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

For The Fiscal Reporting Period

May 14, 1994—June 10, 1994

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LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
1D, 2D, 3D	1-Dimensional, 2-Dimensional, 3-Dimensional
AA	Atomic Absorption
ACF	Alumina (in excess of alkali feldspar), Calcium oxide, Ferromagnesianoxide
ACNW	Advisory Committee on Nuclear Waste
ACRS	Advanced Computer Review System
AECL	Atomic Energy Canada Limited
AES	Atomic Emission Spectrometry
AGU	American Geophysical Union
AML	Arc Macro Language
ASCII	American Standard Code for Information Interchange
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ASU	Arizona State University
ATDTS	Automated Technical Data Tracking System
BFD	Basis for Design
CAI	Color Alteration Index
CAR	Corrective Action Request
CCDF	Complementary Cumulative Distribution Function
CCL	Commitment Control Log
CCM	Constant Capacitance Model
CDM	Compliance Determination Method
CDROM	Compact Disk Read Only Memory
CDS	Compliance Determination Strategy
CDTS	Commission Decision Tracking System
CFD	Computational Fluid Dynamics
CM	Configuration Management
CNWRA	Center for Nuclear Waste Regulatory Analyses
COI	Conflict of Interest

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
COPS	CNWRA Operations
CQAM	CNWRA Quality Assurance Manual
CRWMS	Civilian Radioactive Waste Management System
DAS	Data Acquisition System
DBE	Design Basis Event
DCPM	Division of Contracts and Property Management
DECOVALEX	Development of Coupled Models and Their Validation Against Experiments in Nuclear Waste Isolation
DEM	Digital Elevation Model
DFCSS	Division of Fuel Cycle Safety & Safeguards
DHLWM	Division of High-Level Waste Management
DIE	Determination of Importance Evaluation
DIMNS	Division of Industrial & Medical Nuclear Safety
DLG	Digital Line Graph
DLM	Diffuse Layer Model
DNAG	Decade of North American Geology
DOE	Department of Energy
DRA	Division of Regulatory Applications
DWM	Division of Waste Management
EBS	Engineered Barrier System
EBSPAC	Engineered Barrier System Performance Assessment Code
EDO	Office of the Executive Director for Operations
EDS	Energy Dispersive Spectrometry
EDX	Energy Dispersive X-Ray Spectroscopy
EM	Element Manager
EMPA	Electron Microprobe Analysis
EPA	Environmental Protection Agency
EPR	Electrochemical Potentiokinetic Reactivation

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
EPRI	Electric Power Research Institute
EQA	External Quality Assurance
ESF	Exploratory Studies Facility
FAC	Favorable Condition
FCRG	Format and Content Regulatory Guide
FD&SHA	Fault Displacement and Seismic Hazard Analysis
FEM	Finite Element Method
FFT	Fast Fourier Transform
FIN	Financial Identification Number
FTE	Full Time Equivalent
GEM	General Electrochemical Migration
GIS	Geographic Information System
GPS	Global Positioning Satellite
GROA	Geologic Repository Operations Area
GS	Geologic Setting
GUI	Graphics User Interface
GWSI	Groundwater System Integration
GWTT	Groundwater Travel Time
HLW	High-Level Waste
HRTEM	High Resolution Transmission Electron Microscopy
ICP-AES	Inductively-Coupled Plasma Atomic Emission Spectrometry
IHLRWM	International High-Level Radioactive Waste Management Conference and Exposition
IM	Intermediate Milestone
IMS	Information Management Systems
INEL	Idaho National Engineering Laboratory
INTRAVAL	International Code Validation
I/O	Input/Output

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
IPA	Iterative Performance Assessment
IRM	Office of Information Resources Management
IVM	Interactive Volume Modeling
IWPE	Integrated Waste Package Experiments
JC	Job Code
JRC	Joint Roughness Coefficient
KTU	Key Technical Uncertainty
LAN	Local Area Network
LANL	Los Alamos National Laboratories
LARP	License Application Review Plan
LBL	Lawrence Berkeley Laboratory
LHS	Latin Hypercube Sampling
LLNL	Lawrence Livermore National Laboratory
LSSA	Licensing Support System Administrator
LWR	Light Water Reactor
MGDS	Mined Geologic Disposal System
MH	Mechanical-Hydrological
M&O	Management and Operations
MIT	Massachusetts Institute of Technology
MM	Major Milestone
MPC	Multi-Purpose Canister
MRS	Monitored Retrievable Storage
NAS	National Academy of Science
NCR	Nonconformance Reports
NFS	Network File Server
NMSS	Office of Nuclear Material Safety & Safeguards
NOAA	National Oceanographic and Atmospheric Administration
NRC	Nuclear Regulatory Commission

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
NSRRC	Nuclear Safety Research Review Committee
NTS	Nevada Test Site
NWPA	Nuclear Waste Policy Act, as amended
NWTRB	Nuclear Waste Technical Review Board
OBES	Office of Basic Energy Sciences
OCRWM	Office of Civilian Radioactive Waste Management
OGC	Office of General Counsel
OITS	Open Item Tracking System
OPS	Operations Plans for the Division of High-Level Waste Management for FY94-95
PA	Performance Assessment
PAAG	Performance Assessment Advisory Group
PAC	Potentially Adverse Condition
PAC/FC	Potentially Adverse Condition/Favorable Condition
PA&HT	Performance Assessment and Hydrologic Transport
PASP	Performance Assessment Strategic Plan
PSHA	Probabilistic Seismic Hazard Analysis
PEM	Program Element Manager
PFD	Probabilistic Fault Displacement
PI	Principal Investigator
PMDA	Program Management Decision Analysis Staff
PMPR	Program Manager's Periodic Report
PNL	Pacific Northwest Laboratory
PRA	Probabilistic Risk Assessment
PSAG	Probabilistic System Assessment Group
PTFE	Polytetrafluoroethylene
QA	Quality Assurance
QAP	Quality Assurance Procedure

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
RASA	Regional Aquifer-System Analysis
RDCO	Repository Design, Construction, and Operations
REE	Rare Earth Element
REECO	Reynolds Electrical & Engineering Company, Inc.
RES	Office of Nuclear Regulatory Research
RFA-ROC	Repository Functional Analysis—Repository Operations Criteria
RIC	Repository Isolation Criteria
ROC	Repository Operations Criteria
RPD	Regulatory Program Database
RRT	Regulatory Requirement Topic
RSRG	Real Space Renormalization Group
SAIC	Science Applications International Corporation
SAR	Safety Analysis Report
SCA	Site Characterization Analysis
SCC	Substantially Complete Containment
SCCEX	Substantially Complete Containment Example
SCM	Surface Complexation Models
SCP	Site Characterization Plan
SEM	Scanning Electron Microscopy
SELM	Spectral Element Method
SGML	Standard Generalized Markup Language
SHE	Standard Hydrogen Electrodes
SKI	Swedish Nuclear Power Inspectorate
SLAR	Side Looking Airborne Radar
SNL	Sandia National Laboratories
SOW	Statement of Work
SRA	Systematic Regulatory Analysis

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
WIPP	Waste Isolation Pilot Plant
WMB	Waste Management Branch
WP	Waste Package
WSE&I	Waste Systems Engineering and Integration
WSS	Waste Solidification Systems
WVDP	West Valley Demonstration Project
WVNS	West Valley Nuclear Services
XPS	X-ray Photoelectron Spectroscopy
XRD	X-ray Diffractometry
YM	Yucca Mountain
YMP	Yucca Mountain Project
YMSCO	Yucca Mountain Site Characterization Office
YMR	Yucca Mountain Region

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TITLE: Center for Nuclear Waste Regulatory Analyses
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1. TECHNICAL

1.1 *CNWRA Operations (COPS)*

The NRC and the CNWRA management continued coordination meetings and telephone conferences addressing a range of day-to-day and long-term management topics. CNWRA management staff continued its coordination with specific personnel from the PMDA, DWM, RES/WMB, and DCPM, responding to *ad hoc* requests for information addressing management issues affecting the conduct of CNWRA work. CNWRA senior management participated in a series of meetings at TWFN on June 6-8, 1994. Among the meeting topics were: (i) review of TDOCS system development, (ii) semi-annual award fee determination, (iii) revision of NRC contract clauses as a general contract modification, and (iv) review of policies for the CNWRA or SwRI conducting work for other U.S. Government agencies.

The CNWRA continued its participation with the DWM in various budget-related discussions and meetings, especially in preparation for the development and presentation of FY95 Operations Plans.

The potential for implementing an electronic version of the PMPR remains under consideration.

The current status of CNWRA staffing is indicated in Tables 1 and 2. Recruitment efforts and interviews continued for open positions.

The internal audit report of the CNWRA QA program implementation and selected technical activities was distributed this period. Five deficient areas were identified, and corrective action was initiated in a number of the areas. The audit was observed by an NRC DWM QA staff member. In addition, a supplier qualification survey of the UA was performed for rock mechanics testing services, and a CNWRA QA staff member performed routine QA verification and administrative activities at that location.

The CNWRA presented a successful prototype demonstration of the TDOCS system in connection with the second TDOCS Advisory Group meeting on June 8, 1994, at TWFN. DWM has accepted the CNWRA response in each of the four letters submitted last period as Administrative Milestones, except the security proposal for NFS connections of NMSS nodes with the CNWRA TDOCS server. The CNWRA has requested that the priority for the CNWRA computer security be discussed as soon as possible to avoid further impacts on the current schedule to implement RPD/TDOCS.

The following activities are expected to occur during the next period. The CNWRA will pursue resolution of management issues from the previous NRC/CNWRA management meeting, and it will continue its participation in budget-related discussions and meetings.

Recruitment and interviews will continue, as may be required, for the CNWRA core staff.

After receipt of final guidance from the NRC staff, work will begin on the development of FY95 Operations Plans.

During the next period, the QA staff will: (i) coordinate corrective action responses to the deficiencies identified during the internal audit, (ii) participate in regular COI Management Committee meetings, (iii) conduct QA indoctrinations, (iv) continue CNWRA QA record processing and maintenance, and (v) perform requisite surveillances. In addition, work will continue on the Internal/External QA assignment to reevaluate QA requirements.

The CNWRA will continue development of the TDOCS and discuss the priorities for further work on the security concerns related to the implementation of TDOCS. After receipt of additional information concerning the nature and volume of TDOCS-related documents and/or materials that will be processed through a scanning device, the CNWRA will provide a recommendation on the appropriate scanner hardware and software, delivered as an Administrative Milestone, for NRC review and consideration. During the next several periods, the CNWRA will provide technical advice and support, as appropriate, on NRC requests for technical data from the DOE or other parties.

1.2 *Waste Systems Engineering and Integration (WSE&I)*

There was no activity related to the rulemaking for clarification of siting criteria, and none is expected during the next period. Work so far has been limited to reviewing public comments submitted on the proposed rulemaking to ensure CNWRA staff familiarity with them.

No activity related to support for review of the FCRG was undertaken, and none is anticipated in the near future.

There was essentially no activity undertaken in support of NWPA-mandated actions, and none is expected in the next period.

The NRC concurred with proposals which allow increased opportunities for initiative by the CNWRA in continuing LARP development work. Activities include providing recommendations for revisions to CDSs based on the results of an integration review conducted by the NRC and CNWRA staffs, proposing recommendations for modification of review plan interface tables, conducting an integration review of KTUs, and developing a generic review plan for general information reviews required by 10 CFR Part 60. KTU integration activities have begun, with focused reviews of KTUs being conducted by members of a CNWRA working group established for this purpose. This working group has representatives from all CNWRA technical program elements, with particularly heavy representation from the PA Element. Comments from the reviewers are to be submitted by the end of the next period.

Development proceeded on the CDM for RRT 1.4, Certification of Safeguards (IM 5702-222-411); the CDM for RRT 1.5, Physical Security Plan (IM 5702-222-412); and the CDM for RRT 2.7, Nuclear Material Control (IM 5702-222-413). During meetings with the NRC staff from the DFCSS, who have taken primary responsibility for writing these CDMs, it was determined that traditional NRC Material Control and Accounting activities and reviews would be accomplished under the requirements of CDMs 1.4 and 1.5. CDM 2.7, which deals with safety factors of material control, will be written by DWM and CNWRA staff. Generic text for CDMs dealing with descriptive review plans and CDMs dealing with PACs and FACs was refined and is being used to prepare drafts of those CDMs. Some of the CDMs are expected to be completed in the next period. Activity continues on development of a Crosswalk of Regulatory/Institutional Uncertainties with Review Plan Topics (IM 5702-222-451) which will become an appendix to the LARP.

The CNWRA continued providing support to a special project to provide input to the CDTS. This activity is expected to take approximately 45 days. CNWRA support is limited to those issues related to HLW. A CNWRA staff member has been detailed on a staff exchange to the DWM to facilitate support for this work.

Work is continuing on RPD development with the implementation of Phase II of the RPD design for a generalized report writer. Integration and system testing is proceeding following successful module level testing of major software components. The User Guide for Generalized Report Writer Facility (IM 5702-252-403) is being finalized. It will be delivered with the system on June 30, 1994. Plans are under way for an initial installation of RPD Phase II in July at both the NRC and the CNWRA.

RPD and OITS operation and maintenance efforts continued with the installation of RPD Version 1.0 on some OS/2 workstations following final testing. The DOS/Windows port is proceeding following the final delivery of vendor supplied software. The MacIntosh port installation will commence following testing and installation of the DOS/Windows client application.

A program review of WSE&I Element activities was conducted at TWFN on June 7, 1994. The comments from this program review will be factored into future work.

During the next period, the WSE&I Element will focus on the following areas: (i) producing CDMs; (ii) developing of porting software to support the installation of the RPD on various computer platforms; (iii) completing RPD Phase II (Report Writer) and submission of the associated user guide; (iv) continuing design of the migration/incorporation of OITS into RPD; (v) coordinating LARP development activities throughout the CNWRA, including conducting training necessary to support CDM development; (vi) preparing a Crosswalk of Regulatory/Institutional Uncertainties with Review Plan Topics; (vii) developing an Uncertainty Identification and Resolution Procedure; (viii) continuing expanded CNWRA initiatives on LARP development activities, specifically KTU integration; (ix) supporting the CDTS; and (x) preparing the CNWRA FY95 Operations Plans.

1.3 *External Quality Assurance (EQA)*

With the more intense DOE auditing of the HLW program participants, more CNWRA QA representatives were utilized on the NRC audit observation teams in the field. Specifically, one CNWRA QA representative was a member of the NRC audit observation team at the SAIC DOE audit May 16–20, 1994 (IM 5702-331-410), and the CNWRA report was submitted to the NRC during the reporting period. The CNWRA audit observation report on the DOE audit of REECO was sent to the NRC May 20, 1994 (IM 5702-331-409), following the field work which occurred in the previous period. The trip report on the American Society for Quality Control Fifth International Environmental and Waste Management Conference (AD 5702-331-408) was submitted to the NRC June 7, 1994. The CNWRA provided a QA staff member to the NRC audit observation team for the DOE M&O audit at Vienna, Virginia from June 6–10, 1994 (IM 5702-331-411), however the second half of that audit will take place next period in Las Vegas, Nevada. A single NRC observation audit report will cover and integrate observations from both portions of the audit. Some work continued on the re-evaluation of appropriate QA requirements for CNWRA activities especially those relevant to the contents of the special report.

The NRC EQA PEM and the CNWRA QA Director held audit observation team planning discussions by telephone during this period on anticipated FY94 EQA work, which may include on-site visits, meetings, and observations of DOE audits and surveillances.

Observation audit activities, including the resulting audit observation reports, are planned for DOE audits of the M&O, USGS, and others next period. Work will continue on the re-evaluation of CNWRA QA requirements.

1.4 *Geologic Setting (GS)*

Geology and Geophysics

A first draft for the CDM dealing with Potentially Adverse Condition—Evidence of extreme erosion during the Quaternary Period, Review Plan 3.2.1.10 (AD 5702-422-403), is being reviewed at NRC.

R. Hofmann met with A. Ibrahim and K. McConnell at NRC to discuss output from an error-message free probabilistic fault displacement hazard calculation. The fault displacement hazard calculation indicated an order of magnitude less hazard than ranges reported earlier. Because of the August 18, 1994, due date for the SEISM 1.1 Test Analysis Report, these results will be presented with a recommendation that an analysis to determine the reasons for the difference be conducted in the future. An initial draft of the SEISM 1.1 Test Analysis Report (IM 5702-425-441-406) was completed and submitted for formatting and CNWRA review.

On May 17, 1994, L. McKague, S. Young, and D. Ferrill, briefed the ACNW meeting held in Bethesda, Maryland, on the Tectonics Research programs and tectonic activities in HLW. R. Hofmann and G. Stirewalt also attended the meeting.

R. Hofmann and A. Ibrahim presented a paper entitled Comparison of Published Attenuation Functions to the June 29, 1992, Little Skull Mountain Earthquake Strong Motion at the Fifth IHLRWM.

The GIS library population has been dominated by extended DEM acquisition from the USGS. Three arc second resolution DEM data sets are available in 1×1 degree longitude by latitude data sets. These are being integrated into the GIS database to facilitate analysis of tectonic, hydrologic, and volcanology models over a larger area of the southwestern United States. Also, selected areas of interest are being included to facilitate analysis of natural analog sites for volcanism. Typical file size is 9 to 10 megabytes per 1×1 degree cell.

Continued work in the SRA area is anticipated during the next period. It is anticipated that the CNWRA review of the SEISM 1.1 Test Analysis Report will be completed next period. Further work on SEISM 1.1 is not anticipated this fiscal year. Future efforts will be discussed by NRC staff and management. No reactive work is anticipated.

Geochemistry, Hydrology, and Climatology

M. Miklas and D. Turner participated in the evaluation and integration of the KTUs as part of the effort under way in LARP development.

Final drafts were completed for the CDMs for RRT 3.1.2 Hydrologic Systems Description (IM 5702-424-403), RRT 3.1.3 Geochemical Systems Description (IM 5702-424-404), and RRT 3.1.4 Climatologic and Meteorological System Description (IM 5702-424-405). These are currently in review at both the NRC and CNWRA. M. Miklas and D. Turner worked with N. Coleman to complete a first draft of the CDM for RRT

3.2.4.1 Annual Potential Evapotranspiration (IM 5702-424-402). A.B. Gureghian, R. Wescott, and N. Coleman continued work on the CDM for Review Plan 3.2.2.5 Flooding (IM 5702-424-401).

Analysis of GWTT calculations has continued. Liquid water velocity vectors for times up to 10,000 years have been calculated for the geologic setting in unsaturated/saturated tuff using VTOUGH and for the geologic setting in saturated granite using PORFLOW. Tracking of particles through these velocity profiles is ongoing. Arrival of the particles at the compliance boundary will be used to indicate the GWTT. The CNWRA participated in a teleconference with the NRC on June 9, 1994, during which M. Knapp briefed the staff with regards to the actual intent of the performance measure in 10 CFR Part 60 for the geologic setting (GWTT) at the time it was conceived.

CNWRA staff participated in a teleconference between the NRC and the DOE to clarify points of concern that developed during the review of the DOE Study Plan 8.3.1.2.2.8—Fluid Flow in Unsaturated, Fractured Rock (IM 5702-442-441-001). A number of concerns were clarified, reducing the number of potential open items from 21 to 7. Participants from the NRC and the CNWRA agreed that this was an effective procedure to follow in the future.

Work in the SRA will continue at increased levels during the next several periods to complete the descriptive CDMs. Increased effort in the investigative issues is anticipated in future periods.

1.5 *Engineered Barrier Systems (EBS)*

The Field Engineering Experience for Structural Materials Report (IM 5702-551-430) was completed and delivered to the NRC on June 10, 1994.

Integration of KTUs for EBS has begun in conjunction with the WSE&I Program Element.

Ion-exchange reactions were added to the suite of chemical reactions incorporated into GEM. The ion-exchange model is currently being tested. It was discovered that the conventional method of combining adsorption described by surface complexation models with transport may not conserve charge within the aqueous phase. Modifications to these models to account for charge contained within the electrical double layer is being investigated. The GEM model is part of EBSPAC-Models Development activity for FY94 (IM 5702-523-410) and is also used to analyze diffusion experiments in a cylindrically symmetric crevice.

The SCCEX User's Manual (IM 5702-551-410-010) was issued for CNWRA technical review.

All the authors' rewrite of the Role of Colloids in the Release of Radionuclides from Vitrified Waste Forms and Spent Fuel (IM 5702-523-415) was completed. The report is being prepared for technical review at the CNWRA.

In the next period, Integration of KTUs for EBS will continue in conjunction with the WSE&I Program Element.

The MPC review plan outline will be finalized, and a draft of the review plan will be informally submitted for consideration by the NRC staff.

The draft Colloids Report will be issued for technical and programmatic reviews.

1.6 *Repository Design, Construction, and Operations (RDCO)*

The RDCO Element concentrated on the following activities: (i) development of CDSs, (ii) development of CDM on Shafts and Ramps Design, (iii) evaluation of computer codes for compliance determination and rock joint model development, (iv) conduct of prelicensing interactions, and (v) performance of ESF design reviews.

NRC/CNWRA teleconference meetings regarding CDS integration continued. The draft CDS integration plan that was prepared during Period 8 by the CNWRA team members for CDS integration has been revised during this period to incorporate the review comments made by CNWRA management. One of the proposed activities of the CDS integration plan is the Integration of KTUs, this activity has been initiated during this period.

The development of the CDM for RRT 4.3 Shafts and Ramps Design (IM 5702-622-401-001) continued. J. Hageman and S. Hsiung visited the NRC on May 23–27, 1994, to work with NRC team members to develop two alternative approaches for addressing the regulatory requirements applicable to the Shafts and Ramps Design CDM. Alternative number one would contain the review procedures and acceptance criteria for all these regulatory requirements. Alternative number two would contain the review procedures and acceptance criteria for the regulatory requirements that are uniquely applicable to Shafts and Ramps Design. Further, these criteria are applicable to several CDMs, but they are considered to be most appropriate for placement under the Shafts and Ramps Design CDM. The review procedures and acceptance criteria for the other regulatory requirements applicable to the Shafts and Ramps Design CDM will be adopted by reference to other relevant CDMs. The NRC/CNWRA team recommended alternative number two as the preferred option and NRC management has accepted this recommendation. The second alternative is in the process of further revision before conducting technical review at the CNWRA.

In this period, the evaluation of the finite element code ABAQUS continued. Exploratory analysis of Problem Set 3, Heated Drift in Fractured Rock, was used to refine the original model. Heat flow analysis for Problem Set 3 was conducted. Examination of the results suggested that the external boundary (zero-perturbation boundary), which was kept at a distance of 200 m from the tunnel wall, was too close. Therefore, two additional heat flow analyses were conducted to determine how far away the external boundary should be placed. A set of thermal stress analyses was also initiated for this problem set. A preliminary mesh design with the ABAQUS code is being developed to validate the ability of ABAQUS to model the analytical solution of water dripping down a fracture and imbibing into the unsaturated porous matrix (Problem Set 4). Although this problem set belongs to the second phase of the project (which is slated for the next fiscal year), it has become necessary to do some preliminary work in order to support the development of a test case problem so that the pertinent physical processes could be captured. The porous material in which the repository is to be located has a very small permeability and sorptivity; therefore, it is expected that the active zone around the fracture will be extremely small compared to the distance water can travel along the length of the fracture. This imposes elements with large aspect ratios. ABAQUS's ability to simulate such a phenomenon will be critically evaluated through the numerical analysis of this test case problem.

Development of a constitutive model to simulate the response of a rock joint under pseudostatic and dynamic loads, as observed in the experimental results of the Seismic Rock Mechanics Research Project, is progressing. Assuming the natural rock joint surface a self-affine fractal, several rough surfaces were generated using the midpoint displacement method. These surfaces are being used to verify the computer programs for estimating the dimension of surface fractals using semi-variogram and the 2D FFT methods. Work is under way to clarify some of the uncertainties associated with representing the roughness of natural surfaces uniquely and to characterize the rate of wear observed as the shear progressed in the laboratory experiments.

S. Hsiung participated at the NRC/DOE ESF Title II 90% Design Review Package 2C meeting on May 16-20, 1994, at Las Vegas, Nevada. During this meeting, the NRC/CNWRA participants used the review comments prepared by the NRC/CNWRA staffs during Period 8. This review indicated that some aspects of the DOE seismic design of ESF as contained in Package 2C are inadequate.

A. Chowdhury attended the Fifth IHLRWM. At this conference he organized two sessions and chaired the session on Faulting and Seismic Issues - I. He also participated at the YM tour on May 27, 1994. S. Hsiung and A. Ghosh attended the 1st North American Rock Mechanics Symposium that was held in Austin, Texas, June 1-3, 1994. On funding from the CNWRA Operations Element, A. Chowdhury attended a short course on Advances in Earthquake Engineering Practice that was held at the University of California at Berkeley on May 31-June 4, 1994.

During the next period, activities within the RDCO Element will include: (i) continued development of the CDM on Shafts and Ramps Design, (ii) integration of CDSs, (iii) development of the rock joint model and evaluation of ABAQUS, (iv) coordination of the DBE rulemaking, (v) participation in prelicensing activities, and (vi) work on ESF Title II Design review.

1.7 *Performance Assessment and Hydrologic Transport (PA&HT)*

The PA&HT Element concentrated on the following activities: (i) preparation of a report on the use of expert judgment in PA, (ii) participation in LARP team meetings, (iii) conduct of auxiliary and detailed analyses for IPA, (iv) completion of a user guide for the SEISMO module, (v) preparation of a report on a preprocessor code for TPA, (vi) refinement of the LHS module, and (vii) contribution to an NRC technical paper.

A first draft of the background report on the use of expert judgment in PA was completed. The draft report was provided to the NRC staff for informal review, comment, and input. The report follows the outline previously reviewed by the NRC staff and consists of eight major sections. The document is intended to support a future NUREG/CR on expert judgment that will be developed and issued later in the year. The background report, which is expected to be completed in August, will be submitted to the NRC to fulfill IM 5702-712-405, Background Report on Use of Expert Judgment in PA. This work is being conducted under the scope described in the PA&HT Element Subtask 1.2 of the OPS.

