorn attended a meeting of the PA/TIG with Working Groups 1, 2, 3, and 7 at the DOE-YMP offices in Las Vegas, Nevada. Paul Gnirk prepared and distributed an agenda for this meeting. He also coordinated miscellaneous details with and on behalf of the various individuals who made technical presentations at this meeting. David Parrish attended a meeting of Working Group 4 (Pre-Closure Safety) on September 22 at DOE-HQ in Washington, DC.

Joe Ratigan attended a Working Group 3 meeting in Berkeley, California, on September 27 and 28. Status reports and recommendations for continued work efforts were presented by several group members working on the PACE-89 problems.

October 1989

Paul Gnirk attended the following PA/TIG meetings during the month of October.

- October 11 in Washington, DC: Paul Gnirk attended a meeting of the PA/TIG with DOE-YMP management personnel and SAIC support staff for purposes of discussing the Fiscal Year 1990 performance assessment activities.
- October 12 in Washington, DC: Paul Gnirk attended a meeting of the PA/TIG for purposes of planning near-term activities for the PA/TIG.
- October 18 and 19 in Las Vegas, Nevada: Paul Gnirk attended a PA/TIG meeting concerning the (1) Performance Assessment Working Groups and related performance assessment activities for Fiscal Year 1990; (2) QA requirements for PA activities for Fiscal Year 1990; and (3) Fiscal Year 1990 status review and proposed activities for the ORIGIN-2 computer code at Oakridge National Laboratory (ORNL), which included a briefing by J. W. Roddy (ORNL). On October 20, Paul Gnirk prepared a summary of the meeting with J. W. Roddy on ORIGIN-2 status for PA/TIG.
- October 25 at the SAIC offices in Las Vegas, Nevada: Paul Gnirk attended a PA/TIG meeting with Don Livingston (DOE-YMP) and had teleconferences with Felton Bingham (SNL) and Wally Walters (PNL) regarding the status of the global climate modeling project under the direction of PNL.
- October 26 at the SAIC offices in Las Vegas, Nevada: Paul Gnirk attended a PA/TIG meeting with representatives of LANL regarding the status of the EQ3/6 computer code and associated thermodynamic database.

Paul Gnirk also attended the following meetings:

- October 12 in Washington, DC: Paul Gnirk met with the DOE-HQ personnel, including Don Alexander, and Weston support staff for preparation of guidance to the DOE-YMP on new initiatives for Fiscal Year 1990.
- October 13 at the RE/SPEC Inc. Office in Rapid City, South Dakota: Paul Gnirk met with John Osnes concerning PA activities for Fiscal Year 1990.

November 1989

Paul Gnirk attended the following meetings in November:

- November 2 at the SAIC offices in Las Vegas, Nevada: PA/TIG meeting with representatives of PNL regarding the Fiscal Year 1990 PA activities.
- November 3 he attended, with representatives of PA/TIG, a meeting of DOE-YMP performance assessment personnel with Working Groups 1, 2, and 3 regarding Fiscal Year 1990 activities.
- November 9, he attended a meeting of DOE-HQ and DOE-YMP personnel in Las Vegas, Nevada, for the purpose of discussing the applicability of 10 CFR Part 960 to the Yucca Mountain site.
- November 15, Paul Gnirk traveled to Washington, DC, for the purpose of attending meetings concerning Fiscal Year 1990 performance assessment activities with Don Alexander (DOE-HQ) and Larry Rickertsen (Weston), on November 16,
- November 22 and 27, Paul Gnirk met with management personnel at the RE/SPEC Inc. Office in Rapid City concerning the status of performance assessment activities during Fiscal Year 1990 under the RE/SPEC Inc. contract with DOE-CH.

Paul Gnirk completed and transmitted, on behalf of the PA/TIG, a memorandum to the PA/POG concerning

- Status evaluations of ORIGIN-2, EQ3/6, and Global Climate Modeling
- Observations from meetings of the PA/TIG with the PNL-PASS Program representatives and Performance Assessment Working Groups 1, 2, and 3
- Recommended revisions in the DOE-OCRWM and DOE-YMP Quality Assurance Plan concerning software verification and validation.

December 1989

On December 14, Paul Gnirk, John Osnes, and Tom Feldman attended a meeting of the PA/TIG and Performance Assessment Working Groups 1, 2, and 3, along with representatives of DOE/YMP, in Las Vegas, Nevada.

Paul Gnirk collected and transmitted to Abraham Van Luik (PNL), by request of Donald Alexander (DOE-HQ), reports and related information prepared by RE/SPEC Inc. during past years on the effect of wastage burnup on repository thermal loading.

Paul Gnirk completed, and transmitted to the American Nuclear Society, technical papers entitled (1) *Overview of the U.S. Department of Energy's PACE-90*

Geologic Repository Performance Assessment Exercise Activity coauthored by Donald Alexander (DOE-HQ), Paul Gnirk, Larry Rickertsen (Weston), Jean Younker (SAIC), and Abraham Van Luik (PNL); and (2) *The Status of the Site Characterization and Validation Program in Phase II of the OECD/NEA Stripa Project* coauthored by Paul Gnirk and Bengt Stillborg (SKB). These papers were for presentation at the First Annual International High-Level Radioactive Waste Management Conference in Las Vegas, Nevada, on April 8–12, 1990.

January 1990

During the week ending January 5, Paul Gnirk conferred with John Osnes and Gary Callahan concerning (1) completion of the PACE-89 calculations for the groundwater travel time at the Yucca Mountain site, and (2) Fiscal Year 1990 Performance Assessment activities. On January 31, Paul Gnirk met with John Osnes and others concerning the status of PACE-89 calculations and plans for the total system-CCDF and EPA-scenario calculations.

Tom Feldman attended the Performance Assessment Working Group Meeting in Las Vegas, Nevada, on January 26. The details of the PACE-89 problems were discussed and a schedule was set for delivery of the first set of results. RE/SPEC Inc. kept abreast of the PACE-90 problems in order to be prepared to do supporting calculations.

February 1990

On February 1 in Denver, Colorado, Paul Gnirk attended a meeting of the Nuclear Waste Technical Review Board and DOE-YMP concerning the status of the prioritization study for surface-based testing at the Yucca Mountain site. On February 2, Paul Gnirk met with John Osnes and others at the Rapid City office of RE/SPEC Inc., concerning the status of PACE-89 calculations and plans for the total system-CCDF and EPA-scenario calculations.

On February 20, Paul Gnirk discussed with Steve Gomberg (DOE-HQ) possible dates for a meeting involving representatives of DOE-HQ, DOE-CH/RTP, and RE/SPEC Inc. to discuss PA activities for Fiscal Year 1990. John Osnes and Tom Feldman attended the Performance Assessment Working Group meeting in Las Vegas, Nevada, on February 28–March 1.

March 1990

On March 27, a DOE-HQ Management Review Meeting was held at the offices of RE/SPEC Inc. in Rapid City, South Dakota. Past, present, and future performance assessment integration and support tasks were discussed. Attendees included Donald Alexander (DOE-HQ), Steven Gomberg (DOE-HQ), John Kasprowicz (DOE-CH/RTP), and Larry Rickertsen (Weston). RE/SPEC Inc. personnel at the meeting were Paul Gnirk, William Coons, Ken Ley, Elisa Kephart, Tracy Christian-Frear, Steve Alcorn, John Osnes, Joe Ratigan, Michael Getty, Joel Nieland, David Parrish, and Critz George.

Tracy Christian-Frear completed TRACRN analyses of 20 mm/yr flow and transport of ⁹⁹Tc, ²³⁸U and ²³⁹Pu.

Michael Getty, Joel Nieland, and John Osnes coupled the TRACRN program to a First-Order Reliability Method executive program for probabilistic calculations of cumulative release and made the first test calculations.

April 1990

Tracy Christian-Frear sent Larry Rickertson (Weston) her concentration plume data determined for an infiltration rate of 0.1mm/yr for the radionuclides ^{99}Tc , ^{239}Pu , ^{238}U , ^{230}Th , and ^{226}Ra . This data may be used in a demonstration of three-dimensional database hardware and software at DOE-CH in May.

Joel Nieland and Michael Getty continued test calculations using the first order reliability executive program and the modified TRACRN subprogram. Michael Getty investigated the optimization of the time-stepping algorithm of the TRACRN subprogram by manipulating the time-controlling parameters.

Joel Nieland completed a preliminary Complementary Cumulative Distribution Function (CCDF) calculation. The retardation factors for ^{99}Tc , ^{238}U , and ^{239}Pu in each of the four stratigraphic units modeled were assumed to be lognormally distributed with coefficients of variation of unity. This characterization was arbitrarily chosen for the purpose of checking out the solution methodology. Convergence of the first-order reliability method was achieved using the iterative, steepest-slope algorithm.

Joel Nieland completed a calculation of the saturation and flux levels of a two-dimensional, east-west cross section of Yucca Mountain. The model is the same as that used previously (RSI/TLM-165) with the exception that the area east of the Ghost Dance Fault was not modeled, and the eastern edge of the fault was modeled as impermeable. An infiltration rate of 0.1 mm/yr was used. The results of this calculation are comparable to the previous results, indicating that little water crosses the Ghost Dance Fault under the conditions assumed in the model.

John Osnes worked on the QA documentation for formally inducting the TRUST, TOUGH, and TRACRN programs into the RE/SPEC configuration management system. The configuration of these programs has been maintained according to the RE/SPEC Software Quality Assurance Plan since their acquisition, but had not been formally inducted into the configuration management system. Michael Getty contributed to the preparation of the TRACRN program QA documentation.

On April 24, Paul Gnirk met with John Kasprovicz (DOE-CH/RTP), John Adachi (DOE-CH), Choon Quan (DOE-HQ), and Ken Ley (RE/SPEC) concerning the activities to be carried out under the Performance Assessment Integration Task.

On April 24-25, Tom Feldman attended a Working Group 1 (Total System) meeting at DOE-YMP in Las Vegas, Nevada, at which the results obtained to date for the total system performance assessments were presented and reviewed. On April 25, he was joined by Paul Gnirk.

May 1990

Michael Getty continued preparation of the QA documentation for formally inducting the TRACRN program into the RE/SPEC Inc. configuration management system.

Tracy Christian-Frear evaluated arrival times of radionuclides for various cases of raised and lowered water tables at Yucca Mountain.

