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PROJECT SUMMARY

CENTRAL DESIGN GROUP (CDG)

Magnet Program

The Magnet Industrialization Program Evaluation Board met in Chicago on October 18 to review the 27 applications received from industry. The merit of each application was evaluated, and preparations were made for making recommendations to the Selecting Official.

A second review of the "Prime Item Requirement Document for the Collider Ring Dipole Magnets" was held at the CDG on October 19.

A preliminary report of the modal tests carried out on magnet DD0014 at FNAL last month was received by the CDG. It was determined that the apparent discrepancies between the theoretical model and the test results should be resolved by the two consultants.

Magnet DD0015 was installed and checked out.

The CDG proposal for instrumentation of long magnets DD0016–18 was circulated to the labs. Agreement was reached on the instrumentation for the next long magnet, DD0016.

Extensive analysis was performed on voltage-tap data from magnet DD0012, including all spontaneous and spot-heater quenches at 4.4 K.

Automation of data-file transfer from FNAL began. Improvement of the MTF cryogenic monitoring software continued. One goal is to make recalibration and reanalysis of recent strain-gauge data possible.

A cable data meeting was held on October 5 at the CDG to develop database specifications and organization.

Accelerator Physics

The Correction Elements Working Group studied the possibility of correcting systematic b_3 and b_4 multipole errors in the spool pieces only, the effects of random errors in the dipoles, the effects on the linear optics of introducing a small gap in the middle of each half-cell, and the effects of systematic b_5 in the quadrupoles.

Effects of a finite crossing angle continue to be assessed.

Long-term tracking studies include synchrotron motion.

The design of the linac was reviewed in a workshop attended by scientists from Fermilab, LBL, Los Alamos National Laboratory, and the CDG.

The design of the recently proposed injection module from the linac to the low-energy booster was reexamined to consider the possibility of injecting H^- ions at twice the kinetic energy contemplated in the CDR.

Conventional Facilities

Work continued with RTK and with M. Gilchriese to develop design concepts for the collision halls and associated staging areas. The designs are sufficiently advanced to begin considering the impact of example construction schedules on the overall project schedule.

With the help of the Accelerator Physics Division, substantial progress was made with RTK on developing the tools to adapt lattices to the chosen site. A digital characterization of the site footprint was developed, and the lattice was digitized with an automated transformation into state planar coordinates.

Conventional facilities planning for the remainder of FY89 was presented to the URA Board of Overseers. Emphasis will be on preparation of a site-specific conceptual design report for conventional facilities, which will lead to land acquisition and a supplemental Environmental Impact Statement.

Workshops were held with RTK on geotechnical characterization of the chosen site and on specification of the footprint on the site.

Division members attended a session of the USNC/TT Subcommittee on Contracting Practices and a session of the Chicago Chapter of the Society of Health Physicists.

The long-awaited *SSC Safety Review Document* was released as an SSC special report during October.

BROOKHAVEN NATIONAL LABORATORY (BNL)

All inner and outer coils for DD0016 were wound and cured using the improved tooling. The first coil for DD0017 was produced.

DSS14 was successfully collared.

All collar laminations have been received for rebuilt magnet DDA010. An order was placed for collars for DD0019, to be produced from Kawasaki high-manganese steel.

D0012 has been disassembled and coil size measurements are in progress.

All drawings for Phase I of the Industrialization Program have been forwarded to the CDG, and good progress is being made on the written documentation.

FERMI NATIONAL ACCELERATOR LABORATORY (FNAL)

The first round of tests on magnet DD0015 was completed. The magnet has a collared coil that is free to move within the yoke; it is constrained only at the magnet center. Four training quenches were required to reach limiting plateau current on the lower outer coil. The lower outer coil was recycled from magnet D000Z. Three of the four training quenches originated in the lower inner-to-outer-coil ramp splice, known to be weakly supported. All things considered, this magnet performed remarkably well.

Two important milestones were passed in assembling the dipole coil tooling: the long tooling assembly table was completed, and stacking of the tooling lamination began. The concrete foundation for the yoke/skinning press was completed.

Magnets DD0011, DD0014, and D000X were disassembled. The disassembly of DD0014 revealed buckling of the 20-K shield at a weld joint. The cause of this problem is being investigated.

A model magnet for studying structural response at ambient temperature will be constructed using the D0004 cold mass.

LAWRENCE BERKELEY LABORATORY (LBL)

The prototype production cabling machine was installed and tested at New England Electric Wire. Only a few minor adjustments were necessary. This machine will be used to make wire for the next long magnet campaign.

The most recent LBL magnet, D15B-1, differs in two important ways from the previous series of LBL SSC model dipoles, D15A-X. The main new feature is a new "constant-perimeter" end with an internal support (called the Royet end). The second change, which will be incorporated in future LBL dipole models, is a stiffer clamping system for the horizontally split iron. At 4.3 K the first quench was at 6544 A and the plateau value of 6950 A was reached on the third

quench. After a room-temperature thermal cycle, there was no retraining. Only one quench occurred in the outer layer; the rest originated in the inner layer. Training at 1.8 K was somewhat slow: quenches occurred in both the inner and outer layers. Quenches occurred in the outer layers up to 9400 A and in the inner layers from there up to the peak of 9578 A. This current is a record for the SSC model dipoles and corresponds to a central field of 9.1 teslas.

Winding of 4 coils for LBL's first flared-end model, D15C-1, was completed, and the coils are 50 percent assembled.

Preliminary magnetic design was done on a 22-turn-per-pole and a 20-turn-per-pole magnet. The effect of thicker collars on the field gradient and the maximum field at the conductor were investigated.

CDG REPORT

MAGNET PROGRAM

Magnet Industrialization Program

Following the receipt of 27 applications from industrial companies for participation in Phase I of the Magnet Industrialization Program, the Evaluation Board met in Chicago on October 18. The applications were reviewed and evaluated by the board, and preparations were made for sending the board recommendations to the Selecting Official. DOE officials were also present during the proceedings. Successful candidates will be announced before the end of the calendar year.

In connection with the Magnet Industrialization Program, CDG personnel visited BNL on October 25–26 to discuss the preparation of documentation, to coordinate Phase I activities, and to start preparation for Phase II.

A second review of the "Prime Item Requirement Document for the Collider Ring Dipole Magnets" was held at the CDG on October 19. This document is being edited by J. Knafelc of Martin Marietta, Inc., under a personal services contract. A revised copy of the Prime Item Requirement Document for the Collider Ring Dipole Magnets will be issued early next month, accompanied by Request for Action documents for each item that is missing or incomplete.

An area of the Prime Item Requirement Document that will require further effort is specification of applicable documents. The contract with Martin Marietta will be extended to cover a review of such documents. The specification of the dipole magnet will require the definition of quality control steps to be carried out during the fabrication and assembly of the magnets. Details of such quality control processes are planned to be developed through a contract with Westinghouse Electric Corporation, which will be started next month.

Cryostat Dynamic Analysis

A preliminary report of the modal tests carried out on magnet DD0014 at FNAL last month was received by the CDG. W. Vogen of Vibration Engineering presented the results at a meeting held at the CDG on October 20. Present at the meeting were CDG and FNAL personnel and B. Benda of EQE, Inc., who had performed a mathematical dynamic analysis of the magnet. There were some discrepancies between the theoretical model and the test results; the two consultants will attempt to resolve these discrepancies and to bring the calculations and test results into agreement.

To better understand the transportation environment of a long dipole magnet, it was decided that a test assembly, DSHIP, will be constructed at FNAL. This test magnet will use an old "dummy" cold mass installed in a new Iteration B cryostat. The assembly will be instrumented

with accelerometer and strain gauges and, when complete, will be mounted on a trailer and tested under a variety of road conditions.

Magnet Tests

Installation and checkout of magnet DD0015 was completed. CDG personnel participated in some of the checkout and initial cold tests; the actual quench testing is scheduled to begin November 1.

Instrumentation for Magnets DD0016–18

The CDG proposal for instrumentation of the next series of long magnets, DD0016–18, was circulated to the labs. Agreement was reached on the instrumentation for the next long magnet, DD0016. The CDG suggestion for new temperature and helium-flow sensors was followed by a more detailed proposal for sensors and a plan of action to be presented at the next MSI meeting.

Mathematical Analysis

Work continues on the ANSYS model of the C358 cross section. The model has two features not present in the previous NC9 model: First, the yoke and shell are explicitly included as mechanical elements. Second, magneto-mechanical elements are included so that the forces on coil and yoke can be calculated internally by the program; previously, forces were calculated separately and entered as input. The model appears to form a satisfactory mesh and to behave reasonably under assembly loading; detailed checking is in progress. Reports are still being written for NC9 that summarize Lorentz loading and the use of the yoke as a structural element.

Because the yoke is made of low-carbon steel, it becomes very brittle below –50°C, and because of the way it interacts with the collared coil, it is impossible to avoid bending that creates tensile stress in certain regions. Therefore, an investigation was made into the possibility of failure of the iron yoke due to tensile forces at stress concentration points. Both brittle failure and fatigue crack growth were considered as possible failure modes, and it was determined that brittle fracture is the most likely mechanism of failure. There is no fatigue: parts either fail in the first few cycles if they contain a crack of greater than critical size, or they last indefinitely. For a yoke split on the horizontal midplane and a shell stress due to welding and cooldown of 40 kpsi, the critical crack size is 0.16 inches.

