PROJECT PLAN FOR PERFORMANCE ASSESSMENT RESEARCH

Prepared for

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EFFECTIVITY

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Page No.	Change No.	Date Effective
Title Page	3	03/15/94
ii – iii	3	03/15/94
iv – vi	0	07/30/93
1-1 – 3-1	0	07/30/93
3-2 – 3-3A	3	03/15/94
3-4 – 3-6	0	07/30/93
3-7 – 3-9	3	03/15/94
4-1 – 4-2	0	07/30/93
4-3	3	03/15/94
4-4 – 5-2	0	07/30/93
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CNWRA Form QAP-15-1 (8/91)

CONTENTS

Model Development; (ii) Computational Model Development; and (iii) Model Evaluation. Specific research activities that will be pursued in these tasks are described in the following section.

3.1.1 Task 1: Conceptual Model Development

3.1.1.1 Objective

The objective of Task 1 is to develop conceptual and mathematical models of: (i) the important physical processes such as infiltration, fracture-matrix interactions, multiphase flow, and radiocolloid transport that may significantly affect the isolation capability of the proposed HLW repository and (ii) potentially important disruptive event scenarios. The physical processes and disruptive events to be studied will be based on the findings and recommendations of the IPA activity.

3.1.1.2 Justification

A major issue in assessing the performance of the proposed repository at Yucca Mountain (YM) is the identification of physical processes and events that may significantly affect its performance relative to the U.S. Environmental Protection Agency (EPA) standard, 40 CFR Part 191. The recent IPA Phase 2 study has identified a number of physical processes and disruptive events that appear to have a significant affect on the complementary cumulative distribution function (CCDF) required by the EPA standard. The sensitivity analysis conducted under IPA Phase 2, for example, identified infiltration and the associated flow in the fractures and matrix as the most important factor controlling the CCDF for YM. The sensitivity analysis also showed that water flow rate past the waste package was an important factor. Disruptive events such as climate change, volcanism, seismo-tectonics, and human intrusion are important considerations for future system states, however other scenarios need to be considered.

An improved understanding of water flow phenomena in fractured-porous tuff is a fundamental prerequisite to making sound assessments of total-system PA. Both theoretical and experimental studies are required to develop this understanding. With regards to theoretical studies, a first principles approach is needed that draws on well-established mathematical laws of fluid dynamics. Flow in individual fractures with imbibition into the rock matrix, for example, can be studied by using thin film theory in combination with unsaturated flow theory. Analysis and interpretation of laboratory data for unsaturated hydraulic properties can be used to check mathematical theories. The laboratory data generated by the Geochemical Analogs Research Project for the Peña Blanca site provides an excellent opportunity for supporting the experimental aspects of conceptual and mathematical model development.

Four basic types of site-induced (i.e., geologic in origin) disruptive scenarios were considered in the IPA Phase 2 exercise. However, other site- and repository-induced disruptive scenarios can be postulated for the YM site. A general selection methodology needs to be applied to develop a more complete representation of the future states of the repository system. In order to assess the actual effect of these disruptive events, conceptual models and corresponding mathematical formulations which embody the physics of each process must be developed. This includes development of corresponding probability models that describe the likelihood of occurrence of the disruptive events. The scenario and consequence models developed under this task will be utilized in the IPA Phase 3 exercise for the YM site.

3.1.1.3 Activities

Activities within Task 1 include the following:

- Conceptual Model development for the four identified disruptive scenario classes. Conceptual models will be developed for seismo-tectonic and volcanic events, the climatic change scenario, and for the possibility of deliberate or inadvertent human intrusion. In addition to the conceptual models, possible alternative mathematical formulations and practical methods for implementing the mathematical model through computer programs will be described. For each scenario and associated physical processes, possible simplifications and assumptions will be identified and an assessment made to determine importance to overall system performance. Available computer programs which implement the identified conceptual models and that are applicable to the IPA effort will be analyzed in detail. To the extent possible, scenario probabilities will be estimated using empirical methods, statistical models, expert opinion elicitation, and information available in the scientific literature. Simple consequence modules will be developed to represent these scenarios; these modules will be suitable for incorporation into the TPA code for the repository system. The results of this activity will provide key input to the IPA effort.

- Development of conceptual models for matrix-fracture interaction in unsaturated regimes. Currently there are three alternative approaches that have been used to model flow of water and transport of radionuclides between rock matrix and fractures: (i) the equilibrium approach which assumes that the water pressures in the matrix and the fracture are equal; (ii) the dual continuum approach in which the water pressures in the matrix and fractures are represented by distinct state variables coupled through a flux transfer equation; and (iii) discrete fracture models in which the geometry and hydraulic properties of the fractures are explicitly defined. Theoretical work will be performed that examines the flow of water in fractured porous media at the laboratory scale. This work is aimed at evaluating the applicability of the current modeling approaches. The experimental data, obtained from tuff core samples, will be provided by the Geochemical Natural Analog Project. These activities will be reported in the IM 191094-002 and 191094-004.