Joel Nieland began preparation of RE/SPEC Report Number RSI-0372 based on a technical letter memorandum (TLM) of the subject: *Preliminary Numerical Simulations of the Pre-Waste-Emplacement Hydrology for the Yucca Mountain Site*. The TLM was originally sent to John Kasproicz (DOE) on February 28, 1990. Joel Nieland also began compiling sorption data which will be used to determine the distributions of retardation factors to be used in the CCDF calculations.

On May 11, Paul Gnirk met with John Osnes in Rapid City, South Dakota, to discuss the status of the PA calculational activities for Fiscal Year 1990.

Choon Quan (DOE-HQ) invited RE/SPEC's participation in a demonstration of three-dimensional database hardware and software to be held in Washington, DC, on May 10. Elisa Kephart attended a demonstration of three-dimensional database hardware and software at DOE-HQ. The demonstration was hosted by Don Alexander (DOE-HQ). Elisa Kephart was favorably impressed by the capabilities of the system and felt that it was a suitable system for development of a three-dimensional PA database.

Tracy Christian-Frear and Tom Feldman attended the month'y YMP meeting held by SNL in Albuquerque, New Mexico.

John Osnes, Tom Feldman, and Tracy Christian-Frear attended the Performance Assessment Working Group Meeting in Albuquerque, New Mexico, and a field trip to the Jemez Volcanic Complex on May 23-24, 1990.

June 1990

John Osnes, at the request of Donald Alexander (DOE-HQ), participated in a meeting at Golder Associates in Seattle, Washington, on June 5. The topic of the meeting was application of the FRACMAN computer program, which was developed by Bill Derschowitz (Golder), to the simulation of flow and transport through fracture networks in tuff. In preparation for the meeting, John Osnes compiled a set of background literature on channeling and sent it to Donald Alexander.

On June 6-7, John Osnes attended the DOE-HQ review of the PNL/PASS Program in Richland, Washington. The review was conducted by Donald Alexander, Steven Gomborg (DOE-HQ), Charles Russamono (DOE-HQ), and Larry Rickertsen (Weston). As the result of these meetings, a collaborative effort with Golder and PNL/PASS on fracture network modeling was initiated. Also, cooperative efforts on the development of a prototype three-dimensional PA dataset and on evaluation of Alternative Licensing Strategies were discussed.

On June 11-12, Paul Gnirk met with John Osnes in Rapid City, South Dakota, concerning the status of performance assessment activities, including the additional, programmatic guidance provided by DOE-CH/RTP for Fiscal Year 1990.

On June 19, John Osnes sent a letter to Donald Alexander (DOE-HQ) outlining the contents for a formal volume documenting the PACE-90 results. He developed the description of the contents based upon discussions with Donald Alexander (DOE-HQ) and Jerry Boak (DOE-YMPO).

On June 21, John Osnes, William Boyle, and Larry Padgett attended a meeting at PNL in Richland, Washington. The purpose of the meeting was to organize and coordinate the assembly of a prototype three-dimensional dataset for PACE in cooperation with PNL/PASS. It was concluded that during Fiscal Year 1990, data needed to define the geologic structure of the Yucca Mountain site and the conceptual design for a repository at the site would be acquired from existing databases and publications and be delivered to DOE-HQ. RE/SPEC had the primary responsibility for acquiring the data, managing it, and distributing it to DOE and PNL/PASS. PNL/PASS provided the topographical data and was responsible for presentation and graphical display of the dataset.

On June 22, John Osnes and William Boyle attended a meeting at Golder Associates in Seattle, Washington. The objective of the meeting was to identify a preliminary PA calculation involving transfer of fracture-network modeling technology developed by Golder to performance assessment of the Yucca Mountain site. The meeting involved investigators from RE/SPEC, Golder, PNL/PASS, and Washington State University, and a cooperative effort was planned. After an exchange of information on modeling of flow and transport through fractured rock masses in general and through the tuffs at the Yucca Mountain site in particular, several approaches were considered. It was planned to complete a preliminary PA calculation in Fiscal Year 1990 that involves assessing the effects of the distribution of fracture intersections with emplacement boreholes on design and performance.

On June 27-28, a review of RE/SPEC's support to the RTP was conducted at the RE/SPEC offices in Albuquerque, New Mexico. The reviewers were Choon Quan (DOE-HQ), John Kasprowicz (DOE-CH/RTP), and Hugh Bartholomees (MacTech). Project status, QA activities, progress, and plans were reviewed. In particular, the planned activities for the six Performance Assessment Support subtasks that were identified in the June 8 additional guidance from the RTP were presented and discussed. Presentations were made by William Coons, John Osnes, Ken Ley, Joel Nieland, William Boyle, Tracy Christian-Frear, and Tom Feldman.

On June 29, David Parrish and John Osnes sent Steven Gomborg (DOE-CH) preliminary review comments on a report entitled *Phase I Demonstration of the Nuclear Regulatory Commission's Capability to Conduct a Performance Assessment for a HLW Repository*. They will be submitting final review comments on the report by July 15.

Michael Getty continued preparation of the QA documentation for formally inducting the TRACRN program into the RE/SPEC configuration management system.

Joel Nieland completed the second draft of the report *Numerical Simulations of the Pre-Waste-Emplacement Hydrology for the Yucca Mountain Site* (RSI-0372).

Joel Nieland and John Osnes worked on preliminary probabilistic calculations of normalized cumulative release and groundwater travel times using the First-Order Marginal Distribution (FOMD) method. Estimates of probability distribution parameters for sorption ratios were made from previously published sorption ratio data.

Tracy Christian-Frear completed a preliminary analysis of Scenario 1 (Normal Flow) defined in A. D. Little's report entitled *Conceptual Models for Radionuclide Release for the Yucca Mountain High-Level Radioactive Waste Repository*.

July 1990

John Osnes and David Parrish completed final review comments on the Nuclear Regulatory Commission (NRC) draft report entitled *Phase I Demonstration of the Nuclear Regulatory Commission's Capability to Conduct a Performance Assessment for a HLW Repository* and sent it to Steven Gomberg (DOE-HQ).

William Boyle and Tim Vogt traveled to Dynamic Graphics, a software company in Berkeley, California, for a demonstration of the software and hardware that may be used to analyze and present the data being acquired for the prototype three-dimensional dataset for PACE.

Joel Nieland completed a draft technical letter memorandum (TLM RSI-0169) that presents a demonstration of the use of the FOMD method for determining the probability of exceeding limits stated in the licensing criteria. The draft was reviewed internally, and Joel Nieland began addressing the review comments.

Tracy Christian-Frear obtained data from ORNL on waste canister radionuclide decay history which may help in evaluating the radionuclide releases associated with Scenarios 2, 4 and 5 (borehole canister/direct hit, rhyolitic volcanism, and basaltic volcanism) defined in the report entitled *Conceptual Models for Radionuclide Release from the Yucca Mountain Radioactive Waste Repository* by A. D. Little [1989].

August 1990

On August 1-3, K. Tom Feldman and John Osnes attended a Performance Assessment Working Group (PA/WG) meeting at DOE-YMP in Las Vegas, Nevada.

William Boyle received digitized topographic data of Yucca Mountain from Michael Foley (Battelle-PNL). William Boyle also contacted Tom Blejwas (SNL) regarding digitized geologic data of Yucca Mountain.

Joel Nieland completed the second draft of a technical letter memorandum that presents a demonstration of the use of the FOMD method for determining the probability of exceeding limits stated in the licensing criteria.

September 1990

John Osnes participated in a workshop on performance assessment modeling for development of strategies for site characterization and evaluation of site suitability at Yucca Mountain. The workshop was held on September 19–21, at Golder Associates in Seattle, Washington. The purpose of the workshop was to establish the conceptual framework of a preliminary integrated PA model for the Yucca Mountain site.

Michael Getty completed a suite of data files that contained currently available drillhole stratigraphic information which was to be used in the construction of the three-dimensional database for the Yucca Mountain area. Michael Getty continued to update the stratigraphic data files as additional data became available. Michael Getty recontacted Virgil Frizzell of the U.S. Geological Survey (USGS) in Reston, Virginia, concerning the most recent geologic map of the Yucca Mountain area and was informed that a raster file (database) of the geologic map would be available before the end of the calendar year. Virgil Frizzell said he will forward a hard copy of the map to Michael Getty.

Joel Nieland incorporated review comments into RSI/TLM-169, entitled *Demonstration of the First-Order Marginal Distribution Method for Probabilistic Analysis of a High-Level Nuclear Waste Repository*.

Tom Feldman reviewed the *Performance Assessment Management Plan for the Geologic Repository Program* (DOE/RW-0265P) and the *Performance Assessment Strategy Plan for the Geologic Repository Program* (DOE/RW-0266P). He also condensed and summarized the Working Group 2 report from Bill Lee (UCB/LBL) entitled *Preliminary Calculations of Release Rates of ⁹⁹Tc, ¹²⁹I, ¹³⁵Cs, and ²³⁷Np From Spent Fuel in a Tuff Repository*.

October 1990

Tom Feldman and Duane Labreche attended the October 3–4 PA/WG meeting at YMPO in Las Vegas, Nevada. In addition to Fiscal Year 1990 year-end reports from National Laboratory contractors, plans for Fiscal Year 1991 YMPO PA/WG work were discussed. Tom Feldman talked with Jerry Boak (DOE-YMPO) and U. Sun Park (SAIC, YMPO) on October 4 about RE/SPEC's interest in helping with the Fiscal Year 1991 PA work.

Michael Getty completed digitizing the surficial geologic and structural data for the Yucca Mountain area from the current USGS geologic quadrangle of the Yucca Mountain area for use in the construction of the three-dimensional prototype dataset. Michael Getty edited the digitized data into a more usable form and began a memorandum as an index to the dataset. Michael Getty also updated existing lithologic/stratigraphic and static watertable data files as additional information became available.

RSI/TLM-169, entitled *Demonstration of the First-Order Marginal Distribution Method for Probabilistic Analysis of a High-Level Nuclear Waste Repository* was submitted to John Kasprovicz on October 8, 1990.

A draft of Topical Report RSI-0372 entitled *Numerical Simulations of the Pre-Waste-Emplacement Hydrology for the Yucca Mountain Site* was submitted to John Kasprovicz (DOE-CH) and Richard Baker (DOE-RTP) on October 26, 1990. Copies of the draft report also were sent to the OSTI. This report is a formal documentation of the study previously reported in Technical Letter Memorandum RSI/TLM-165, which was submitted to John Kasprovicz on February 28, 1990, to satisfy Fiscal Year 1990 deliverable. The technical letter memorandum was not a referenceable document and, as such, is of limited value to YMP. Consequently, its contents were expanded into the topical report.