Data Analysis

CDG personnel continue to participate in the analysis of long-magnet test data. In parallel with the routine preparation of plots for distribution and reports, a detailed study was performed of a troublesome artifact in the shell-strain-gauge data seen on all long magnets. The shell strains depend upon some parameter of refrigerator operation that is not simply related to the magnet

pressure or temperature. This dependence does not appear to affect the variation of strain with magnet current, but it does seriously interfere with our ability to determine cooldown strains.

Extensive analysis was performed on voltage-tap data from magnet DD0012, including all spontaneous and spot heater quenches at 4.4 K. SSC internal reports were published on these results.

Software Development

Work began to automate data-file transfer from FNAL. New command procedures were written to identify and copy new data from the MTF computers to the local CDG VAX cluster. Work was also begun to understand and implement the new SDS data prescription in quench data files. CDG personnel continued to help the MTF staff upgrade their cryogenic monitoring software. Additional programming effort was directed toward making it possible to recalibrate and reanalyze recent strain-gauge data. Tables of material properties and magnet characteristics are being developed for use in detailed analyses of magnet performance; appropriate subroutines and functions are to be written to make these data accessible to analysis programs.

Cable Database

Progress continued on database design, particularly in defining the components of the structure. A meeting was held to share information on the wire and cable manufacturing process, emphasizing problems arising from proprietary information.

CDG personnel participated in a cable data meeting on October 5 at the CDG. Work concentrated on detailed specification of the data to be included and on discussion of the database table organization. Work with the database program Sybase continued, focusing on the transfer of data from the database programs used at other labs.

Expansion

Interviews were held with candidates for programmer and magnet test physicist. The programmer position entered the second round of interviews; promising candidates were identified and are being pursued. Search efforts for the magnet test physicist position were expanded.

ACCELERATOR PHYSICS

Correction Elements Working Group

The possibility is being studied of correcting systematic b_3 and b_4 multipole errors in the spoolpieces only (i.e., no bore-tube corrector greater than b_2 and no lumped corrector anywhere in the half-cell other than in the spoolpiece). Current results indicate that, without two families of

b_3 and b_4 correctors, this cannot be done. In particular, the tune shifts at zero amplitude do not meet the tune-shift criterion off-momentum. Results with two families of correctors are under study.

Investigation of the effects of the addition of random errors in the dipoles has begun. Initially only b_2 will be corrected, using binning. No binning, infinite binning, and seven bins will all be studied. Studies will include bore-tube and lumped schemes, both remote and local.

A study of the lattice effects of introducing a small gap in the middle of each half-cell of a cell, once every *nth* cell was undertaken. The effects on the linear optics of the SSC are not too great, providing n is an odd number of cells. A gap of three meters/half-cell will produce a beta and dispersion wave of approximately 3 percent for $n = 9$. These distortions would necessitate rematching the optics of the straight sections, but would not seriously complicate the lattice design.

Studies of the effects of systematic b_5 in the quadrupoles, which were discovered to have a serious effect on the HERA aperture, are being performed. Results should be available soon.

Crossing Angle and SYNCH Conversion

Effects of the small crossing angle on the optics of the SSC continue to be examined. This is presently a slow process as the major computer tool, the SYNCH lattice-design program, currently runs on VAX computers. Because of the need to constantly modify the beam's closed orbit, recalculate all of the element matrices about the new closed orbit, determine the new dispersion functions, adjust vertical and horizontal kicks to zero for both the closed orbit and dispersion functions, and iterate the entire process many times, the program runs very slowly on the VAX. In order to speed up this process, an effort is presently under way to make SYNCH run on a CRAY-2 at the MFE Computers in Livermore.

10,000-Turn Tracking of the SSC Injection Lattice

Work is currently in progress to study the dynamic aperture, smear, linear aperture, presence of chaos, and phase-space topology of the proposed 90° injection lattice (SSC–146) by tracking the lattice for 10,000 turns and comparing results with high-order maps generated for the same machines. Multipole errors are added to the dipoles. Six cases have been studied: three different seeds for the multipole errors at two different betatron tunes.

By tracking for 10,000 turns we have been able to show that:

- The 10,000-turn dynamic aperture is not much different from the 400-turn dynamic aperture.
- Synchrotron motion has a minor effect on the 10,000-turn dynamic aperture. (10,000 turns represents 50 to 100 synchrotron periods.)

- Momentum offsets up to 5 parts per 10,000 have a small effect upon dynamic aperture. (Momentum offset refers to the situation in which the average momentum of the bunch is not the design momentum, hence the closed orbit of the bunch is different from the design closed orbit.)

To look for the presence of chaotic motion near the dynamic aperture, tracked particle coordinates are compared with non-linear toroidal invariants calculated from analysis of high-order maps. The maps are produced using the recently developed differential algebra techniques and analyzed using the normal form methods described in SSC-166. The non-linear toroidal invariants are typically more accurate by a factor of 10 than the "linear" Courant-Snyder invariants. The sensitivity to chaotic behavior is adequate to detect diffusion that would interfere with the required long-term stability, about 10^7 turns during injection.

Linac Parameters Workshop

The CDG is about to launch the next iteration of an SSC linac design. A workshop was held on October 10–11 to review the SSC linac design of the Conceptual Design Report. This workshop was held to collect the wisdom of experts who were asked to help CDG identify the relevant issues and to provide advice. It was attended by some 13 people from the SSC/CDG, Fermilab, LBL, and Los Alamos. Developments of the linac design since the CDR include

- the possible desire to operate the SSC at higher luminosities (e.g., $L = 10^{34}$ cm^{-2}s^{-1}).
- new and improved designs for the low-, medium-, and high-energy boosters.
- major advances in linac designs made in the last few years.

The following discussion sessions were held:

M. Tigner	Introduction
H. Thiessen	Suggestions for changes to the CDR
S. Schriber	Optimal frequencies and rf structures
S. Holmes	Emittance control
A. Chao	Beam diagnostics
R. Stiening	Provisions for later upgrades
A. Chao	Summary

Many issues were identified for consideration in this next linac design iteration. An SSC note, SSC–N–561, covering this workshop is being issued.

LEB Injection

The design of the injection module from the linac to the low-energy booster, recently proposed by E. Colton and H. Thiessen, has been reexamined to consider the possibility of injecting H^- ions at approximately twice the energy contemplated in the CDR (600 MeV). This module can be modified to allow injection at 1133 MeV without requiring a change in the low-energy booster design (i.e., no increase in the length of the straight section). The two main requirements for injecting at the higher energy are (1) decreasing the injection angle of the ions to the minimum allowed by the geometry and (2) changing the length and magnetic fields of the two bumps so that they no longer run at the same fields.

CONVENTIONAL FACILITIES

Collision Hall Studies

Development with RTK of design concepts for collision halls and associated staging areas continued during October. Primary input for the design concepts was provided by M. Gilchriese. C. Laughton, a geotechnical engineer from the CERN LEP project, joined the division for the month and contributed a great deal to the cavern and shaft design. An important aspect was the development of an example construction schedule for the halls to determine how they might fit into the overall project schedule; this work is being done by RTK with guidance from C. Laughton. A. Autin, a graduate in architecture from Ecole Polytechnique with experience at CERN, joined the division and began to develop concepts for the surface resources required for detector assembly and operation.

Lattice Footprint Adaptation to the SSC Site

Considerable progress was made on developing protocols and tools to adapt the collider lattice to the SSC site. Two workshops were held with RTK on coordinate systems and the transformation of coordinates to the state planar coordinates. The Accelerator Physics Division provided a technical database with 1000 reference points characterizing the lattice. A programmed transformation within an RTK database expresses these points in a site coordinate system. These coordinates are then electronically transmitted to RTK, where they are related to a digitized site template and to the USGS coordinate system. Using commercially available software relating the USGS system to state planar coordinates, the lattice points are transformed into state planar coordinates for each of the sites on the Best Qualified List (BQL). Progress was also made in digitizing the characteristics of each site so that detailed studies of the location can be readily undertaken.

Presentation to the URA Board of Overseers

On October 31, a presentation was made to the URA Board of Overseers of the present and projected program for the Conventional Facilities Division. This presentation focused on footprint studies, site investigations, and environmental work leading to a site-specific conceptual design report that would serve as the baseline for the supplemental EIS required for construction. This plan makes use of the large pool of data and knowledge gained in the siting and draft EIS processes.

Geotechnical

A workshop was held with RTK to devise a program for geotechnical characterization of the selected site. D. Goss, who assisted with the geotechnical and site aspects of the project while on sabbatical from Nebraska Wesleyan, participated. The workshop was designed to review data available in submissions from the BQL states and to study the requirements for additional geotechnical data, in order to reasonably characterize the chosen site and determine the final footprint.

Tunnel Cross Section Draft Report

A draft report was accepted from RTK on a study of the tunnel cross section with respect to operations in the tunnel: generic handling and installation procedures and equipment are reviewed. The report, including space requirements for working in the tunnel, will be completed in December. Use of robotic surveillance techniques and possible additional constraints on the tunnel spaces will be studied subsequently.

