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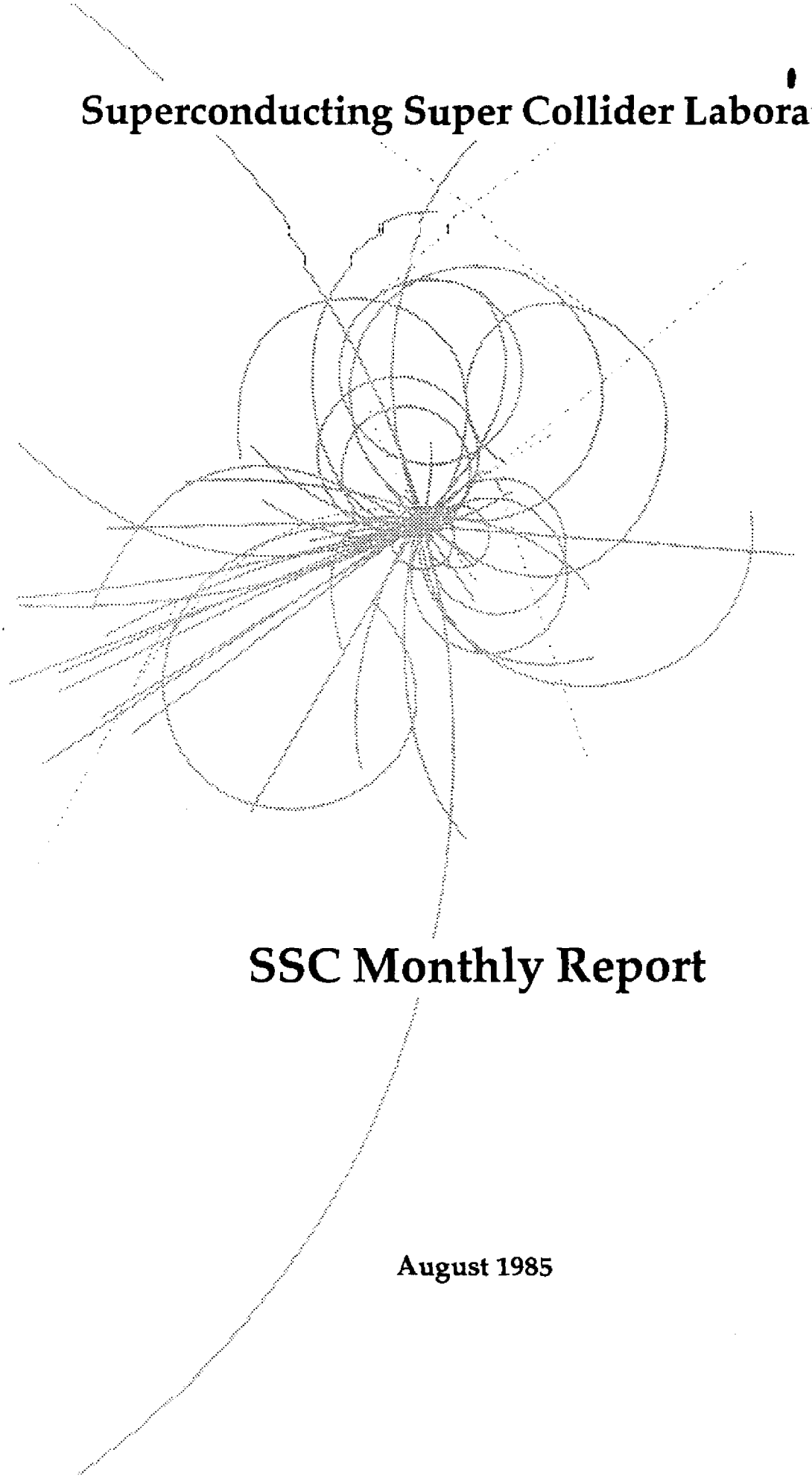
Superconducting Super Collider Laboratory

SSC-47



SSC Monthly Report

August 1985

SSC MONTHLY REPORT

AUGUST 1985

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SSC MONTHLY REPORT

AUGUST 1985

A. Project Summary

- The major activity within the Central Design Group centered on making preparations for the meeting of the Magnet Selection Advisory Panel (MSAP) August 25-28. Prior to the convening of the meeting, a considerable amount of background material was assembled which involved the Magnet Division, Accelerator Systems Division, Conventional Systems Division, and the Accelerator Physics Division (see individual section reports for detailed descriptions).