Participation in the LARP team meetings continued at an increased level. A. Bagtzoglou, R. Manteufel, and R. Baca are the principal contributors to this activity. This effort is currently focusing on a broad review and integration of more than 50 KTUs. This work was conducted under the scope described in the PA&HT Element Subtask 2.1 of the OPS.

Work on the auxiliary analysis on infiltration phenomena at YM continued. As part of this auxiliary analysis, S. Stothoff examined an approach for generating synthetic hourly values of climatic variables such as air temperature, relative humidity, wind speed, and precipitation. The autocorrelation and cross-correlation structures of climatic data obtained from Beatty and Desert Rock stations were examined. To model the diurnal response of air temperature as a function of solar conditions, an analytical solution for air temperature was extended which closely matches the measured data. Work continued on the auxiliary analysis dealing with flow around the waste package. Cartesian and cylindrical grids have been constructed for a single waste package and repository scale simulations. Some numerical problems have been encountered and they are being investigated. This work is being performed by P. Lichtner, with assistance from M. Seth and J. Walton (consultants). As part of this auxiliary analysis, improvements and modifications of the VTOUGH code were made. This work is being conducted under the scope described in the PA&HT Element Subtask 2.3 of the OPS.

R. Manteufel and O. Phillips (consultant) continued work on an abstracted model of near-field flow to evaluate the thermal protection offered by a zone of hot desiccated rock created by high thermal loading. A draft paper entitled The Infiltration of a Liquid Finger Down a Fracture into Superheated Rock was prepared and submitted for technical review. It is anticipated that J. Firth will participate in the near-field flow analyses as part of his staff exchange assignment at the CNWRA. This work was conducted under the scope described in the PA&HT Element Subtask 2.3 of the OPS.

Work on the development of a hydrostratigraphic model for the YM site continued. Hydraulic conductivity and porosity data are being added to the geologic framework model developed using the EarthVision software. This work is being performed by S. Young. Work also continued on development of technical specifications for a new fault scenario model. The theoretical basis for this model is similar to that used in the EPRI TSPA model. This work is being performed by G. Stirewalt. This work was conducted under the scope described in the PA&HT Element Subtask 2.3 of the OPS.

A technical report was prepared on the INVENT computer code which will be utilized as a preprocessor code for TPA. The code provides a GUI and generates inventory data based on calculations performed by the ORIGIN2 computer code. The report, which is authored by H. Karimi, R. Janetzke, and A. Lozano (SwRI), is presently in technical review. The final report will be issued as a CNWRA report and submitted to the NRC to fulfill IM 5702-723-430, Letter Report on Demonstration of a GUI and Centralized Database for TPA Code. This work was conducted under the scope described in the PA&HT Element Subtask 2.3 of the OPS.

Work was performed by H. Blochowitz and R. Janetzke on the refinement and documentation of the LHS module of the TPA code. This work was motivated by QA reasons following the detection of a number of FORTRAN errors in the code. The errors were primarily associated with the routine that generates the beta distribution. The FORTRAN source code was modified and then tested to ensure that the problem was corrected. The modified sampling module designated as LHS94 is being documented as required by the technical operating procedure TOP-018 dealing with configuration management of engineering and scientific codes. This work was conducted under the scope described in the PA&HT Element Subtask 2.3 of the OPS.

The user guide for the SEISMO module of the TPA code was completed and submitted to the NRC to fulfill IM 5702-723-421, User Guide for SEISMO Module. The authors of this report are C. Freitas (SwRI), R. Codell, and N. Eisenberg. R. Baca edited and contributed to the finalization of the report. R. Hofmann, V. Kapoor, S. Hsiung, P. Lichtner, and A. Ibrahim performed the technical review of the document. This work was conducted under the scope described in the PA&HT Element Subtask 2.3 of the OPS.

R. Baca reviewed the current QAP-001 procedure for maintaining scientific notebooks. The purpose of the review was to develop and propose revisions to the procedure that would better address the activities of the modelers and analysts. A set of revisions and additions to the procedure were developed in collaboration with R. Folck (SwRI). This work was conducted under the scope described in the PA&HT Element Subtask 2.3 of the OPS.

Assistance was provided to the NRC staff on the preparation of a paper on PA activities. This paper will be presented by the NRC staff to the Commissioners. E. Bonano (consultant) contributed a section of the paper. This work was conducted under the scope described in the PA&HT Element Subtask 2.3 of the OPS.

A.B. Gureghian attended the 1994 IHLRWM. He presented a paper entitled Sensitivity and Probabilistic Analyses of the Impact of Climate Conditions on the Infiltration Rate in a Variably Saturated Multilayered Geologic Medium. The paper summarized work conducted previously in connection with the IPA Phase 2.5 exercise. This work was conducted under the scope described in the PA&HT Element Subtask 2.3 of the OPS.

In the next period, the PA&HT Element will direct its efforts in the following areas: (i) continuing the preparation of the background report on use of expert judgment, (ii) continuing work on the auxiliary and detailed analyses, (iii) continuing documentation of the LHS94 module, and (iv) conducting integration meetings with PIs working on research projects.

1.8 *Research*

Research Project 1—Overall Research

Preparations continued for the Natural Analogs/Performance Assessment Working Session scheduled for June 14–15 in San Antonio. Pre-meeting exercises, consisting of flow and transport calculations based on data derived from the Peña Blanca and Akrotiri analog sites, continued with participation by CNWRA and NRC staff.

Preparations continued for the Workshop on Rock Mechanics Issues in Repository Design and Performance Assessment. To date about 10 abstracts from organizations outside the NRC and the CNWRA and more than 15 responses have been received. The abstracts are being reviewed by CNWRA and NRC staff.

Drafting of the Sub-regional Ground-Water Flow and Transport Studies Project Plan by an interdisciplinary team continued during this period.

Receipt of an SOW for the new Near-Field Research Project is anticipated for the near future; upon receipt of the SOW, work will begin on development of a project plan. Preparation for the Rock Mechanics workshop is anticipated to continue. The Analogs/PA Working Session is scheduled for the first week of Period 10. Writing of the Sub-regional Ground-Water Flow and Transport Studies Project Plan is anticipated to continue, with a scheduled completion of July 29, 1994.

Research Project 2—Geochemistry

The Topical Report on Geochemistry (MM 5704-014-094-002), which was submitted to the NRC on April 29, 1994, is undergoing review by three external peer reviewers. The report will be revised based on NRC and peer review and will be published as a NUREG/CR. A paper by W. Murphy, R. Pabalan, J. Prikryl, and C. Goulet (Reaction Kinetics and Thermodynamics of Dissolution and Growth of Analcime and Clinoptilolite at 25 °C), which is based on Section 3 of the Geochemistry report, has been prepared for submittal to the American Journal of Science and was submitted to the NRC for programmatic approval. A paper by R. Pabalan (Thermodynamics of Ion-Exchange Between Clinoptilolite and Aqueous Solutions of Na^+/K^+ and Na^+/Ca^{2+}), which is based on Section 2 of the report, is now in press in Geochimica et Cosmochimica Acta. A paper by R. Pabalan and F.P. Bertetti (Thermodynamics of Ion-Exchange Between Na^+/Sr^{2+} Solutions and the Zeolite Mineral Clinoptilolite) was published in the Materials Research Society Symposium Proceedings Volume 333. A paper by R. Pabalan and F.P. Bertetti (Experimental and Modeling Studies of Ion-Exchange Interactions Between Aqueous Electrolytes and the Zeolite Mineral Clinoptilolite) has been accepted for oral presentation at the 49th Annual Calorimetry Conference which will be held on July 31–August 4, 1994 in Santa Fe, New Mexico.

The final report for the Geochemistry Research Project will be revised based on comments from the NRC and peer reviewers and will be submitted by the end of the fiscal year to terminate the project.

Research Project 3—Thermohydrology

The Thermohydrology Research Project has been active in several areas during the past reporting period including: (i) preparation and conduct of laboratory-scale experiments, (ii) calculation of hydraulic properties of the test media, and (iii) development of analytical and mathematical models of physical mechanisms associated with moisture redistribution in isothermal and nonisothermal regimes.

The most recent laboratory experiment in the Test 6 series of coupled-effects experiments was completed. This particular experiment was conducted using ceramic, a material with relatively high permeability, as the test medium. Initiation of the next experiment in this series with cement slurry as the test medium, a material with relatively low permeability, is under way. Analysis and interpretation of the experimental results are ongoing.

The gas-gradient, coupled-processes test, using a cylindrical container constructed with a cement-slurry medium, is ongoing. Baseline density measurements are being obtained to establish the initial moisture content of the test cell. An additional test cell with a cement-slurry medium has been prepared. A cell with more refined material dimensions and properties has been designed and is being constructed. A high degree of effort is being expended to fabricate these more refined test cells as a way to reduce uncertainty in the density measurements of the coupled-processes experiments.

Results from the gas-gradient, coupled-processes experiments will be used to assess theories developed through dimensional analysis of heat and mass transfer in unsaturated fractured rock. The coupled processes experiments are being conducted by R. Green, and S. Svedeman, L. Bishop, and F. Dodge (SwRI).

Hydraulic characterization of media used in the laboratory-scale experiments are continuing. These media include the cement mixtures to be used in the gas-gradient tests, and alumina powders used in several completed experiments. The saturated hydraulic conductivity, porosity, and retention curve for the ceramic have been prepared. These values are being used in the analysis of the experimental results. This work is being conducted by K. Meyer, J. Wachsmuth, and R. Green.

Progress towards completion of the dimensional analyses studies has continued. A new mixed-gas model is being formulated that incorporates aspects of both the dry- and wet-gas models. This new analysis will include the incorporation of a liquid flow component when completed. This work is being conducted by F. Dodge (SwRI) and R. Green.

Theoretical analysis of flow mechanisms and identification of simple mathematical models to represent flow in a thermosyphon have continued. Prediction of gas flow through porous media under the imposition of a heat load has continued. This work is being conducted by R. Manteufel and H. Castellaw.

In the next period, work will continue in four areas: (i) continuation of the gas-gradient coupled-processes tests using a cement slurry as the test medium, (ii) conduct of hydraulic property measurement experiments of cement mixtures and alumina, (iii) continuation of the Test 6 series with a cement mixture, and (iv) scoping measurements of the dimensional analysis and preferential flow investigations.

Research Project 4—Seismic Rock Mechanics

The Seismic Rock Mechanics Research Project has nine tasks. Among these tasks, Task 1, Focused Literature Search; Task 2, Laboratory Characterization of Jointed Rock; and Task 3, Assessment of Analytical Models/Computer Codes, are complete. Task 6, YM Scoping Analysis, has been delayed pending the availability of the data associated with YM. Active tasks for the remaining FY94 include: Task 4, Rock Dynamics Laboratory and Field Studies; Task 5, Groundwater Hydrology Field Studies; Task 7, Technical Report; Task 8, Semi-Annual Research Reports; and Task 9, DECOVALEX Modeling and Laboratory Studies. In this reporting period, primary effort was devoted to: (i) the laboratory study of a small-scale jointed rock mass physical model for Task 4, (ii) mechanical-hydrological laboratory study and DECOVALEX Phase III modeling for Task 9, (iii) mechanical properties testing of the Lucky Friday Mine rock specimens for Task 5, and (iv) report preparation for Tasks 5, 7, and 8.

The construction activities for small-scale model tests of jointed rock mass using a shaking table continued. The assemblage of the jointed rock mass components to the small-scale model was completed during this period. Constant tension loads were applied to the vertical and horizontal cables to constrain the assemblage and to provide initial stress boundary conditions to the model. Relaxation of the tension loads on the cables was observed after the load application. The relaxation initially was quite large and increased at a decreasing rate. The cables were tightened several times to maintain the constant load condition until the relaxation had essentially stopped. The relaxation of cable loads was expected due to the compaction or consolidation of the assemblage of the rock mass components. Calibration of the instruments to be used for measurements of joint normal and shear displacements, cable loads, and excavation closure were completed during this period. All instruments except those for closure measurements were installed at the predetermined locations on and within the model. The model assemblage was placed on the shaking table using a specially designed lifting device. No measurable disturbance was observed as a result of the moving. Testing of the data acquisition system for the small-scale model experiment started. The shaking table test of jointed rock mass will be conducted during Period 10. J. Philip will visit the CNWRA to observe the testing.

The activities associated with the coupled MH experiments continued. MH experiments were conducted under normal load using the primary apparatus as well as without normal load using a second apparatus. Preliminary modeling of Test Case 3 (TC3), Big Ben experiment, of DECOVALEX Phase III using the ABAQUS finite element code was completed. M. Ahola attended the 4th DECOVALEX Workshop that was held in Oxford, England, on May 30-June 3, 1994. At that workshop, he presented both modeling and experimental results.

The preparation of the Report for Groundwater Hydrology Field Studies (MM 5704-035-094-002) and the Final Project Report for the Seismic Rock Mechanics Research Project (MM 5704-037-094-002) continued during this period. Testing of cylindrical specimens to determine mechanical properties of the Lucky Friday Mine rocks was complete and the results have been included in the Report for Groundwater Hydrology Field Studies (MM 5704-035-094-002).

M. Ahola presented a paper entitled Comparison of Coupled Thermal-Mechanical-Hydrological Analyses of a Fractured Rock Mass coauthored by A. Chowdhury, S. Hsiung, and J. Philip at the Fifth IHLRWM. S. Hsiung presented a paper entitled An Investigation of Rock Joint Models on Prediction of Joint Behavior under Pseudostatic Cyclic Shear Loads coauthored by A. Ghosh and A. Chowdhury at the 1st North American Rock Mechanics Symposium held at Austin, Texas, June 1-3, 1994.

During the next period, activities within the Seismic Rock Mechanics Research Project will include: (i) testing of the assemblage of the small-scale rock mass model, (ii) preparation of the Report for Groundwater Hydrology Field Studies (MM 5704-035-094-002), (iii) DECOVALEX modeling and experiments, (iv) preparation of the Final Report for the Seismic Rock Mechanics Research Project (MM 5704-037-094-002) to document the results obtained from the Seismic Rock Mechanics Research Project and make recommendations on use of these results, (v) preparation of the semi-annual research report, and (vi) organization of the Rock Mechanics workshop.

Research Project 5—Integrated Waste Package Experiments (IWPE)

A new data acquisition system for the crevice chemistry measurements was purchased, and initial tests indicate that the pH readings are quite stable. This system will be tested further under electrochemical conditions. A poster on the crevice chemistry research was prepared for display at the Gordon Research Conference on Aqueous Corrosion to be held in July 1994, at New London, New Hampshire.

Further repassivation potential tests were performed on crevice specimens for comparison to those previously generated for pitting. The results obtained thus far indicate that the repassivation potential for crevice corrosion is approximately the same as the repassivation potential for deep pits. This confirms the assumption made in SCCEX calculations regarding the commonality of repassivation potential for these two phenomena. The crevice specimens were analyzed for depth of corrosion.

Long-term localized corrosion testing is continuing for the ninth month. No localized corrosion has been observed on the specimen held at a potential 100 mV below the repassivation potential.

New tests initiated for the purpose of comparing the results of slow strain rate tests with those of constant deflection tests are continuing. Tests are being conducted in a 1,000-ppm chloride solution containing 10^{-2} molar thiosulfate. The specimens were inverted so that half of the gage length was above the solution level. Initially, tensile specimens of type 316L SS were strained at a rate of 1.0×10^{-6}/sec to 105 percent of yield strength. Straining was then interrupted and the load monitored with time. One specimen was tested under open circuit conditions and another one under an applied anodic potential. No significant decrease in the load was observed over a period of 18 days. The specimens were then strained to 130 percent of the yield strength and again monitored with time. To date, a 10-percent decrease in the load has been observed for both specimens. The specimens will be examined by SEM at the conclusion of the tests to determine if the relaxation of the load is an indication of stress corrosion cracking.

Constant-deflection tests of alloy 825 are continuing in highly concentrated chloride solutions using U-bend specimens. Although no stress corrosion cracking has been observed in these environments, localized corrosion has been detected on the straight legs of the U-bend specimens.

Boiling nitric acid tests are being conducted on mill-annealed, mill-annealed and cold-worked, and solution-annealed specimens to be followed by sensitization treatments at 700 °C for times ranging from 0.1 to 100 hr. The results to date suggest that without solution annealing prior to cold work, sensitization of alloy 825 only occurs to a limited extent. No increase in the degree of sensitization was observed on mill-annealed specimens after receiving 20 to 61 percent cold working prior to thermal exposure within the sensitization range. The microstructure of the various specimens is currently being investigated.

Long-term localized corrosion and stress corrosion cracking tests will continue. Additional U-bend tests using the heat of material presently used for slow strain rate tests will be conducted in order to allow direct comparison of the two techniques. Further nitric acid tests of mill-annealed plus cold-worked and sensitized specimens will be terminated since it is clear that this processing sequence does not accelerate sensitization. Boiling nitric acid testing and microstructural examination of sensitized cold-worked alloy 825 following solution annealing will be initiated.

Research Project 6—Stochastic Analysis of Large-Scale Flow and Transport in Unsaturated Fractured Rock (Stochastic)

During this reporting period, the research activities focused on the following: (i) incorporation of technical and programmatic reviewer comments of the technical report entitled Stochastic Analyses of Large-Scale Unsaturated Flow and Transport in Layered Heterogeneous Media, and (ii) presentations of Stochastic Project results at the IHLWRM.

The peer review of the report on effective properties is complete. The review by T. Rasmussen (University of Georgia) can be summarized as: "While I respect your assault on the subject, I am sure you would agree with me that the effort is not yet won. Let us hope that more studies like this will take place in the near future." The review by A. Journel (Stanford University) can be summarized as: "This review work is the most complete known to me on the subject of modeling flow in fractured unsaturated rocks. It is destined to become itself a reference for petroleum engineers and hydrogeologists faced with prediction of flow patterns in fractured porous media....At the time of this review I know of no other compilation so complete and critically documented. The authors have gone beyond the task of [a] mere review providing new contributions to the topic of scale averaging, of the impact of fractures, and having developed and tested key software for flow simulation in fractured media." Comment resolution and modifications to the report will commence in the next period. With completion of the peer review of this report, IM 20-5704-054-094-004 will be fulfilled.

Two presentations, one on the topic of effective hydraulic properties by S. Mohanty and the other on the topic of stochastic simulation of flow and transport by A. Bagtzoglou, were made at the IHLWRM.

During the next reporting period, the activities will concentrate on incorporating the peer-reviewer comments for the technical report on effective properties and submission of the report on large-scale flow and transport, thus fulfilling MM 20-5704-053-094-001.

Research Project 7—Geochemical Analogs

Alpha spectrometry to measure U and Th activities of whole rock samples from Level +10 of the Nopal I analog site continued. Samples being analyzed by alpha spectrometry were collected along a traverse across the northern margin of the deposit. Gamma counting and XRD analysis of material from a fracture on Level +10 of Nopal I was initiated. Material for these analyses was collected from a relatively continuous, sub-vertical fracture that trends to the north and appears to bound the deposit on the east. Optical microscopy indicates the presence of Fe-oxides, jarosite, kaolinite, and minor uranophane (in samples near the deposit).

Selective leachate analyses of vertical profile samples from the Delta 3 area of the Akrotiri analog site were completed. Elements measured include Cu, Ag, Co, Fe, Mn, Sn, Pb, and Zn. Interpretation of the results of these analyses was begun.

Using PORFLOW, a flow and transport model is being developed to simulate migration of components (Cu and Sn in particular) from bronze artifacts buried in volcanic rock in area Delta 3 at the Akrotiri analog site. The model is 1D, infiltration is periodic (seasonal), and the source term is constrained by alteration product solubilities. Water composition, infiltration flux, hydrologic properties of the rock, and retardation coefficients are being estimated using a variety of weather, petrographic, laboratory, and literature data.

A Topical Report entitled Fracture Transport of Uranium at the Nopal I Analog Site, (IM 5704-065-094-006) was completed and submitted to the NRC on May 19, 1994. An abstract for presentation at the Geological Society of America Annual Meeting, entitled Uranium Transport and Retention in Silicic Tuff: Comparative Inventories within a Fracture Network, was written, reviewed, modified, and submitted to the NRC on June 1, 1994. A second abstract for presentation at the Geological Society of America Annual Meeting, entitled The Role of Secondary Mineral Formation on Uranium Retardation and Transport at the Peña Blanca Natural Analog Site was written and was submitted for internal review. A paper on determination of *in situ* distribution coefficients is being prepared based on literature review. This paper has been invited for presentation at the Natural Analogs Working Group meeting in September. W. Murphy presented an invited plenary session speech at the Fifth IHLRWM titled CNWRA Natural Analog Research at Peña Blanca and Santorini. Preparations continued for the Analogs/PA Workshop scheduled for June 14-15, 1994, at the CNWRA.

During Period 10, activities within the Geochemical Analog Research Project are anticipated to include: (i) continuation of gamma spectrometry analyses of Nopal I samples, (ii) continuation of petrographic study of Nopal I samples, (iii) continuation of modeling of flow and transport at the Akrotiri site, (iv) interpretation of leachate analyses of the tuff from the Akrotiri site, and (v) participation in the Analogs/PA Workshop.

Research Project 8—Sorption Modeling

Experiments studying ^{233}U sorption on quartz sand and on montmorillonite are in progress. These experiments will determine the effects of pH and solid-mass to solution-volume ratio (M/V) on U sorption. New quartz experiments with initial U concentrations of 5 and 500 ppb were initiated. New experiments on U sorption on montmorillonite were also initiated using initial U concentration of 50 ppb and M/V equal to 0.025 g/L.

Modeling of the montmorillonite sorption experiments continued. Surface complexes of $>SiO\text{-}UO_2^+$ and $>AlO\text{-}UO_2OH^o$, with binding constants of approximately 1.4 and −4.8, respectively, provided good modeling results. This model was able to simulate sorption behavior as a function of pH at both M/V ratios considered. Additional effort was focused on simulating uranium sorption on goethite as a function of pH, total carbon, and M/V to provide input for the Analogs/PA Workshop to be conducted at the CNWRA during Period 10. Modeling results are still being compiled and checked for accuracy and completeness. P. Lichtner has also begun to adapt surface complexation models for incorporation in the reactive transport code GEM. Model parameters developed in the Sorption Modeling Project will be provided to establish a database for the sorption reactions.

M. Lupkowski (SwRI) presented a paper coauthored with R. Pabalan at the American Geophysical Union Spring Meeting which was held May 23-27, 1994, in Baltimore, Maryland. The title of the paper is Molecular Dynamics Simulation of Uranyl Sorption on Mineral Surfaces.

Uranium sorption experiments on montmorillonite and quartz will continue. Modifications to the atmosphere controlled glove box are in progress and U sorption experiments at elevated pCO_2 will start as soon as the modifications are completed. Modifications to the laboratory facilities to permit experimental work with neptunium and plutonium are still in progress. Modeling efforts will continue to compile surface complexation binding constants and simulate sorption data as it becomes available from experimental activities.

Research Project 9—Performance Assessment (PA)

In this reporting period, the technical staff concentrated on: (i) planning for peer review of technical reports, (ii) conducting fracture flow simulations using Peña Blanca core data, (iii) documenting a new infiltration model for IPA, and (iv) conducting a study of data filtering.

Planning was completed for peer reviews of three technical reports: (i) Water Film in a Fracture in Unsaturated Porous Medium (CNWRA 94-009), (ii) Near-Field Conceptual Models: Theory and Application (CNWRA report in preparation), and (iii) Analysis of Hydraulic Characteristics of Hydrothermally-Altered Tuff (CNWRA report in preparation). The first document was recently submitted to the NRC to fulfill IM 5704-191-094-002, Study of Water Film Flow in a Fracture with Imbibition. A draft of the second report was completed this reporting period. The three reports will be peer reviewed by a three-person group of outside experts. The comments and recommendations of the peer reviewers will be incorporated in the reports which will then be transmitted to the NRC for issuance as NUREG/CRs. This work is being conducted under the scope described in Task 1 of the PA Research Project Plan for FY94–95.

Computer simulations of unsaturated flow were performed for the Peña Blanca Natural Analog site using the CTOUGH (CNWRA version of the VTOUGH code). The unsaturated hydraulic properties of tuff cores were fit using the van Genuchten equations; these were combined with the so-called Klaveter and Peters averaging approach to incorporate hydraulic properties of discrete fractures. These initial simulations, which illustrate the rates and directions of water movement, will be presented at the Analogs/PA Workshop to be held at the CNWRA during Period 10. Flow simulations will be used to assist in the design of infiltration experiments that will be performed under the Geochemical Analogs Project. These simulations will be documented in the draft technical report entitled Analysis of Hydraulic Characteristics of Hydrothermally-Altered Tuff (IM 5704-191-094-004). This work is being conducted under the scope described in Task 1 of the PA Research Project Plan for FY94–95.

Work continued on preparation of the technical report on the new infiltration model, referred to as BREATH. Development of the new model was motivated by the need to support the IPA auxiliary analysis on infiltration. This new model is designed to simulate the infiltration process as a function of meteorologic conditions. The computer code solves the variably saturated flow and heat transfer equations with time varying boundary conditions at the land surface. S. Stothoff is preparing a CNWRA report to document the theory, computational techniques, and user instructions for use of the code. This report will be a new deliverable entitled Infiltration Model for IPA Auxiliary Analysis (IM 5704-192-094-005). In addition, work was performed on evaluating various transform techniques for improving the convergence and accuracy of the numerical solver for the variably saturated flow equation; a journal article is being prepared which presents results of the evaluation. This work is being conducted under the scope described in Task 2 of the PA Research Project Plan for FY94–95.