November 1990

Michael Getty completed digitizing the surficial geologic and structural data for the Yucca Mountain area for use in the construction of the three-dimensional prototype dataset. Michael Getty drafted the digitized data and continued preparing a three-dimensional plot of the geology, structure, and topography from data contained in the dataset. Michael Getty drafted a memorandum which provided a synopsis and index of the three-dimensional prototype dataset for the Yucca Mountain area.

Tom Feldman and Duane Labreche continued work on the PACE-90 documentation task until PA activities were curtailed because of lack of funding. During the week of November 23, Tom Feldman met with Ralston Bernard (SNL-6313) to discuss RE/SPEC's PACE-90 documentation task. On November 28-29, Tom Feldman attended the DOE/NRC Technical Exchange on Performance Assessment in Albuquerque, New Mexico. A summary of the PACE-90 work was presented to the NRC and discussed.

December 1990 Through July 1991

No activity.

August 1991

Duane Labreche and Sharon Petney reviewed the PACE-90 Documentation Compendium. Tracy Christian-Frear and Tom Feldman worked on finalizing the report. William Coons reviewed the report and made significant changes that will be incorporated.

September 1991

William Coons, Ken Ley, and Steve Alcorn provided a review with comments of the PACE-90 Compendium.

Tracy Christian-Frear and Tom Feldman completed a report entitled, *Compendium of PACE-90 Analyses* and submitted copies to DOE-YMPO and DOE-CH.

October 1991 Through June 1992

No activity.

5.0 STATUS REVIEWS — CWBS 1.1.3.2.3

The following review activities are divided into sections on the performance of total systems, engineered barrier systems, and natural systems. Respective computer programs or codes associated with these three activities are TRACRN, AREST, and TRUST/TOUGH.

5.1 TOTAL SYSTEMS PERFORMANCE — TRACRN

September 1988 Through June 1989

No activity.

July 1989

The RE/SPEC Albuquerque Office received a copy of the TRACRN workstation version of the nuclide transport code TRACR3D from LANL. This program was to be used to solve some total systems PA problems defined by PA Working Group 1. RE/SPEC installed, compiled, ran the first test problem, and made an evaluation and assessment of the code. Updates and changes required to make the code more efficient, reliable, and user-friendly were recommended.

Professor Eric Nuttall of the University of New Mexico Chemical Engineering Department, as a consultant to RE/SPEC, provided technical assistance for adopting TRACRN for use on VAX and Macintosh computers (Eric Nuttall had previously made similar modifications of TRACRN for installation on University of New Mexico (UNM) machines).

Tom Feldman, working with consultant Eric Nuttall, installed the National Center for Supercomputer Applications (NCSA) Image Post-Processing Graphics Package on the RE/SPEC Mac IIx. TRACRN was compiled on the MAX IIx using 77/MPW.

August 1989

John Ball, Tom Feldman, consultant Eric Nuttall, and Tracy Christian-Frear continued to convert the nuclide transport code TRACRN onto the VAX 11/750.

The RE/SPEC Albuquerque Office completed conversion of the TRACRN and successfully solved sample problems with this code on the VAX 11/750. The NCSA Image Post-Processor was installed on the MAX IIx, and TRACRN as compiled and linked on the MAX IIx using FORTRAN 77/MPW. Tracy Christian-Frear formatted the input parameters for a simulation of nuclide transport in one dimension (vertical) as proposed by Working Group 1 and obtained the source-term data for the PACE-89 problem from PNL and formatted it for use on the VAX 11/750. Tracy Christian-Frear also (1) reformatted the output of TRACRN so that it can be used on the MAX IIx for the NCSA Image Post-Processing Package and (2) requested

the stratigraphy data for the Yucca Mountain site to be used in the calculational exercise problems.

Calculations of the matrix and fracture transport of ^{99}Tc and ^{238}U at flux rates of 20 mm per year and 0.1 mm per year using a one-dimensional approximation and the TRACRN code were completed. Tracy Christian-Frear also worked on a two-dimensional flow and transport problem.

September 1989 Through November 1989

Tracy Christian-Frear completed analysis of the Working Group 1 PACE-89 transport problem. On October 26 at LANL, she discussed with Kay Birdsell, an author of the TRACRN code, the new changes made in the code and results of the completed analyses.

Tracy Christian-Frear and Tom Feldman completed writing a technical letter memorandum (TLM-RSI(ALO)-0045) entitled, *Evaluation of Nuclide Transport at the Proposed Yucca Mountain Nuclear Waste Repository Site Using the Transport Code TRACRN*. The technical review of the TLM was completed in accordance with RE/SPEC Inc. QA procedures. Paul Gnirk reviewed it and agreed with the authors' comments that the Technetium release rates appeared to be in error. Paul Gnirk requested that the authors obtain new release rates for the nuclides at lower flux rates, and redesign the geometry to allow for a standoff distance for the repository from the faults. He also requested that the results of the analyses to be related in a report rather than a TLM.

Tracy Christian-Frear compared the RE/SPEC Inc. version of TRACRN with an updated version from LANL written for the SUN. The difference between the new SUN version and the RE/SPEC Inc. version was in definition of the bit sizing of the arrays. Tracy Christian-Frear incorporated the LANL changes into the RE/SPEC Inc. version of TRACRN.

December 1989

John Osnes met with Tracy Christian-Frear at the RE/SPEC Inc. Offices in Albuquerque, New Mexico, on December 15. They discussed the TRACRN calculations and exchanged copies of the TRACRN, TOUGH, and TRUST84 programs.

January 1990 Through March 1990

Tracy Christian-Frear completed a new analysis of the Yucca Mountain Nuclear Waste Repository (using TRACRN) predicated on updated source term data from PNL and a redesigned two-dimensional section. The analysis was based on the PACE-89 problem definition. These analyses involved 0.1 mm/yr flow and transport of ^{99}Tc , ^{238}U , ^{239}Pu , ^{234}U , ^{230}Th and ^{226}Ra and incorporated new k_d factors received from Ken Eggert of LANL. She also completed TRACRN analyses of 20 mm/yr flow and transport of ^{99}Tc , ^{238}U and ^{239}Pu .

Tracy Christian-Frear hosted Michael Getty of the RE/SPEC Inc. Rapid City Office and showed him the basic operation of the nuclide transport program TRACRN.

John Osnes and Michael Getty reviewed the report *Conceptual Models for Radionuclide Release for the Yucca Mountain High-Level Radioactive Waste Repository* by Arthur D. Little. They evaluated the capability of the TRACRN program to model the radionuclide release associated with the six scenarios presented in the report. Their evaluation was summarized in a memo to Larry Rickertsen.

A memorandum by John Osnes concerning a proposed problem for demonstration of the FOMD method for calculating the probability of exceeding cumulative release limits as defined in 40 CFR 191.13 was reviewed and transmitted to Larry Rickertsen (Weston) for his review.

Michael Getty, Joel Nieland, and John Osnes coupled the TRACRN program to a First-Order Reliability Method executive program for probabilistic calculations of cumulative release and made the first test calculations.

Michael Getty and John Osnes reviewed literature to develop a database of saturation measurements of various boreholes at Yucca Mountain. Michael Getty prepared a memorandum to Paul Gnirk describing the results of the literature search.

John Osnes prepared the quality assurance documentation for formally inducting the programs TRUST, TOUGH, and TRACRN into the RE/SPEC Inc. Configuration Management System.

April 1990 Through June 1992

No activity.

5.2 ENGINEERED BARRIER SYSTEM PERFORMANCE – AREST

September 1988 Through July 1989

No activity.

August 1989

On August 7, William Coons, Malcolm Panthaki, and Steve Alcorn briefed William Glassley (LLNL) on PA modeling of cement materials. The RE/SPEC Albuquerque Office requested the AREST computer code from PNL to evaluate the level of effort required to adapt the code to the RE/SPEC VAX computer system and solve problems defined for the Performance Assessment Calculational Exercise (PACE-89).

September 1989

Steve Alcorn and David Parrish conferred with Paul Gnirk concerning use of the AREST code for the PACE-89 problems. It was determined that the version of the AREST code received from PNL was restricted to saturated rock conditions. To be

of use on sample problems, the code would have needed to be enhanced to consider unsaturated transport. Because modification of the code to consider unsaturated conditions would have been beyond reach of the budget, the adaptation of the code to the RE/SPEC VAX was discontinued.

October 1990 Through June 1992

No activity.

5.3 NATURAL SYSTEM PERFORMANCE – TRUST AND TOUGH

September 1988 Through June 1989

No activity.

July 1989

John Osnes initiated efforts to perform preliminary performance assessment calculations based upon the Natural Barrier Technical Integration Problems defined by Performance Assessment Working Group 3. Specifically, these efforts were focused on obtaining a solution to Problem 4 of the problem set for pre-emplacement conditions at the Yucca Mountain site during Fiscal Year 1989 using the TRUST computer program. Problem 5 of the problem set for post-emplacement conditions at the Yucca Mountain site was considered depending on manpower and funding availability. The TOUGH computer program, a derivative of TRUST, was intended for the latter problem.

The TRUST84 computer program was obtained from the NESC and was converted from FORTRAN IV to ANSI-standard FORTRAN-77 for execution on a VAX/VMS computer. The modified version of TRUST immediately solved simple verification problems that were obtained previously from the author of TRUST at the University of California-Berkeley. However, the solution to the sample problem included in the NESC distribution was not obtained immediately. The automatic time-stepping algorithm in TRUST seemed to be very sensitive to the difference in precision carried by the NESC CDC 7600 computer and the RE/SPEC VAX/VMS computer. The sample problem finally was solved successfully by changing some of the input parameters that control the time-stepping algorithm.

A copy of the TOUGH84 computer program was obtained from the NESC during July. The TOUGH program was intended for application to the PACE-89 Problem 5 problem set for post-emplacement conditions at Yucca Mountain. The level of effort required to convert TOUGH and solve problems was evaluated. This activity was contingent on manpower and funding availability.

Paul Gnirk met with John Osnes at the RE/SPEC office in Rapid City, South Dakota, regarding the adaptation of TRUST and TOUGH groundwater computer codes to the VAX computer.

August 1989

The model (geometry, boundary conditions, and material properties) for the pre- and post-emplacement problems were formulated and a few preliminary calculations based on this model were performed at the RE/SPEC Rapid City Office. Since both the TRUST84 and the TOUGH computer programs use the Integrated Finite-Difference Method (IFDM) to solve subsurface flow and transport problems, a pre-processor based on existing finite-element mesh generator (FASTQ) was developed to expedite production of the IFDM meshes. Model development for PACE-89 Problem 4 defined by Working Group 3 began the last week of August.