- The MSAP Panel and its Consultants met from August 25-28 to hear presentations, deliberate, and produce a first draft of their report. Two and one-half days were devoted to open meetings where presentations from the R&D participants and proponents of the various magnet types were heard. In attendance, in addition to the Panel and Consultants, were five representatives from each of the four R&D centers and including representatives of URA and DOE. During meetings ample opportunity was provided for airing of all views with relevant discussions. The report of the MSAP and the magnet style decision by the Director is expected next month.

- A second run of the photodesorption experiment with cryogenic beam tubes was made at the NSLS early this month. In this second run, the background partial pressures were decreased by about a factor of ten and beam-dependent pressure rise for hydrogen gas, and gas at mass number 28 was observed. Preliminary analysis indicates that the SSC luminosity lifetime will not be significantly affected by the residual gap.

- BNL. During the month of August major activities centered around the assembly and test of the third and fourth (4 cm) 4.5 meter magnets in this series. Results were, as for the previous magnets, excellent in that the magnets reached design field in relatively few training quenches and exhibited good field quality. Additionally, the first straight ended inner coil has been wound and looks very good.

- Fermilab. Cryostat development activity during August consisted of refinements to the Design D cryostat in anticipation of the fabrication of the first six full-size magnets early in 1986. Effort focused on thermal and mechanical performance of the suspension system, design of shipping restraint, and specification of the interconnections.

After a series of difficulties, an effective way has been found to form the ends of one meter dry wound coils. Using this new technique a 4 cm aperture model with "straight" ends was completed.

- LBL. The sixth Design D 1-m model reached 6.7 tesla with the first quench at 6.4 tesla. The last three models had improved superconductor and reached 6.6, 6.8, and 6.7, respectively, with only one training quench occurring below 6.4 tesla.

  Coils were completed for the next two models which will have the BNL insulation scheme with fiberglass-epoxy.

  IGC successfully completed Phase I of their development contract and extruded the two first stage Phase II billets.

  An industry-laboratory workshop was held at LBL with about 30 attendees, equally divided between the laboratories, U.S. superconductor industry, and the U.S. cable industry.

- TAC. Three magnets were measured this month, and the magnet errors are reasonable; however, the skew quadrupole term is systematic and larger than desired.

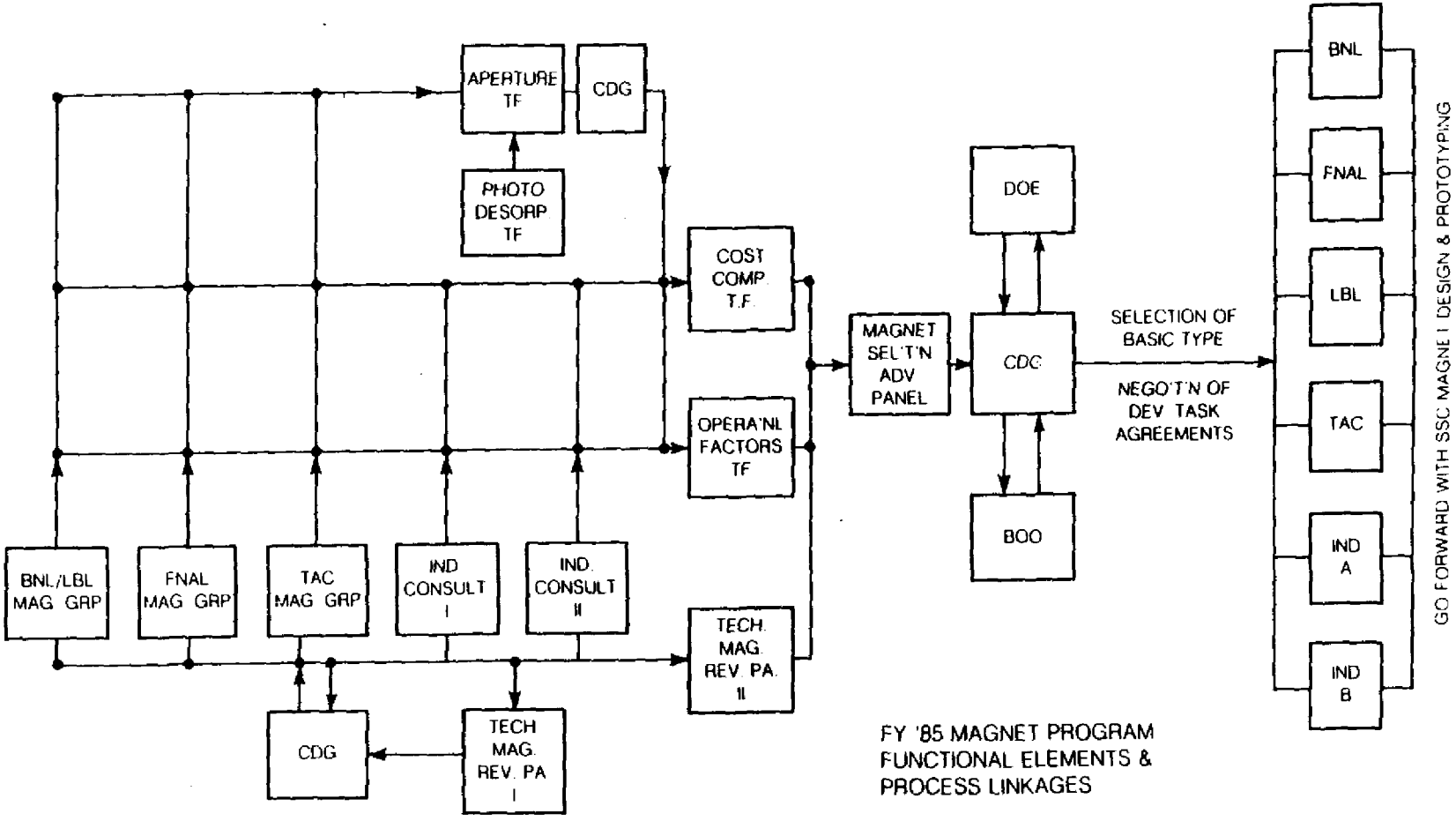
  The cold mass of the long magnet (28 m) at General Dynamics has been assembled.