- Conceptual model development for two-phase flow in high temperature regimes. Simple conceptual models for PA will be developed for two-phase flow in nonisothermal and high-temperature regimes. An investigation will be conducted to gauge the importance of two-phase phenomena to the performance objectives of the proposed repository. The investigation may include: (i) the hot repository concept where nearby host rock temperatures above 100–200 °C are expected to persist for hundreds of years; and (ii) magmatic intrusion where molten rock at temperature on the order of 1,000 °C approaches the repository. Each of these processes and events may introduce unique two-phase flow regimes. For example, condensate dripping in fracture networks may be important for the hot repository, and large-scale thermally driven convection currents may be important for magmatic intrusion into the vicinity of Yucca Mountain. The simplified conceptual models are expected to accurately represent the physics, yet conservatively bound the consequences, of two-phase flow so that the models are useful to the IPA work currently being conducted. As a first step toward this goal, a review of the state-of-the-art in modeling two-phase flow in nonisothermal and high temperature regimes will be reported as IM 191094-003.

- Participation in international activities. Scenario analysis has been recognized as a major step in PA at the international level. The Organization of Economic Cooperation and Development has organized a group to identify a method that may find international acceptance. Participation in such group activities will be of help in formulation of scenario analysis methods.

- Modeling Reactive Transport. A number of areas in PA modeling require consideration of mass transport with chemical reaction. Examples in the near field are localized corrosion, waste form dissolution including consideration of colloid formation, and transport of radionuclides away from the waste package. In the far field portion of the geologic setting, reactive transport models are needed for analysis of nonlinear sorption phenomena, colloid dissolution, mass redistribution leading to changes in near field hydraulic properties (e.g., fracture coatings), and mass redistribution leading to changes in the geochemical environment surrounding the waste packages.

  Reactive transport models must take into account a variety of physicochemical processes including advection, diffusion, electromigration, sorption, precipitation, dissolution, colloid formation, chain decay of radionuclides, and a wide variety of chemical kinetic formulations. Because of the large number of processes, it is imperative that only those which may significantly impact the ability of the repository to meet its performance criteria be analyzed and incorporated into IPA models. However, those important processes which are exceedingly complex to model in detail should not necessarily be replaced by simple models if current modeling strategies are too computationally expensive to incorporate into PA models. Because the objective of Task 2 is to improve computational methods so that increased levels of detail and realism can be added to PA models, considerable effort will be devoted in this activity to analyzing, developing, and implementing computationally efficient procedures for modeling complex reactive transport processes.

3.1.3 Task 3: Model Evaluation

3.1.3.1 Objective

The objective of this task is to develop a systematic methodology for the validation of models. This methodology is expected to provide the basis for a staff technical position on regulatory requirements for model validation. The NRC is currently developing a regulatory framework for providing guidance on model validation. This framework is being developed as a joint effort with the Swedish Organization, SKI. As used here, the term model validation implies an accuracy assessment (National Research Council, 1990) process consisting of: (i) a comparison of model predictions against experimental data; and (ii) an evaluation of goodness-of-fit. The degree of correlation between model calculations and experimental data is then used to establish a basis for confidence in the model's predictive capability. Thus, the validation process is viewed from the perspective of building confidence in models and not to produce "validated" models in a generic sense.

3.1.3.2 Justification

Mathematical models of water flow and radionuclide transport will be extensively used to assess the ability of the proposed Yucca Mountain HLW repository to meet the performance objectives outlined in the EPA rule and in NRC regulations. In view of the reliance placed on mathematical models, it is essential that the theory upon which they are based be well established, and, insofar as possible, that they be adequately tested (i.e., verified and validated). From a regulatory standpoint, the goal of model validation, regardless of how it is achieved, is to reduce the risk that use of the model may lead to incorrect decisions regarding the safety of the repository. Although this goal of validation is primarily based on the need to establish certification procedures for models which satisfy the policy objectives of the regulatory agencies and the courts, its satisfaction will also meet the technical requirements regarding the correctness of model hypotheses.

3.1.3.3 Activities

Task 3 activities are delineated below:

- Validation methodology development. It is apparent that long-term predictive models can not be fully validated for a specific site. A model validation methodology that is acceptable in the regulatory arena will be developed. This methodology will be documented in a NUREG/CR report.