Paul Gnirk briefed Antanas Bindokas (DOE-CH) concerning the progress to date on the adaptation of the TRACRN, TOUGH, and TRUST84 computer codes to the VAX computer at RE/SPEC, and he also reviewed the progress to date with John Osnes in the RE/SPEC Rapid City office.

September 1989

Calculation of PACE-89 Problem 4 defined by Working Group 3 (pre-emplacement hydrology) was delayed by problems associated with the generation of a flow network for the irregular stratigraphy found at the Yucca Mountain site. Although a pre-processor was developed to calculate a flow network compatible with TRUST84 from a GENESIS-formatted finite element mesh, preliminary runs using TRUST84 indicated that the current approximations of skewed surfaces introduce unacceptable errors in the solution. These errors plus the extended absence of John Osnes resulted in the analyses of Problem 4 not being completed by the end of September.

October 1989 Through March 1990

John Osnes submitted an updated version of TRUST84 for VAX/VMS computers to the NESC on October 13, 1989. This version is based on the CDC 7600 version received from the NESC in June. It was modified to run on the RE/SPEC Inc. VAX computer for performance assessment calculations in Fiscal Year 1989. He also submitted the VAX/VMS version of TOUGH to the NESC on October 24, 1989.

John Osnes and Joel Nieland completed a draft TLM entitled *Preliminary Numerical Simulations of the Pre-Waste-Emplacement Hydrology for the Yucca Mountain Site*. This TLM presents the analyses of PACE-89 Problem 4 defined by the Performance Assessment Working Group 3. John Osnes completed a computer program that calculated and plotted flowpaths based on hydrological simulations performed by the TOUGH program. The groundwater travel times along the flowpaths were calculated by the program. This program significantly refined the travel-time calculations made previously, and its results were included in the second draft of the TLM. The revised draft was forwarded to Paul Gnirk for his review. Paul Gnirk completed his review of the draft TLM and discussed his comments with the authors. The TLM was completed and sent to John Kasprowicz (DOE-CH), Donald Alexander (DOE-HQ), Steven Gomberg (DOE-HQ) and Larry Rickertsen (Weston) on February 28.

John Osnes, Joel Nieland, and Darrell Svalstad worked on the PACE-89 performance assessment calculations on groundwater travel time using the TOUGH program. A pre-processor that was developed to calculate a flow network compatible with TOUGH and TRUST84 from a GENESIS-format finite element mesh was modified to make use of the program OGRE. OGRE was a program was developed at Lawrence Berkeley Laboratory to generate discrete grids for Integrated Finite Difference (IFD) type computer programs such as TRUST84. Darrell Svalstad coupled the program OGRE to the pre-processor and added subroutines to generate many of the flow network and boundary condition data blocks required as input by the IFD programs TRUST84 and TOUGH. Preliminary test runs on TRUST84 indicated that use of OGRE would resolve the modeling problems associated with inclined surfaces such as the dipping stratigraphy and faulting at Yucca Mountain.

A problem with convergence in the iterative solution technique used by TOUGH was encountered by Joel Nieland. The problem occurred when an element changed from being partially saturated to saturated and vice versa. When this change took place, TOUGH formed a new set of equations for the element. In the analyzed model, an element oscillated between partial saturation and saturation, and the iterative solution did not converge until the time steps were reduced to impractical levels. The cause of this convergence problem was identified and remedied; and a pressure adjustment that resulted in the calculation of incorrect fluxes between elements was removed.

Several TOUGH simulations were completed for calculating the pre-emplacement groundwater time at Yucca Mountain. The first model included only the region west of the Ghost Dance Fault, and it provided a basis for calibrating the boundary conditions and material properties to the expected field conditions. In this model, the saturations in all of the units above the repository horizon were substantially higher than expected, even at an infiltration rate of 0.1 mm/yr. The Ghost Dance Fault and the full east-west cross section were then incorporated in the model and, because of the extreme difference in the hydraulic properties of the Ghost Dance Fault as compared to the tuff units, the calculation progressed very slowly. Calculations were completed with infiltration rates of 0.1, 0.5, and 1.0 mm/yr.

A calculation in which the properties of the fault elements were the same as the adjoining tuff elements was completed. The steady-state conditions from this last calculation were to be used as the initial conditions in the model in which the Ghost Dance Fault was represented as a highly permeable material.

Joel Nieland completed a draft of a TLM that presents these results and groundwater travel times of these models. The TLM then went into internal review.

On December 18–19, Paul Gnirk met with John Osnes concerning Fiscal Year 1990 Performance Assessment activities.

April 1990 Through June 1992

No activity.

6.0 INTERNATIONAL PROGRAMS

Activities from international programs stem from RE/SPEC support of the OECD/NEA. RE/SPEC's activities are divided into the Stripa Project and associated programs involving sealing materials and fracture transmissivities.

6.1 STRIPA PROJECT – CWBS 1.1.3.2.5

September 1988 Through December 1988

No activity.

January 1989

In response to a request from Carl Cooley (DOE-HQ), via Jeff Gibson (Weston), Paul Gnirk compiled pertinent information and drafted an analysis on the history and activities of the Stripa Project Task Force on Fracture Flow Modeling. The draft analysis was sent to Michael Ferrigan (DOE-CH).

On January 20, 1989, Paul Gnirk met with Michael Ferrigan and others at the DOE-CH offices for a briefing on the status of Phase III of the Stripa Project, including the activities of the two Task Forces and the various scheduled meetings of the Joint Technical Committee, the Technical Subgroup, and the Task Forces.

February 1989

On February 2, 1989, Paul Gnirk met with Michael Ferrigan et al., at DOE-CH regarding the OECD/NEA Stripa Project.

On February 20–22, 1989, Paul Gnirk chaired a meeting of the Task Force on Fracture Flow Modeling at the RE/SPEC Office in Albuquerque, New Mexico. On February 23, the Task Force visited the WIPP site near Carlsbad, New Mexico.

March 1989

Paul Gnirk attended meetings of the Task Force on Sealing Materials and Techniques and the Technical Subgroup for the OECD/NEA Stripa Project in Sweden during the time period of March 7–18, 1989.

April 1989

Telephone discussions were held at various times with Bengt Stillborg regarding the agenda and activities for the Annual Meeting of the Joint Technical Committee of the OECD/NEA Stripa Project in Sweden in June 1989. Paul Gnirk reviewed the report by William Dershowitz (Golder Associates) concerning the plan for Cross-Verification of Fracture-Flow Modeling Codes in Phase III of the OECD/NEA Stripa Project. Preparation (by David Parrish et al.) of portions of the state-of-the-art report on model validation for the OECD/NEA Stripa Project was completed.

Paul Gnirk met with Michael Ferrigan on April 26 at DOE-CH regarding the Annual Meeting of the Joint Technical Committee of the OECD/NEA Stripa Project in Sweden in June 1989.

May 1989

Paul Gnirk coordinated the logistics of travel by Robert Levich (DOE-YMP), Michael Ferrigan (DOE-CH/RTP), and himself for purposes of the Joint Technical Committee meeting in Sweden and the site visit to the low-level radioactive waste repository under construction at the TVO reactor site in Finland.

Paul Gnirk coordinated the continuing activities required for preparation of the United States contribution to the state-of-the-art report on model validation for the Task Force on Fracture-Flow Modeling.

On May 10, Paul Gnirk met with Michael Ferrigan (DOE-CH/RTP), Robert Levich (DOE-YMP), and Edward Patera (LANL) at the DOE-YMP offices in Las Vegas, Nevada, for the purpose of reviewing the agenda for the Joint Technical Committee meeting in Sweden in June, evaluating United States positions on various agenda topics, and coordinating the logistics for travel to the Joint Technical Committee meeting and the low-level radioactive waste repository under construction at the TVO reactor site in Finland.

June 1989

On June 1, Paul Gnirk met with Michael Ferrigan (DOE-CH/RTP) to discuss logistics for and details of the Joint Technical Committee meeting in Sweden on June 13-15 and the visit to the TVO repository (under construction) in Finland.

Paul Gnirk coordinated the activities at RE/SPEC for preparation of the United States contribution to the state-of-the-art report on model validation for the Task Force on Fracture Flow Modeling.

On June 12, Bengt Stillborg (Stripa Project Manager), Gunnar Ramqvist (Stripa Mine Manager), and Paul Gnirk briefed K. Uematsu (new NEA Director General) and Brigitta Roland (Swedish Secretarite for Energy at OECD) on the status of the OECD/NEA Stripa Project and accompanied them on an inspection visit to the investigation sites in the Stripa Mine in Sweden.

On June 13-15, Paul Gnirk attended the Twelfth Meeting of the Joint Technical Committee of the OECD/NEA Stripa Project in Örebro and at the Stripa Mine in Sweden.

On June 19, Paul Gnirk together with Michael Ferrigan (DOE-CH/RTP) and Robert Levich (DOE-YMP) made an inspection visit to the KPA-STORE interim storage facility for spent nuclear fuel and the VLJ repository (under construction) for the disposal of low-level and intermediate-level radioactive wastes at the TVO nuclear power plant site at Olkiluoto, Finland.

July 1989

On July 12 in Argonne, Illinois, Paul Gnirk discussed with Michael Ferrigan (DOE-CH/RTP) the Stripa Symposium in early October 1989.

August 1989

On August 10 and 11, Paul Gnirk met with Roland Pusch (Clay Technology AB-Sweden) in Albuquerque, New Mexico, concerning the investigative activities on sealing materials and techniques for Phase III of the OECD/NEA Stripa Project.

On August 17 at DOE-HQ, Paul Gnirk met with Michael Ferrigan (DOE-CH/RTP) concerning the Stripa Symposium in Stockholm in early October 1989.

Paul Gnirk prepared and submitted to DOE-CH/RTP an official foreign travel request for travel to Sweden during the last week in September and the first week in October, to attend meetings of the Task Force on Fracture Flow Modeling and the Principal Investigators of the Site Characterization and Validation Program for the OECD/NEA Stripa Project and to attend and participate in the NEA/SKB International Symposium on the OECD Stripa Project (In Situ Experiments Associated With the Disposal of Radioactive Waste).

September 1989

On September 8, Paul Gnirk met with Robert Levich (DOE-YMP) to discuss logistics and attendees to the Stripa Symposium in Stockholm during the first week of October 1989.

Paul Gnirk briefed Michael Ferrigan (DOE-CH/RTP) on Stripa activities at DOE-HQ on September 14.