B. Project Report

I. Central Design Group

Magnet Program. The magnet selection process was developed in consultation with the concerned community and made public in November, 1984. It is diagrammed in the attached figure. Early in 1985 a Technical Magnet Review Panel (TMRP) was convened to review the status of the SSC magnet R&D program (see last month's report) and to recommend modifications to the on-going program which would assure that the technical information needed would be available for a selection decision by the end of FY 1985. The TMRP, composed of senior representatives from the particpating institutions, as well ad disinterested parties with relevant technical expertise, delivered an interim report in December. Their recommendations were incorporated into subsequent agreements and contracts negotiated with the participating R&D institutions and industrial firms.

In addition to the results of model tests and engineering and manufacturing process studies, selection of a suitable magnet must take the needed magnetic aperture into account. Accordingly an Aperture Task Force, directed by the CDG, and participated in by the world-wide community of experts in this matter, was formed. Single particle dynamics, collective effects, and vacuum considerations were taken into account. All of the information provided by the above-mentioned activities was supplied to two task forces formed by the CDG with broad community participation. The responsibility of the Cost Comparison Task Force was to complete detailed cost estimates of all magnet-dependent SSC systems considering, in turn, all of the candidate magnet types. The responsibility of the Operations and Commissioning Task Force was to examine the operational implications of each of the candidate magnet types. In carrying out its responsibility, the CDG Cost Comparison Task Force made



FY '85 MAGNET PROGRAM FUNCTIONAL ELEMENTS & PROCESS LINKAGES

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independent analyses but received detailed input from proponents of the various candidate magnet types as well as magnet cost estimates and manufacturing plans produced by industrial firms under contract to the CDG. The Operations and Commissioning Task Force received input from both European and U. S. experts in accelerator and storage ring operation. The TMRP, reconstituted with essentially its original membership supplemented by addition of a Japanese expert on superconducting magnets for accelerators, met during July, 1985, for the purpose of reviewing and codifying the results of the SSC magnet R&D program. The TMRP final report was published August 5, 1985.

The reports of these task forces, as well as the background information supplied to them, were forwarded to a Magnet Selection Advisory Panel (MSAP), along with the final report of the TMRP. The charge to the MSAP, including the criteria they were to use in making their recommendations and the composition of the Panel, was published in May, 1985, and reviewed by the Department of Energy in its annual review of the CDG in June, 1985. The proponents of the various magnet types were given an opportunity to comment on the draft charge and proposed composition of the panel before formal announcement. The Panel members were chosen for their experience in large technical systems, superconductivity technology, accelerator design and operation, use of accelerators for particle physics, underground construction, or experience with complex science and technical policy matters. They were Professor Frank Sciulli, Columbia University (Chairman); Dr. Eberhard Keil, CERN; Dr. Neal Lane, University of Colorado; Dr. Michael McAshan, Stanford University; Dr. John Rees, SLAC; Mr. E. Parke Rohrer, Rohrer Associates; Dr. Avin Tollestrup, Fermilab and Chairman of TMRP; and Professor Bjorn Wiik, DESY and University of Hamburg. In addition, three industrial consultants were appointed to advise the Panel. Each of the consultants and the firms with which they are

associated have extensive experience in the technology of superconductivity and magnets utilizing it. They are Dr. Ray Beuligmann, General Dynamics Convair Division; Dr. Cord-Henrich Dustmann, Brown, Boveri et Cie; Dr. John Hulm, Westinghouse Electric Corporation.