USNC/TT Subcommittee on Contracting Practices

J. Sanford and T. Toohig attended a working meeting of the USNC/TT Subcommittee on Contracting Practices in Underground Construction for the SSC held in Washington October 4–5. The study is funded by the DOE in response to advice received from the underground construction community. J. Sanford represented the CDG Director and T. Toohig was present as a technical resource. Senior contracting personnel from DOE Headquarters and from the DOE Chicago Operations office were also present.

Society of Health Physicists, Chicago Chapter

On October 5, T. Toohig made a presentation on health physics considerations for the SSC to the Chicago Chapter of the Society of Health Physicists. Participants came not only from the high-energy physics community in the Chicago area, but also from the DOE and from education, industry, and medicine.

Release of the SSC Safety Review Document

The *SSC Safety Review Document* (SRD), a generic treatment of the safety concerns and mitigations for the SSC, was released as SSC-SR-1037. Important contributions to the document were made by the Safety and Health Physics personnel from all of the HEP laboratories, by DOE environmental, health, and safety personnel, and by university personnel on sabbatical leave at the CDG.

BNL REPORT

MODEL MAGNETS

Magnet Assembly

Inner and outer coils for DD0016 were wound and cured using the new inner and outer mandrels, the new winding machine setup, and the new second curing press. In addition, the first outer coil was wound and cured for DD0017. Measured coil azimuthal size variations are very small (the standard deviation is ±1.3 mils), with the exception of a collar problem discovered in the lead and return ends. (In the case of DD0016 this problem will be remedied by the use of tapered shims; the press will be appropriately modified in time for DD0017.)

The collar assembly for DSS14 was successfully completed using the original collaring method based on rectangular-key collars.

All collars have been received for rebuilt magnet DDA010. An order was placed for collars for DD0019, to be made from Kawasaki high-manganese steel.

Coil stress profile measurements were completed on short magnet DSS15. Strain gauge transducer calibrations were completed for DDA010.

Following the disassembly of DD0012, new azimuthal size measurements were made on its inner coils.

Trim Coils

Coil 16 was tested. In spite of the promise of the strippable polyimide incorporated in this coil, it exhibited an unacceptable training performance, as did an earlier coil made from ML-insulated wire. In view of the poor performance, further development of this material was discontinued.

The 1.6-m sextupole trim coil was assembled onto a beam tube and forwarded for testing. Meanwhile, Multiwire has embarked on the production of the first full-length trim coil. Additional short trim coils have been requested for use in the ongoing development effort on thermoplastic adhesives.

Beam Tubes

Design work is well under way on a warm bore tube. Components for the first subassemblies are being detailed, and some prototype parts are being produced.

TOOLING AND FACILITIES

Coils

As noted above, inner and outer coils for the new batch of DD dipoles were successfully produced with the improved winding and curing tooling. Stacking and welding fixtures for the new inner and outer formblock laminations were completed, and assembly and welding of the formblock stacks and modules is proceeding. New piping connections are being incorporated in the double curing of DSS magnets.

Yoke

A short test was performed on the six-inch-long model made from quarter-inch yoke laminations, in order to further study the loss in coil prestress due to springback after keying.

Horizontal Test Facility

Work concentrated on the fabrication of the feed and return end cans for Bays A and B. The floor layout of both bays and a variety of components, both mechanical and electrical, are being designed. Good progress is being made on parts for the 7-kA power supply.

Test Equipment

The last components for Mole C were detailed, and production of components is under way in the shops. Meanwhile, design work has started on the larger Mole D, and various pieces of hardware were ordered.

Trim Coil Test Facility

Higher priorities in other areas temporarily halted work on this facility. Some design changes were made and the first parts were released to the shops.

SUPERCONDUCTOR

Cable Procurement

The cable required for DSS16, 17, and 18 has arrived from LBL. It will be inspected and insulated in early November.

Tooling

Modifications to the wrapping line to permit the safe wrapping of cable at twice the present speed of four feet per minute were completed. A test run proved successful.

Miscellaneous

During October, samples of polyimide film from two separate manufacturers were tested and wrapped on scrap cable to compare their properties with those of DuPont's Kapton polyimide film. A report will be made to the Cable Task Force shortly. It is hoped that equivalent films may be approved so that future large orders for insulating material may be made as competitive bids.

INDUSTRIALIZATION

All Phase I drawings (based on DD0014) were sent to the CDG and will then be forwarded to the industrial firms. Meanwhile, preparation of the written documentation is progressing; the goal is to finish around the first of the year.

FNAL REPORT

DIPOLE CRYOSTAT

The Heat Leak Test Facility was reconfigured for the measurement of the Design B insulation system (aluminized Mylar and Reemay) from 300 to 80 K. Measurements will begin in November.

Disassembly of long magnet model DD0014 revealed buckling of the 20-K shield halfway between the anchor post and the next post toward the lead end. The buckling occurred at the joint in the shield shell. Plans are being formulated to conduct a short shield (a single post-to-post span) bowing test to evaluate the shield's tolerance to warmup. The previously planned long shield bowing tests, which will evaluate the performance of both the 20- and 80-K shields to cooling, will follow.

DD0014 modal analysis discussions were held among the analytical modeler (EQE), the modal analyzer (Vibration Engineering), the cryostat designers, and the CDG. Discussions included a description of analysis results and a comparison of measured and predicted fundamental modes of vibration. A discrepancy of a factor of two exists between the measured (4.89 Hz) and the predicted cold mass fundamental frequency (8.84 Hz). EQE is reviewing the modal analysis results and is working with Vibration Engineering on understanding the differences. Fermilab will remeasure the stiffness parameters of the support posts and the cold mass. Further structural response analysis will not continue until the discrepancies between measurement and prediction are resolved. Agreement to 20–30 percent is required.

A dedicated cryostat model for the warm measurement of the magnet structural response to shipping, handling, and seismic loads will be constructed. The model will incorporate the D0004 cold mass. The model will consist of cold mass, suspension system, and vacuum vessel, in addition to appropriate instrumentation. Shields and insulation will not be included. Work will begin on the model in November. Once completed, the model will be initially mounted on a tractor-trailer, to be acquired by the CDG, and subjected to over-the-road measurements.

Discussions were held at the CDG regarding revision of the Magnet Systems Requirements. It is planned to complete the Systems Requirements Document in December.

Work on the vertical probe transporters continued. Testing of the prototype, the Inchworm, has begun. The Inchworm is performing as designed and is being driven by computer control. A full-length beam tube is to be provided by BNL for continued Inchworm evaluations at Fermilab. Procurement of components for a self-storing retractable transporter continues.

Procurement of FY89 long magnet cryostat components continued. The long-lead-time materials required for the support posts, anchor tie bars, insulation, interconnections, and so forth were ordered. Vendors' interest in and ability to fabricate the cryostat components,

including support posts, anchor tie bars, insulation blankets, and vacuum vessels, is being assessed.

Magnet industrialization preparations continue. Phase I drawings and specifications corresponding to magnet DD0014 were forwarded to the CDG for review and comment. Details of the Phase I Magnet Industrialization Program at Fermilab are being put into final form.

MAGNETIC MEASUREMENTS

DD0015 was cooled down. In the future, interleaving the testing of Tevatron and SSC magnets may require SSC magnets to be cooled while Tevatron magnets are being tested. Tevatron magnets run with subcooled liquid at about 1.5 atm; the first part of the DD0015 cooldown was devoted to study of low-pressure cooling methods. The cooldown rate in this mode was significantly slower than in previous tests, so the second part of the cooldown was done at high pressure.

A series of strain gauge runs was made: the magnet was taken to currents of 3900, 4500, 5000, and 5500 A. The first spontaneous quench occurred at 5625 A, during an attempt to reach 5900 A. After four training quenches, the magnet reached a stable quench plateau at about 6400 A at 4.4 K. The first two and the fourth training quenches were in the lower ramp splice; the third training quench and all plateau quenches were in the lower outer coil near the return end. The lower outer coil was formerly in magnet D000Z. The calculated critical current for this coil is about 400 A higher than the plateau quench current. Two plateau quenches occurred at 4.38 K, two at 4.42 K, and one at 4.50 K; the temperature dependence of the quench current is just that expected for conductor-limited quenches. The cause of the lower-than-expected quench current is not understood.

Following the quench studies, a strain gauge run took the magnet to 6300 A. The average inner coil stress at $I = 0$ was approximately 5400 psi, a little higher than for DD0012 and DD0014. With excitation the stress dropped more rapidly than DD0012 and DD0014, similar to DD0010. At 6300 A, the average stress was 1900 psi. The average outer coil stress dropped from 2700 psi at 0 A to 1900 psi at 6300 A. The coil grew in length by about 70 mils at each end. The coil length as a function of current shows about 20 mils of hysteresis; the coil was longer on the down ramp than on the up ramp. About 25 percent of the longitudinal Lorentz force appears in the skin, essentially independent of location except at the center, where the collared coil is anchored to the yoke and skin by shims, as in DD0012 and DD0014. This implies that the force transfer from the coil to the shell occurs between the end of the magnet and the first shell strain gauge (about 25 inches from the end). The longitudinal force on the shell also shows hysteresis, with the hysteresis loop traced in the opposite direction from the coil. This implies a non-elastic component to the transfer of longitudinal force from the coil to the shell. When the coil extension is converted to a force and added to the force deduced from the

shell strains, the total force matches the expected longitudinal Lorentz force within about 10 percent at 6300 A.