Paul Gnirk prepared a travel cost estimate and justification for Renee Coleman at (DOE-HQ), at the request of Michael Ferrigan, for the Stripa Project meetings and Stripa Project symposium in Stockholm, Sweden, on September 25–October 7.

On September 26, Paul Gnirk met with Bengt Stillborg (Stripa Project Manager) at the SKB offices to complete preparations for the Stripa Project meetings and the Stripa Symposium. Paul Gnirk chaired the Fourth Meeting of the Task Force on Fracture Flow Modeling at the Victory Hotel in Stockholm on September 27–28. On September 29–30, Paul Gnirk attended a meeting on validation procedures within the Site Characterization Validation (SCV) program at the ABEM offices in Sundbyberg.

October 1989 Through March 1990

On October 2, 1989, Paul Paul Gnirk participated in an inspection visit to the Swedish repository for low- and intermediate-level radioactive waste at Forsmark. On October 3–4, he attended and cochaired three sessions of the NEA/SKB Stripa Symposium in Stockholm. On October 5, he participated in an inspection visit to the Stripa Mine; and on October 6, he participated in a briefing on the OECD/NEA Stripa Project, and an inspection visit of the Stripa Mine for Admiral Kenneth Carr and his associates of the NRC. Paul Gnirk completed a trip report to DOE-CH. He also completed and transmitted to OECD/NEA the Preface/Forward and Executive

Summary of the 1989 NEA/SKB International Symposium on the Stripa Project for publication in the proceedings.

On October 7, Paul Gnirk prepared memoranda relating to the meeting of the Task Force on Sealing Materials and Techniques in Zürich, Sweden, in early December 1989. On October 9–10, he and Bengt Stillborg completed a Stripa memorandum concerning cancellation of the scheduled meeting. This memorandum was faxed to the Task Force delegates and Principal Investigators for comment. On October 16–17, based on communications with country delegates and Principal Investigators, Paul Gnirk and Bengt Stillborg decided to again schedule the meeting in Zürich during the first week of December 1989. Paul Gnirk prepared a travel request to DOE-CH/RTP for foreign travel to Zürich, Switzerland, on December 4–7, 1989, to chair the meeting. On December 4–7, Paul Gnirk chaired the meeting of the Task Force on Sealing Materials and Techniques in Zürich, Switzerland, including participation in inspection visits to the Paul-Scherrer-Institute (Swiss National Laboratory) in Wuerenlingen and the Institutes of (1) Fuel Mechanics and Foundation Engineering and (2) Building Materials, Materials Chemistry, and Corrosion at the Swiss Federal Institute of Technology in Hoenggerberg. Paul Gnirk completed and transmitted to DOE-CH/RTP a trip report and minutes for the meeting.

On October 16–17, Paul Gnirk interacted with Bill Dershowitz (Golder Associates) and Bengt Stillborg (Stripa Project Manager) on the preparation of the cross-verification report for the fracture-flow modeling codes (AERE Harwell, LBL, Golder Associates) by an independent third party. On December 13, Paul Gnirk met with Michael Ferrigan (DOE-CH/RTP), Robert Levich (DOE-YMP), Richard Blaney (DOE-HQ), Bill Dershowitz (Golder Associates), and Jane Long (LBL) in Denver, Colorado, to discuss the extent of the DOE involvement, via LBL and Golder Associates, in the Fracture-Flow modeling activity for the OECD/NEA Stripa Project. On December 22, he held telephone conversations with Bengt Stillborg (SKB), Bill Dershowitz (Golder Associates), and Frank Schwartz (Ohio State University) concerning the cross-verification activities for the fracture-flow computer codes under the OECD/NEA Stripa Project.

Paul Gnirk, Bengt Stillborg (SKB) and William Dershowitz (Golder Associates), completed the agenda and invitation letter for the Fifth Meeting of the Task Force on Fracture Flow Modeling for the Stripa Project, to be held in Seattle, Washington, on February 13–16, 1990. Paul Gnirk collected and transmitted to Robert Levich (DOE-YMP), at his request, copies of information related to the formation, implementation, and various activities of the Task Force on Fracture Flow Modeling. On February 14–15, Paul Gnirk attended and chaired the meeting.

Paul Gnirk completed preparation of the draft report entitled *The Process for Validation of the Groundwater Flow and Nuclide Transport Models in the SCV Program*.

Paul Gnirk and Bengt Stillborg completed the agenda and invitation letter for the meeting of the Technical Subgroup of the Stripa Project, to be held in Interlaken, Switzerland, on March 12–15, 1990. Paul Gnirk completed and transmitted to

DOE-CH/RTP a request for approval of travel to Sweden and Switzerland for purposes of chairing meetings of the Task Force on Sealing Materials and Techniques and the Technical Subgroup for the OECD/NEA Stripa Project during the time period of March 5-16, 1990. By request of Michael Ferrigan (DOE-CH/RTP), Paul Gnirk completed and transmitted to DOE-CH/RTP the nine-point justification for foreign travel as an attachment to his "request for foreign travel." Paul Gnirk completed, and transmitted to Bengt Stillborg and Roland Pusch (Clay Technology AB) in Sweden, the revised agenda for the Task Force Meeting.

Paul Gnirk's activities in Sweden and Switzerland were:

- March 5: SKB Offices, Stockholm, Sweden: attended an organizational and planning meeting with Bengt Stillborg (Stripa Project Manager) and Per-Eric Ahlström (JTC Chairman) and traveled from Stockholm to Örebro with him.
- March 6: attended the Eighth Meeting of the Force on Sealing Materials and Techniques for the OECD/NEA Stripa Project which began with a field trip to the Stripa Mine.
- March 7-8: chaired the Eighth Meeting of the Task Force on Sealing Materials and Techniques for the OECD/NEA Stripa Project in Örebro, Sweden.
- March 8: traveled from Örebro to Stockholm with Bengt Stillborg (Stripa Project Manager) and on March 9, met with Karl-Eric Almen at the SKB offices on details of the Technical Subgroup meeting.
- March 12: traveled with Bengt Stillborg and Neil Chapman to Interlaken to meet with the Principal Investigators and to attend the Stripa Project Technical Subgroup Meeting.
- March 13-15: cochaired the Technical Subgroup Meeting.
- March 16: attended a wrap-up meeting of the Principal Investigators with the Stripa Project Manager and the Technical Subgroup Chairmen, and traveled from Interlaken to Frankfurt via Zürich.

Paul Gnirk, reviewed the draft minutes for the Eighth Meeting of the Task Force on Sealing Materials and Techniques and transmitted his comments to James Steadman (Building Research Establishment/UK).

Paul Gnirk, at the request of Michael Ferrigan, prepared explanatory information concerning the request from Bengt Stillborg to the Joint Technical Committee members for the Stripa Project for approval of funding for five proposals for new and additional work in Phase III of the Stripa Project and transmitted this information to Michael Ferrigan and Robert Levich.

On December 18-19, Paul Gnirk began preparation of a technical paper on the status of the Stripa SCV Program for the International High Level Radioactive Waste Conference in Las Vegas, Nevada, in April 1990.

April 1990

On April 9–11, Paul Gnirk attended the High-Level Radioactive Waste Management meeting in Las Vegas, Nevada, and presented two papers; (1) *Overview of the U.S. Department of Energy's PACE-90 Geologic Repository Performance Assessment Exercise Activity* (Donald Alexander, Paul Gnirk, Larry Rickertsen, Jean Younker, and Abraham Van Luik) and (2) *The Status of the Site Characterization and Validation Program in Phase III of the OECD/NEA Stripa Project* (Paul Gnirk and Bengt Stillborg).

May 1990

Paul Gnirk began reviewing and correcting the Technical Subgroup meeting minutes from the meeting held in Interlaken, Switzerland, March 12–16, 1990, as requested by Bengt Stillborg (Stripa Project Manager).

During the week of May 14–18, Paul Gnirk conferred with Bengt Stillborg and Michael Ferrigan concerning the status of the SCV tests at the Stripa Mine, and a briefing by Bengt Stillborg and Paul Gnirk to the NWTRB on the OECD/NEA Stripa Project in Sweden on May 28–29.

June 1990

On May 28, Paul Gnirk met with Bengt Stillborg and Gunnar Ramqvist (Stripa Mine Manager) at the Stripa Mine regarding the status of full-scale, disturbed-zone scaling test in the BMT drift.

On May 29, Paul Gnirk participated with Bengt Stillborg and Gunnar Ramqvist in a briefing of the Nuclear Waste Technical Review Board on Phase III of the OECD/NEA Stripa Project at the Stripa Mine, and conducted a tour of the investigation sites in the mine for the assembled group.

On June 15, Paul Gnirk transmitted copies of the minutes of the annual Technical Subgroup meeting for the OECD/NEA Stripa Project (March 13–15, 1990, in Interlaken, Switzerland) to Michael Ferrigan and John Kasprowicz, and to Donald Alexander (DOE-HQ), Steven Gomborg (DOE-CH), René Jackson (DOE-HQ), Robert Levich (DOE-YMPO), and Tom Hunter (SNL).

July 1990

No activity.

August 1990

On August 21 at DOE Headquarters in Washington, DC, Paul Gnirk briefed Dick Blaney (DOE-HQ), Bill Danker (DOE-HQ), Bob Levich (DOE-YMP), and John Kasprowicz on the status of the OECD/NEA Stripa Project, including the recommendations of the Technical Subgroup on the future conduct of the project, in preparation for the annual meeting of the Joint Technical Committee. On August 27–29, Paul Gnirk attended the annual meeting of the Joint Technical Committee for the OECD/NEA Stripa Project in Winnipeg, Manitoba.

September 1990

On September 10, Paul Gnirk attended and participated in a meeting of the Principal Investigators for the Stripa Project SCV Program in Stockholm, Sweden.

On September 11-13, Paul Gnirk chaired a meeting of the Stripa Project Task Force on Fracture Flow Modeling in Helsinki, Finland.

On September 14, Paul Gnirk participated in a field trip by the Stripa Project Task Force on Fracture Flow Modeling to the Low-Level Waste/Intermediate-Level Waste (LLW/ILW) repository site (under construction) at the TVO reactor station in Olkilouto, Finland.

October 1990

On October 16-17, Paul Gnirk chaired a meeting of the OECD/NEA Stripa Project Task Force on Sealing Materials and Techniques in Sherbrooke, Quebec Canada.