The Panel and its Consultants met at Berkeley August 25-28 to hear presentations, deliberate, and produce a first draft of their report. Two and one-half days were devoted to open meetings where presentations from the R&D participants and proponents of the various magnet types were heard as well as reports on the several CDG analyses. In attendance, in addition to the Panel and Consultants, were five representatives of each of the four R&D centers, as well as representatives of URA and DOE. During the meetings ample opportunity was provided for airing of all views with relevant discussions. A final report and decision will be released next month.

Conventional Systems. A considerable amount of background material was assembled for the MSAP meeting. This consisted of an analysis of the costs associated with the conventional systems required by the different magnetic field strengths being considered. The dominate item, the cost of the collider tunnel, was driven by the different lengths required for the collider ring. The parameters used are shown in the following table:

Mag Field (T)	Length (kft)	Length (km)
6.4	302	92
5.5	328	102
3.0	564	172

Unit costs for the tunnels were provided by the A/E team of RTK, following a survey of nationwide information. They supplemented this by performing two "contractor-style" estimates for soft-ground and cut-and-cover enclosure construction. The analysis was completed by combining the lengths with the unit costs, and adding the cost of the special sections, utilities, roads,

etc., for the three circumferences. The MSAP was provided with the quantitative results, as well as an analysis of the range of values under differing assumptions for geological conditions, and with variations of unit cost.

RTK has been actively involved in a variety of tasks associated with the conceptual design of the collider ring for the SSC. The tasks range from reviewing the status of tunneling R&D to examining the requirement for the technical systems within different tunnel configurations. A group of RTK personnel visited Norton Air Force Base in California to collect the unclassified reports on the tunneling and geotechnical considerations that have been pursued for the deep-basing schemes of the ICBM and the development of similar information for the MX program. The RTK staff returned to their Oakland office with numerous volumes of material. This information is currently being studied as part of their evaluation of the status of tunneling technology. Further work is being done by RTK and their sub-contrator, Earth Technology Corp., on the development of several generic site models to be used in the conceptual design of the SSC. These models will help to advance the design of the conventional systems by providing "realistic" geological assumptions. Both the matters of tunnel technology and generic geotechnical site development are being reviewed by RTK's advisory panel in order to get the best perspective on the challenging problems. In addition, RTK continues to examine the tunnel safety issues that must be faced in the SSC project.

Other activites during the month consisted of a trip to Texas by T. Toohig of the CDG to visit a tunnel project that is underway near Austin, and to hear a discussion of proposed tunnel R&D by personnel from TAC and Texas A&M University.

Preparations are being made for a workshop on the anticipated radiation environment around the collider. The workshop to be held in October will examine the potential sources of radiation. The results of the workshop will supplement the informa- tion provided to interested parties in the Site Parameters Document. In anticipation of this work, Dr. Klaus Goebel of CERN gave a talk during the month on the radiation considerations and calculations that were undertaken at CERN in preparing for the construction of LEP.

Accelerator Systems. The preparation for the MSAP meeting was divided into two major categories, preparation of various cost estimates and presentations of task force results. In the 1984 Reference Designs Study the cost estimates for technical systems (other than magnets and cryogenics) were assumed to be the same independent of the magnet type. For the purpose of comparing total costs of magnet-dependent systems for MSAP, more accurate systems costs were provided. Several scaling rules were derived for the technical systems that depend on magnet type. The most important of these rules was the way that the systems scaled with ring circumference and with the number of cryostats. The RDS estimates were used for the basic costs, and the scaling rules were applied to the appropriate parts of the technical systems.

In order to understand the impact of the aperture calculations on the cost of the magnet-dependent systems, scaling rules were derived to be able to estimate the way that the total magnet dependent system cost varied with physical aperture and half-cell length. The scaling rules that were derived for this purpose were fairly simple and could be used only to illustrate the way that costs varied as a function of the two variables for a particular type of magnet. The results of these calculations have been presented in the Aperture Task Force Report (SSC-SR-1013).

Presentations of the results of the Task Force on SSC Commissioning and Operations (SSC-SR-1005), the Task Force on Power Supplies and Quench Protection (SSC-SR-1006), and the preliminary results of the photodesorption experiment were prepared for MSAP.