The cold pump originally used for low-temperature tests on stand 4 has been returned to the Accelerator Division. A new pump for stand 4 has been delivered but is not yet operational. Current plans are to attempt to use the room-temperature pumping system designed for stand 5. It is expected that this will drop the temperature to 4.0 K or a little below.

LONG MAGNET FABRICATION

Cryostat Work

Disassembly of DD0011 was finished October 7. The cold mass was cut in half and shipped to LBL on October 14.

Disassembly of D000X was finished on October 10. This cold mass will be saved for a vacuum vessel survey weight.

Disassembly of DD0014 was finished October 18. The cold mass will be shipped to BNL.

Clean up of the welds of all subassemblies from these magnets was completed. Assembly of the new vacuum vessel was begun. The D000X Design A vacuum vessel was scrapped.

Parts for the DSHIP transportation model are being prepared for assembly.

Coil Work

Assembly of the winding table continues. The mechanical portion is expected to be completed in mid-November. Some items still have not been received from BNL. Delivery is promised for mid-November.

The long tooling table was completely assembled October 25.

A 7-foot tooling stacking table for making short packs of laminated tooling was installed in the Industrial Center Building. Cleaning of upper collaring laminations was begun on October 29. Stacking of these laminations has started on the 7-foot table.

The lower weldments for curing and collaring presses were placed into location, the first step in assembling these presses.

The poured-in-place concrete foundation for the yoke/skinning press was completed.

F Series Model Program

Magnet F3 was shipped to Lab 2 on November 3. Testing is scheduled to begin on November 14.

Winding of inner coils for magnet F4 was begun.

End pieces for F4 inner coil were completed. F4 outer coil parts are currently being machined at the Fermilab shops.

F4 inner coils will be wound in November. Outer coils will be wound in December. Magnet F4 will then be collared, potted, and cut into cookies.

Magnets F5 and F6 will be identical to F4 (NC9 cross section). They will be tested cold.

Design is continuing on end parts for Magnets F7-9 (C358D cross section). These parts will be ready for machining by January 1, 1989.

LBL REPORT

SUPERCONDUCTOR AND CABLE

The prototype production cabling machine was installed at the New England Electric Wire plant. A series of acceptance tests were performed. The machine performed to specification; only a few minor corrections were required. A second trial run is scheduled for November, and representatives of the superconductor wire manufacturers will be taught to operate the cabler then. The cable-measuring machine is being upgraded to include a more user-friendly operating software package, new relay logic to make operation more fail-safe, and hydraulic cylinders to replace those that leaked.

Production of cable is to begin in December for the next long magnet campaign, beginning at BNL in March.

MAGNET MODELS

D15B-1

This magnet was tested from October 3–19.

This magnet differs in two major ways from the previous series of LBL SSC model dipoles, D15A-X. Models designated D15B-X have a new constant perimeter design end with an internal support (called the Royet end). The second change, which will be incorporated in future LBL dipole models, is a stiffer clamping system for the horizontally split iron. Previously, two-inch-wide clamps on six-inch centers around a split (unwelded) shell were used; in this magnet, three times as many clamps were used to effect complete clamping coverage of the same shell; larger diameter clamp bolts were also used.

At 4.3 K the first quench was at 6544 A and the plateau value of 6950 A was reached on the third quench. After a room-temperature thermal cycle, there was no retraining. Only one quench occurred in the outer layer; all the others originated in the inner layer. Training at 1.8 K was somewhat slow: quenches occurred in both the inner and outer layers, predominantly in the outer layers up to 9400 A and in the inner layers up to the peak of 9578 A. This current is a record for the SSC model dipoles and corresponds to a central field of 9.1 teslas.

D15C-1

Winding of 4 coils for LBL's first flared-end model is completed. Assembly of these coils is 50 percent completed.

QUADRUPOLE MAGNETS

Preliminary magnetic design was done on a 22-turn-per-pole and a 20-turn-per-pole magnet. The effect of thicker collars on the field gradient and the maximum field at the conductor were investigated.

PROJECT COST DATA

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TABLE C-1

CENTRAL DESIGN GROUP

OCTOBER

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.1	ADMINISTRATION	-3.1	102.5	3.6	103.0	103.0	6246.0
1.2	PROGRAM PLANNING & MANAGEMENT	25.8	11.8	17.7	55.3	55.3	1190.0
1.3	ACCELERATOR R & D	-62.6	142.8	-48.0	32.2	32.2	17004.0
1.4	CONVENTIONAL SYSTEMS DEVELOPMENT	-13.0	9.6	-11.3	-14.8	-14.8	1740.0
	PROGRAM COSTS	-53.0	266.8	-38.1	175.7	175.7	26180.0
1.41	RTK COSTS	0.0	60.4	0.0	60.4	60.4	750.0
	CDG/RTK COSTS	-53.0	327.2	-38.1	236.1	236.1	26930.0
	COMMITMENTS					1799.8	
	DELTA COMMITMENTS					791.2	

TABLE C-2

BROOKHAVEN NATIONAL LABORATORY

OCTOBER

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
2.1	MAGNET DESIGN	55.7	26.1	44.9	126.7	126.7	3348.0
2.2	17-M COLD MASS FABRICATION	106.7	89.9	108.0	304.6	304.6	4134.0
2.3	TOOLING & FIXTURES	9.3	98.5	59.2	167.0	167.0	640.0
2.4	BEAM TUBE DEVELOPMENT	18.6	0.0	10.2	28.8	28.8	633.0
2.5	1.8-M DIPOLE FABRICIATION	9.3	133.0	11.7	154.0	154.0	538.0
2.6	TRIM COIL DEVELOPMENT	18.6	0.9	10.7	30.2	30.2	752.0
2.7	MAGNET MEASUREMENT	92.8	15.9	59.7	168.4	168.4	3341.0
2.8	INDUSTRIALIZATION	9.3	0.0	5.1	14.4	14.4	316.0
	MAGNET TOTALS	320.3	364.3	309.5	993.9	993.9	13702.0
2.9	ACCELERATED LIFE TESTS	23.2	2.5	14.1	39.8	39.8	898.0
	BNL R & D TOTALS	343.5	366.8	323.6	1033.7	1033.7	14600.0
	COMMITMENTS					2469.1	
	DELTA COMMITMENTS					2469.1	
	EQUIPMENT COSTS	0.0	0.0	0.0	0.0	0.0	2947.0
	EQUIPMENT OPEN COMMITMENTS					0.0	

TABLE C-3

FERMI NATIONAL ACCELERATOR LABORATORY

OCTOBER

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
3.1	GENERAL	0.0	0.4	0.1	0.5	0.5	160.0
3.2	LONG MAGNET FABRICATION	39.5	23.2	20.2	82.9	82.9	1361.0
3.3	MAGNETIC MEASUREMENTS	42.8	27.8	22.8	93.4	93.4	1560.0
3.4	COLD MASS FABRICATION	29.0	17.6	15.0	61.6	61.6	2766.0
3.5	INDUSTRIALIZATION	21.1	0.1	6.8	28.0	28.0	300.0
3.6	CELL TESTS	0.0	0.0	0.0	0.0	0.0	0.0
	PROGRAM COSTS	132.4	69.1	64.9	266.4	266.4	6147.0
	COMMITMENTS					777.0	
	DELTA COMMITMENTS					777.0	
	EQUIPMENT COSTS	0.0	22.4	0.0	22.4	22.4	1640.0
	EQUIPMENT OPEN COMMITMENTS					272.1	

TABLE C-4

LAWRENCE BERKELEY LABORATORY

OCTOBER

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
4.1	GENERAL	6.7	1.3	3.8	11.8	11.8	350.0
4.2	SUPERCONDUCTOR & CABLE	14.8	2.0	8.0	24.8	24.8	1340.0
4.3	CABLE SHORT SAMPLE TEST FACILITY	11.2	1.4	5.9	18.5	18.5	50.0
4.4	DIPOLE MAGNET DEVELOPMENT	90.0	17.6	51.1	158.7	158.7	760.0
4.5	QUADRUPOLE MAGNETS	0.0	0.0	0.0	0.0	0.0	260.0
4.6	COIL PROPERTIES	0.0	0.0	0.0	0.0	0.0	200.0
4.7	TECHNOLOGY TRANSFER TO INDUSTRY	0.0	0.0	0.0	0.0	0.0	50.0
	MAGNET R & D TOTALS	122.6	22.3	68.8	213.7	213.7	3010.0
4.8	ACCELERATOR THEORY SUPPORT	19.9	1.1	9.9	30.9	30.8	410.0
	R & D COST TOTAL	142.5	23.4	78.7	244.6	244.5	3420.0
	COMMITMENTS					95.0	
	DELTA COMMITMENTS					-250.0	