November 1990

During the month of November 1990, Paul Gnirk was involved in the following activities on behalf of the Stripa project:

- Early November: Paul Gnirk completed, and transmitted to SKB in Stockholm, Sweden, a preliminary review and revision of the draft minutes of the annual meeting of the Joint Technical Committee that was convened in Winnipeg, Manitoba/Canada in August 1990.
- November 27: Paul Gnirk met with Karl-Erik Almen (Assistant Stripa Project Manager) at the SKB offices in Stockholm, Sweden, for the purpose of completing final revisions to the minutes for the 1990 meeting of the Joint Technical Committee.
- November 28: Paul Gnirk met at the ABEM offices in Stockholm with the Scientific Coordinators, John Black (Golder Assoc.-UK) and Olle Olsson (ABEM-Sweden) for the Stripa Project SCV Program for the purpose of discussing final reporting on the outcome of the field investigations at the SCV site in the Stripa Mine.
- November 29: Paul Gnirk, John Black (Golder Assoc.-UK), and Olle Olsson (ABEM-Sweden) met at the ABEM offices in Stockholm with Professor Ivars Neretneiks (KTH-Sweden) and Lars Birgersson (Chemflow-Sweden) for the purpose of the remaining tracer tests with the hydrological tests at the SCV site through June 30, 1990 (date at which all activities in the Stripa Mine will cease).
- November 30: Paul Gnirk, John Black (Golder Assoc.-UK), and Olle Olsson (ABEM-Stockholm) met at the NEA offices in Paris, France, with Jean-Pierre Olivier and his staff of OECD/NEA for the purpose of discussion of (1) the

status of the final field and modeling activities in Phase III of the Stripa Project, and (2) any activities of interest to the international community following the conclusion of the Stripa Project.

December 1990

During December 1990, Paul Gnirk prepared the paper entitled *Process and Criteria for Validation of the Groundwater Flow Models in the OECD/NEA International Stripa Project* for presentation at the 1991 International High-Level Radioactive Waste Management Conference in Las Vegas, Nevada, on April 28–May 2, 1991. In addition, he coordinated with Bengt Stillborg (Stripa Project Manager) on preparations for meetings of

- Principal Investigators of the SCV Program in January 1991
- Task Force on Fracture Flow Modeling in February 1991
- Task Force on Sealing Materials and Techniques in March 1991
- Technical Subgroup in March 1991.

January 1991

During the week of January 7–11, 1991, Paul Gnirk met in Stockholm, Sweden, with (1) the Principal Investigators of the SCV Program to coordinate the tracer tests with the hydrologic and sealing tests in the Stripa Mine and (2) Bengt Stillborg (Stripa Manager), to prepare draft agendas and coordinate the practical arrangements for scheduled meetings of the Task Force on Fracture Flow Modeling, the Task Force on Sealing Materials and Techniques, and the Technical Subgroup in February and March, all for the OECD International Stripa Project. During the remainder of the month, he continued to coordinate, by telephone and facsimile, the agendas and arrangements for the meetings with Bengt Stillborg and the various Principal Investigators for the Stripa Project.

February 1991

Paul Gnirk's activities were:

- February 4–8: In concert with Bengt Stillborg (Stripa Project Manager), completed preparation of the agenda and related details for the annual meeting of the Technical Subgroup in Sweden on March 18–21.
- February 18–22: Completed Revision 2 of the "Process and Criteria for Validation of the Groundwater Flow Models at the SCV Site in the Stripa Mine."
- February 25–28: Chaired the Seventh Meeting of the Task Force on Fracture Flow Modeling in Key Biscayne, Florida.

March 1991

During March 1991, Paul Gnirk was involved in the following activities on behalf of the Stripa Project.

- Participated with Bengt Stillborg in a briefing for Per-Eric Ahlström (Chairman of the Joint Technical Committee) on the status of the investigative activities, final reporting, schedule, and budget at the SKB offices in Stockholm, Sweden, on March 11.
- Chaired the Tenth Meeting of the Task Force on Sealing Materials and Techniques in Helsinki, Finland, on March 12–13, and participated in a field trip to the low/intermediate-level waste repository under construction at Olkiluoto on March 14.
- Co-chaired a meeting of the Principal Investigators on March 18 and the annual meeting of the Technical Subgroup on March 18–20 in Västerås, and participated in an inspection visit to the Stripa Mine on March 21.
- Prepared for, and coordinated activities with, Bengt Stillborg prior to the meetings in Finland and Sweden on March 11–21, as well as subsequently prepared a memorandum for DOE on the status of, and plans for completion of, the Stripa Project, including remaining meetings and symposia.

April 1991

During the month of April, Paul Gnirk was involved in the following activities in support of the OECD/NEA International Stripa Project:

- April 2: At the request of William Danker, gave a briefing on the status of the Stripa Project, including the outcome of the Technical Subgroup (TSG) meeting in Sweden in March, to DOE-HQ, DOE-YMP, SAIC, and Weston personnel at the Forrestal building in Washington, DC.
- April 30: Presented the paper entitled *Process and Criteria for Validation of the Groundwater Flow Models in the OECD/NEA International Stripa Project* at the 1991 International High-Level Radioactive Waste Management Conference in Las Vegas, Nevada.
- During April: Coordinated with Bengt Stillborg (Stripa Project Manager) on the preparation of the agendas and related details for the meeting of the Task Force on Fracture Flow Modeling in St. Johns, Newfoundland/Canada on June 3–6 and the meeting of the Joint Technical Committee at Forsmark, Sweden, on June 11–13, as well as on the design of the "Stripa Time Capsule."

May 1991

Paul Gnirk contacted the Principal Investigators for the groundwater flow and transport modeling for the purposes of discussing the progress on their modeling

activities and the content of their intended presentations to the Task Force on Fracture Flow Modeling at its scheduled meeting in St. John's, Newfoundland/Canada on June 3-6.

Paul Gnirk prepared and distributed a memorandum to the Task Force on Fracture Flow Modeling on the status of the modeling activities by the Principal Investigators.

Paul Gnirk coordinated with Bengt Stillborg on preparations for meetings of the Task Force on Fracture Flow Modeling and the Joint Technical Committee in June, and prepared material for presentation at those meeting.

June 1991

Paul Gnirk chaired the Eighth Meeting of the Task Force on Fracture Flow Modeling at its scheduled meeting in St. John's, Newfoundland/Canada. He also participated in the Fourteenth Meeting of the Joint Technical Committee in Forsmark and Stripa, Sweden.

These activities supported the development of plans for the evaluation and characterization of geologic media in the United States under the DOE-OCRWM program, in particular, the DOE-Yucca Mountain Site Characterization Project and the DOE-CH/Repository Technology Program.

July 1991

No activity.

August 1991

Paul Gnirk and Bengt Stillborg worked on the preparations, including the agenda, for the meeting of the Task Force on Sealing Materials and Techniques that will be held in Rapid City, South Dakota, during the week of September 23-27, 1991, on behalf of the Task Force on Fracture Flow Modeling.

Paul Gnirk began review of the final reports on the predictions of groundwater flow into the Validation Drift at the SCV site in the Stripa Mine.

September 1991 Through June 1992

No activity.

6.2 SEALING MATERIALS – CWBS 1.1.2.1.1

September 1988 Through April 1989

No activity.

May 1989

William Coons presented a technical paper entitled *Estimated Longevity of Performance of Portland Cement Grout Seal Materials* to the "Workshop on Sealing of Radioactive Waste Repositories" in Braunschweig, West Germany, on May 22-25.

William Coons contributed information on sealing technology to Harald Åhagen. He also participated in discussions regarding the details of technology transfer activities in support of the YMPO.

June 1989

William Coons participated in the technology transfer of Stripa Field Tests for input to tests planned by the YMPO. Included in this effort are interviews with the Principal Investigators and a written section on the lessons learned from the Stripa Field Tests. This technology transfer supported anticipated field testing and planning at the Yucca Mountain Site. A detailed itinerary of his activities includes the following:

- June 2: Met with Harald Åhagen and Roland Pusch regarding the BMT comments and its application to Yucca Mountain. Discussions also ensued with Drs. Lennart Börjesson and Teruo Yahira regarding fracture sealing.
- June 5–8: Briefed Drs. Bengt Stillborg and Anders Bergström regarding progress made in interviews.
- June 9: Visited the KLABB facility in Oskersham, viewed a video tape, and toured the facility. Also visited the site for the proposed rock laboratory on the Island of Aspe. The briefing and site tour were given by Goren Beckblom.
- June 12: Worked at the SKB offices on the draft text and met with Harald Åhagen.
- June 13: Together with Harald Åhagen, interviewed Roland Pusch in Lund.
- In Stockholm during June 14–16: Reworked the text and generated new text for preliminary review/comment by contributors.
- June 19–21: Prepared foreign trip report for travel to West Germany (May 20–25) and Sweden (May 29–June 17).

July 1989

William Coons discussed with Michael Ferrigan (DOE-CH), Harald Åhagen (DOE-YMP), Michael Cloninger (DOE-YMP), and William Glassley (LLNL) the geochemical and mechanical modeling of Portland cement (Technology Transfer from Stripa to YMPO).

August 1989

No activity.

September 1989

William Coons discussed with Malcolm Gray (AECL) the long-term assessment program meeting scheduled for October 14 in Pinawa.

On September 24, Steve Alcorn and William Coons met with Joe Fernandez of Sandia and briefed him on the structural background and the technology developments of the Sealing Task Force of the Stripa Project in case Joe Fernandez decided to be an observer at the next Task Force meeting. Technology transfer and field tests from Stripa to NNWSI was also discussed with Joe Fernandez, who declined to review drafts of "lessons learned from Stripa."

October 1989 Through March 1990

During the week of November 13-17, William Coons (RE/SPEC) met with Mike Ferrigan (DOE-CH/RTP) and briefed him on Stripa activities.

William Coons prepared a presentation for the Seventh Meeting of the Task Force on Sealing Materials and Techniques of the OECD/NEA Stripa Project. On December 2, he traveled to Zürich, Switzerland, and on December 4-7 attended the meeting. William Coons prepared a foreign trip report.

William Coons reviewed the Stripa Quarterly input and reviewed the Annual Report published by SKB.

William Coons reviewed Ivars Neretnieks' note on diffusion-driven grout dissolution and forwarded the note to Mike Ferrigan at DOE-CH/RTP. He also began review of technical documents cited by and related to Neretnieks' note (SKB 88-08; SKB 89-24; SKB 89-2) and prepared an outline for his response. He prepared a presentation critiquing Ivars Neretnieks' grout degradation model for presentation to the Task Force in Örebro. He reviewed the technical contents and the tone of the note with Michael Ferrigan (DOE-CH/RTP) via telephone. He also discussed the analysis of Neretnieks' note with Paul Gnirk (Task Force Chairman) and Bengt Stillborg (SKB Project Manager).