- Methodology demonstration. The validation methodology developed above will be demonstrated with respect to an NRC PA model using data from the Las Cruces Trench Experiment, and to the extent feasible, data from the University of Arizona experiments at Apache Leap test site. This work will examine the effects of model complexity on model predictions; this may provide insight on how much characterization data is enough to yield sound calculations. Progress on this methodology demonstration will be documented in the semi-annual research reports.

- Participation in projects similar to INTRAVAL and GEOVAL. CNWRA staff will actively participate in international projects to learn from the international experience as well as to make use of validation data sets at the international level. In addition, natural analogues may provide data sets for limited long-term validation of PA models. An effort will be made to identify appropriate data sets.

- Development of nondimensional parameters. The approach of nondimensionalizing the processes involved in PA may be investigated to see if: (i) time- and space-scales can be interchanged; and (ii) a validation experiment based on a specific site can be designed and executed in reasonable time.

3.1.4 Task 4: Semi-Annual Research Reports

3.1.4.1 Objective

The objective of this task is to provide an account of PA Research work in the CNWRA semi-annual research reports.

3.1.4.2 Justification

Research progress and current research findings are required to be reported in the semi-annual research reports.

3.1.4.3 Activities

The sole activity of Task 4 is to provide summary reports of research findings which will be included in the semi-annual research reports.

3.2 SCHEDULES, MILESTONES, AND DELIVERABLES

The milestones listed in Table 3-1 are a combination of several new milestones and two milestones carried over from FY93. With regard to the new milestones, the first three digits of the milestone number denote the project and task number (e.g., 192 indicates Task 2 of the nineteenth specific research project); the following three digits identify the fiscal year in which the specific milestone within the task is to be completed. In cases where multiple deliverables may be needed to support a single activity, an additional three digits have been added to indicate the sequential number of the deliverable within the activity. Upon approval, these milestones and activities will be incorporated into the integrated CNWRA schedules. In addition, contributions will be made to the CNWRA semi-annual research report.

Table 3-1. List of milestones and completion dates

Milestone Number	Milestone Type	Deliverable Description	Completion Date
112008-000	Intermediate	Technology Transfer - PORFLOW Code	TBD FY94
191094-001	Intermediate	Review of Scenario Selection Methodologies	03/31/94
191094-002	Intermediate	Study of Water Film Flow in a Fracture with Imbibition	06/30/94
191094-003	Intermediate	Near-Field Conceptual and Mathematical Models for Flow	08/31/94
191094-004	Intermediate	Analysis of Hydraulic Characteristics of Hydrothermally-Altered Tuff	07/29/94
194094-020	Intermediate	Semi-Annual Report 1994 - 1	08/12/94
193095-000	Intermediate	Topical Report on Model Validation Methodology	09/30/95
192095-001	Major	Topical Report on Advanced Computational Methods in PA	09/30/95
191095-003	Intermediate	Report on Scenario Classes for IPA Modules	11/30/94
191095-005	Intermediate	Topical Report on Conceptual and Mathematical Models of Matrix-Fracture Interactions in Tuff	08/31/95
192095-010	Intermediate	Topical Report on Evaluation of Massively Parallel and Heterogeneous Computing	09/30/95
194095-015	Intermediate	Semi-Annual Report 1994 - 2	02/15/95
194095-020	Intermediate	Semi-Annual Report 1995 - 1	08/12/95