TABLE C-5

PROGRAM SUMMARY - SUPERCOLLIDER

OCTOBER

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.	CDG PROGRAM	-53.0	266.8	-38.1	175.7	175.7	26180.0
1.41	RTK PROGRAM	0.0	60.4	0.0	60.4	60.4	750.0
2.	BNL SSC PROGRAM	320.3	364.3	309.5	994.1	993.9	14600.0
3.	FNAL SSC PROGRAM	132.4	69.1	64.9	266.4	266.4	6147.0
4.	LBL SSC PROGRAM	122.6	22.3	68.8	213.7	213.7	3420.0
	TOTAL SSC PROGRAM COSTS	522.3	782.9	405.1	1710.3	1710.1	51097.0
	COMMITMENTS					5140.9	
	DELTA COMMITMENTS					3787.3	
	EQUIPMENT COSTS					22.4	4587.0
	EQUIPMENT OPEN COMMITMENTS					272.1	

TABLE C-6

MONTHLY AND CUMULATIVE SUMMARY
OF PLANNED AND ACTUAL COSTS AND COMMITMENTS

1.0 CENTRAL DESIGN GROUP - SUPERCOLLIDER

MONTH	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	1158.0	1158.0	236.1	236.1	1027.3	2035.9	1799.8	791.2
NOV	1238.8	2396.8						
DEC	1319.6	3716.3						
JAN	1400.4	5116.7						
FEB	1588.9	6705.6						
MAR	1831.2	8536.8						
APR	2154.4	10691.2						
MAY	2477.6	13168.8						
JUN	2827.7	15996.4						
JUL	3177.7	19174.2						
AUG	3608.6	22782.8						
SEP	4147.2	26930.0						

2.0 BROOKHAVEN NAT'L LAB - SUPERCOLLIDER

MONTH	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	1216.7	1216.7	1033.8	1033.8	3502.9	3502.9	2469.1	2469.1
NOV	1216.7	2433.3						
DEC	1216.7	3650.0						
JAN	1216.7	4866.7						
FEB	1216.7	6083.3						
MAR	1216.7	7300.0						
APR	1216.7	8516.7						
MAY	1216.7	9733.3						
JUN	1216.7	10950.0						
JUL	1216.7	12166.7						
AUG	1216.7	13383.3						
SEP	1216.7	14600.0						

3.0 FERMI NAT'L ACCEL LAB - SUPERCOLLIDER

MONTH	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	512.3	512.3	266.4	266.4	1043.4	1043.4	777.0	777.0
NOV	512.3	1024.5						
DEC	512.3	1536.8						
JAN	512.3	2049.0						
FEB	512.3	2561.3						
MAR	512.3	3073.5						
APR	512.3	3585.8						
MAY	512.3	4098.0						
JUN	512.3	4610.3						
JUL	512.3	5122.5						
AUG	512.3	5634.8						
SEP	512.3	6147.0						

4.0 LAWRENCE BERKELEY LAB - SUPERCOLLIDER

MONTH	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	285.0	285.0	244.6	244.6	-5.4	339.6	95.0	-250.0
NOV	285.0	570.0						
DEC	285.0	855.0						
JAN	285.0	1140.0						
FEB	285.0	1425.0						
MAR	285.0	1710.0						
APR	285.0	1995.0						
MAY	285.0	2280.0						
JUN	285.0	2565.0						
JUL	285.0	2850.0						
AUG	285.0	3135.0						
SEP	285.0	3420.0						

0.0 PROGRAM SUMMARY - SUPERCOLLIDER

MONTH	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	3171.9	3171.9	1780.9	1780.9	5568.2	6921.8	5140.9	3787.3
NOV	3252.7	6424.6						
DEC	3333.5	9758.1						
JAN	3414.3	13172.4						
FEB	3602.8	16775.2						
MAR	3845.2	20620.3						
APR	4168.3	24788.6						
MAY	4491.5	29280.1						
JUN	4841.6	34121.7						
JUL	5191.7	39313.3						
AUG	5622.5	44935.9						
SEP	6161.1	51097.0						

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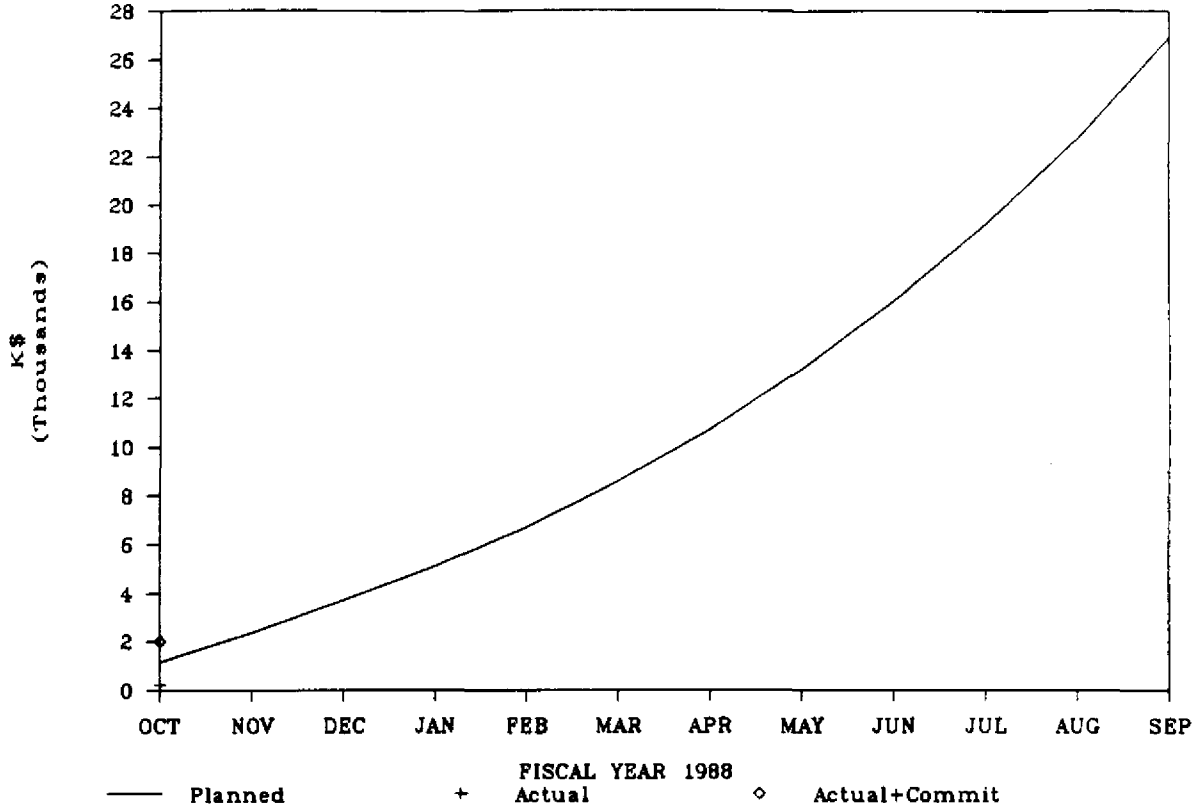
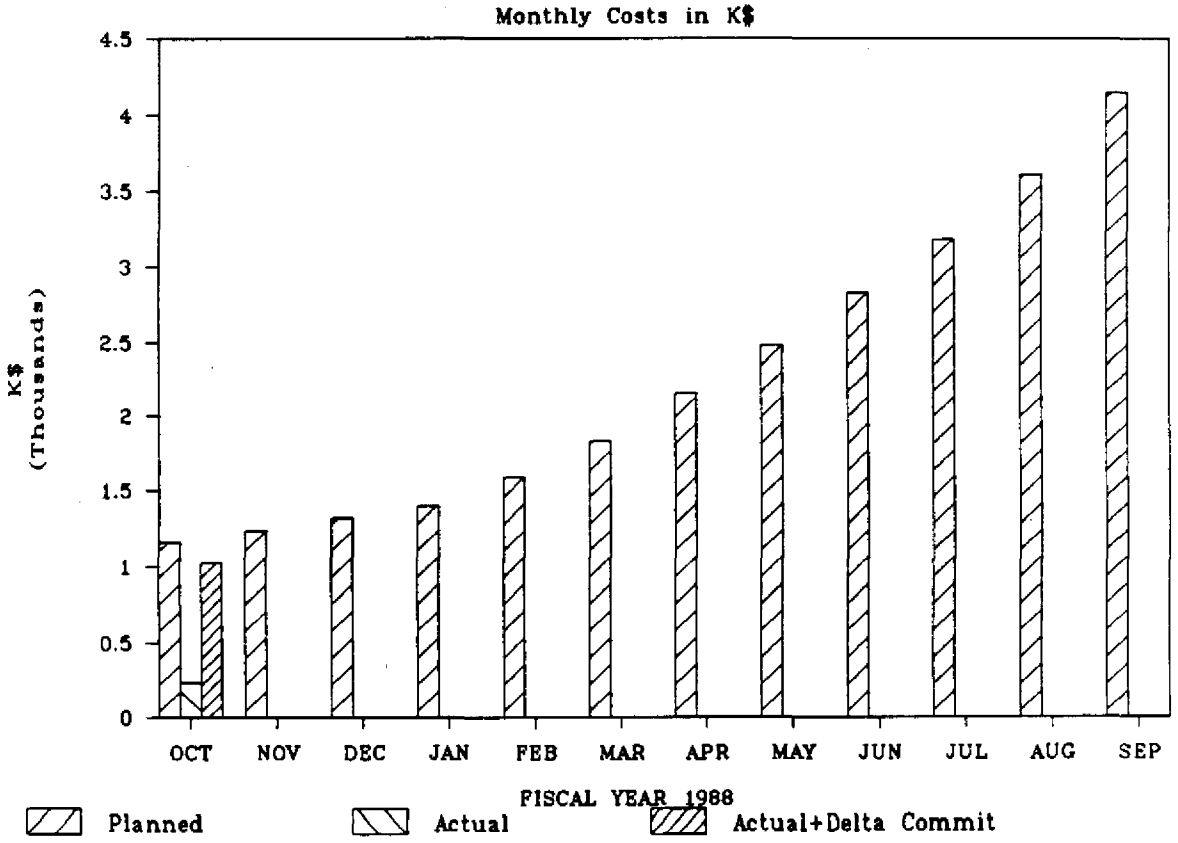