William Coons prepared a foreign travel request to attend the Eighth Task Force Meeting on Sealing Materials and Techniques for the OECD/NEA Stripa Project to be held in Örebro, Sweden, on March 6-8, and the Stripa Project Technical Subgroup Meeting on March 12-16, 1990, in Interlaken, Switzerland. He finalized his presentation for the Sealing Task Force Meeting, and exchanged presentation materials with Malcolm Gray (AECL) and Roland Pusch (Clay Technology AB). William Coons also reviewed a proposal by Roland Pusch to test clay/cement interaction. This proposal was made at the Sealing Task Force meeting for delegate consideration. William Coons also finalized travel arrangements for the meetings and coordinated the logistics with other Task Force Members (i.e., Malcolm Gray and Roland Pusch.)

William Coons' activities in Sweden and Switzerland were:

- March 5: Traveled to Örebro and met with Ronald Pusch (Coordinator of Sealing Research for the Stripa Project).
- March 6: Attended the Eighth Meeting of the Task Force on Sealing Materials and Techniques for the OECD/NEA Stripa Project which began with a field trip to the Stripa Mine.

- March 7–8: Attended the Eighth Meeting of the Task Force on Sealing Materials and Techniques for the OECD/NEA Stripa Project in Örebro, Sweden.
- March 9: Attended a wrap-up/planning meeting in Stockholm with Roland Pusch (Clay Technology AB) and Malcolm Gray (AECL).
- March 12: Attended organizational meetings with technical collaborators in sealing investigations and attended the Stripa Project Technical Subgroup Meeting.
- March 13–15: Prepared, supported, and presented technical recommendations of the Task Force on Sealing to the Technical Subgroup Meeting.
- March 16: Attended wrap-up meetings with technical collaborators in sealing investigations.

April 1990 Through May 1990

No activity.

June 1990

William Coons reviewed several SKB documents including *Diffusion of Selected Cations Through Clay Across Mineral Surfaces*. He also met with Steve Alcorn to review technical progress on incorporation of diffusion into the cement grout degradation model.

July 1990

Steve Alcorn, Mike Wallace, and Tracy Christian-Frear completed the incorporation of the diffusion equations with the cement degradation model for long-term Portland cement seal performance.

August 1990

On August 7 in Washington, DC, John Osnes, Paul Gnirk, and Ken Ley discussed concepts for an OCRWM Technology Transfer Program with Barry Gale (DOE-HQ). Barry Gale had requested that William Coons give a formal briefing on the concepts, but because of William Coons' recent illness, the formal briefing had to be postponed. Instead, informal discussions were held and comments on the concepts were noted for inclusion in the formal briefing by William Coons.

On August 22, William Coons briefed Bob Terrell, Barry Gale, John Kasprowicz, Joanne Lowry, and other DOE-HQ and contractor staff on the preliminary plan for the OCRWM technology transfer. Ken Ley also attended the briefing.

September 1990

On September 12, at DOE Headquarters in Washington, DC, William Coons met with Bob Terrell (DOE-HQ) and John Kasprowicz in regard to concept development for an OCRWM Technology Transfer Program. William Coons also spoke with Carl Conner (DOE-HQ) to receive additional input. A follow-up meeting was scheduled for September 20, 1990.

On September 20, 1990, at DOE-HQ in Washington DC, William Coons met with Carl Conner, Jim Bresee, and Bob Terrell regarding Technology Transfer Concepts Development.

October 1990

William Coons interacted with Golder Associates regarding the applicability of Decision Analysis networks to the OCRWM Programs.

William Coons and Steve Alcorn participated in the Ninth Meeting of the OECD/NEA Stripa Project Task Force on Sealing Materials and Techniques in Sherbrooke, Quebec, Canada, on October 16–17. Steve Alcorn made a presentation on progress made in the incorporation of diffusion processes into the modeling of the longevity of grout repository seals. Steve Alcorn and William Coons also participated in field trips to Sherbrooke University, Hande Chemicals, AECL Whiteshell, and the Underground Research Laboratory (URL) on October 18 and 19.

November 1990 Through January 1991

No activity.

February 1991

William Coons and Ken Ley had various conversations with Richard Lark (DOE-CH) with reference to RE/SPEC Inc. international activities. In addition, William Coons was asked to supply a cost breakdown for RE/SPEC's activities on the above work for Fiscal Years 1991, 1992, and 1993.

Steve Alcorn assisted William Coons with preparation of a projected budget for Stripa Project related activities for Fiscal Year 1992. Steve Alcorn also prepared the minutes of the Ninth Meeting of the Task Force on Sealing Materials and Techniques held in Sherbrooke, Quebec, Canada, in October 1991. He also assisted William Coons in the preparation of presentations for the Tenth Meeting of the Task Force on Sealing Materials and Techniques to be held March 12–13 in Helsinki, Finland, and the TSG Meeting to be held in Västerås, Sweden, the following week.

Steve Alcorn initiated discussions internal to RE/SPEC dealing with the role of diffusion processes and very low-flow conditions, on the potential for cement to develop fractures. There was a possibility that this would occur in response to precipitation of secondary phase in pores and channels of the cement which would likely affect long-term performance.

March 1991

In early March, Steve Alcorn assisted William Coons in the final preparations for presentations at the Tenth Meeting of the Task Force on Sealing Materials and Techniques held March 12–13 in Helsinki, Finland, and for the TSG Meeting held in Västerås, Sweden, on March 19–21. The following items were emphasized in the presentations.

- Accomplishments in terms of project milestones and advances in the state-of-the-art.

- Tasks remaining to be done before the end of the project.
- Deliverables for the next Task Force Meeting.
- Recommended areas of further investigation (detailed quantitative calculations to evaluate the role of diffusion in cement seal degradation, improvement of thermodynamic data on cement phases, etc.).

As the delegate from the United States, William Coons attended and made technical presentations at the Tenth Meeting of the Task Force on Sealing Materials and Techniques. As an official observer, he provided technical support at the Annual Meeting of the TSG.

At the Task Force Meeting, new tasks were defined by the Task Force for performing and reporting by the next meeting. Steve Alcorn determined scope and estimate budgets for these new tasks.

At the request of the Stripa Project Manager, William Coons had meetings with Steve Alcorn, Mike Wallace, and Tracy Christian-Frear to review the status of technical investigations and to gain assurances that they were proceeding on schedule.

Internal discussions continued for defining a rigorous approach to evaluating the role of diffusion processes and very low-flow conditions in the potential for cement degrading via: (1) increased porosity and permeability and (2) fracture development.

William Coons completed a technical review of programs in the modeling of cement performance.

April 1991 Through August 1991

No activity.

September 1991

William Coons reviewed seal material progress and presentation with Malcolm Gray (AECL) and reviewed the U.S. Principal Investigator's input. He also attended the 11th Annual Stripa Task Force meeting in Rapid City, South Dakota.

October 1991

William Coons transmitted written review comments of the Stripa document entitled *Final Report on Test 4 — Sealing of Natural Fracture Zone* to the author, Roland Pusch (Clay Technology — AB).

He also collaborated with Steve Alcorn in the preparation of the Stripa document *Theoretical Investigations of Grout Seal Longevity — II. Geomechanical Modeling of Grout-Groundwater-Rock Interactions at the Seal-Rock Interface*, authored by Steve Alcorn, William Coons, and Tracy Christian-Frear.

November 1991 Through June 1992

No activity.

6.3 FRACTURE TRANSMISSIVITIES – CWBS 1.1.1.3.1

September 1988 Through March 1989

No activity.

April 1989

John Osnes received the technical reviews of the draft report entitled *Analysis of Well Test Data — Application of Probabilistic Models to Infer Hydraulic Properties of Fractures*. These reviews were performed by Tom Doe (Golder Associates) and Bruce Buxton (Battelle-Columbus). Also, Anders Winberg (SGAB) (one of the report's coauthors) verbally transmitted SGAB's and SKB's principal comments on the report. A strategy for resolving all of these review comments and finalizing the report was defined, and the time and cost involved was estimated. Tom Doe and Bruce Buxton each had five comments that will each involve minor technical or editorial efforts. SGAB and SKB had one major comment, and involved a substantial technical effort to resolve. Their comment was that more guidance for the design of well-test programs, one of the original objectives of the project, needed to be developed and incorporated in the report. The technical effort to develop the requested design guidance commenced near the end of April.

May 1989

Analyses of synthetic transmissivity data were completed to determine the effect of the number of tests and the section length on the bias and the variance of the maximum-likelihood estimator of the conductive-fracture probability. Also, the error in the estimate of the conductive-fracture probability that is introduced by the lower measurement limit of the equipment was analyzed. These analyses contribute to defining guidance for the design of well-test programs — an item requested by SKB and SGAB in their reviews of the draft report describing the results of this project.

John Osnes traveled to Pinawa, Manitoba, Canada, to meet with Anders Winberg. Progress on design guidelines for well-test programs was discussed, and Anders Winberg provided additional editorial comments regarding the draft report.

Further work on design guidance for well-test programs was deferred until the review comments of Tom Doe and Bruce Buxton regarding the draft report entitled *Analysis of Well Test Data — Application of Probabilistic Models to Infer Hydraulic Properties of Fractures* had been addressed. It was anticipated that the authorized funding for finalizing the draft report would not be adequate to fully address all of these comments and to continue work on well-test design guidance. Consequently, the review comments were prioritized so that the major comments

could be addressed and the final report submitted for publication within the current budget.

June 1989

Analyses of the synthetic transmissivity data indicated that the effect of section length on the estimates of conductive-fracture probability was negligible, contrary to the conclusions presented in the draft report. Consequently, a comparison between the sums of transmissivities measured in 2-m sections with the transmissivities measured in the equivalent 25-m sections was made to verify that the 2-m and 25-m data underlying the estimates in the draft report were not fundamentally different. This comparison revealed some significant differences between the 2-m and the equivalent 25-m data. These differences were brought to the attention of Anders Winberg (SGAB) in a memorandum submitted to him. Also, the results of the work on design guidelines for well-test programs was summarized in the memorandum. It was anticipated that the latter information would be edited for inclusion in the draft report.

July 1989 Through December 1989

No activity.

January 1990

John Osnes met with Cris Svemar (SKB representative at DOE/YMPO) in Las Vegas, Nevada, and discussed the status of the topical report entitled *Analysis of Well Test Data — Application of Probabilistic Models to Infer Hydraulic Properties of Fractures*. A tentative date of April 30 was set for finalizing the report and completing the project.