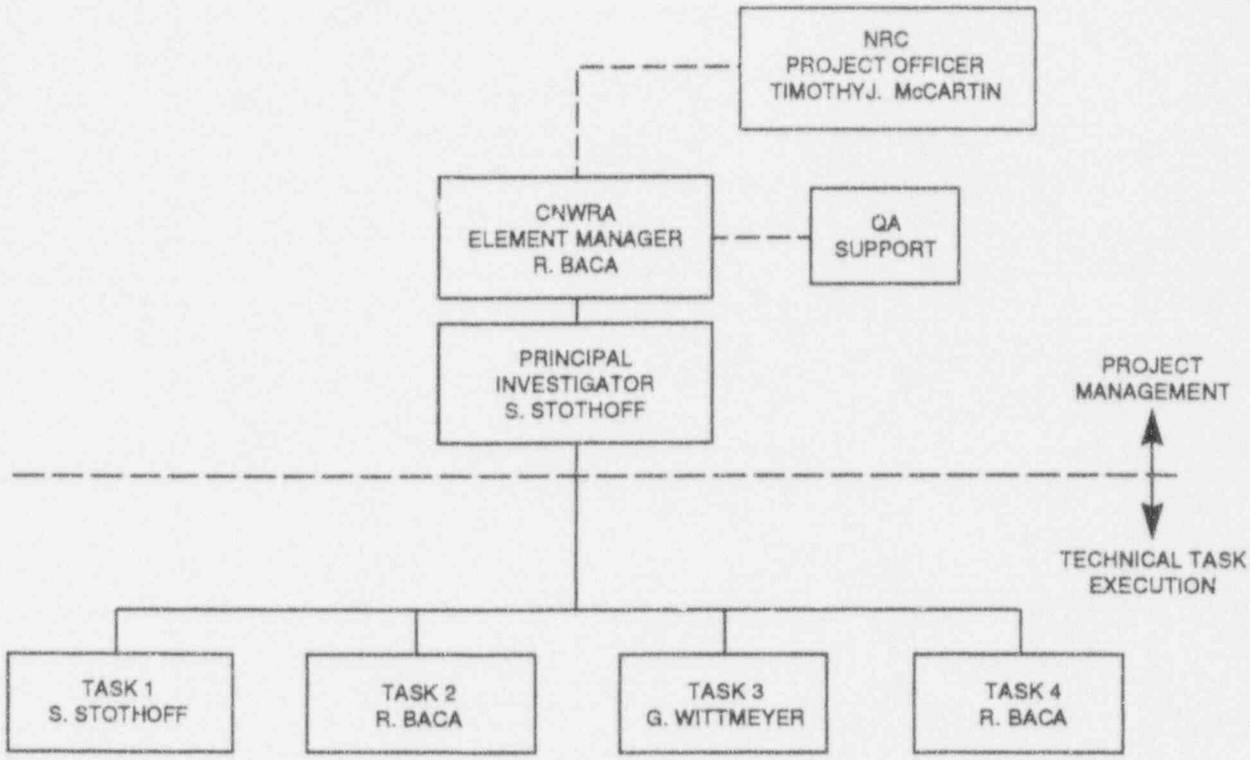

Figure 4-2. Project staff support

4.3 PERSONNEL

Because of the multidisciplinary nature of the PA Research Project, it will draw personnel from different elements of the CNWRA as well as obtain assistance from outside experts who will act as consultants. At the present time, key CNWRA personnel for this project are: Robert Baca, Amvrossios Bagtzoglou, A. Berge Gureghian, Vivek Kapoor, Sitakanta Mohanty, Peter Lichtner, Randall Manteufel, David Turner, and Gordon Wittmeyer. Other CNWRA participants may be identified later. The outside consultants will include Drs. A.K. Runchal, M.S. Seth, D. Dougherty, and H.D. Nguyen.

4.4 CORPORATE RESOURCES

4.4.1 General Resources

The following resources will be used:

- SwRI library and document retrieval system
- Library Databases - National Technical Information Service, DOE, Geosearch, Rock Mechanics, etc.; and
- SwRI support resources for drafting, publications services, general administration, etc.