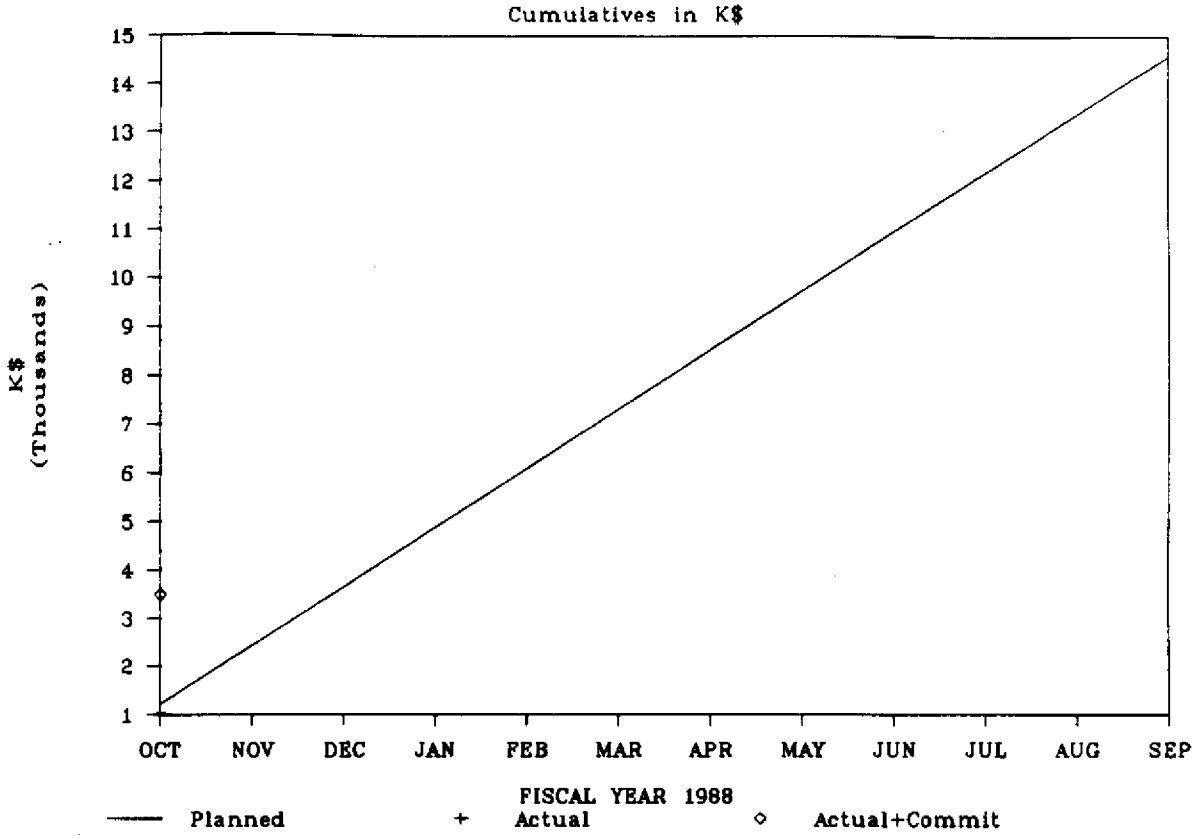
1.0 CENTRAL DESIGN GROUP

Monthly Costs in K$



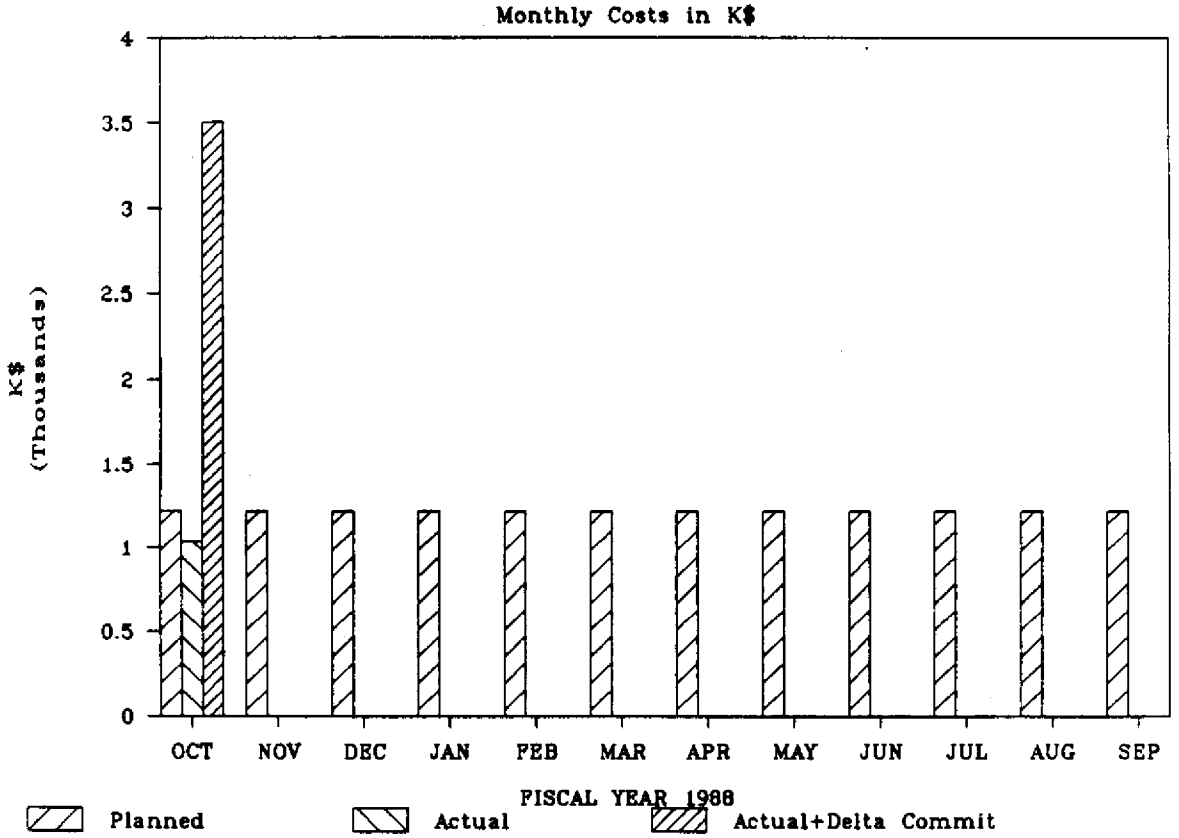
2.0 BROOKHAVEN NAT'L LAB

Cumulatives in K$



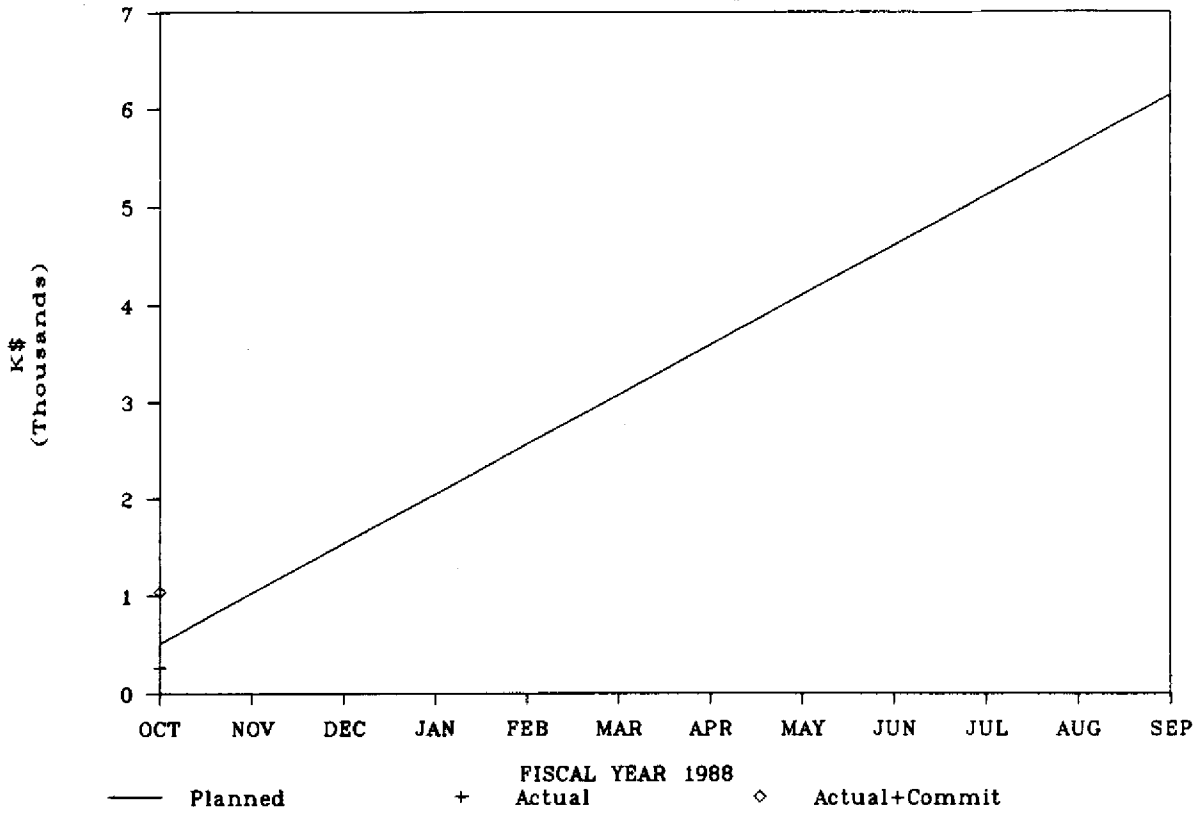
2.0 BROOKHAVEN NAT'L LAB

Monthly Costs in K$