In the previous reporting period, a new activity was initiated under Task 3 on Model Validation. The activity, which is being performed by G. Wittmeyer and B. Sagar, entails a study of data filtering and its impact on model predictions. Hydrologic data for the Las Cruces trench is being used to evaluate unsaturated flow model predictions. The aim of the activity is to gain insights regarding the degree to which predictive reliability is dependent on the amount of available data. Effort focused on building the necessary computational tools to conduct this computationally intensive study. In particular, work was performed on implementing a more efficient conjugate gradient matrix solver in the

PORFLOW code; this development was necessary to reduce computer execution time and thereby allow more simulations to be performed for each sampling plan. This activity was conducted under the scope described in Task 3 of the PA Research Project Plan for FY94–95.

In the next reporting period, work will be directed to: (i) preparing a section of the Semi-Annual Research report, (ii) continuing documentation of the infiltration model, (iii) continuing work on a report on the near-field conceptual and mathematical models, (iv) continuing the work on data filtering, (v) formatting the previous CNWRA technical report on review of scenario selection methodologies into NUREG/CR format, and (vi) continuing work on hydrologic analysis and modeling of fracture flow at the Peña Blanca Natural Analog site.

Research Project 10—Volcanic Systems of the Basin and Range

During Period 9, elicitation of nominations for the peer-review panel was given a high priority. In response to 150 letters soliciting nominations for panel membership, 61 responses have been received with 185 people named as potential reviewers. Of these 185 people, 31 have expressed interest in panel participation, 5 are possibly interested, and 25 are unavailable. For people that are available and interested in panel participation, 14 have at least 5 nominations, 11 have at least 6 nominations and 7 have 7 or more nominations. Overall, people with at least 7 nominations adequately represent the desired specializations in basaltic volcanism eruption dynamics, Basin and Range volcanology, volcanic heat and mass transport processes, and probability modeling. However, the list of interested candidates with at least 7 nominations is highly skewed towards eruption dynamics.

Review of uncertainty in the GIS database continued during this period. Data compilation activities were limited to acquisition of aeromagnetic and radar data for selected volcanic fields.

In the next period, compilation of responses will continue to June 22, 1994. Invitation letters will be sent to leading nominees on June 23, 1994, with follow-up calls on June 28, 1994, to determine interest. Additional letters will be sent on June 28 if required. Little activity will occur on this task during Periods 10 and 11 due to extended field work in Kamchatka related to the Field Volcanism Project.

Research Project 11—Tectonic Processes

Tectonics Research has continued to add *in situ* stress data to the database with emphasis on the addition of data from the NTS. Emphasis has been placed on compiling fault slip information and entering slip data into the ARC/INFO database. Conodont CAI data for the NTS and the surrounding area have now been acquired from A. Harris (USGS). Work has continued on the display and interpretation of the conodont CAI data.

Integrated work between Regional Tectonics Research and Regional Hydrology Research has continued and focused on comparing interpreted groundwater flow directions and *in situ* stress in Yucca Flat. Preparation of the semi-annual report has been a major focus in Tectonics Research during the present reporting period.

Semi-annual report preparation will continue during the next reporting period. Research will focus on compiling fault slip data, addition of the newly acquired CAI data to the ARC/INFO coverage, and critical review of the database. Integrated work between Regional Tectonics Research and Regional Hydrology Research will continue during the next period with emphasis on the effects of *in situ* stress on groundwater flow, and the geometry of the regional carbonate aquifer. Summer field work in Tectonics Research is still in the planning phase and will likely include trips to the northern part of the Death Valley/Furnace Creek/Fish Lake Valley fault system (California and Nevada), and the San Francisco Volcanic Field (Arizona). Planning of summer field work will continue during the next reporting period and field work may be initiated during the period.

Research Project 12—Field Volcanism

A report entitled Geophysics Topical Report: Application of Seismic Tomographic and Magnetic Methods to Issues in Basaltic Volcanism (MM 5704-144-001) was completed during this period. This report is now in final CNWRA review and will be delivered as planned in Period 10. The report summarizes CNWRA research conducted during 1993 and 1994 on the applications and limitations of geophysical methods to the study of intrusive or buried extrusive basalts. The objective of this summary is to review the application of geophysical methods in use in the YMR as part of site characterization, discuss the application of these methods in the context of volcanism studies, and explore the utility and limitations of geophysical methods in volcanism studies through presentation of parametric models and the results of numerical experiments.

Final preparations were made during this period for field work at the Tolbachik cinder cones, Russia.

Field work will be carried out at the Tolbachik cinder cones during the next period. The technical and programmatic CNWRA reviews of the Geophysics Topical Report (MM 5704-144-001) will be completed and the report will be delivered to the NRC.

Research Project 13—Regional Hydrogeologic Processes

In this reporting period, efforts in Task 1 (Literature Review and Data Collection) focused on the collection and interpretation of regional stress data from Yucca Flat. A total of 64 measurements of mean borehole breakout orientations have been plotted on a base map and used to infer the mean direction of maximum horizontal stress. It is postulated that fracture apertures parallel to the maximum horizontal stress have larger hydraulic apertures than those that are perpendicular. The transmissivity of the fractured Paleozoic carbonate aquifer may, therefore, be assumed to be anisotropic with the major axis of the transmissivity ellipse parallel to the inferred maximum horizontal stress. Water level measurements from boreholes which penetrate the Paleozoic carbonate aquifer in Yucca Flat have been contoured and drawn on the base map. Assuming that the square root of the ratio of the maximum to minimum principal transmissivities is equal to 2 and oriented 49 degrees east of north, the hydraulic gradient and corresponding flow directions were also plotted on the base map. The map suggests that when anisotropy of transmissivity is incorporated, the computed flow directions differ markedly from those constructed assuming a hydraulically isotropic system.

In Task 2 (Conceptual Model Development) of the project, progress continues to be made on digitizing the surface exposure of those units comprising the Paleozoic carbonate aquifer. K. Spivey is presently digitizing the carbonate exposures in areas north and northwest of Cactus Flat and Gold Flat. Efforts are continuing on correlating the surface exposure of the Paleozoic carbonate units with measurements of the depth to, and thickness of, the lower carbonate aquifer obtained from water and oil wells, as well as from emplacement holes at NTS. These correlations will be used to construct geologic and hydrostratigraphic cross-sections. Geologic cross-sections constructed by International Technology Corporation and Geotrans, Inc., as part of the environmental restoration program at NTS will be obtained and balanced to assure their accuracy.

Future activities will focus on completing the semi-annual research report which will detail the work outlined above under Task 1. Work will continue on summarizing existing data and conceptual models of flow in the Death Valley Region.

1.9 *Waste Solidification Systems (WSS)*

The draft of the Vitrification Plant Hot Operations and High Level Waste Interim Storage Final Safety Analysis Report (SAR-003) was received at the CNWRA from the WVDP. A team of reviewers has been organized to review the SAR-003. Initial comments are due to the NRC on July 18, 1994. The SAR has extensive coverage of the vitrification system as well as details of the processes. There are several references associated with the SAR. The WVDP is to provide a set of these references to the CNWRA. Significant delays in obtaining critical references may delay the completion of the preparation of the initial comments.

In the next period, review of the draft version of SAR-003 will be initiated and the first round of comments compiled. A detailed review of the referenced documents will be initiated. Also, a revision of the overall schedules in the WSS Program Element will be prepared to support the current support needs of the NRC review of the DOE SAR-related documents.

1.10 *Monitored Retrievable Storage (MRS)*

During this period, no work assignment was received from the NRC.

The CNWRA will await further guidance on MRS from the NRC.

2. MANAGEMENT ISSUES

None.

3. MAJOR PROBLEMS

None.

4. SUMMARY OF SCHEDULE CHANGES

Schedule changes that have become necessary are summarized in Table 3. This table provides formal documentation of: (i) schedule changes for IMs that occurred during the preceding period or are anticipated to occur during the subsequent period, and (ii) schedule changes for MMs that are anticipated to occur during subsequent periods. Each item listed has been discussed with the cognizant NRC PEM and other parties, as appropriate. In the case of MMs, the matter has been discussed with the NRC Contracting Officer and/or the designated representative of DCPM.

5. SUMMARY FINANCIAL STATUS

Table 4 indicates the financial status of the CNWRA in the context of authorized funds established by the NRC. Total commitments of the CNWRA are $375,524. Appendix A displays planned and actual costs to date, without allowance for fee, on both a per-period and a cumulative basis. In addition, these data do not include commitments, and variances are shown on both a dollar and percentage basis. Pertinent information is provided for the CNWRA program as a whole, the DWM JC, the RES DRA JC, the DIMNS JC, and the DFCSS JC, as well as for each Program Element and Project. This information is provided in both graphical and tabular form.

Cost variances over the past three reporting periods suggest distinct trends between DWM and RES elements and projects. Specifically, the DWM spending reflects increased spending whereas the RES spending continues to show about an 8 percent aggregate underrun. Although the CNWRA continues to show an underrun status, the percentage of underrun is decreasing.

The declining underrun status in the DWM JC may be attributed principally to accelerated spending in the COPS, EQA EBS, and PA activities. The COPS, WSE&I, EBS, RDCO, and PA&HT Elements continue to adhere to the estimated spending levels, while the GS Element remains consistently overspent. DWM aggregate spending will adhere to its current level or it may accelerate to accommodate planned activities. Based on last quarter spending, the DWM elements will probably spend approximately 3 percent less than the total budget for the balance of this current fiscal year.

Total spending in the RES JC will probably show a continued pattern of below-estimate spending. With the exception of Seismic Rocl. Mechanics, Stochastic Analysis of Large-Scale Flow and Transport in Unsaturated Fractured Rock, Field Volcanism, and Tectonic Processes, all RES projects currently are underrun. Although peer reviews and augmented student labor will increase costs somewhat during the next two periods, the RES JC will likely be underspent by about 8 percent for the rest of this current year. Late receipt of SOWs and delays in completing the associated project plans may exacerbate this situation.

Core CNWRA staff, employed in an integrated and matrix structure, continue to divide their time equitably among the DWM elements and RES projects. This distribution of labor is evident in the JC spending trends. It is important to note in this regard that reallocation of core staff from task-to-task and project-to-project does not affect aggregate CNWRA spending nor the attendant accomplishment of assigned work and associated deliverables. Where possible, subcontractor, consultant, and SwRI resources have been and continue to be introduced to augment CNWRA labor, thus mitigating underspending and improving the on-time delivery of products. However, not all activities lend themselves to such augmentation. Efforts have been most effective in bringing additional resources to bear on (i) longer term activities where the investment in training and programmatic familiarization are cost-effective; (ii) certain software development efforts where programmatic awareness is not, in general, necessary; and (iii) reactive program work, particularly technical review of design and site characterization documents. Because many areas of work do not fit these criteria and we have not been tasked as extensively as anticipated in area "iii", we have been unable to significantly decrease the current underrun situation through the employment of non-core resources. This situation is anticipated to continue, and may be exacerbated by lack of further core-staff hiring in the face of current DOE programmatic uncertainties and lack of a firm base of work for others.

The actual cost through Period 9 for the DWM JC is 5.0 percent below the estimated cost. All of the elements, except GS, show cost underruns which are explained in the following paragraphs.

The aggregate underspending of 6.1 percent in the COPS Element reflects the accumulation of both the old and new work breakdown structure account numbers (071-076 and 151-156). For FY94 to date, all subtasks are under projected expenditure levels, including both series of work breakdown structure account numbers, except Management Support and Planning (Subtask 151) and DWM Computer Systems Support (Subtask 155). All costs associated with TDOCS Development (Subtask 156) prior to Period 7 remained in Subtask 155, since all activities related to TDOCS were resident in that subtask. Actual has not surpassed estimated spending in Subtasks 151 and 155 since Period 5 and Period 4, respectively, and such actual spending is not expected to exceed each period's revised estimates for the balance of this fiscal year. Expenditures for Subtask 153 during Periods 10 through 13 will represent the CNWRA staff's participation in the development and presentation of FY95 Operations Plans. As anticipated, Subtask 154 costs in Periods 7 through 9 have exceeded estimates due to the preparation for and conduct of the CNWRA QA audit as well as subsequent report writing activities. Actual spending in Subtask 156, TDOCS Development, has remained under budget over the last three periods, and expenditures are expected to be consistent with estimates for the balance of FY94.

The WSE&I Element was 2.2 percent underspent at the end of this period. This represents an essentially constant level of variance for the last two periods. There may be a slight over expenditure during the next period as additional SwRI staff are utilized to complete RPD Phase II implementation. Subsequent to this, use of non-CNWRA labor will be reduced.

Actual costs for the EQA Element are currently 35.9 percent below the estimated spending plan. This underrun is due to the early postponement of DOE audits in the fiscal year. The DOE audits planned through the remainder of the fiscal year are on a much more compressed schedule, due to the earlier postponements, and the rate of expenditure during this period in this element has risen substantially. It is anticipated that the increase in NRC observation audits will continue to accelerate spending, but a significant underrun will remain.

The total GS Element was 11.8 percent overspent at the end of Period 9. This reflects a 58.8 percent overrun in Geology and Geophysics and a 32.6 percent underrun in Hydrology, Geochemistry, and Climatology. The overrun in the Geology and Geophysics area reflects the effort to complete two IMs added to earlier overruns. The underrun in the Hydrology, Geochemistry, and Climatology area continues to reflect the low level of assignments and staff involvement in these disciplines. Efforts are under way to develop a plan to increase the appropriate CNWRA staff involvement in SRA activities, especially Investigations of Issues Related to Hydrology, Geochemistry, and Climatology, according to guidance from the NRC. Increased efforts in GWTT continue to reflect consistently increasing spending.

The expenditures through Period 9 for the EBS Element are 6.0 percent below the planned costs. Expenditures are expected to increase in future periods and remain close to planned levels.

Costs incurred to date for the RDCO Element are 6.6 percent below those planned. The decrease in spending this period reflects intense staff involvement in critical RES activities. Costs will increase as the DBE rulemaking, CDS development, and prelicensing activities continue.

In the PA&HT Element, the cost variance for the DWM activities continued to decrease. At the end of Period 9, the spending was 13.7 percent under the projected amount. A steady reduction of cost variance is expected as progress is made on the various auxiliary analyses, the expert judgment study, and as new tasking on the EPA standard is provided by the NRC. In addition, increased efforts on CDS integration and consistency reviews are planned.

The actual cost through Period 9 for the RES JC is 8.2 percent below the estimated cost. All of the projects, except Seismic Rock Mechanics, Stochastic Analysis of Large-Scale Flow and Transport in Unsaturated Fractured Rock, Field Volcanism, and Tectonic Processes, show cost underruns which are explained in the following paragraphs.

Costs incurred to date for the Overall Research Project were 10.8 percent below projected costs. Future costs are anticipated to closely follow planned values as costs attendant to workshops and preparation of project plans are incurred.

At the end of Period 9, spending for the Geochemistry Project is 2.5 percent below the budgeted amount. The rate of expenditure is expected to increase during the next few periods due to conference travel and preparation of a paper to be presented at the conference. External peer reviewers of the project final report are also expected to complete their review within the next two periods and submit their invoices.

Actual costs for the Thermohydrology Research Project are currently 7.0 percent below estimated costs. The spending rate is expected to increase over the next few months during periods of high project activity associated with the completion of the experimental portion and the final analyses of the project.

Seismic Rock Mechanics Research Project costs incurred to date are 3.8 percent more than the planned expenditure. This is because of the efforts needed for participation at the 4th DECOVALEX Workshop in Oxford, England, and for preparation for the shaking table test of jointed rock mass that will be conducted during Period 10. Expenditures are expected to remain close to planned levels, although they will exceed planned amounts for the next two periods.

The IWPE Research Project costs to date are 5.1 percent less than planned. Activities in the IWPE Research Project will continue to increase, and the costs will be close to the project plan in the future periods.

At the end of Period 9, the Stochastic Research Project was 30.2 percent over the projected costs. With two periods remaining in the duration of the project, it is anticipated that the final overrun will be approximately 30 percent.

At the end of Period 9, the Geochemical Natural Analog Research Project was 3.4 percent under planned costs. Project costs for the remainder of the fiscal year should approximate planned values. Occasional, short-term cost deviations corresponding largely to field research expenses are anticipated.

At the end of Period 9, the Sorption Modeling Research Project was 1.2 percent under planned costs. Spending levels during the next few periods are expected to remain close to budgeted costs.

Total expenditures in Period 9 in the Volcanic Systems of the Basin and Range Research Project were 19.9 percent less than expected. Underspending is attributed to increased effort in the Field Volcanism project during Period 9. It is anticipated that spending will remain low in Period 10, also due to activities in the Field Volcanism project. Expenses are expected to increase sharply in the final periods as the peer review activities increase.

As of the end of Period 9, Regional Hydrology Research Project was 12.8 percent underspent. Activities related to stress-conductivity evaluations and database loading are anticipated to increase spending beginning in Period 10.

Total expenditures through Period 9 for the Field Volcanism Research Project are 5.2 percent more than expected. This spending was due to (i) preparation of the MM in application of geophysical methods to volcanology, and (ii) preparation for field work at Tolobachik volcano. Spending will remain at about the same rate due to field work, then decrease sharply in the final periods due to peer review activities in the Volcanic Systems of the Basin and Range Research Project.

The Tectonics Research Project was 18.2 percent overspent at the end of Period 9. This reflects a continuation of the planned spending rate following an overall decrease in the cost overrun for the project during Period 7. Payment of a consultant for work done early in the fiscal year contributed about 10 percent of this period's expenditures. Efforts to control spending will continue during the next reporting period.

At the end of Period 9, the PA Research Project costs were 19.6 percent under the projected amount. This cost variance is primarily due to limited the activity in Tasks 2 and 3. However, this variance will decrease rapidly over the next two periods because of a focused effort on completion of remaining milestones, completion of three new deliverables which were recently added to the project, and consultant costs associated with external peer reviews of three technical reports.

The expenditures in the WSS Project are 23.7 percent below the planned level. The nature of the tasks in this program element reflect the dependence on several documents to be received from the DOE. Recently, the CNWRA received the Vitrification SAR from the DOE. The review of this and other associated documents has been initiated. Activities and expenses related to the review of the DOE documents will be significant during the next several periods.

In the MRS Project, no work was assigned to the CNWRA by the NRC. Costs incurred to date for the MRS project are 64.9 percent below those planned. E. Shum has indicated that the CNWRA may not receive additional work assignments until an MRS site is identified.

TABLE 1. CNWRA CORE STAFF - HIRING PROFILE AND STATUS (06/10/94)

EXPERTISE/EXPERIENCE	FISCAL YEAR (PLANNED)								OPEN THIS YEAR*
	FY94				FY95	FY96	FY97	FY98	
	1Q	2Q	3Q	4Q					
ADMINISTRATION	5	5	5	5	5	5	5	5	0
CODE ANALYSIS/DEVELOPMENT	2	3	3	3	3	3	3	3	1
DATABASE MANAGEMENT & DATA PROCESSING	2	2	2	2	2	2	2	2	0
ELECTROCHEMISTRY	1	1	1	1	1	1	1	1	0
ENGINEERING GEOLOGY/GEOLOGICAL ENGNG	1	1	1	1	1	1	1	1	0
ENVIRONMENTAL SCIENCES	1	1	1	1	1	1	1	1	0
GEOCHEMISTRY	5	6	6	6	6	6	6	6	1
GEOHYDROLOGY/HYDROGEOLOGY	5	5	6	6	7	7	7	7	0
GEOLOGY	2	2	2	2	3	3	3	3	0
HEALTH PHYSICS	1	1	1	1	1	1	1	1	0
INFORMATION MANAGEMENT SYSTEMS	2	2	2	2	2	2	2	2	0
MATERIAL SCIENCES	4	4	4	4	4	4	4	4	0
MECHANICAL, INCLUDING DESIGN & FABRICATION	1	1	1	1	1	1	1	1	0
MINING ENGINEERING	1	1	1	1	1	1	1	1	0
NUCLEAR ENGINEERING	1	1	1	1	1	1	1	1	0
NUMERICAL MODELING/HP (a)	1	1	1	1	1	1	1	1	1
PERFORMANCE ASSESSMENT	4	5	5	6	6	6	6	6	2
QUALITY ASSURANCE	2	2	2	2	2	2	2	2	0
RADIOISOTOPE GEOCHEMISTRY	1	1	1	1	1	1	1	1	0
REGULATORY ANALYSIS	1	1	1	1	1	1	1	1	0
ROCK MECHANICS	3	3	4	4	4	4	4	4	1
SEISMOLOGY	1	1	1	1	1	1	1	1	0
SOURCE-TERM/SPENT FUEL DEGRAD.	1	1	1	1	1	1	1	1	0
STRUCTURAL GEOLOGY/SEISMO-TECTONICS	3	3	3	3	3	3	3	3	0
SYSTEMS ENGINEERING	1	1	1	1	1	1	1	1	0
VOLCANOLOGY/IGNEOUS PROCESSES	2	2	2	2	2	2	2	2	0
TOTAL CORE STAFF PLANNED	54	57	59	60	62	62	62	62	6

Staffing Summary

	Professional	Support	Total
Current	53	16	69
Limited Term	1	0	1
Offers Made	0	0	0
Planned This Date	54	16	70
Planned End of FY94*	60	17	77

*Include staff planned for work for others

(a) Interview scheduled next period

(b) Resumes being solicited

(c) Offer made

(d) Offer pending

(e) Offer accepted

TABLE 2. CNWRA CORE STAFF - CURRENT PROFILE (06/10/94)

EXPERTISE/EXPERIENCE	
ADMINISTRATION	J.LATZ, W.PATRICK, H.GARCIA, P.MACKIN, J.RUSSELL, B.SAGAR
CODE ANALYST	R.JANETZKE, R.MARTIN
DATABASE MANAGEMENT AND DATA PROCESS	A.JOHNSON, A.JACOB
ELECTROCHEMISTRY	G.CRAGNOLINO
ENGINEERING GEOLOGY/GEOLOGICAL ENGNG	G.OFOEGBU
ENVIRONMENTAL SCIENCES	P.LaPLANTE
GEOCHEMISTRY	W.MURPHY, R.PABALAN, E.PEARCY, J.PRIKRYL, D.TURNER, P.BERTETTI*
GEOHYDROLOGY/HYDROGEOLOGY	A.BAGTZOGLOU, R.GREEN, S.STOTHOFF, G.WITTMEYER, V.KAPOOR, S.MOHANTY
GEOLOGY	L.McKAGUE, M.MIKLAS
HEALTH PHYSICS	J.HAGEMAN
INFORMATION MANAGEMENT SYSTEMS	R.JOHNSON, R.MARSHALL
MATERIAL SCIENCES	P.NAIR, H.MANAKTALA, N.SPIDHAR, D.DUNN
MECHANICAL, INCLUDING DESIGN & FABRICATION	C.TSCHOEPE
MINING ENGINEERING	S-M.HSIUNG
NUCLEAR ENGINEERING	H.KARIMI
NUMERICAL MODELING/SIMULATION	
PERFORMANCE ASSESSMENT	R.BACA, A.B.GUREGHIAN, R.MANTEUFEL
QUALITY ASSURANCE	B.MABRITO, R.BRIENT
RADIOISOTOPE GEOCHEMISTRY	D.PICKETT (Start date 6/20/94)
REGULATORY ANALYSIS	S.SPECTOR (law)
ROCK MECHANICS	A.CHOWDHURY, M.AHOLA, A.GHOSH
SEISMOLOGY	R.HOFMANN
SOURCE-TERM/SPENT FUEL DEGRAD	P.LICHTNER
STRUCTURAL GEOLOGY/SEISMO-TECTONICS	G.STIREWALT, S.YOUNG, D.FERRILL
SYSTEMS ENGINEERING	A.DeWISPELARE
VOLCANOLOGY/IGNEOUS PROCESSES	C.CONNOR, B.HILL

*LIMITED TERM

TABLE 3. SUMMARY OF SCHEDULE CHANGES

Milestone Number	Type	Description	Original Date	Revised Date	Rationale for Change
5702-723-430	IM	Letter Report on Demonstration of a GUI and Centralized Database for TPA Code	6/30/94	7/15/94	Additional time required for technical review.