Table A-1. PA research estimated spending plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	612	408	612	612	408	612	408	408	612	408	612	408	612	6,737
Center PI-3	2,090	2,014	2,014	2,557	2,092	2,053	1,007	1,046	1,085	1,048	1,007	1,046	1,065	20,143
Center PI-2	2,064	2,103	2,103	2,660	2,165	2,134	2,103	2,165	2,103	2,134	2,103	2,103	2,134	28,076
Center PI-1	2,359	2,280	2,301	2,877	2,344	2,323	[illegible]	1,662	1,726	1,641	1,683	1,620	1,683	26,162
Center Tech	1,356	1,374	1,354	1,705	1,364	1,364	[illegible]	4,814	4,794	4,804	4,794	4,804	4,804	42,128
Center Clerical	546	534	544	688	544	544	[illegible]	534	544	544	544	534	544	7,191
Center Labor	9,026	8,714	8,930	11,099	8,918	9,031	[illegible]	10,630	10,865	10,578	10,745	10,516	10,864	130,436
Center Burden	3,944	3,808	3,902	4,850	3,897	3,947	4,597	4,645	4,748	[illegible]	4,696	4,595	4,747	57,000
Center Overhead	8,690	8,390	8,598	10,686	[illegible]	8,696	10,128	10,234	[illegible]	[illegible]	10,345	10,124	10,459	125,582
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	688	637	693	804	720	637	693	665	693	665	693	665	665	8,918
SwRI PI-1	852	851	851	1,078	851	851	737	756	737	737	737	737	794	10,572
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	1,539	1,488	1,544	1,881	1,571	1,488	1,430	1,421	1,430	1,403	1,430	1,403	1,459	19,489
SwRI Burden	672	650	675	822	687	650	625	621	625	613	625	613	638	8,516
SwRI Overhead	2,566	2,481	2,573	3,136	2,619	2,481	2,384	2,369	2,384	2,338	2,384	2,338	2,432	32,487
ADP Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	453	453	453	567	450	453	453	453	453	453	453	453	453	6,000
Quality Assur.	491	489	491	613	491	491	492	486	492	491	491	489	491	6,500
Report Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tphone & Tgram	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Travel	0	0	0	0	0	0	16,377	0	0	0	0	0	0	16,377
Consultants	6,661	6,709	6,719	9,701	6,806	6,622	3,041	3,031	3,041	3,031	3,041	2,900	2,997	64,300
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	34,043	33,183	33,885	43,357	34,026	33,858	50,047	33,894	34,500	33,713	34,210	33,430	34,541	466,687
Center CFC	569	549	563	700	562	569	663	670	685	667	677	663	685	8,221
SwRI CFC	175	170	176	215	179	170	163	162	163	160	163	160	166	2,222
Tot Estimate Cost	34,787	33,902	34,624	44,271	34,767	34,597	50,873	34,726	35,347	34,540	35,051	34,253	35,392	477,129
Fee	2,723	2,655	2,711	3,469	2,722	2,709	4,254	2,881	2,932	2,866	2,908	2,842	2,936	38,606
Tot Cost with Fee	37,510	36,557	37,334	47,740	37,489	37,306	55,127	37,607	38,290	37,406	37,959	37,095	38,328	515,736
% Completion	7.27%	7.09%	7.24%	9.26%	7.27%	7.23%	10.69%	7.29%	7.42%	7.25%	7.36%	7.19%	7.43%	100.00%
Cumulative Cost	37,510	74,067	111,401	159,141	196,630	233,935	289,062	326,669	364,949	[illegible]	440,313	477,408	515,736	
Cumul Completion	7.27%	14.36%	21.60%	30.86%	38.13%	45.36%	56.05%	63.34%	70.76%	78.02%	85.38%	92.57%	100.00%	