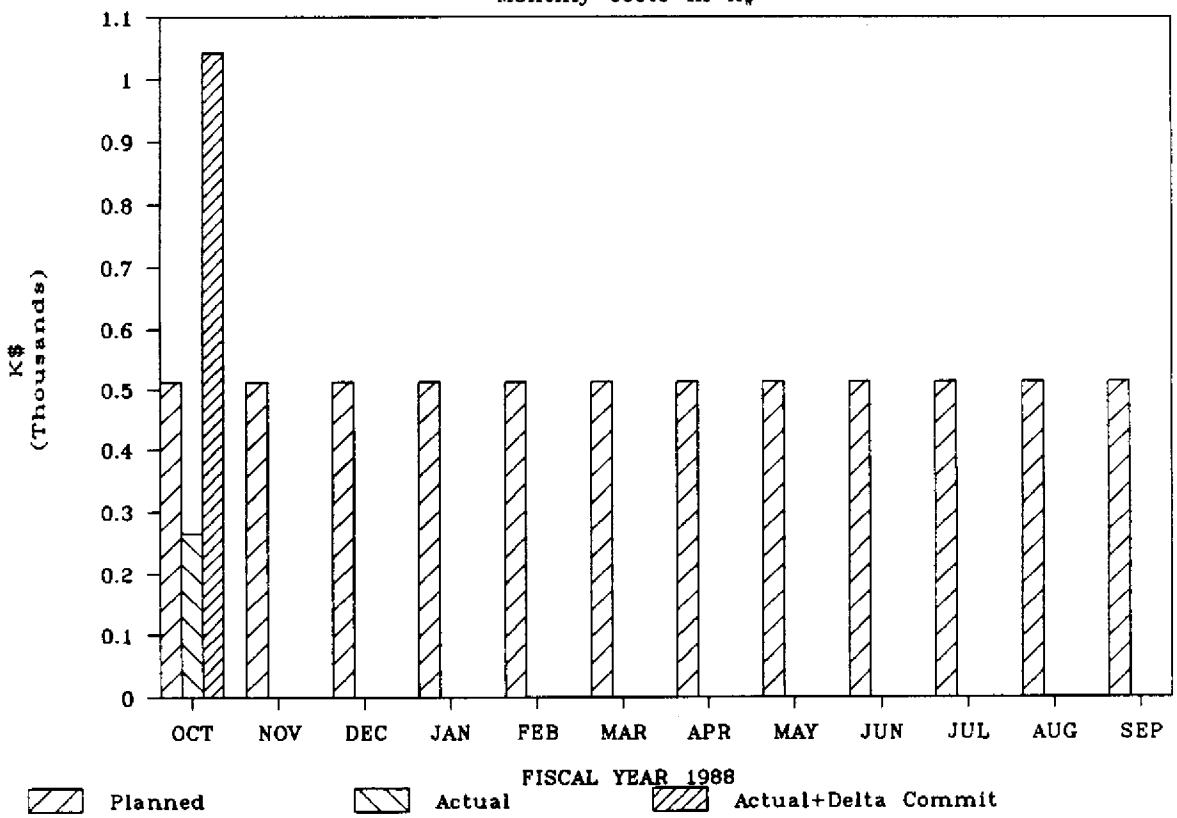
3.0 FERMI NAT'L ACCEL LAB

Cumulatives in K$



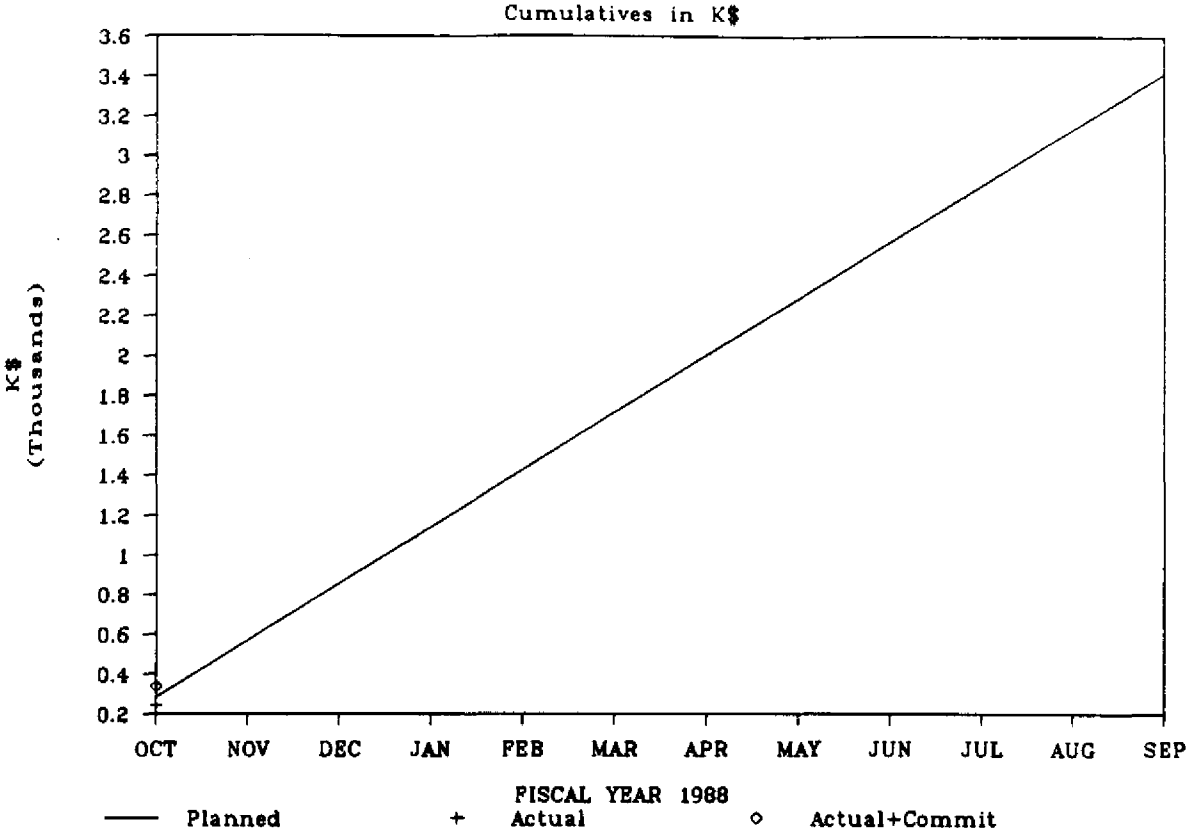
3.0 FERMI NAT'L ACCEL LAB

Monthly Costs in K$



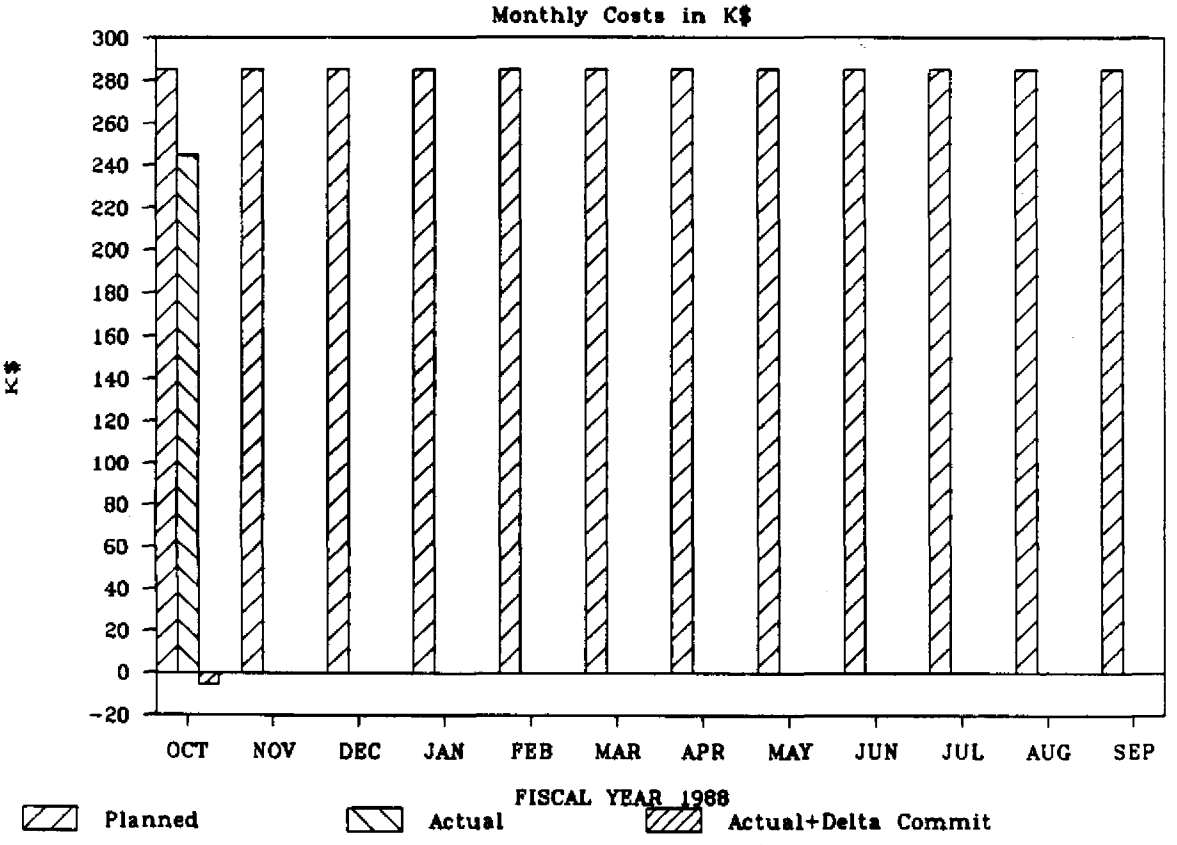
4.0 LAWRENCE BERKELEY LAB

Cumulatives in K$