TABLE 4. FINANCIAL STATUS

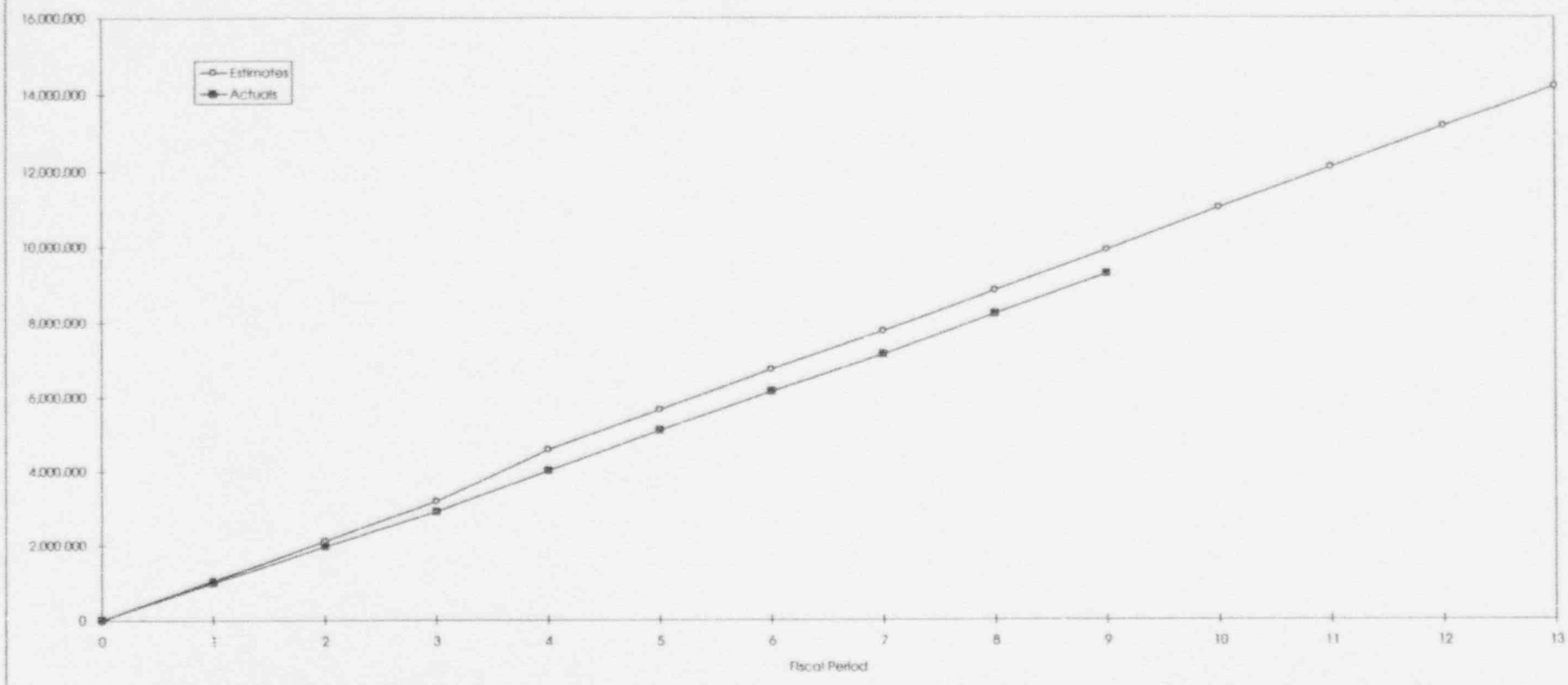
	Funds Authorized*	Funds Costed to Date**	Funds Uncosted	Commitments
GS	3,567,399	2,138,991.01	1,428,407.99	15,828.18
EBS	2,376,992	1,346,411.80	1,030,580.20	27,159.88
RDCO	1,206,199	1,668,407.31	(462,208.31)	28,784.70
WSEI	2,582,731	2,332,795.65	249,935.35	10,025.10
EQA	1,284,454	172,613.97	1,111,840.03	1,943.00
PA	2,480,853	2,360,017.37	120,835.63	177,991.15
COPS	4,329,800	3,646,789.08	683,010.92	19,987.00
HLW	17,828,428	13,666,026.19	4,162,401.81	281,719.01
OVERALL	466,856	327,525.65	139,330.35	901.28
GEOCHEM	388,410	364,240.64	24,169.36	0.00
THERMO	924,236	649,914.05	274,321.95	3,097.00
SEISMIC	1,208,067	836,102.51	371,964.49	44,813.49
IWPE	1,377,499	925,538.54	451,960.46	1,362.60
STOCH	510,727	455,179.02	55,547.98	1,200.00
ANALOGS	1,069,663	687,909.11	381,753.89	3,310.00
SORPTION	996,066	697,692.18	298,373.82	3,264.60
RES PA	795,113	816,381.42	(21,268.42)	17,554.34
VOLCAN (R)	427,348	462,512.13	(35,164.13)	1,345.20
VOLCAN (FLD)	774,382	404,317.83	370,064.17	12,758.06
REG HYDRO	774,545	196,052.66	578,492.34	0.00
TECTONIC	1,236,738	543,546.91	693,191.09	4,198.71
RES	10,949,650	7,366,912.65	3,582,737.35	93,805.28
WSS	235,392	151,261.04	84,130.83	0.00
MRS	56,231	17,073.73	39,157.27	0.00
TOTAL	29,069,701	21.201,273.61	7,868,427.26	375,524.29

* Additional Authorized Funds of $2,576,788 for HLW and $314,325 for RES have not been allocated.
** Costed to Date includes Base Fee. Additional fee awarded is not included. Amount authorized includes carryover .

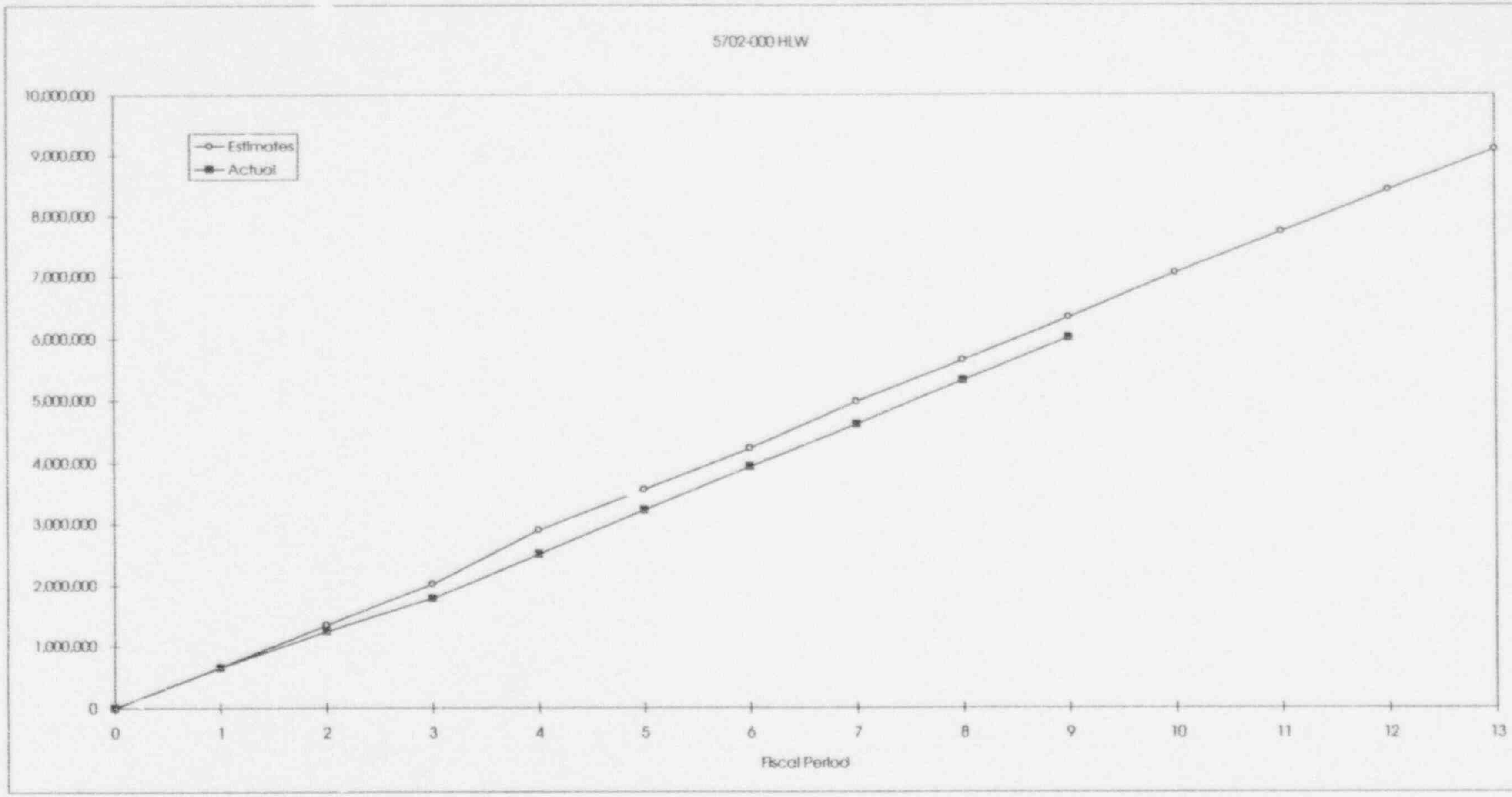
APPENDIX A

PLANNED AND ACTUAL COSTS, AND COST VARIANCES

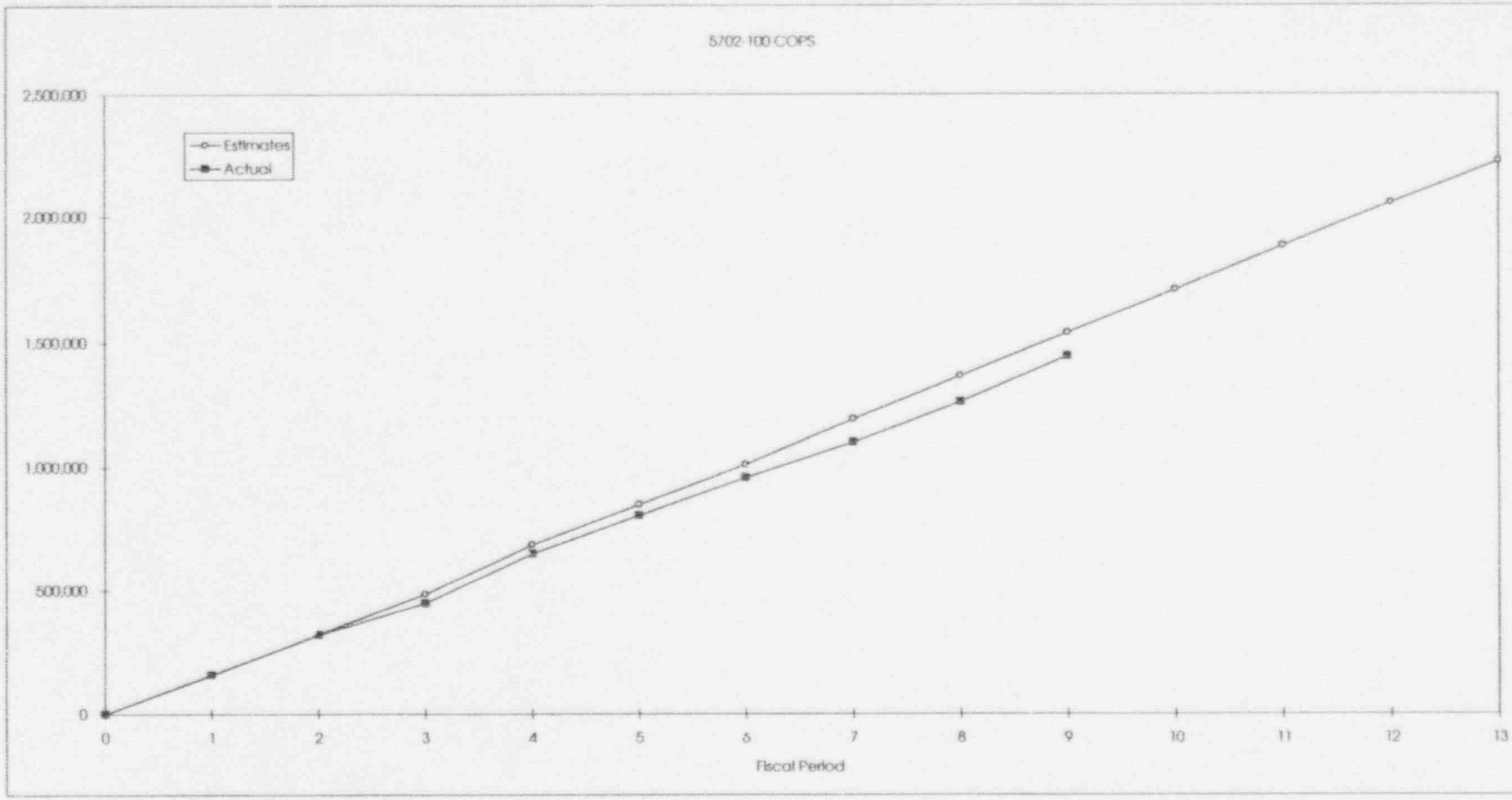
5700-000 CENTER COMPOSITE



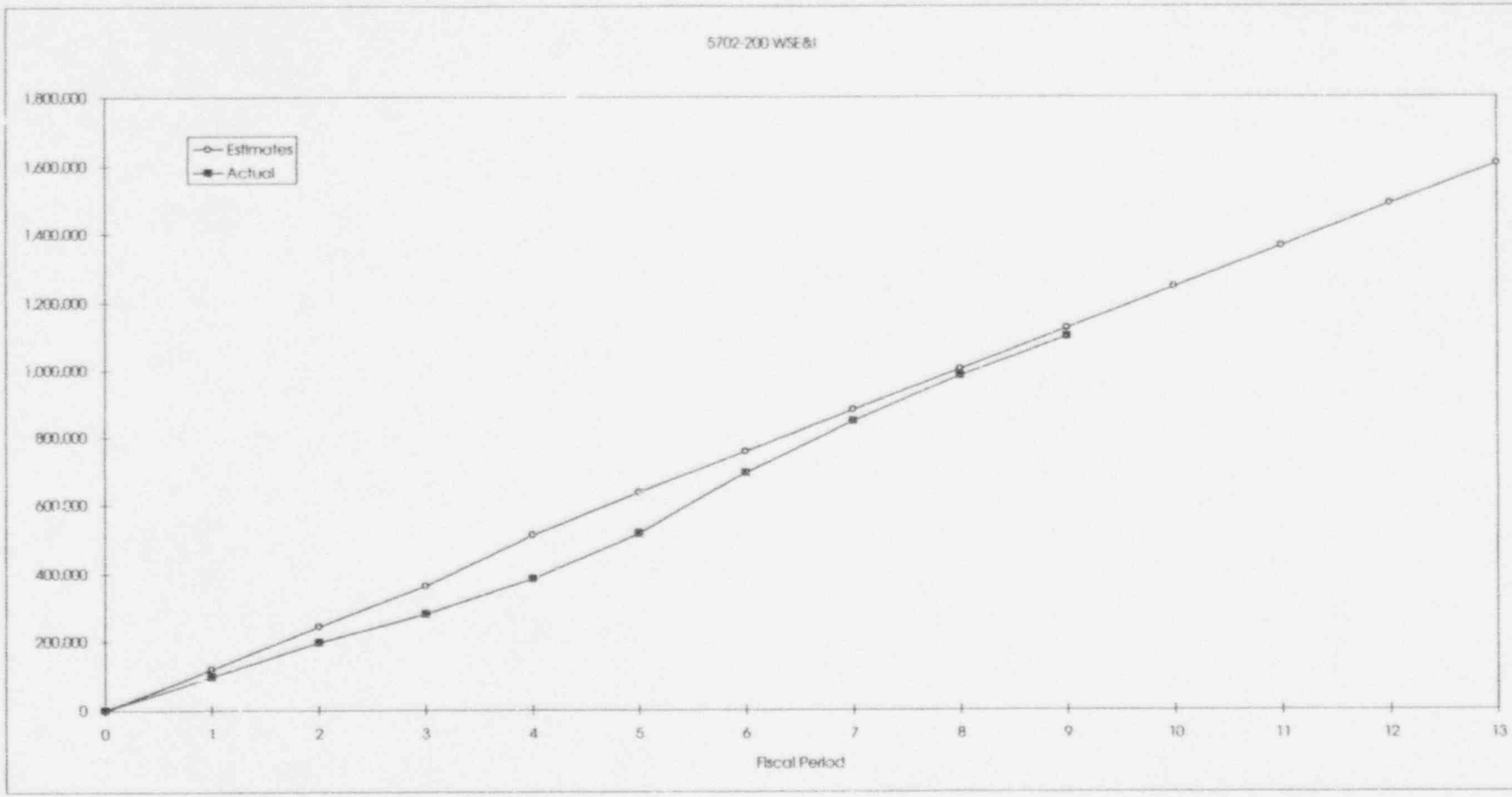
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	1,036,251	1,078,946	1,059,336	1,414,291	1,078,045	1,071,882	1,014,150	1,072,881	1,074,638	1,129,355	1,058,997	1,070,915	1,024,255	9,900,420
ACT. PERIOD COST	988,990	968,936	933,235	1,128,970	1,078,151	1,053,022	982,940	1,080,961	1,054,851	0	0	0	0	9,270,055
VARIANCE, $	47,261	110,010	126,101	285,321	(106)	18,860	31,210	(8,080)	19,787	0	0	0	0	630,365
VARIANCE, %	4.6%	10.2%	11.9%	20.2%	0.0%	1.8%	3.1%	-0.8%	1.8%	0.0%	0.0%	0.0%	0.0%	6.4%
EST. FY CUMUL	1,036,251	2,115,197	3,174,533	4,588,824	5,666,869	6,738,751	7,752,901	8,825,782	9,900,420	11,029,775	12,088,772	13,159,687	14,183,942	
ACTUAL FY CUMUL	988,990	1,957,925	2,891,160	4,020,130	5,098,281	6,151,304	7,134,244	8,215,204	9,270,055	0	0	0	0	
PERCENT COMPLETE	7.0%	13.8%	20.4%	28.3%	35.9%	43.4%	50.3%	57.9%	65.4%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	47,261	157,272	283,373	568,694	568,588	587,447	618,657	610,578	630,365	0	0	0	0	
VARIANCE, %	4.6%	7.4%	8.9%	12.4%	10.0%	8.7%	8.0%	6.9%	6.4%	0.0%	0.0%	0.0%	0.0%	



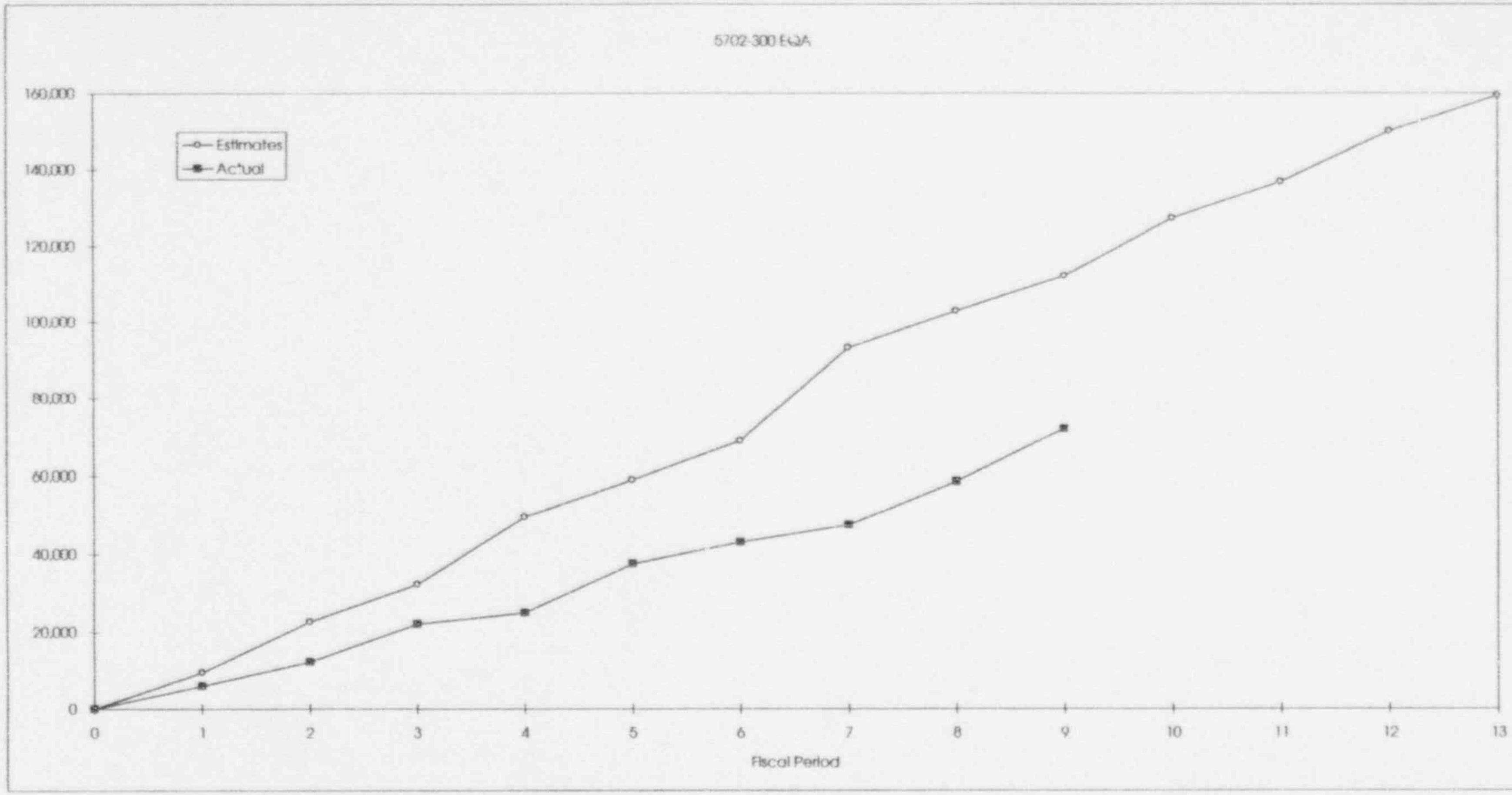
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	657,900	683,467	673,276	876,775	670,044	664,041	747,693	677,579	681,092	713,118	681,421	685,782	664,624	6,331,867
ACT. PERIOD COST	644,178	600,899	531,606	721,653	723,345	715,068	673,816	711,145	691,351	0	0	0	0	6,013,061
VARIANCE, $	13,722	82,568	141,670	155,122	(53,301)	(51,027)	73,877	(33,566)	(10,259)	0	0	0	0	318,806
VARIANCE, %	2.1%	12.1%	21.0%	17.7%	-8.0%	-7.7%	9.9%	-5.0%	-1.5%	0.0%	0.0%	0.0%	0.0%	5.0%
EST. FY CUMUL	657,900	1,341,367	2,014,643	2,891,418	3,561,462	4,225,503	4,973,196	5,650,775	6,331,867	7,044,985	7,726,406	8,412,188	9,076,812	
ACTUAL FY CUMUL	644,178	1,245,077	1,776,683	2,498,336	3,221,681	3,936,749	4,610,565	5,321,710	6,013,061	0	0	0	0	
PERCENT COMPLETE	7.1%	13.7%	19.6%	27.5%	35.5%	43.4%	50.8%	58.6%	66.2%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	13,722	96,290	237,960	393,082	339,781	288,754	362,631	329,065	318,806	0	0	0	0	
VARIANCE, %	2.1%	7.2%	11.8%	13.6%	9.5%	6.8%	7.3%	5.8%	5.0%	0.0%	0.0%	0.0%	0.0%	



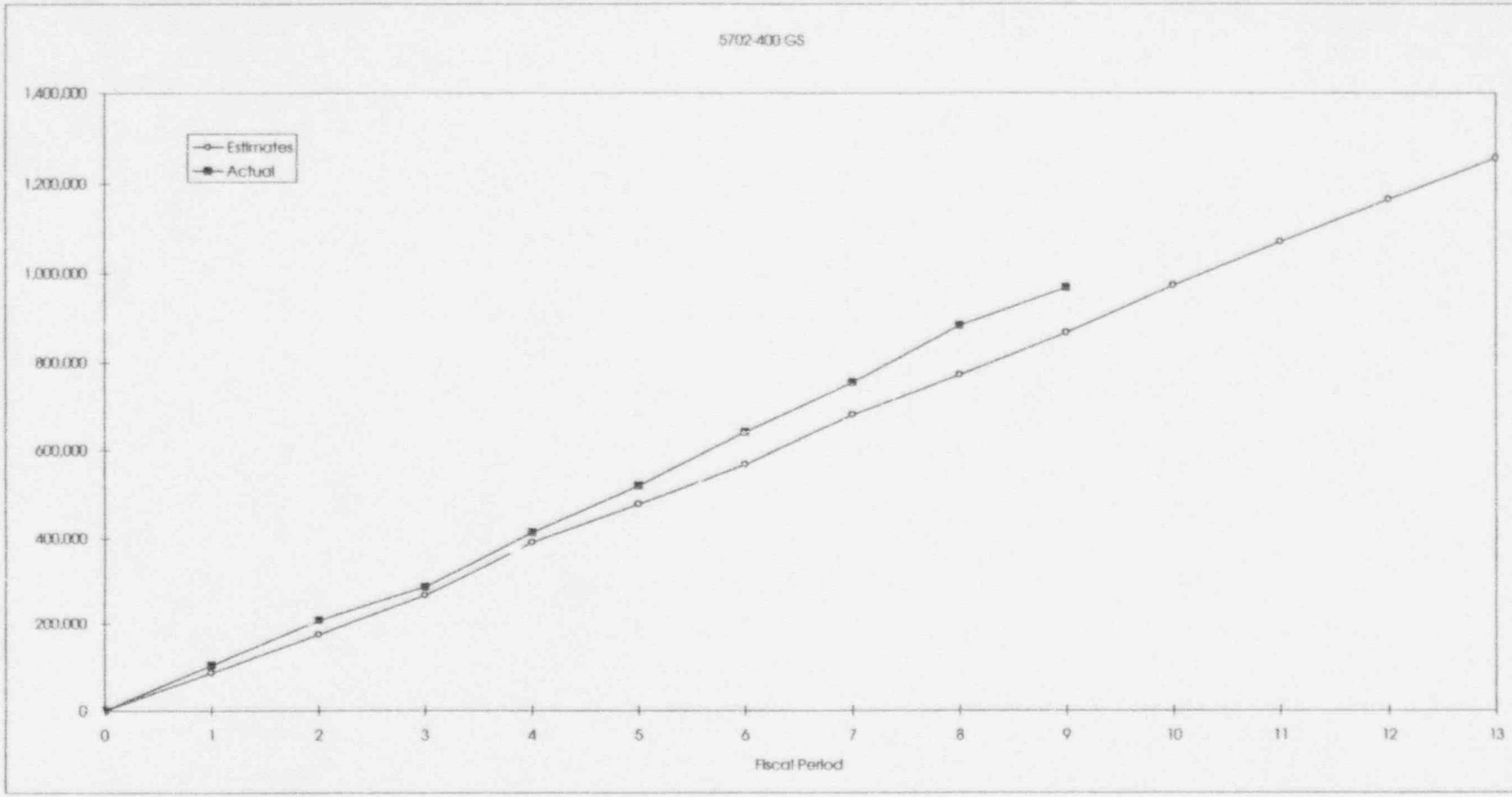
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	158,237	166,818	158,580	204,037	160,928	161,388	181,456	172,949	174,616	171,415	170,141	172,223	168,862	1,539,009
ACT. PERIOD COST	160,035	161,950	125,227	202,472	155,313	150,826	141,954	163,030	183,818	0	0	0	0	1,444,624
VARIANCE, $	(1,798)	4,868	33,353	1,565	5,615	10,562	39,502	9,919	(9,202)	0	0	0	0	94,385
VARIANCE, %	-1.1%	2.9%	21.0%	0.8%	3.5%	6.5%	21.8%	5.7%	-5.3%	0.0%	0.0%	0.0%	0.0%	6.1%
EST. FY CUMUL	158,237	325,055	483,635	687,672	848,600	1,009,988	1,191,444	1,364,393	1,539,009	1,710,424	1,880,565	2,052,788	2,221,650	
ACTUAL FY CUMUL	160,035	321,985	447,211	649,683	804,996	955,822	1,097,776	1,260,806	1,444,624	0	0	0	0	
PERCENT COMPLETE	7.2%	14.5%	20.1%	29.2%	36.2%	43.0%	49.4%	56.8%	65.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(1,798)	3,070	36,424	37,989	43,604	54,166	93,668	103,587	94,385	0	0	0	0	
VARIANCE, %	-1.1%	0.9%	7.5%	5.5%	5.1%	5.4%	7.9%	7.6%	6.1%	0.0%	0.0%	0.0%	0.0%	