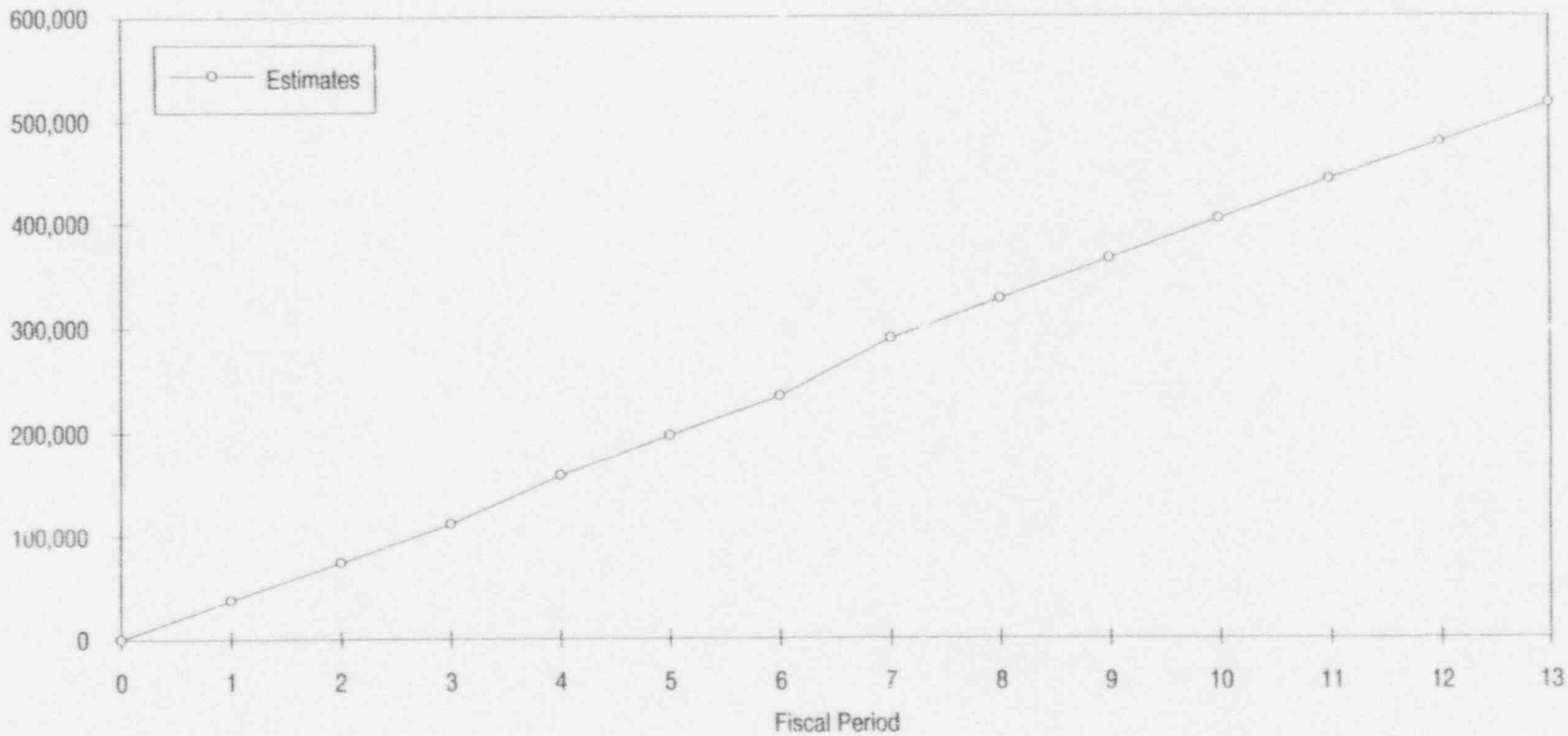

Figure A-1. PA research estimated spending plan, FY94

Table A-2. PA research estimated labor plan, FY94

Center Labor	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	12	8	12	12	8	12	8	8	12	8	12	8	12	132
Center PI-3	54	52	52	66	54	53	26	27	28	27	26	27	28	520
Center PI-2	69	68	68	86	70	69	68	70	68	69	68	68	69	910
Center PI-1	111	107	108	135	110	109	78	78	81	77	79	76	79	1,228
Center Tech	135	137	135	170	136	136	478	480	478	479	478	479	479	4,200
Center Clerical	53	52	53	67	53	53	53	52	53	53	53	52	53	700
Total Center Labor	434	424	428	536	431	432	711	715	720	713	716	710	720	7,690

SwRI Labor	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	25	23	25	29	26	23	25	24	25	24	25	24	24	322
SwRI PI-1	45	45	45	57	45	45	39	40	39	39	39	39	42	559
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SwRI Labor	70	68	70	86	71	68	64	64	64	63	64	63	66	881

Table A-3. PA research task 1 estimated spending plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	153	102	153	153	102	153	102	102	153	102	153	102	153	1,684
Center PI-3	890	852	891	1,085	891	391	465	465	465	465	465	465	465	8,754
Center PI-2	1,298	1,299	1,299	1,639	1,330	1,299	1,330	1,330	1,299	1,299	1,299	1,299	1,299	17,320
Center PI-1	765	746	767	938	746	767	1,321	1,321	1,343	1,300	1,343	1,279	1,300	13,935
Center Tech	753	762	752	963	752	762	752	762	752	762	752	762	752	10,031
Center Clerical	31	31	31	41	31	31	31	31	31	31	31	31	31	411
Center Labor	3,890	3,792	3,893	4,809	3,852	3,903	4,001	4,011	4,043	3,959	4,043	3,938	4,000	52,134
Center Burden	1,700	1,657	1,701	2,101	1,683	1,706	1,749	1,753	1,767	1,730	1,767	1,721	1,748	22,783
Center Overhead	3,745	3,651	3,749	4,630	3,709	3,758	3,852	3,862	3,892	3,812	3,892	3,791	3,851	50,194
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	220	194	222	249	222	194	471	471	471	471	471	471	443	4,570
SwRI PI-1	284	284	284	359	284	284	454	454	454	454	454	454	511	5,012
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	504	478	505	609	505	478	925	925	925	925	925	925	954	9,582
SwRI Burden	220	209	221	266	221	209	404	404	404	404	404	404	417	4,187
SwRI Overhead	840	796	842	1,015	842	796	1,542	1,542	1,542	1,542	1,542	1,542	1,590	15,972
ADP Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	151	151	151	189	150	151	151	151	151	151	151	151	151	2,000
Quality Assur.	38	37	38	47	38	38	38	37	38	38	38	37	38	500
Report Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tphone & Tgram	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Travel	0	0	0	0	0	0	4,070	0	0	0	0	0	0	4,070
Consultants	1,559	1,549	1,559	1,917	1,646	1,462	2,255	2,245	2,255	2,245	2,255	2,245	2,342	25,534
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	12,647	12,320	12,660	15,532	12,646	12,501	18,987	14,930	15,016	14,806	15,016	14,754	15,091	186,957
Center CFC	245	239	245	303	243	246	252	253	255	250	255	248	252	3,286
SwRI CFC	57	54	58	69	58	54	105	105	105	105	105	105	109	1,092
Tot Estimate Cost	12,950	12,614	12,963	15,955	12,947	12,801	19,345	15,288	15,377	15,161	15,377	15,107	15,452	191,336
Fee	1,012	986	1,013	1,247	1,012	1,000	1,614	1,269	1,276	1,258	1,276	1,254	1,283	15,500
Tot Cost with Fee	13,961	13,599	13,976	17,201	13,959	13,802	20,959	16,557	16,653	16,419	16,653	16,361	16,735	206,835
% Completion	7.44%	6.58%	6.76%	8.32%	6.75%	6.67%	10.13%	8.01%	8.05%	7.94%	8.05%	7.91%	8.09%	100.00%
Cumulative Cost	13,961	27,560	41,536	58,737	72,696	86,498	107,456	124,013	140,666	157,086	173,739	190,100	206,835	
Cumul Completion	7.44%	13.32%	20.08%	28.40%	35.15%	41.82%	51.95%	59.96%	68.01%	75.95%	84.00%	91.91%	100.00%	