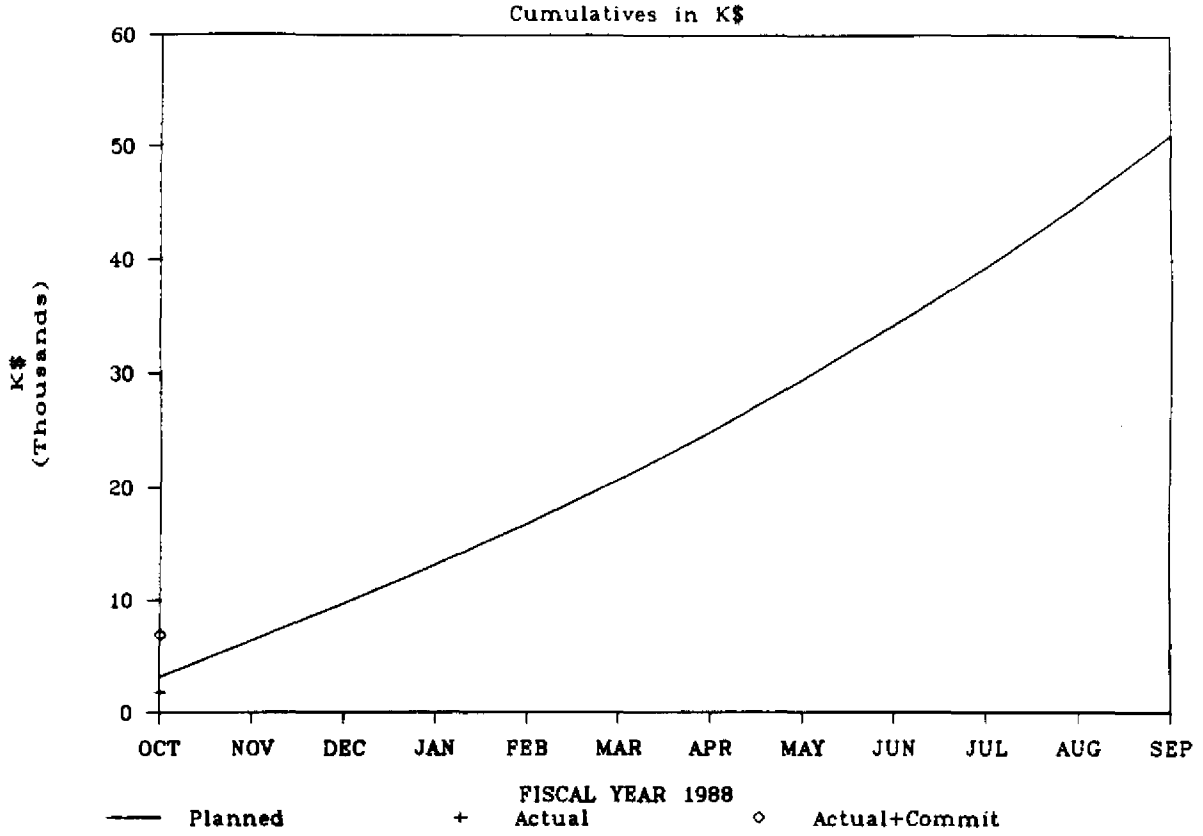
4.0 LAWRENCE BERKELEY LAB

Monthly Costs in K$



0.0 PROGRAM SUMMARY – SUPERCOLLIDER

Cumulatives in K$



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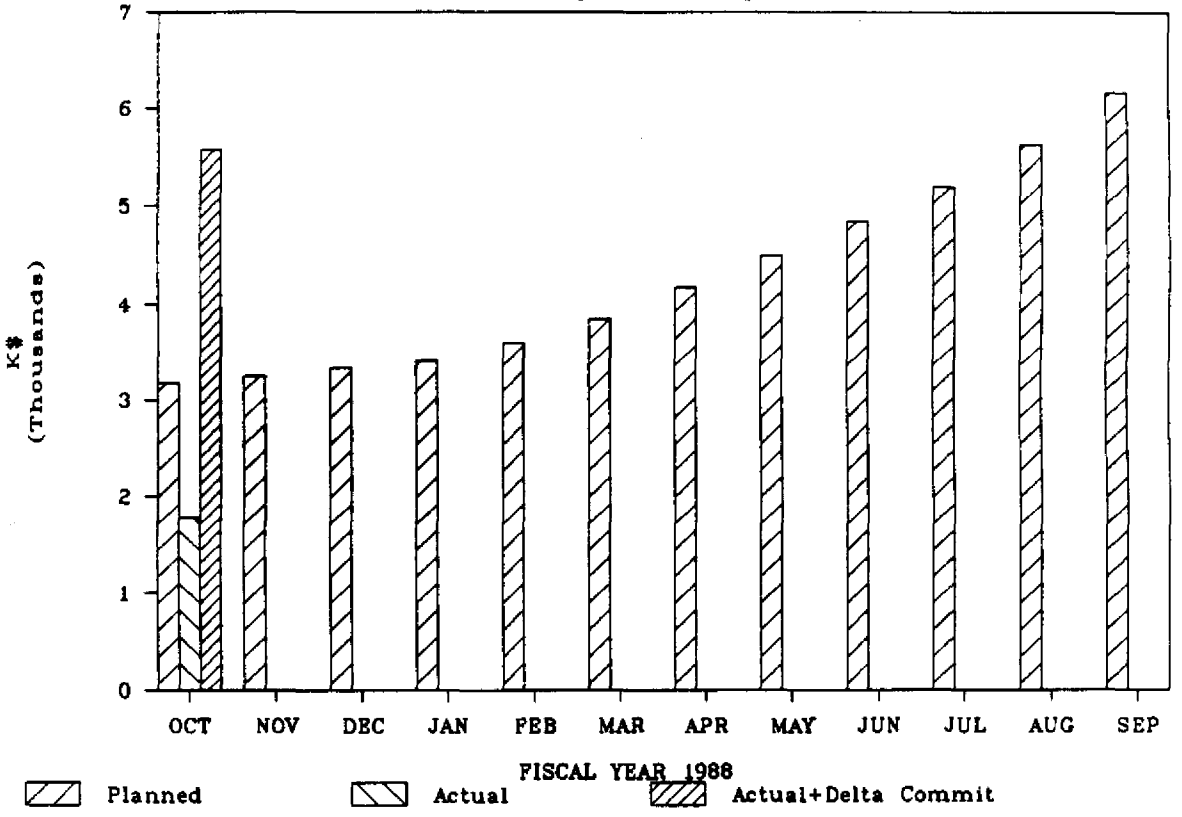
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