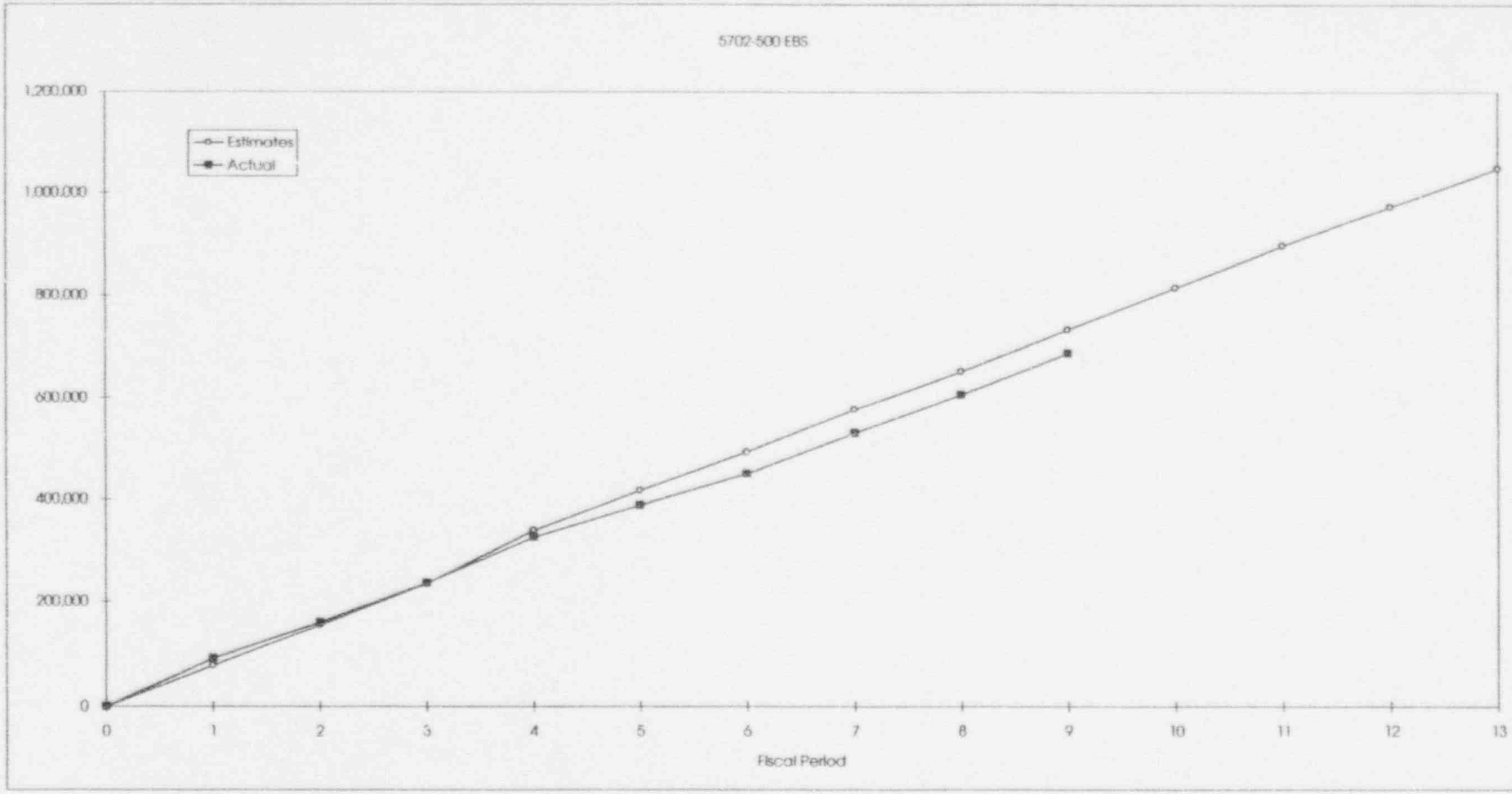
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	119,827	123,641	118,376	151,465	121,502	121,740	122,552	122,722	120,476	122,817	118,103	123,956	117,767	1,122,301
ACT. PERIOD COST	98,078	98,795	83,026	102,918	135,074	173,506	154,749	135,897	115,546	0	0	0	0	1,097,590
VARIANCE, $	21,749	24,846	35,350	48,547	(13,572)	(51,766)	(32,197)	(13,175)	4,930	0	0	0	0	24,711
VARIANCE, %	18.1%	20.1%	29.9%	32.1%	-11.2%	-42.5%	-26.3%	-10.7%	4.1%	0.0%	0.0%	0.0%	0.0%	2.2%
EST. FY CUMUL	119,827	243,468	361,844	513,309	634,811	756,551	879,103	1,001,825	1,122,301	1,245,118	1,363,221	1,487,177	1,604,944	
ACTUAL FY CUMUL	98,078	196,874	279,900	382,818	517,891	691,397	846,146	982,043	1,097,590	0	0	0	0	
PERCENT COMPLETE	6.1%	12.3%	17.4%	23.9%	32.3%	43.1%	52.7%	61.2%	68.4%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	21,749	46,594	81,944	130,491	116,920	65,154	32,957	19,782	24,711	0	0	0	0	
VARIANCE, %	18.1%	19.1%	22.6%	25.4%	18.4%	8.6%	3.7%	2.0%	2.2%	0.0%	0.0%	0.0%	0.0%	



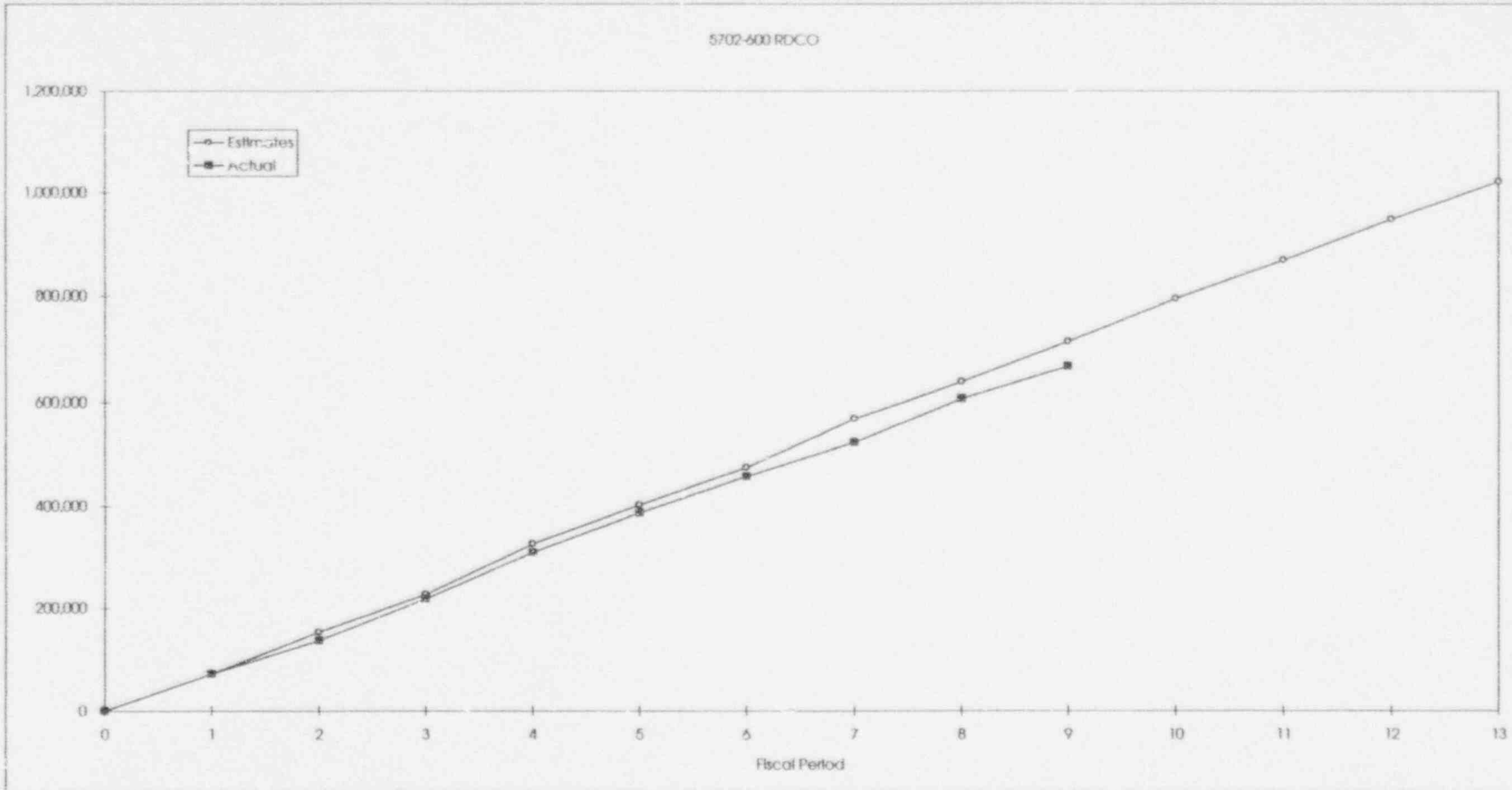
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	9,472	13,130	9,619	17,387	9,419	9,745	24,398	9,543	9,395	15,020	9,619	13,130	9,543	112,108
ACT. PERIOD COST	5,931	6,296	9,795	3,003	12,542	5,524	4,459	11,051	13,286	0	0	0	0	71,887
VARIANCE, $	3,541	6,834	(176)	14,384	(3,123)	4,221	19,939	(1,508)	(3,891)	0	0	0	0	40,221
VARIANCE, %	37.4%	52.0%	-1.8%	82.7%	-33.2%	43.3%	81.7%	-15.8%	-41.4%	0.0%	0.0%	0.0%	0.0%	35.9%
EST. FY CUMUL	9,472	22,602	32,221	49,608	59,027	68,772	93,170	102,713	112,108	127,128	136,747	149,877	159,420	
ACTUAL FY CUMUL	5,931	12,227	22,022	25,025	37,567	43,091	47,550	58,601	71,887	0	0	0	0	
PERCENT COMPLETE	3.7%	7.7%	13.8%	15.7%	23.6%	27.0%	29.8%	36.8%	45.1%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	3,541	10,375	10,199	24,583	21,460	25,681	45,620	44,112	40,221	0	0	0	0	
VARIANCE, %	37.4%	45.9%	31.7%	49.6%	36.4%	37.3%	49.0%	42.9%	35.9%	0.0%	0.0%	0.0%	0.0%	



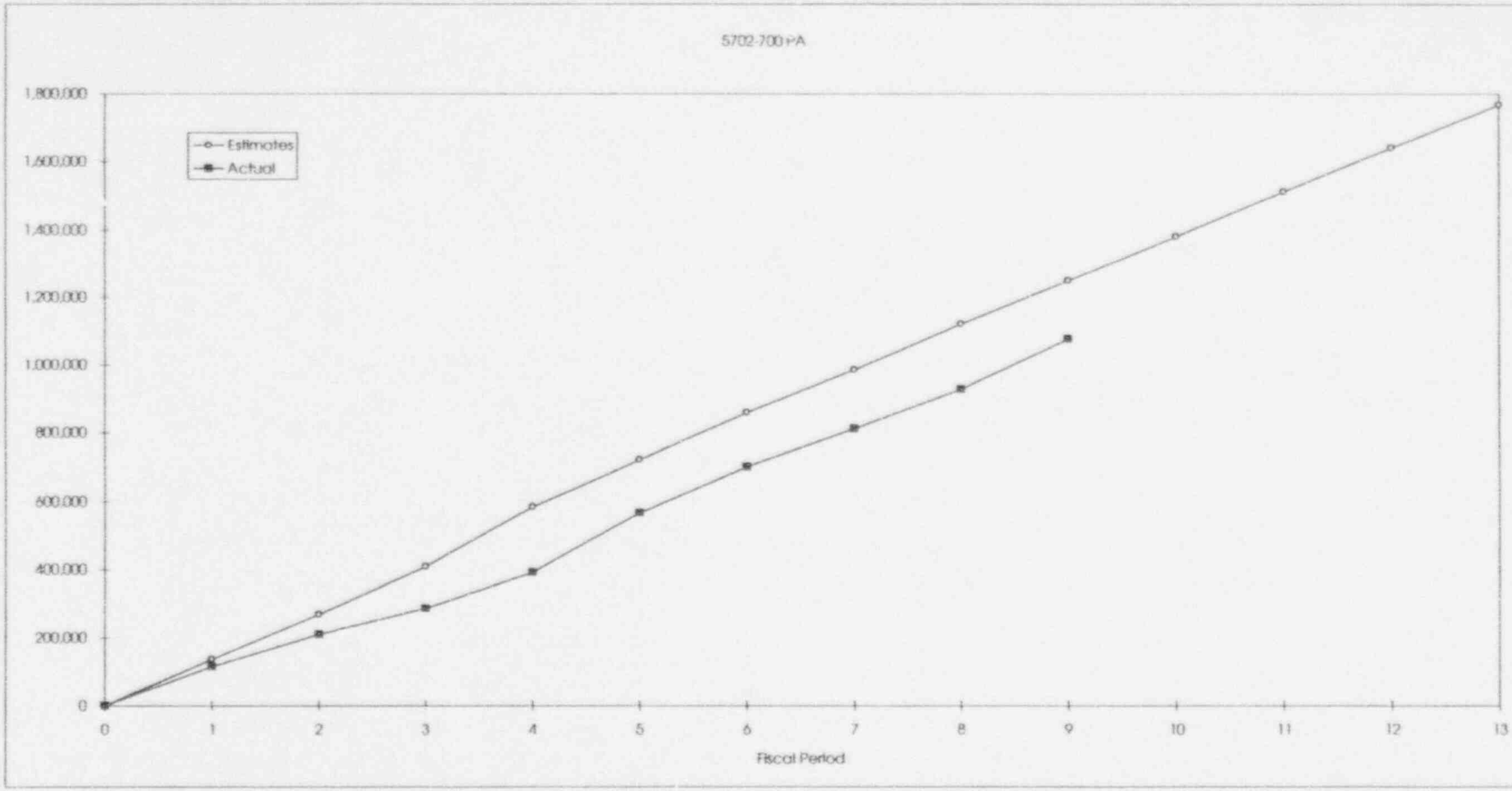
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	85,199	89,534	91,769	124,743	88,111	88,443	112,570	90,681	94,493	108,147	96,917	94,226	91,166	865,543
ACT. PERIOD COST	103,969	104,642	78,620	126,025	107,488	120,307	113,676	127,911	85,441	0	0	0	0	968,079
VARIANCE, $	(18,770)	(15,108)	13,149	(1,282)	(19,377)	(31,864)	(1,106)	(37,230)	9,052	0	0	0	0	(102,536)
VARIANCE, %	-22.0%	-16.9%	14.3%	-1.0%	-22.0%	-36.0%	-1.0%	-41.1%	9.6%	0.0%	0.0%	0.0%	0.0%	-11.8%
EST. FY CUMUL	85,199	174,733	266,502	391,245	479,356	567,799	680,369	771,050	865,543	973,690	1,070,607	1,164,833	1,255,999	
ACTUAL FY CUMUL	103,969	208,611	287,232	413,257	520,745	641,052	754,728	882,639	968,079	0	0	0	0	
PERCENT COMPLETE	8.3%	16.6%	22.9%	32.9%	41.5%	51.0%	60.1%	70.3%	77.1%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(18,770)	(33,878)	(20,730)	(22,012)	(41,389)	(73,253)	(74,359)	(111,589)	(102,536)	0	0	0	0	
VARIANCE, %	-22.0%	-19.4%	-7.8%	-5.6%	-8.6%	-12.9%	-10.9%	-14.5%	-11.8%	0.0%	0.0%	0.0%	0.0%	



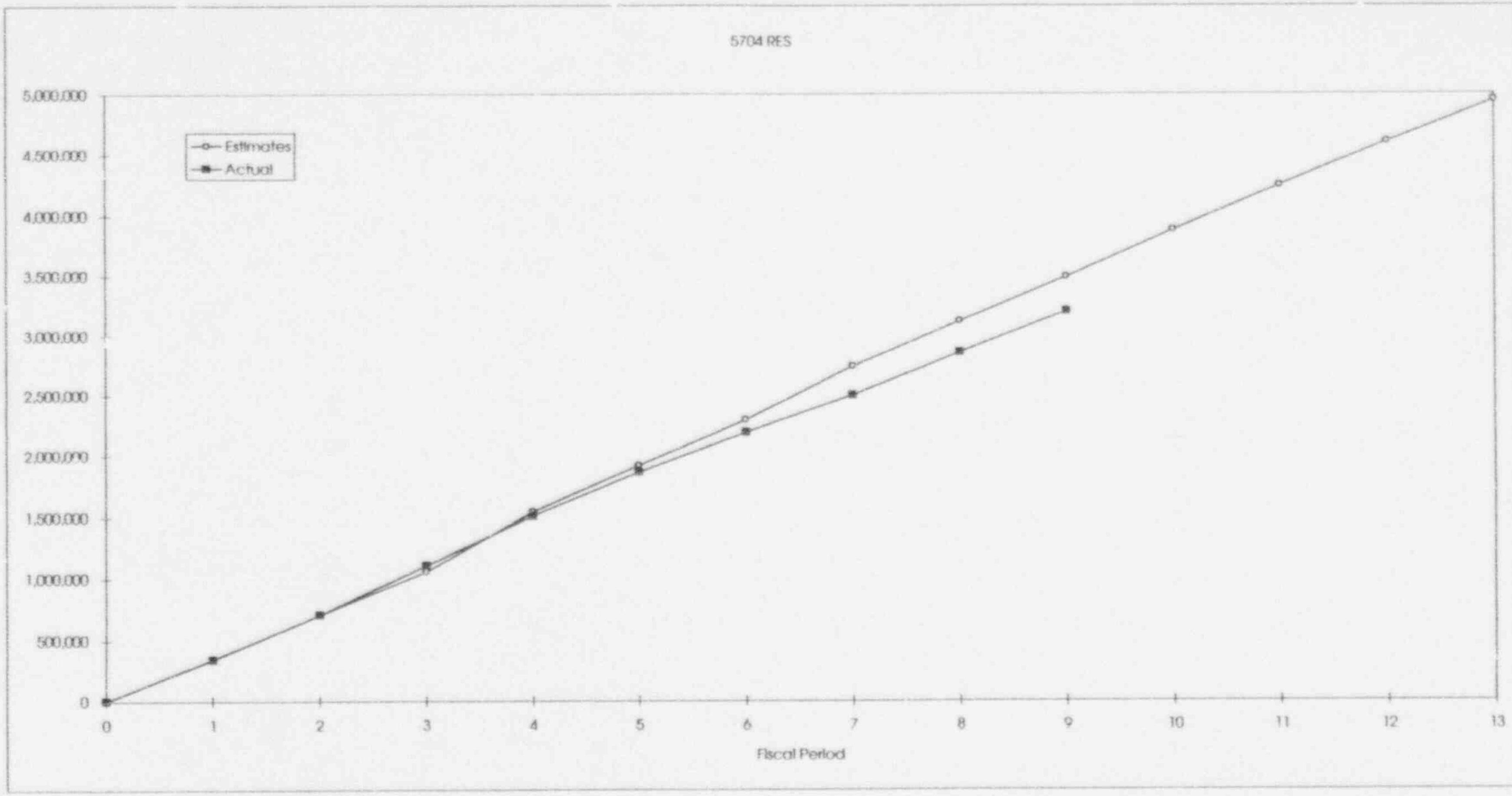
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	76,356	76,589	81,729	103,642	77,971	75,208	84,524	74,539	79,238	84,381	81,687	75,658	75,384	729,796
ACT. PERIOD COST	89,924	68,848	76,194	90,429	62,146	61,174	80,174	76,556	80,357	0	0	0	0	685,803
VARIANCE, $	(13,568)	7,741	5,535	13,213	15,825	14,034	4,350	(2,017)	(1,119)	0	0	0	0	43,993
VARIANCE, %	-17.8%	10.1%	6.8%	12.7%	20.3%	18.7%	5.1%	-2.7%	-1.4%	0.0%	0.0%	0.0%	0.0%	6.0%
EST. FY CUMUL	76,356	152,945	234,674	338,316	416,287	491,495	576,019	650,558	729,796	814,177	895,864	971,522	1,046,906	
ACTUAL FY CUMUL	89,924	158,773	234,967	325,396	387,542	448,716	528,890	605,446	685,803	0	0	0	0	
PERCENT COMPLETE	8.6%	15.2%	22.4%	31.1%	37.0%	42.9%	50.5%	57.9%	65.5%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(13,568)	(5,828)	(293)	12,920	28,745	42,779	47,130	45,112	43,993	0	0	0	0	
VARIANCE, %	-17.8%	-3.8%	-0.1%	3.8%	6.9%	8.7%	8.2%	6.9%	6.0%	0.0%	0.0%	0.0%	0.0%	



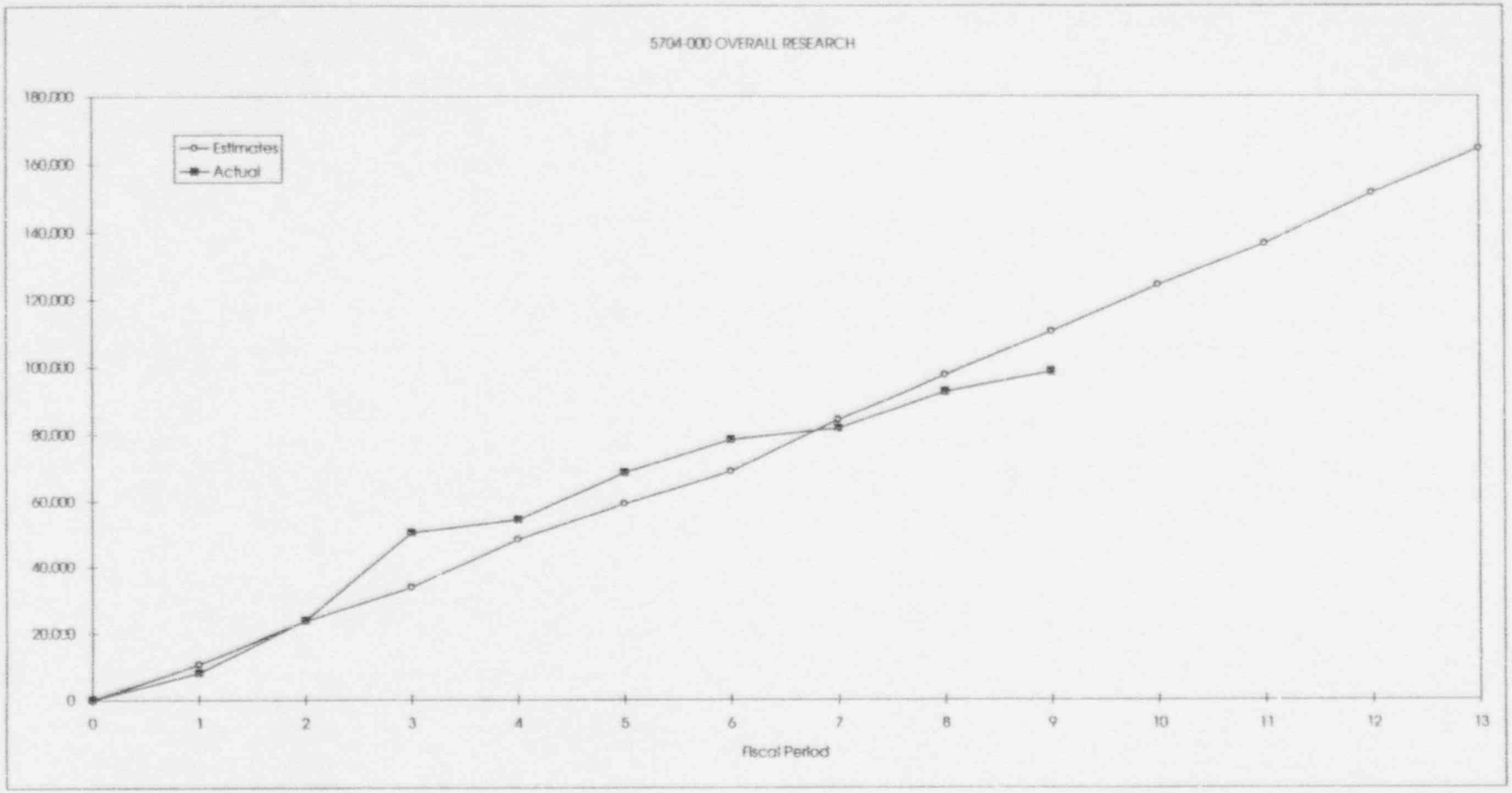
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	72,685	80,430	73,220	99,845	76,147	72,059	93,419	70,965	75,924	80,708	72,414	79,689	72,757	714,694
ACT. PERIOD COST	72,067	64,548	81,312	92,428	76,019	69,791	67,524	82,685	60,986	0	0	0	0	667,361
VARIANCE, $	618	15,882	(8,092)	7,417	128	2,268	25,895	(11,720)	14,938	0	0	0	0	47,333
VARIANCE, %	0.8%	19.7%	-11.1%	7.4%	0.2%	3.1%	27.7%	-16.5%	19.7%	0.0%	0.0%	0.0%	0.0%	6.6%
EST. FY CUMUL	72,685	153,115	226,335	326,180	402,327	474,386	567,805	638,770	714,694	795,402	867,816	947,505	1,020,262	
ACTUAL FY CUMUL	72,067	136,615	217,927	310,355	386,374	456,165	523,689	606,375	667,361	0	0	0	0	
PERCENT COMPLETE	7.1%	13.4%	21.4%	30.4%	37.9%	44.7%	51.3%	59.4%	65.4%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	618	16,500	8,408	15,825	15,953	18,221	44,116	32,395	47,333	0	0	0	0	
VARIANCE, %	0.8%	10.8%	3.7%	4.9%	4.0%	3.8%	7.8%	5.1%	6.6%	0.0%	0.0%	0.0%	0.0%	