Table A-4. PA research task 2 estimated spending plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	153	102	153	153	102	153	102	102	153	102	153	102	153	1,684
Center PI-3	736	736	697	930	736	736	116	155	155	155	116	155	155	5,579
Center PI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center PI-1	638	639	639	810	639	639	0	0	0	0	0	0	0	4,005
Center Tech	452	461	451	562	461	451	3,892	3,892	3,892	3,892	3,892	3,892	3,902	30,091
Center Clerical	62	62	62	82	62	62	62	62	62	62	62	62	62	822
Center Labor	2,041	2,000	2,003	2,537	2,000	2,041	4,172	4,210	4,261	4,210	4,223	4,210	4,271	42,180
Center Burden	892	874	875	1,108	874	892	1,823	1,840	1,862	1,840	1,845	1,840	1,867	18,433
Center Overhead	1,965	1,926	1,928	2,442	1,926	1,965	4,016	4,054	4,103	4,054	4,065	4,054	4,112	40,611
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	248	249	249	305	277	249	0	0	0	0	0	0	0	1,578
SwRI PI-1	284	284	284	359	284	284	0	0	0	0	0	0	0	1,778
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	531	533	533	664	561	533	0	0	0	0	0	0	0	3,355
SwRI Burden	232	233	233	290	245	233	0	0	0	0	0	0	0	1,466
SwRI Overhead	885	889	889	1,107	935	889	0	0	0	0	0	0	0	5,593
ADP Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	151	151	151	189	150	151	151	151	151	151	151	151	151	2,000
Quality Assur.	38	37	38	47	38	38	38	37	38	38	38	37	38	500
Report Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tphone & Tgram	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Travel	0	0	0	0	0	0	7,141	0	0	0	0	0	0	7,141
Consultants	5,102	5,160	5,160	7,784	5,160	5,160	786	786	786	786	786	655	655	38,766
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	11,838	11,803	11,810	16,168	11,889	11,903	18,127	11,078	11,201	11,079	11,108	10,947	11,094	160,045
Center CFC	129	126	126	160	126	129	263	265	269	265	266	265	269	2,659
SwRI CFC	61	61	61	76	64	61	0	0	0	0	0	0	0	383
Tot Estimate Cost	12,027	11,990	11,997	16,404	12,079	12,092	18,390	11,343	11,470	11,344	11,375	11,212	11,364	163,086
Fee	947	944	945	1,293	951	952	1,541	942	952	942	944	930	943	13,227
Tot Cost with Fee	12,974	12,934	12,941	17,697	13,030	13,044	19,930	12,285	12,422	12,286	12,319	12,143	12,307	176,313
% Completion	7.11%	7.34%	7.34%	10.04%	7.39%	7.40%	11.30%	6.97%	7.05%	6.97%	6.99%	6.89%	6.98%	100.00%
Cumulative Cost	12,974	25,908	38,850	56,547	69,577	82,622	102,552	114,837	127,259	139,543	151,863	164,006	176,313	
Cumul Completion	7.11%	14.69%	22.03%	32.07%	39.46%	46.86%	58.16%	65.13%	72.18%	79.15%	86.13%	93.02%	100.00%	