February 1990 Through August 1991

No activity.

September 1991

On September 27, John Osnes submitted the final draft of a topical report entitled *Analysis of Well Test Data — Application of Probabilistic Models to Infer Hydraulic Properties of Fractures*. This report is a Fiscal Year 1991 deliverable. The report was revised extensively in response to external reviews of the original draft by Tom Doe (Golder Associates), Bruce Buxton (Battelle Memorial Institute), and Swedish reviewers. The report was internally reviewed by William Boyle.

October 1991 Through June 1992

No activity.

7.0 CODE EVALUATION AND DOCUMENTATION — CWBS 1.1.3.2.1

September 1988 Through September 1989

The Software Quality Assurance Maintenance Program (SQAMP) was developed by RE/SPEC in 1983 to automate a large portion of the identification, documentation, and control functions for a configuration management system for computer codes, computer documentation, and related computer files. Since it was anticipated that SQAMP would be an integral part of the code evaluation and documentation effort, the User's Manual for SQAMP was revised and edited to be suitable for external publication and distribution.

John Osnes and Darrell Svalstad attended an American Society of Quality Control Course on Software Quality Assurance in Minneapolis, Minnesota, on October 9–14, 1988. The course covered objective and quantitative approaches for documenting computer software. These approaches were needed for the anticipated code documentation effort for this task.

The *User's Manual for SQAMP: Software Quality Assurance Maintenance Program* was submitted to DOE-CH. The User's Manual was prepared at QA Level III and does not satisfy all of the documentation requirements specified in NUREG-0856. SQAMP and its installation program SQINS were submitted with the Restricted Rights Notice that states that these computer programs are copyrighted by RE/SPEC and should be classified as restricted computer software under the definitions of the Rights-in-Data Clause.

One of the major activities under this task was documentation of computer codes (or upgrade the current documentation) to satisfy the standards provided by the NRC report NUREG-0856. Documentation of three RE/SPEC codes to NUREG-0856 standards had been nearly completed before this contract was transferred from Stone & Webster Engineering Corporation (SWEC) to DOE-CH. Revisions to the documentation for SPECTROM-32, SPECTROM-41, and SPECTROM-55 in response to several external reviews was nearly complete. The documentation for these codes was completed for DOE-CH.

The following documentation and codes were submitted to DOE-CH, OSTI, and NESC:

- *Documentation of SPECTROM-41: A Finite Element Heat Transfer Analysis Program* was submitted on August 18.
- *Documentation of SPECTROM-32: A Finite Element Thermomechanical Stress Analysis Program* was submitted on August 29.

- The source code for SPECTROM-55, and the *Documentation of SPECTROM-55: A Finite Element Thermohydrogeological Analysis Program* were submitted on September 29.

October 1989 Through March 1990

On October 25, 1989, the *User's Manual for SQAMP: Software Quality Assurance Maintenance Program* (DOE/CH/10378-3) and the SQAMP program were submitted to NESC.

Natalie Eslinger and Barbara Evenson (an independent consultant) began activities to bring the documentation for the SQAMP program to QA Level I (satisfying the NUREG-0856 requirements). A draft activity plan, an outline of the User's Manual, and an outline of the Internals Manual were completed and internally reviewed. Preparation of the SQAMP Internals Manual and User's Manual continued.

April 1990

Natalie Eslinger and Barbara Evenson continued preparation of the SQAMP program documentation. A draft outline of the Internals Manual and several chapters of the draft User's Manual were internally reviewed. Natalie Eslinger incorporated review comments in the Internals Manual, discussed SQAMP internal algorithms with John Osnes, and flowcharted the main SQAMP subroutines. Barbara Evenson continued working on the User's Manual.

May 1990

Natalie Eslinger continued preparation of the Internals Manual for SQAMP. Barbara Evenson completed a rough draft of the User's Manual for SQAMP and began incorporating review comments in the first draft. The two volumes are part of a set of three volumes of SQAMP documentation intended to fulfill the requirements of NUREG-0856. The project was progressing well and was on schedule.

June 1990

Natalie Eslinger continued writing the SQAMP Internals Manual. Barbara Evenson continued incorporating comments into the first draft of the SQAMP User's Manual.

July 1990

The first draft of the *SQAMP Internals Manual* was completed and was in internal review. Barbara Evenson continued preparation of the second draft of the *SQAMP User's Manual*. The third volume of the SQAMP documentation set entitled *SQAMP Code Assessment* was being prepared.

August 1990

The *SQAMP User's Manual*, the *SQAMP Internals Manual* and the *SQAMP Code Assessment* document was to be prepared as three separate reports, rather than three volumes of one report. The draft of the *SQAMP User's Manual* was completed and reviewed. Comments were being incorporated into the draft *SQAMP*

Internals Manual. The *SQAMP Internals Manual* and the *SQAMP Code Assessment* were being reviewed.

September 1990

Draft copies of the *SQAMP User's Manual*, RSI-0380, *SQAMP Internals Manual*, RSI-0374, and the *SQAMP Code Assessment and Support*, RSI-0381, were completed and reviewed internally.

October 1990

The internal review of the *SQAMP User's Manual* (Topical Report RSI-0380) was completed by one reviewer (Joel Nieland) and was 50 percent complete by the second reviewer (John Osnes). The review comments were extensive.

Both internal reviews of the *SQAMP Internals Manual* (Topical Report RSI-0374) and the *SQAMP Code Assessment and Support Document* (Topical Report RSI-0381) were completed. The comments of one of the reviewers were addressed, but revisions based on the second set of comments were delayed because the lead author (Natalie Eslinger) began maternity leave in October. John Osnes, the second author, addressed those comments in November.

November 1990

Review and revision of the SQAMP documentation continued until the middle of November when all performance assessment activities were curtailed because of lack of funding. About another man-month of effort remained to complete the drafts of the three reports that comprised the documentation.

December 1990 Through June 1992

No activity.

8.0 EVALUATION OF ACTIVITIES

Table 8-1 provides a milestone schedule for each of the six tasks summarized in Chapters 2 through 7. Of the 32 subtasks or activities identified for these six tasks, 26 were completed on schedule, 4 were completed behind schedule, and 2 were not completed. The range of delay for the 4 activities completed behind schedule varied from 2 weeks to 6 months. The two activities not completed are cited below:

- **CODE EVALUATION AND DOCUMENTATION - CWBS 1.1.3.2.1**
Upgrade documentation of SQAMP to satisfy NUREG-0856 requirements.
- **PERFORMANCE ASSESSMENT - CWBS 1.1.3.2.3**
TRACRN calculations of cumulative releases defined by A. D. Little for US-EPA.

In September 1989, a User's Manual for SQAMP was completed and submitted to the DOE. This manual was scheduled to be expanded and upgraded to satisfy NUREG-0856 requirements in Fiscal Year 1990. The upgrade consisted of three separate documents, which were all drafted but not completely reviewed and revised for final submission because funding for this activity was diverted towards other activities.

The TRACRN calculation of cumulative releases was not completed because release scenarios and A. D. Little's calculations were not made available by EPA. Although some planning was initiated, this activity never fully commenced and consequently was not completed.

Table 8-1. Milestone Schedule

Description	Completion Date	
	Schedule	Actual
PROJECT MANAGEMENT - CWBS 1.1.3.1.1 Submit Management Plan	05/06/89	05/06/89
PROJECT QUALITY ASSURANCE - CWBS 1.1.3.1.2 Submit QA Manual	02/27/89	02/27/89
Submit QA Plan	05/08/89	06/08/89
PERFORMANCE ASSESSMENT INTEGRATION SUPPORT - CWBS 1.1.3.2.3 Deliver PASP Review Draft	06/29/89	06/29/89
Demonstration of FOMD for calculation of probability of exceeding cumulative release limits	06/30/90	10/26/90
TRACRN calculations of cumulative releases defined by A. D. Little for US-EPA	10/30/90	—
STATUS REVIEWS - CWBS 1.1.3.2.3 TRACRN analyses of PACE-89 total-system transportation problem	11/30/89	11/30/89
TOUGH analyses of PACE-89 natural-barrier problem 4	03/31/90	03/31/90
INTERNATIONAL PROGRAMS - CWBS 1.1.3.2.5, 1.1.2.1.1, 1.1.1.3.1 Task Force Meeting on Fracture Flow Modeling	02/23/89	02/23/89
Task Force Meeting on Sealing Materials and Techniques	03/10/89	03/10/89
Technical Subgroup Meeting	03/16/89	03/16/89
Joint OED/NEA and CEC Workshop on Sealing Radioactive Waste Repositories	05/25/89	05/25/89
Joint Technical Committee Meeting	06/15/89	06/15/89
Task Force Meeting on Fracture Flow Modeling	09/28/89	09/28/89
Third Symposium of the OECE/NEA Stripa Project	10/05/89	10/05/89
Seventh Task Force Meeting on Sealing Materials and Techniques	12/07/89	12/07/89
Fifth Task Force Meeting on Fracture Flow Modeling	02/16/90	02/16/90
Workshop on Hydrologic Testing	02/28/90	02/28/90
Annual Technical Subgroup Meeting	03/16/90	03/16/90
Eighth Task Force Meeting on Sealing Materials and Techniques	03/08/90	03/08/90
Submit Topical Report RSI-0338 <i>Analysis of Well Test Data — Application of Probabilistic Models to Infer Hydraulic Properties of Fractures</i>	04/30/90	10/30/91
Thirteenth Joint Technical Subgroup Meeting	08/31/90	08/31/90
Sixth Task Force Meeting on Fracture Flow Modeling	09/13/90	09/13/90
Ninth Meeting of the Task Force on Sealing Materials and Techniques	10/17/90	10/17/90
Seventh Meeting of the Task Force on Fracture Flow Modeling	02/28/91	02/28/91
Tenth Meeting of the Task Force on Sealing Materials and Techniques	03/14/91	03/14/91
Annual Technical Subgroup Meeting	03/21/91	03/21/91
Eighth Meeting of the Task Force on Fracture Flow Modeling	06/06/91	06/06/91
Fourteenth Meeting of the Joint Technical Committee	06/13/91	06/13/91
Eleventh Meeting of the Task Force on Sealing Materials and Techniques	09/26/91	09/26/91
CODE EVALUATION AND DOCUMENTATION - CWBS 1.1.3.2.1 Complete documentation of computer codes	09/15/89	09/29/89
Upgrade documentation of SQAMP to satisfy NUREG-0856 requirements	09/30/90	—

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