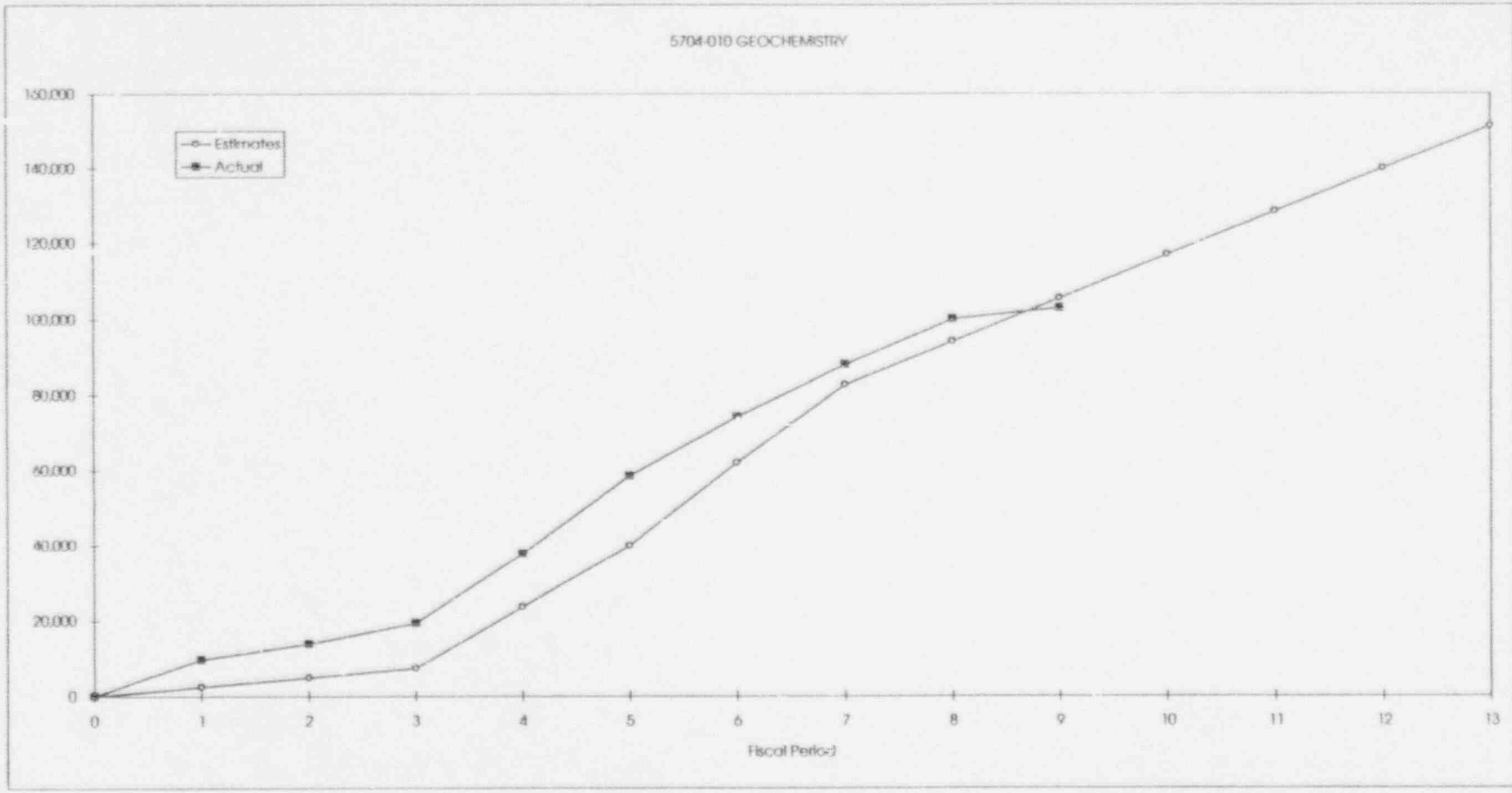
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	136,124	133,325	139,983	175,656	135,966	135,458	128,774	136,180	126,950	130,630	132,540	126,900	129,145	1,248,416
ACT. PERIOD COST	114,173	95,819	77,432	104,378	174,763	133,941	111,280	114,014	151,918	0	0	0	0	1,077,717
VARIANCE, $	21,951	37,506	62,551	71,278	(38,797)	1,517	17,494	22,166	(24,968)	0	0	0	0	170,699
VARIANCE, %	16.1%	28.1%	44.7%	40.6%	-28.5%	1.1%	13.6%	16.3%	-19.7%	0.0%	0.0%	0.0%	0.0%	13.7%
EST. FY CUMUL	136,124	269,449	409,432	585,088	721,054	856,512	985,286	1,121,466	1,248,416	1,379,046	1,511,586	1,638,486	1,767,631	
ACTUAL FY CUMUL	114,173	209,992	287,424	391,802	566,565	700,505	811,785	925,799	1,077,717	0	0	0	0	
PERCENT COMPLETE	6.5%	11.9%	16.3%	22.2%	32.1%	39.6%	45.9%	52.4%	61.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	21,951	59,457	122,008	193,286	154,489	156,007	173,501	195,667	170,699	0	0	0	0	
VARIANCE, %	16.1%	22.1%	29.8%	33.0%	21.4%	18.2%	17.6%	17.4%	13.7%	0.0%	0.0%	0.0%	0.0%	



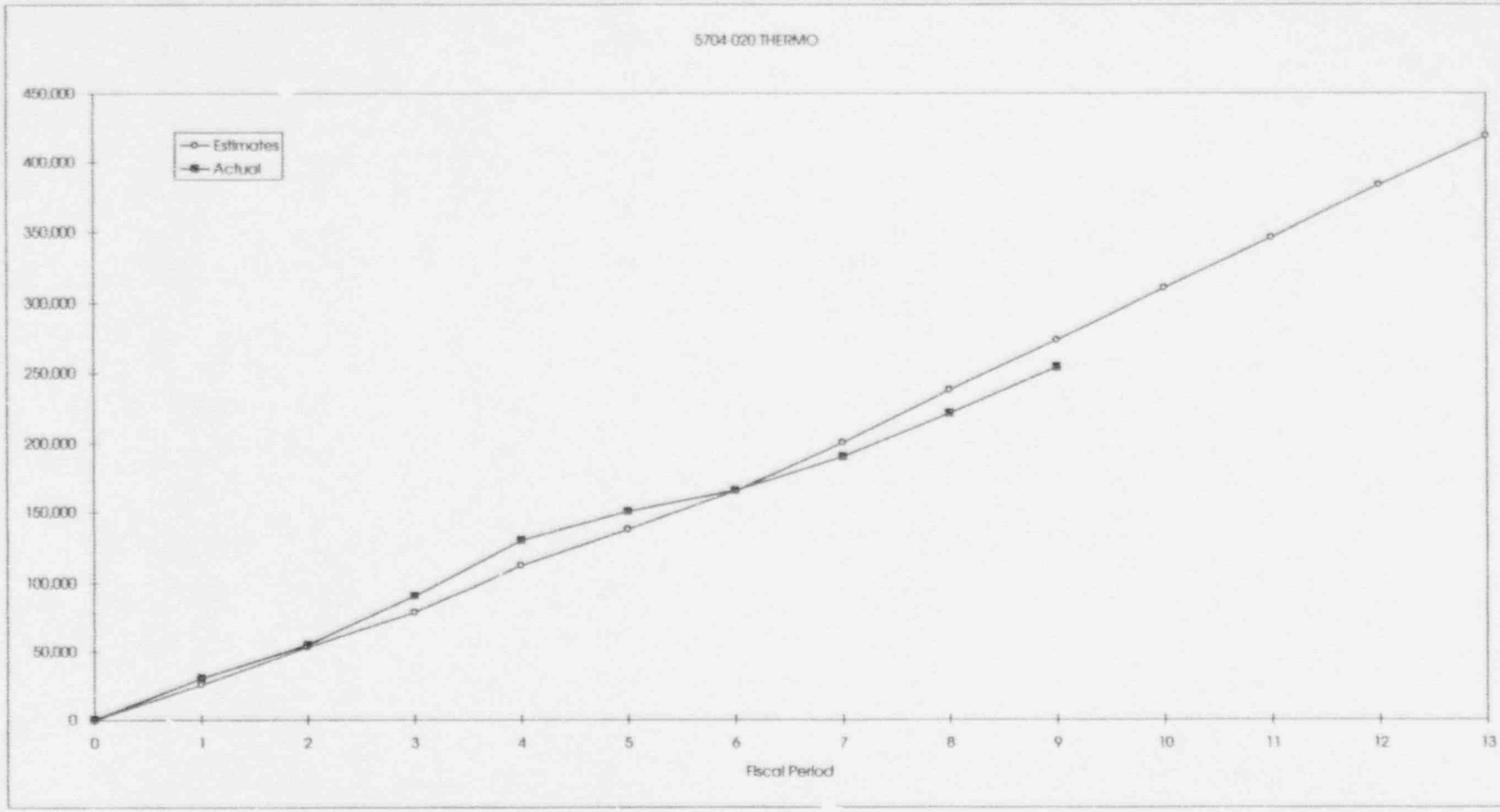
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	345,037	360,641	350,759	489,674	373,097	375,287	443,430	378,904	371,967	391,344	357,089	365,466	343,321	3,488,796
ACT. PERIOD COST	342,323	364,760	399,889	404,182	350,424	330,940	305,497	356,554	346,781	0	0	0	0	3,201,349
VARIANCE, $	2,714	(4,119)	(49,130)	85,492	22,673	44,347	137,933	22,350	25,186	0	0	0	0	287,447
VARIANCE, %	0.8%	-1.1%	-14.0%	17.5%	6.1%	11.8%	31.1%	5.9%	6.8%	0.0%	0.0%	0.0%	0.0%	8.2%
EST. FY CUMUL	345,037	705,678	1,056,437	1,546,111	1,919,208	2,294,495	2,737,925	3,116,829	3,488,796	3,880,140	4,237,229	4,602,695	4,946,016	
ACTUAL FY CUMUL	342,323	707,083	1,106,972	1,511,154	1,861,578	2,192,518	2,498,015	2,854,569	3,201,349	0	0	0	0	
PERCENT COMPLETE	6.9%	14.3%	22.4%	30.6%	37.6%	44.3%	50.5%	57.7%	64.7%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	2,714	(1,405)	(50,535)	34,957	57,630	101,977	239,910	262,260	287,447	0	0	0	0	
VARIANCE, %	0.8%	-0.2%	-4.8%	2.3%	3.0%	4.4%	8.8%	8.4%	8.2%	0.0%	0.0%	0.0%	0.0%	



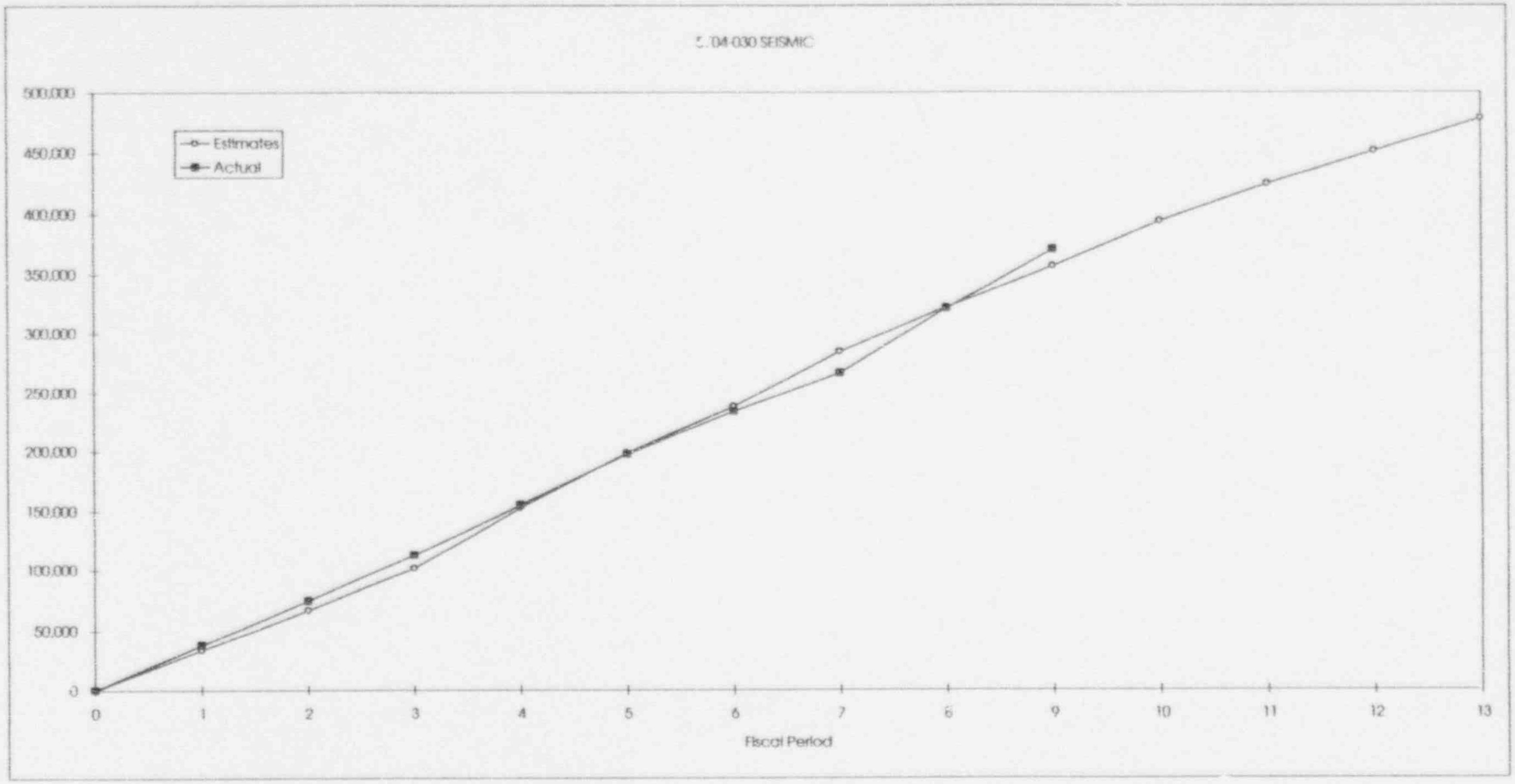
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	10,705	12,830	10,214	14,593	10,754	9,785	15,443	13,077	12,921	13,823	12,357	14,972	12,920	110,322
ACT. PERIOD COST	8,084	15,638	26,636	3,894	14,289	9,817	3,571	10,693	5,790	0	0	0	0	98,412
VARIANCE, $	2,621	(2,808)	(16,422)	10,699	(3,535)	(32)	11,872	2,384	7,131	0	0	0	0	11,910
VARIANCE, %	24.5%	-21.9%	-160.8%	73.3%	-32.9%	-0.3%	76.9%	18.2%	55.2%	0.0%	0.0%	0.0%	0.0%	10.8%
EST. FY CUMUL	10,705	23,535	33,749	48,342	59,096	68,881	84,324	97,401	110,322	124,145	136,502	151,474	164,394	
ACTUAL FY CUMUL	8,084	23,721	50,357	54,252	68,541	78,358	81,929	92,622	98,412	0	0	0	0	
PERCENT COMPLETE	4.9%	14.4%	30.6%	33.0%	41.7%	47.7%	49.9%	56.3%	59.9%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	2,621	(186)	(16,608)	(5,910)	(9,445)	(9,477)	2,395	4,779	11,910	0	0	0	0	
VARIANCE, %	24.5%	-0.8%	-49.2%	-12.2%	-16.0%	-13.8%	2.8%	4.9%	10.8%	0.0%	0.0%	0.0%	0.0%	



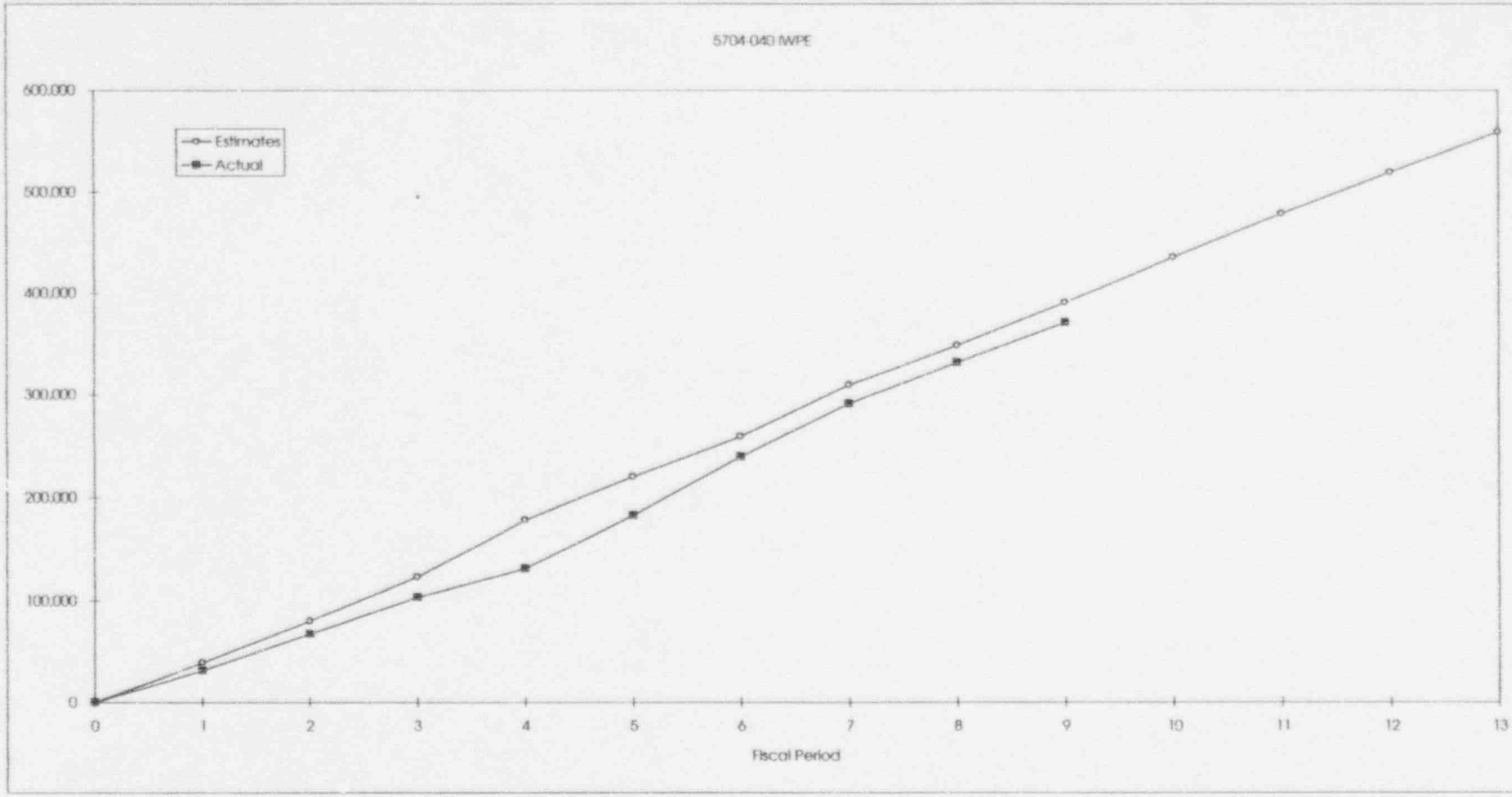
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	2,381	2,292	2,502	16,354	16,354	21,997	20,844	11,366	11,366	11,366	11,461	11,461	11,463	105,456
ACT. PERIOD COST	9,570	4,153	5,451	18,497	20,566	15,808	13,968	11,840	2,964	0	0	0	0	102,817
VARIANCE, $	(7,189)	(1,861)	(2,949)	(2,143)	(4,212)	6,189	6,877	(474)	8,402	0	0	0	0	2,639
VARIANCE, %	-301.9%	-81.2%	-117.9%	-13.1%	-25.8%	28.1%	33.0%	-4.2%	73.9%	0.0%	0.0%	0.0%	0.0%	2.5%
EST. FY CUMUL	2,381	4,673	7,175	23,529	39,883	61,880	82,724	94,090	105,456	116,822	128,283	139,744	151,207	
ACTUAL FY CUMUL	9,570	13,723	19,174	37,671	58,238	74,045	88,013	99,853	102,817	0	0	0	0	
PERCENT COMPLETE	6.3%	9.1%	12.7%	24.9%	38.5%	49.0%	58.2%	66.0%	68.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(7,189)	(2,050)	(11,999)	(14,142)	(18,355)	(12,165)	(5,289)	(5,763)	2,639	0	0	0	0	
VARIANCE, %	-301.9%	-193.7%	-167.2%	-60.1%	-46.0%	-19.7%	-6.4%	-6.1%	2.5%	0.0%	0.0%	0.0%	0.0%	



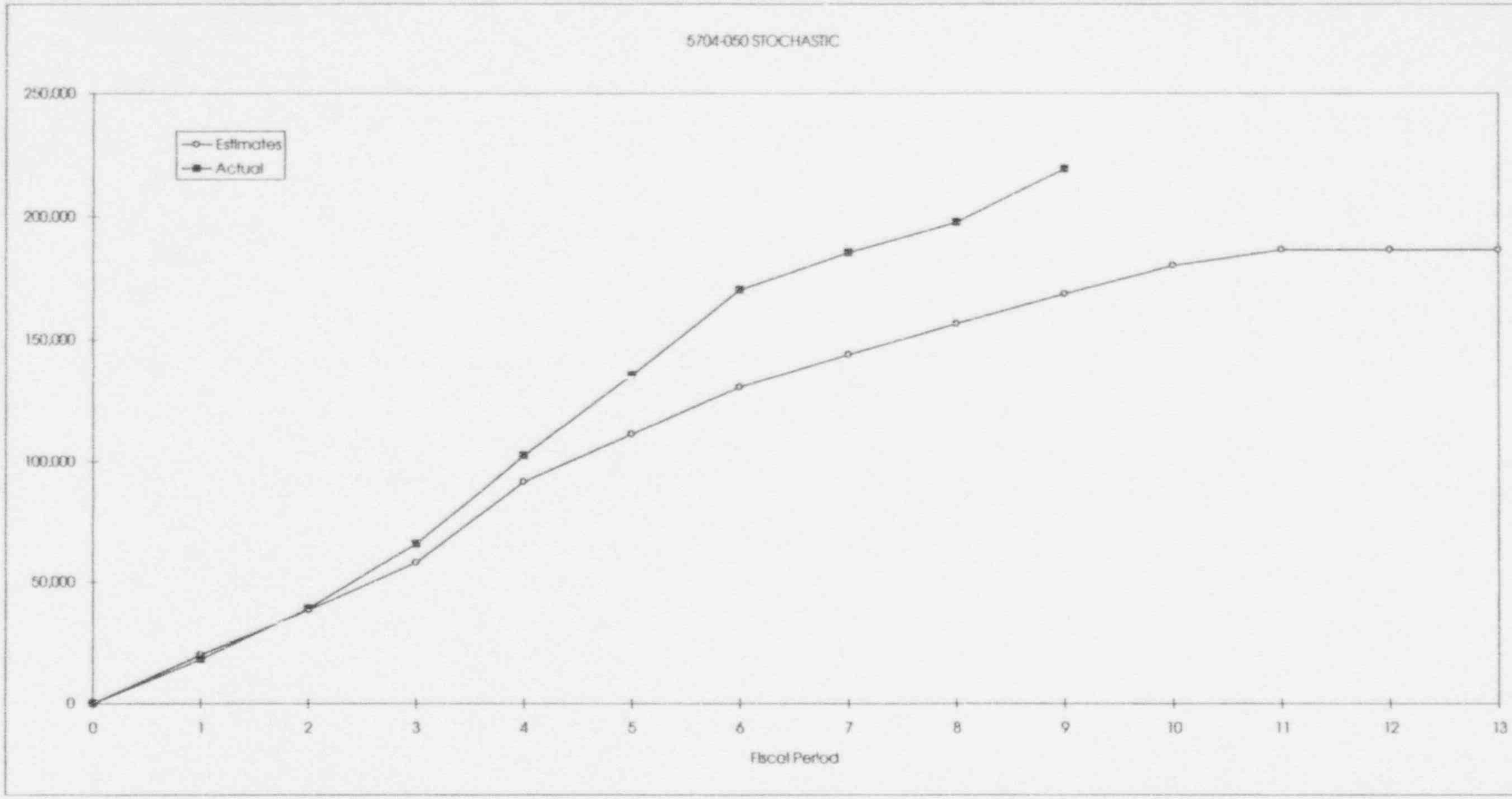
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	25,828	27,200	25,454	33,994	24,997	27,909	34,995	37,396	35,396	37,360	35,467	37,084	35,700	273,169
ACT. PERIOD COST	30,464	24,159	35,990	39,219	20,617	15,183	24,777	30,868	32,740	0	0	0	0	254,015
VARIANCE, $	(4,636)	3,041	(10,536)	(5,225)	4,380	12,726	10,218	6,528	2,657	0	0	0	0	19,154
VARIANCE, %	-18.0%	11.2%	-41.4%	-15.4%	17.5%	45.6%	29.2%	17.5%	7.5%	0.0%	0.0%	0.0%	0.0%	7.0%
EST. FY CUMUL	25,828	53,028	78,482	112,476	137,473	165,382	200,377	237,773	273,169	310,529	345,996	383,080	418,780	
ACTUAL FY CUMUL	30,464	54,623	90,613	129,832	150,449	165,632	190,408	221,276	254,015	0	0	0	0	
PERCENT COMPLETE	7.3%	13.0%	21.6%	31.0%	35.9%	39.6%	45.5%	52.8%	60.7%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(4,636)	(1,595)	(12,131)	(17,356)	(12,976)	(250)	9,969	16,497	19,154	0	0	0	0	
VARIANCE, %	-18.0%	-3.0%	-15.5%	-15.4%	-9.4%	-0.2%	5.0%	6.9%	7.0%	0.0%	0.0%	0.0%	0.0%	