Table A-5. PA research task 3 estimated spending plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	153	102	153	153	102	153	102	102	153	102	153	102	153	1,684
Center PI-3	309	271	310	349	310	271	310	271	310	271	310	271	310	3,873
Center PI-2	652	680	711	866	711	711	660	711	680	711	711	680	711	9,220
Center PI-1	658	618	661	788	661	639	170	149	170	149	170	149	170	5,154
Center Tech	151	150	150	191	150	150	150	160	150	150	150	150	150	2,007
Center Clerical	62	62	62	82	62	62	62	62	62	62	62	62	62	822
Center Labor	1,985	1,884	2,047	2,429	1,996	1,987	1,475	1,456	1,526	1,446	1,557	1,415	1,557	22,760
Center Burden	867	823	895	1,061	872	868	645	636	667	632	680	618	680	9,946
Center Overhead	1,911	1,814	1,971	2,339	1,922	1,913	1,420	1,402	1,469	1,392	1,499	1,362	1,499	21,913
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	220	194	222	249	222	194	222	194	222	194	222	194	222	2,769
SwRI PI-1	284	284	284	359	284	284	284	303	284	284	284	284	284	3,782
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	504	478	505	609	505	478	505	497	505	478	505	478	505	6,552
SwRI Burden	220	209	221	266	221	209	221	217	221	209	221	209	221	2,863
SwRI Overhead	840	796	842	1,015	842	796	842	828	842	796	842	796	842	10,921
ADP Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	151	151	151	189	150	151	151	151	151	151	151	151	151	2,000
Quality Assur.	38	37	38	47	38	38	38	37	38	38	38	37	38	500
Report Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tphone & Tgram	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Travel	0	0	0	0	0	0	5,166	0	0	0	0	0	0	5,166
Consultants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	6,516	6,191	6,670	7,964	6,547	6,440	10,463	5,223	5,420	5,141	5,494	5,066	5,494	82,620
Center CFC	125	119	129	153	126	125	93	92	96	91	98	89	98	1,434
SwRI CFC	57	54	58	69	58	54	58	57	58	54	58	54	58	747
Tot Estimate Cost	6,698	6,364	6,857	8,177	6,730	6,620	10,614	5,371	5,574	5,287	5,650	5,210	5,650	84,801
Fee	521	495	534	636	524	515	889	444	461	437	467	431	467	6,821
Tot Cost with Fee	7,220	6,860	7,390	8,813	7,254	7,135	11,503	5,815	6,034	5,724	6,117	5,640	6,117	91,622
% Completion	7.19%	7.49%	8.07%	9.62%	7.92%	7.79%	12.55%	6.35%	6.59%	6.25%	6.68%	6.16%	6.68%	100.00%
Cumulative Cost	7,220	14,080	21,470	30,283	37,537	44,672	56,175	61,991	68,025	73,749	79,865	85,506	91,622	
Cumul Completion	7.19%	15.37%	23.43%	33.05%	40.97%	48.76%	61.31%	67.66%	74.24%	80.49%	87.17%	93.32%	100.00%	

Table A-6. PA research task 4 estimated spending plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	153	102	153	153	102	153	102	102	153	102	153	102	153	1,684
Center PI-3	155	155	116	194	155	155	116	155	155	155	116	155	155	1,937
Center PI-2	114	124	93	155	124	124	93	124	124	124	93	124	124	1,537
Center PI-1	298	277	234	341	298	277	170	192	213	192	170	192	213	3,068
Center Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Clerical	391	380	390	483	390	390	390	380	390	390	390	380	390	5,136
Center Labor	1,110	1,038	987	1,325	1,069	1,099	872	953	1,035	963	923	953	1,035	13,361
Center Burden	485	454	431	579	467	480	381	416	452	421	403	416	452	5,839
Center Overhead	1,069	999	950	1,276	1,030	1,058	839	917	997	927	889	917	997	12,864
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Burden	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Overhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADP Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quality Assur.	377	378	377	472	377	377	378	377	378	377	377	378	377	5,000
Report Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tphone & Tgram	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Travel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Consultants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	3,042	2,868	2,745	3,652	2,943	3,015	2,470	2,663	2,862	2,688	2,592	2,664	2,861	37,065
Center CFC	70	65	62	84	67	69	55	60	65	61	58	60	65	842
SwRI CFC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot Estimate Cost	3,112	2,934	2,807	3,736	3,011	3,084	2,525	2,723	2,927	2,748	2,650	2,724	2,926	37,907
Fee	243	229	220	292	235	241	210	226	243	228	220	226	243	3,059
Tot Cost with Fee	3,355	3,163	3,027	4,028	3,246	3,325	2,735	2,949	3,171	2,977	2,870	2,950	3,170	40,966
% Completion	7.92%	7.72%	7.39%	9.83%	7.92%	8.12%	6.68%	7.20%	7.74%	7.27%	7.01%	7.20%	7.74%	100.00%
Cumulative Cost	3,355	6,518	9,545	13,573	16,819	20,144	22,879	25,828	28,999	31,976	34,846	37,796	40,966	
Cumul Completion	7.92%	15.91%	23.30%	33.13%	41.06%	49.17%	55.85%	63.05%	70.79%	78.06%	85.06%	92.26%	100.00%	