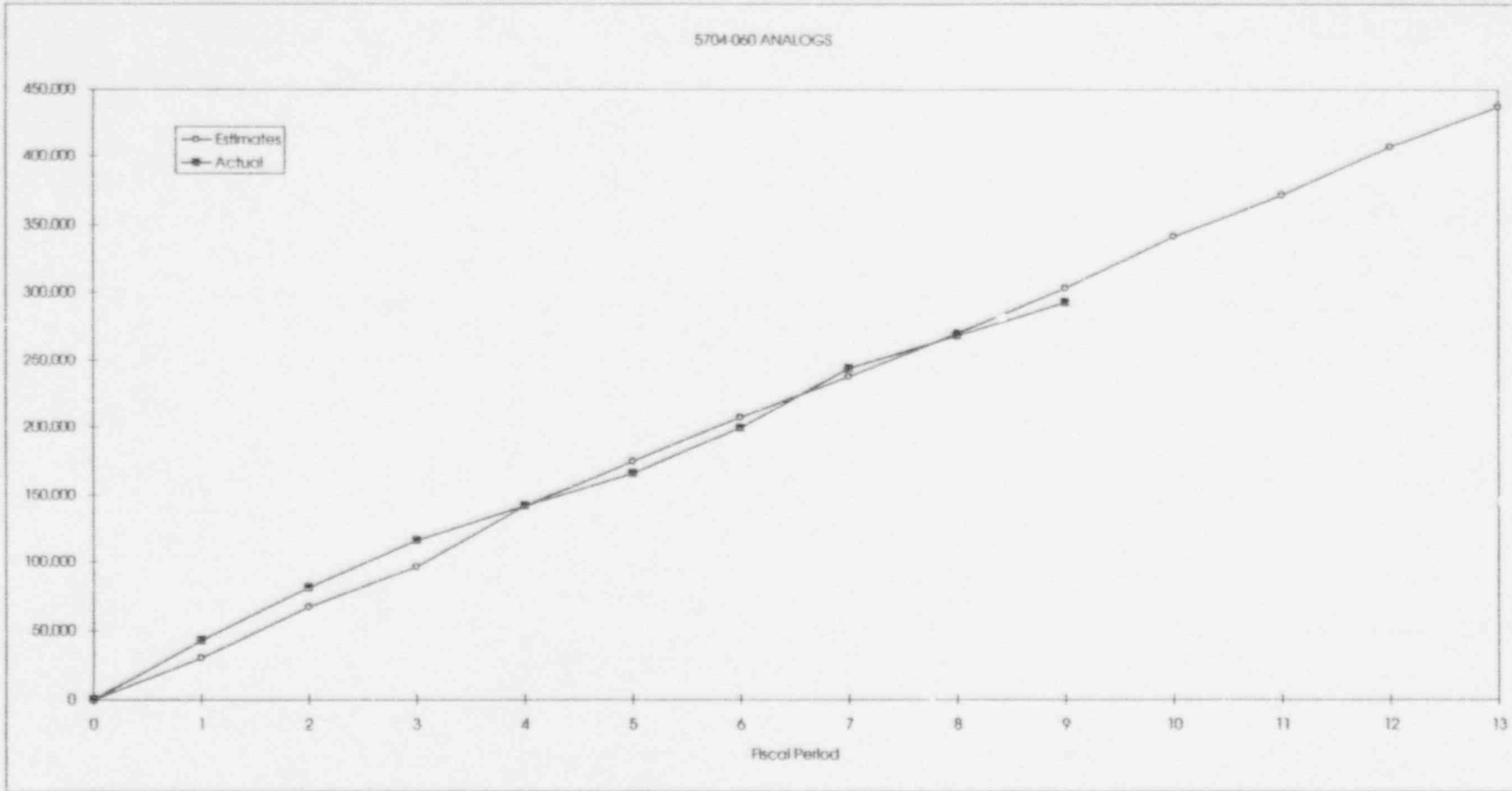
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	33,622	33,080	34,675	51,591	45,249	39,412	46,631	37,487	34,798	37,497	30,447	26,518	26,679	356,545
ACT. PERIOD COST	37,662	36,655	38,201	42,511	42,271	36,476	32,597	54,679	49,077	0	0	0	0	370,129
VARIANCE, $	(4,040)	(3,575)	(3,526)	9,080	2,978	2,936	14,034	(17,192)	(14,279)	0	0	0	0	(13,584)
VARIANCE, %	-12.0%	-10.8%	-10.2%	17.6%	6.6%	7.4%	30.1%	-45.9%	-41.0%	0.0%	0.0%	0.0%	0.0%	-3.8%
EST. FY CUMUL	33,622	66,702	101,377	152,968	198,217	237,629	284,260	321,747	356,545	394,042	424,489	451,007	477,686	
ACTUAL FY CUMUL	37,662	74,317	112,518	155,028	197,299	233,776	266,373	321,052	370,129	0	0	0	0	
PERCENT COMPLETE	7.9%	15.6%	23.6%	32.5%	41.3%	48.9%	55.8%	67.2%	77.5%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(4,040)	(7,615)	(11,141)	(2,060)	918	3,853	17,887	695	(13,584)	0	0	0	0	
VARIANCE, %	-12.0%	-11.4%	-11.0%	-1.3%	0.5%	1.6%	6.3%	0.2%	-3.8%	0.0%	0.0%	0.0%	0.0%	



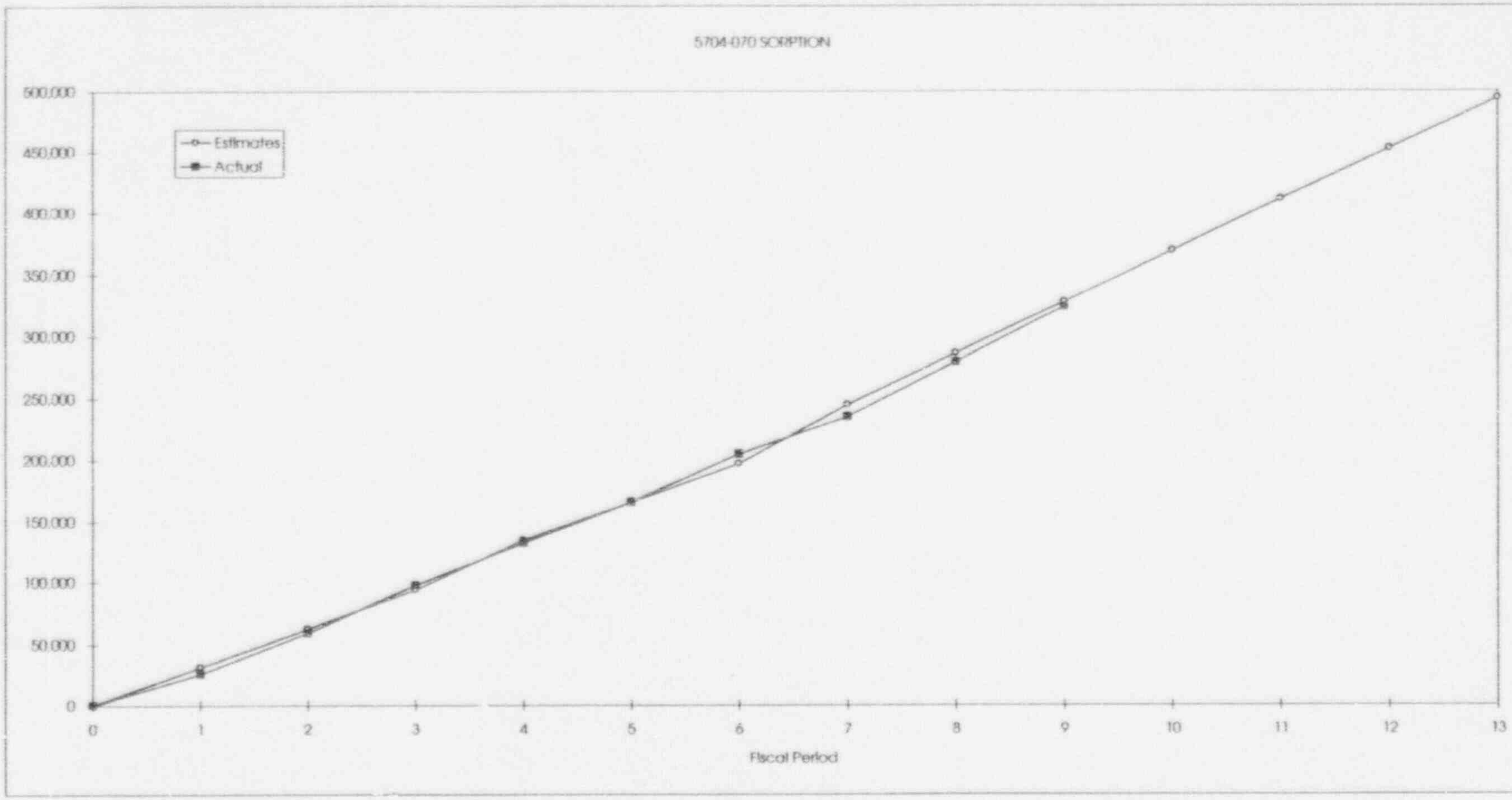
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	39,126	41,310	43,232	54,736	41,652	38,840	50,775	38,681	42,344	44,233	43,218	41,167	39,654	390,696
ACT. PERIOD COST	31,353	36,368	35,843	28,347	50,692	56,819	51,580	40,435	39,281	0	0	0	0	370,717
VARIANCE, $	7,773	4,942	7,389	26,389	(9,040)	(17,979)	(805)	(1,754)	3,063	0	0	0	0	19,979
VARIANCE, %	19.9%	12.0%	17.1%	48.2%	-21.7%	-46.3%	-1.6%	-4.5%	7.2%	0.0%	0.0%	0.0%	0.0%	5.1%
EST. FY CUMUL	39,126	80,436	123,668	178,404	220,056	258,896	309,671	348,352	390,696	434,929	478,147	519,314	558,968	
ACTUAL FY CUMUL	31,353	67,721	103,564	131,911	182,603	239,422	291,001	331,436	370,717	0	0	0	0	
PERCENT COMPLETE	5.6%	12.1%	18.5%	23.6%	32.7%	42.8%	52.1%	59.3%	66.3%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	7,773	12,715	20,104	46,493	37,453	19,474	18,670	16,916	19,979	0	0	0	0	
VARIANCE, %	19.9%	15.8%	16.3%	26.1%	17.0%	7.5%	6.0%	4.9%	5.1%	0.0%	0.0%	0.0%	0.0%	



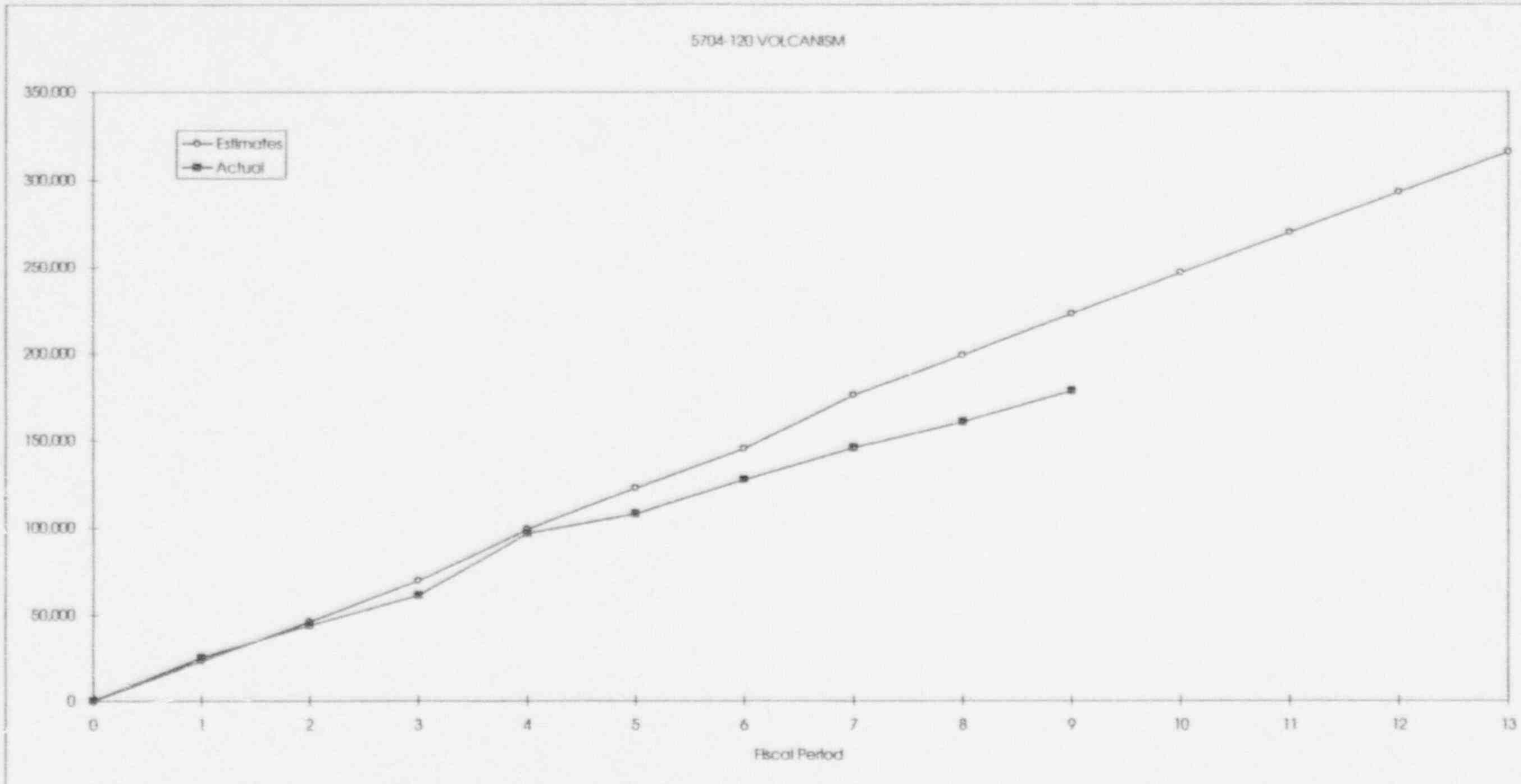
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	19,575	18,792	19,609	33,801	19,404	19,049	13,384	12,796	11,900	11,900	6,297	0	0	168,310
ACT. PERIOD COST	17,707	21,171	26,806	36,731	32,646	34,990	15,381	12,314	21,424	0	0	0	0	219,170
VARIANCE, $	1,868	(2,379)	(7,197)	(2,930)	(13,242)	(15,941)	(1,997)	482	(9,524)	0	0	0	0	(50,860)
VARIANCE, %	9.5%	-12.7%	-36.7%	-8.7%	-68.2%	-83.7%	-14.9%	3.8%	-80.0%	0.0%	0.0%	0.0%	0.0%	-30.2%
EST. FY CUMUL	19,575	38,367	57,976	91,777	111,181	130,230	143,614	156,410	168,310	180,210	186,507	186,507	186,507	
ACTUAL FY CUMUL	17,707	38,878	65,684	102,415	135,062	170,052	185,433	197,747	219,170	0	0	0	0	
PERCENT COMPLETE	9.5%	20.8%	35.2%	54.9%	72.4%	91.2%	99.4%	106.0%	117.5%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	1,868	(511)	(7,708)	(10,638)	(23,881)	(39,822)	(41,819)	(41,337)	(50,860)	0	0	0	0	
VARIANCE, %	9.5%	-1.3%	-13.3%	-11.6%	-21.5%	-30.6%	-29.1%	-26.4%	-30.2%	0.0%	0.0%	0.0%	0.0%	



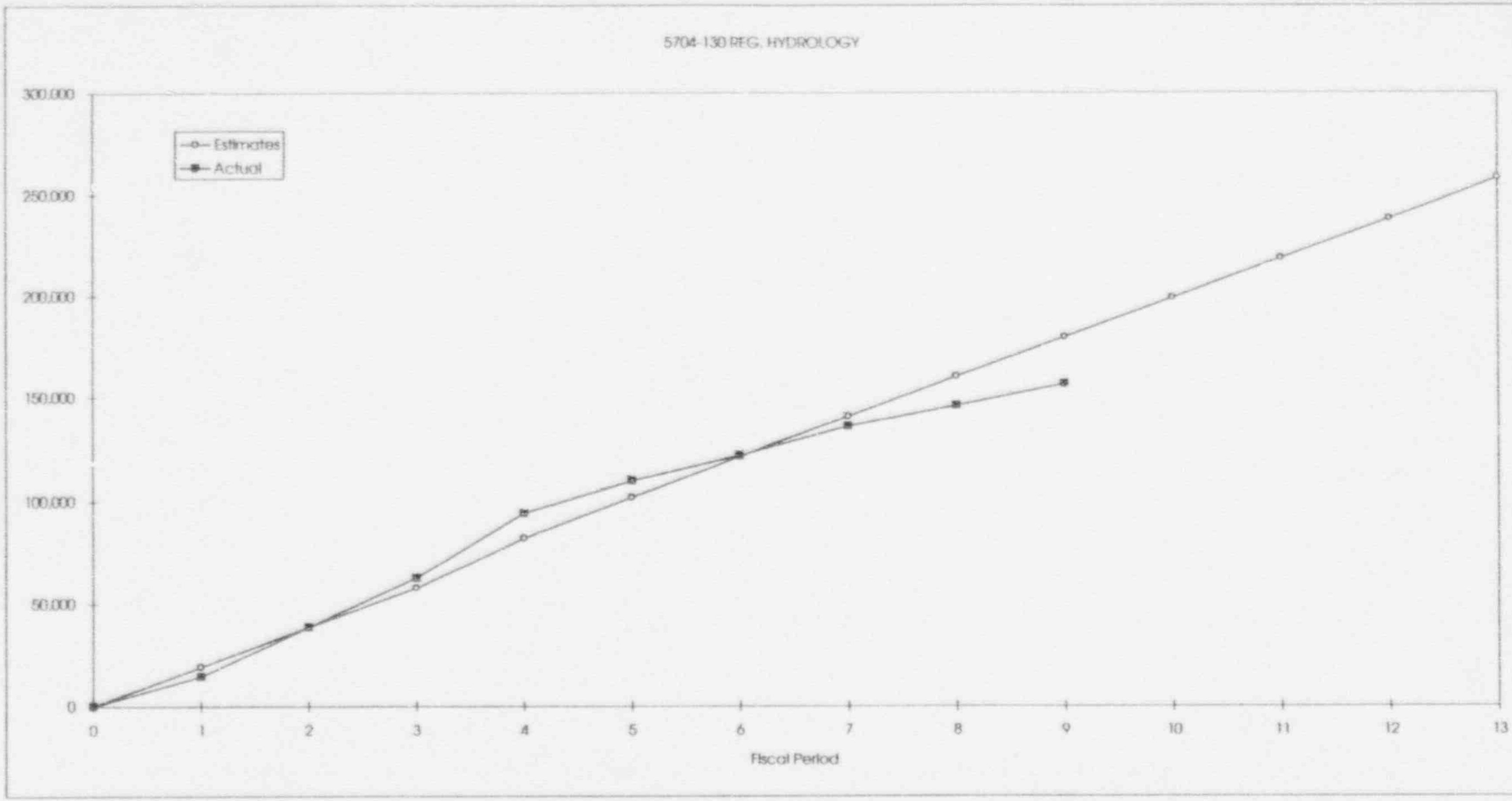
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	30,461	35,818	29,786	45,606	33,067	32,420	30,166	32,428	33,275	38,121	29,862	35,818	29,841	303,027
ACT. PERIOD COST	42,564	37,938	35,406	25,782	24,303	33,431	44,233	24,442	24,492	0	0	0	0	292,590
VARIANCE, $	(12,103)	(2,120)	(5,620)	19,824	8,764	(1,011)	(14,067)	7,987	8,783	0	0	0	0	10,437
VARIANCE, %	-39.7%	-5.9%	-18.9%	43.5%	26.5%	-3.1%	-46.6%	24.6%	26.4%	0.0%	0.0%	0.0%	0.0%	3.4%
EST. FY CUMUL	30,461	66,279	96,065	141,671	174,738	207,158	237,324	269,752	303,027	341,148	371,010	406,828	436,669	
ACTUAL FY CUMUL	42,564	80,502	115,908	141,690	165,992	199,424	243,656	268,098	292,590	0	0	0	0	
PERCENT COMPLETE	9.7%	18.4%	26.5%	32.4%	38.0%	45.7%	55.8%	61.4%	67.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(12,103)	(14,223)	(19,843)	(19)	8,746	7,734	(6,332)	1,654	10,437	0	0	0	0	
VARIANCE, %	-39.7%	-21.5%	-20.7%	0.0%	5.0%	3.7%	-2.7%	0.6%	3.4%	0.0%	0.0%	0.0%	0.0%	



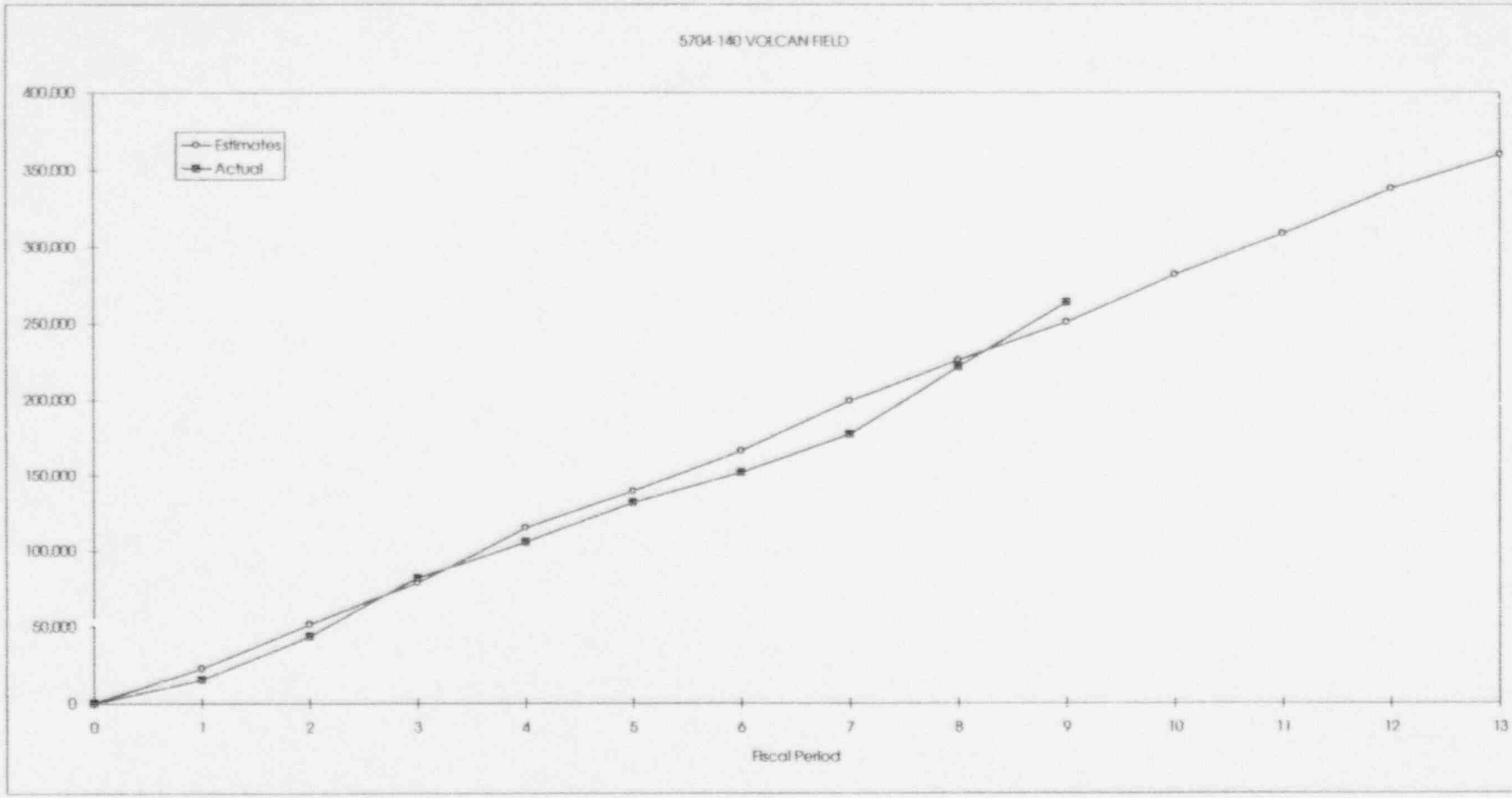
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	31,291	31,043	31,271	41,047	30,992	31,141	47,926	41,408	41,699	41,383	41,647	41,500	41,778	327,818
ACT. PERIOD COST	25,722	33,108	38,493	35,263	33,063	39,302	30,134	43,846	44,927	0	0	0	0	323,858
VARIANCE, $	5,569	(2,065)	(7,222)	5,784	(2,071)	(8,161)	17,792	(2,438)	(3,228)	0	0	0	0	3,960
VARIANCE, %	17.8%	-6.7%	-23.1%	14.1%	-6.7%	-26.2%	37.1%	-5.9%	-7.7%	0.0%	0.0%	0.0%	0.0%	1.2%
EST. FY CUMUL	31,291	62,334	93,605	134,652	165,644	196,785	244,711	286,119	327,818	369,201	410,848	452,348	494,126	
ACTUAL FY CUMUL	25,722	58,830	97,323	132,586	165,649	204,951	235,085	278,931	323,858	0	0	0	0	
PERCENT COMPLETE	5.2%	11.9%	19.7%	26.8%	33.5%	41.5%	47.6%	56.4%	65.5%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	5,569	3,504	(3,718)	2,066	(5)	(8,166)	9,626	7,188	3,960	0	0	0	0	
VARIANCE, %	17.8%	5.6%	-4.0%	1.5%	0.0%	-4.1%	3.9%	2.5%	1.2%	0.0%	0.0%	0.0%	0.0%	



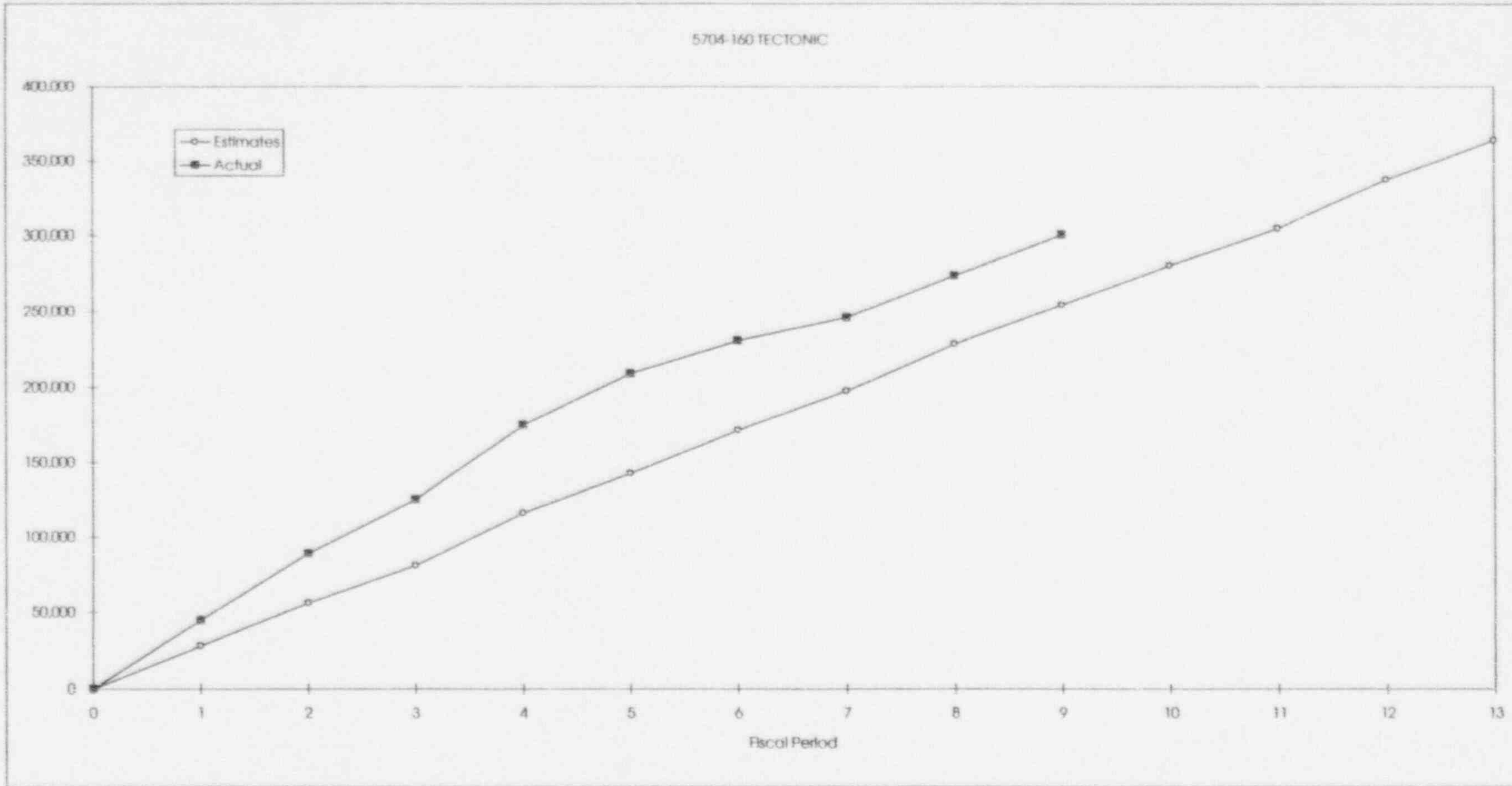
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	23,268	22,780	23,376	29,743	23,388	22,798	30,359	22,761	23,696	24,298	23,188	23,091	23,054	222,169
ACT. PERIOD COST	25,206	19,156	16,566	35,830	11,197	19,485	18,454	14,519	17,534	0	0	0	0	177,946
VARIANCE, $	(1,938)	3,624	6,810	(6,087)	12,191	3,313	11,905	8,242	6,162	0	0	0	0	44,223
VARIANCE, %	-8.3%	15.9%	29.1%	-20.5%	52.1%	14.5%	39.2%	36.2%	26.0%	0.0%	0.0%	0.0%	0.0%	19.9%
EST. FY CUMUL	23,268	46,048	69,424	99,167	122,555	145,353	175,712	198,473	222,169	246,467	269,655	292,746	315,800	
ACTUAL FY CUMUL	25,206	44,363	60,928	96,758	107,955	127,440	145,894	160,412	177,946	0	0	0	0	
PERCENT COMPLETE	8.0%	14.0%	19.3%	30.6%	34.2%	40.4%	46.2%	50.8%	56.3%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(1,938)	1,685	8,496	2,409	14,600	17,913	29,818	38,061	44,223	0	0	0	0	
VARIANCE, %	-8.3%	3.7%	12.2%	2.4%	11.9%	12.3%	17.0%	19.2%	19.9%	0.0%	0.0%	0.0%	0.0%	



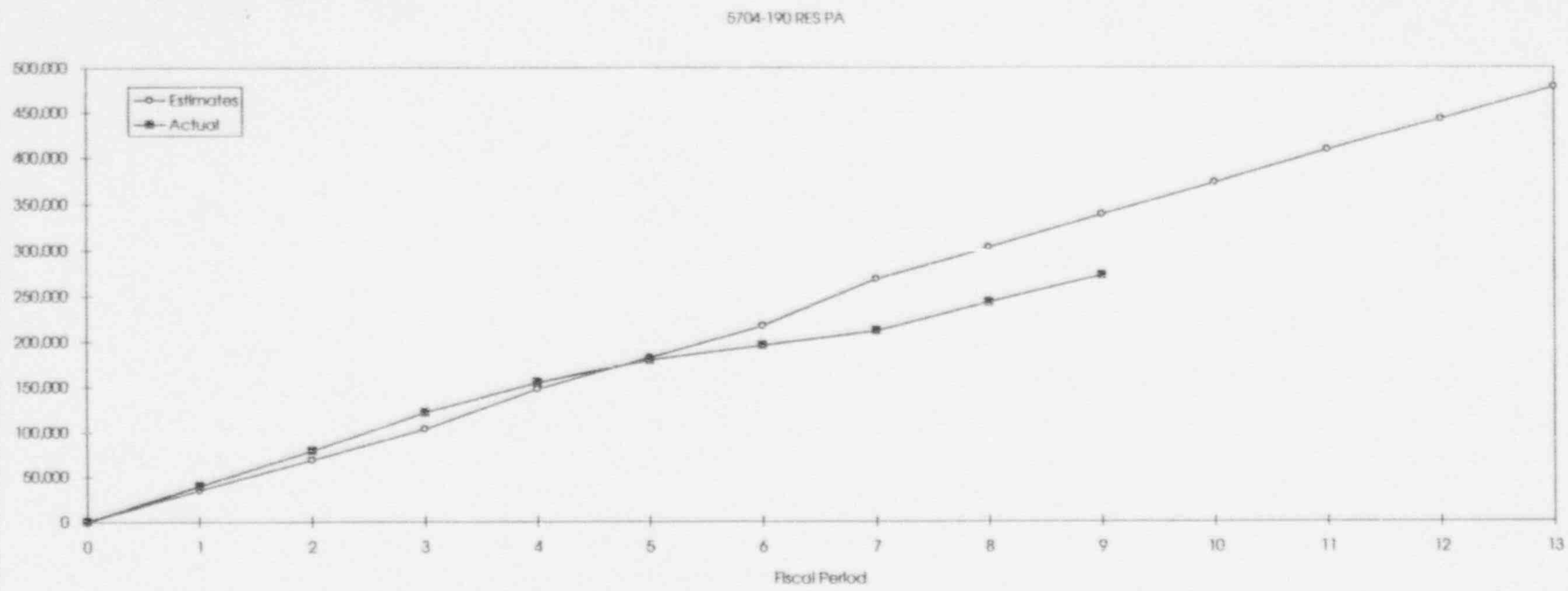
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	19,414	19,303	19,200	23,909	19,954	19,506	18,991	19,560	19,402	19,653	19,199	19,756	19,958	179,239
ACT. PERIOD COST	14,792	23,858	24,066	31,288	15,783	11,944	13,985	9,746	10,874	0	0	0	0	156,336
VARIANCE, $	4,622	(4,555)	(4,866)	(7,379)	4,171	7,562	5,006	9,814	8,528	0	0	0	0	22,903
VARIANCE, %	23.8%	-23.6%	-25.3%	-30.9%	20.9%	38.8%	26.4%	50.2%	44.0%	0.0%	0.0%	0.0%	0.0%	12.8%
EST. FY CUMUL	19,414	38,717	57,917	81,826	101,780	121,286	140,277	159,837	179,239	198,892	218,091	237,847	257,805	
ACTUAL FY CUMUL	14,792	38,650	62,716	94,004	109,787	121,731	135,716	145,462	156,336	0	0	0	0	
PERCENT COMPLETE	5.7%	15.0%	24.3%	36.5%	42.6%	47.2%	52.6%	56.4%	60.6%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	4,622	67	(4,799)	(12,178)	(8,007)	(445)	4,561	14,375	22,903	0	0	0	0	
VARIANCE, %	23.8%	0.2%	-8.3%	-14.9%	-7.9%	-0.4%	3.3%	9.0%	12.8%	0.0%	0.0%	0.0%	0.0%	



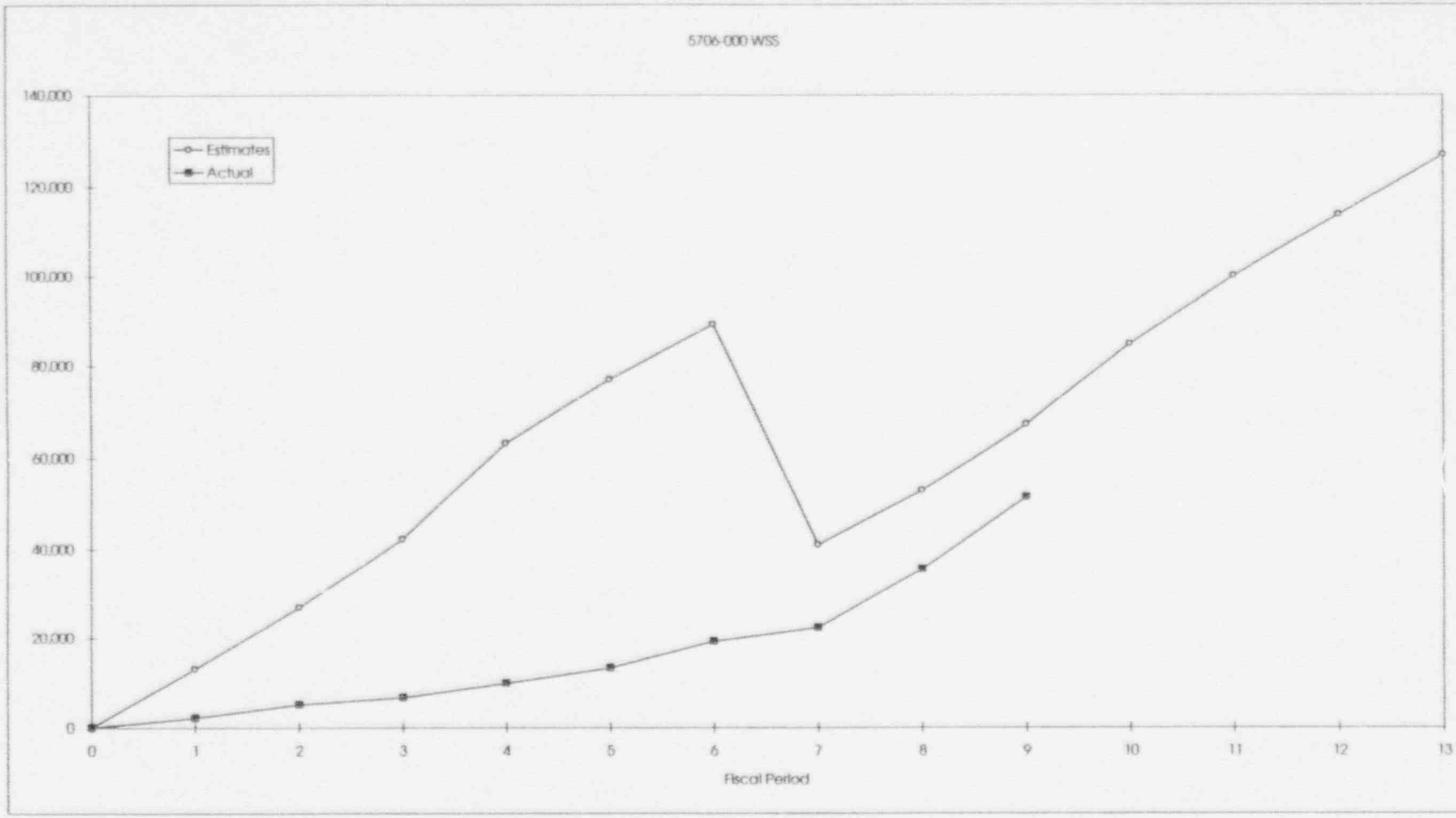
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	22,326	28,953	27,013	36,633	24,212	27,076	33,095	26,535	24,703	31,069	27,013	28,953	22,337	250,546
ACT. PERIOD COST	15,217	28,385	37,962	24,061	25,858	20,159	25,554	44,161	42,218	0	0	0	0	263,575
VARIANCE, $	7,109	568	(10,949)	12,573	(1,646)	6,917	7,541	(17,626)	(17,515)	0	0	0	0	(13,029)
VARIANCE, %	31.8%	2.0%	-40.5%	34.3%	-6.8%	25.5%	22.8%	-66.4%	-70.9%	0.0%	0.0%	0.0%	0.0%	-5.2%
EST. FY CUMUL	22,326	51,279	78,292	114,925	139,137	166,213	199,308	225,843	250,546	281,615	308,628	337,581	359,918	
ACTUAL FY CUMUL	15,217	43,602	81,564	105,625	131,483	151,643	177,196	221,357	263,575	0	0	0	0	
PERCENT COMPLETE	4.2%	12.1%	22.7%	29.3%	36.5%	42.1%	49.2%	61.5%	73.2%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	7,109	7,677	(3,272)	9,300	7,654	14,570	22,112	4,486	(13,029)	0	0	0	0	
VARIANCE, %	31.8%	15.0%	-4.2%	8.1%	5.5%	8.8%	11.1%	2.0%	-5.2%	0.0%	0.0%	0.0%	0.0%	



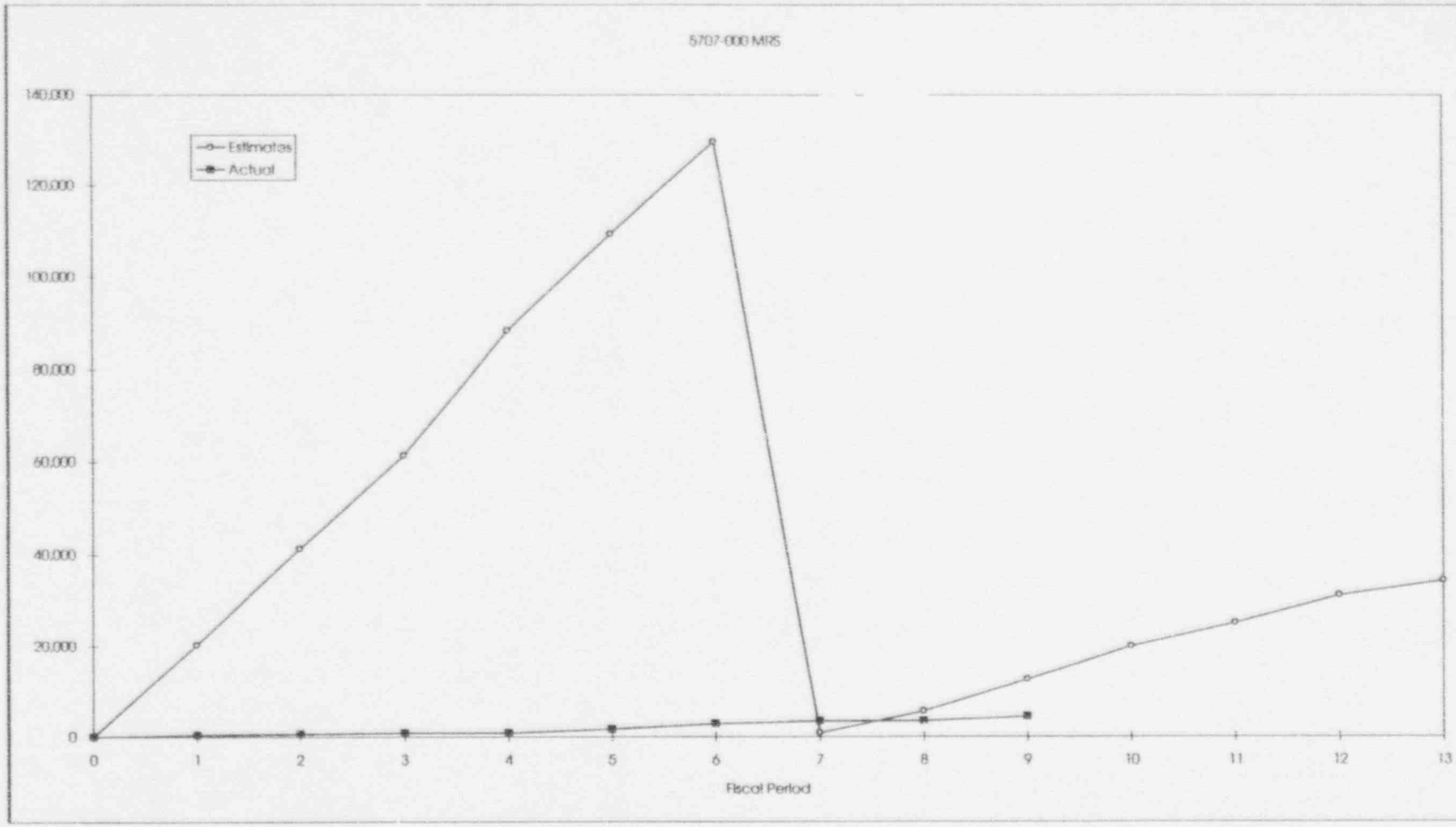
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	27,357	28,497	24,920	35,059	26,639	28,942	25,930	30,833	25,862	26,797	23,611	32,879	26,162	254,039
ACT. PERIOD COST	44,248	44,712	36,034	49,680	34,211	21,432	15,253	28,308	26,354	0	0	0	0	300,230
VARIANCE, $	(16,891)	(16,215)	(11,114)	(14,621)	(7,572)	7,510	10,677	2,525	(492)	0	0	0	0	(46,191)
VARIANCE, %	-61.7%	-56.9%	-44.6%	-41.7%	-28.4%	25.9%	41.2%	8.2%	-1.9%	0.0%	0.0%	0.0%	0.0%	-18.2%
EST. FY CUMUL	27,357	55,854	80,774	115,833	142,472	171,414	197,344	228,177	254,039	280,836	304,447	337,326	363,488	
ACTUAL FY CUMUL	44,248	88,960	124,994	174,673	208,884	230,316	245,569	273,876	300,230	0	0	0	0	
PERCENT COMPLETE	12.2%	24.5%	34.4%	48.1%	57.5%	63.4%	67.6%	75.3%	82.6%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(16,891)	(33,106)	(44,220)	(58,840)	(66,412)	(58,902)	(48,225)	(45,699)	(46,191)	0	0	0	0	
VARIANCE, %	-61.7%	-59.3%	-54.7%	-50.8%	-46.6%	-34.4%	-24.4%	-20.0%	-18.2%	0.0%	0.0%	0.0%	0.0%	



ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	34,787	33,902	34,624	44,272	34,767	34,597	50,874	34,725	35,348	34,540	35,052	34,253	35,392	337,896
ACT. PERIOD COST	39,733	39,459	42,436	33,080	24,928	16,094	16,012	30,705	29,107	0	0	0	0	271,554
VARIANCE, $	(4,946)	(5,557)	(7,812)	11,192	9,839	18,503	34,862	4,020	6,241	0	0	0	0	66,342
VARIANCE, %	-14.2%	-16.4%	-22.6%	25.3%	28.3%	53.5%	68.5%	11.6%	17.7%	0.0%	0.0%	0.0%	0.0%	19.6%
EST. FY CUMUL	34,787	68,689	103,313	147,585	182,352	216,949	267,823	302,548	337,896	372,436	407,488	441,741	477,133	
ACTUAL FY CUMUL	39,733	79,192	121,627	154,708	179,635	195,729	211,741	242,446	271,554	0	0	0	0	
PERCENT COMPLETE	8.3%	16.6%	25.5%	32.4%	37.6%	41.0%	44.4%	50.8%	56.9%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(4,946)	(10,503)	(18,314)	(7,123)	2,717	21,220	56,082	60,102	66,342	0	0	0	0	
VARIANCE, %	-14.2%	-15.3%	-17.7%	-4.8%	1.5%	9.8%	20.9%	19.9%	19.6%	0.0%	0.0%	0.0%	0.0%	



ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	13,040	13,732	15,343	21,070	13,720	12,282	(48,252)	11,730	14,498	17,559	15,343	13,732	13,071	67,163
ACT. PERIOD COST	2,192	2,956	1,534	3,099	3,547	5,854	3,070	13,199	15,780	0	0	0	0	51,230
VARIANCE, $	10,848	10,776	13,809	17,971	10,173	6,429	(51,322)	(1,469)	(1,282)	0	0	0	0	15,933
VARIANCE, %	83.2%	78.5%	90.0%	85.3%	74.1%	52.3%	106.4%	-12.5%	-8.8%	0.0%	0.0%	0.0%	0.0%	23.7%
EST. FY CUMUL	13,040	26,772	42,115	63,185	76,905	89,187	40,935	52,665	67,163	84,722	100,065	113,797	126,868	
ACTUAL FY CUMUL	2,192	5,148	6,682	9,780	13,327	19,181	22,250	35,450	51,230	0	0	0	0	
PERCENT COMPLETE	1.7%	4.1%	5.3%	7.7%	10.5%	15.1%	17.5%	27.9%	40.4%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	10,848	21,624	35,433	53,405	63,578	70,006	18,685	17,215	15,933	0	0	0	0	
VARIANCE, %	83.2%	80.8%	84.1%	84.5%	82.7%	78.5%	45.6%	32.7%	23.7%	0.0%	0.0%	0.0%	0.0%	



ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	20,274	21,106	19,958	26,772	21,184	20,272	(128,721)	4,668	7,081	7,334	5,144	5,935	3,239	12,594
ACT. PERIOD COST	297	321	206	37	835	1,160	558	63	939	0	0	0	0	4,415
VARIANCE, $	19,977	20,785	19,752	26,736	20,349	19,112	(129,279)	4,605	6,142	0	0	0	0	8,179
VARIANCE, %	98.5%	98.5%	99.0%	99.9%	96.1%	94.3%	100.4%	98.7%	86.7%	0.0%	0.0%	0.0%	0.0%	64.9%
EST. FY CUMUL	20,274	41,380	61,338	88,110	109,294	129,566	845	5,513	12,594	19,928	25,072	31,007	34,246	
ACTUAL FY CUMUL	297	618	824	860	1,696	2,856	3,414	3,476	4,415	0	0	0	0	
PERCENT COMPLETE	0.9%	1.8%	2.4%	2.5%	5.0%	8.3%	10.0%	10.2%	12.9%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	19,977	40,762	60,514	87,250	107,598	126,710	(2,569)	2,037	8,179	0	0	0	0	
VARIANCE, %	98.5%	98.5%	98.7%	99.0%	98.4%	97.8%	-304.0%	36.9%	64.9%	0.0%	0.0%	0.0%	0.0%	