A second data run of the photodesorption experiment from cryogenic beam tubes was made at NSLS early this month. In this second run, the background partial pressures were decreased by about a factor of ten and beam-dependent pressure rise for hydrogen gas and a gas at mass number 28 (assumed to be carbon monoxide) was observed. In the earlier first run, only hydrogen pressure rise was observed. The preliminary analysis of these data indicates that the luminosity lifetime in the SSC will not be significantly affected by the residual gas in the beam tube. If future experiments, scheduled to be completed in the next few months, verify these preliminary results, then the physical aperture of the magnets will not be affected by the synchrotron radiation-induced gas desorption. These data, the analysis, and the results were presented to MSAP.

Accelerator Theory and Computation. More aperture information has been gathered for the cost comparison between the superferric and the cosine theta magnet designs. In particular, a simulation code KICK has been developed; it deals with simplified lattices consisting of only cells with thin elements. The program is expected to be useful for investigation of momentum-dependent

effects, effects of misalignment, and when simulations of operation issues become important after the aperture studies. The additional aperture information gathered agree quite well with the previous results and are added to the SSC Aperture Estimate for Cost Comparisons (SSC-SR-1013) which was presented to MSAP.

Additional impedance calculations have been carried out following the Impedance Workshop held June 26-27 at LBL. The bellow impedance is caculated for two methods of shielding: the inner bellows and the sliding contacts. These results basically confirm the preliminary results obtained in the workshop that shielding the bellows by inner bellows still produces a large impedance which is uncomfortably close to a projected threshold for beam loss while shielding with slid- ing contacts provides a much smaller impedance. Dependences of the sliding contact impedance on the geometry of the contact are being studied.

II. Laboratory Programs

A. BNL.

1. General

Analytical Studies. Most of this period was devoted to work preparatory to designing a non-dogboned end. Two computer programs were modified to accept multi-layer designs.

The superconductor and iron required for a 4 tesla, 30 mm i.d. coil dipole was estimated for use in cost estimates. The decrease in superconductor permitted by a 50% increase in critical current density in the present 6.5 tesla design was estimated in the latter case, the less-wide cables allow the iron aperture to be smaller, resulting in 5.7% less amp-turns. The copper-to-superconductor ratio increases from 1.3 to 1.9 and from 1.8 to 2.7 in the inner and outer cables, respectively.

A computer analysis using the Poisson code of the 40 mm coil i.d. 2-in-1 SSC design was completed. Previous analysis of this design used program MDP which is unreliable at low field with this geometry. The new analysis shows that cross-talk is low at low field even when the two apparently are run with unequal excitation. In the 5:1 momentum ratio case (low side at injection) the quadrupole term is -0.3×10^{-4} in the low side and 0.2×10^{-4} in the high side. At 6.5 T with equal excitation the quadrupole is about -1.2×10^{-4}.

2. Model Magnets

a. 4.0 cm Aperture x 4.5 m Long Magnets.

- As reported above, assembly and test of the third and fourth dipoles, SLN010 and SLN011, were completed.
- Tests were conducted to measure coil stress at cryogenic temperatures and in magnetic fields. The data are currently being reviewed.

- A procedure was developed for locating and repairing turn-to-turn shorts in ends of coils by returning the coil to the curing press and loading with a hydraulic cylinder to recreate the short. After probing as per the electrical groups directions, we were able to locate and repair one inner coil turn-to-turn short by this method. However, the other inner coils made during this period were free of shorts at the ends.

- As reported, the first straight inner coil has been wound. Note: the wedges for this magnet have been stripped from inner coils I-2 and I-3 used on SLN008.

- Trim coil substrate for the fifth and sixth magnets have been wired and being mounted to bore tubes. This will be the first use of 0.008 in. wire.

- The first Multiwire trim coil was tested. The coil reached short sample and had superior training behavior compared with conventionally wound coils.

- PCK has successfully plated a short section of Nitronic 40 SSC bore tube. The sample is presently undergoing test of dc resistivity ratio measurements at zero magnetic field. Work has started on setting up a test to determine the resistivity ratio at magnetic fields up to 5 tesla.

- Detailing began on straight ended magnet yoke parts after completion of a layout of the coils in the yoke.

- Released design of brass filler pieces for the straight ended magnet.

- Updated and revised a report on collars that was originally prepared for the Tollestrup Technical Magnet Review Committee.

- Commenced design of the internal lead crossover for the straight ended magnet.

b. <u>4.0 cm Aperture x 16.6 m Long Magnets:</u>

- Incorporated a final revision to the 16.6 m magnet yoke lamination increasing the width of the vertical keyway for the collar key. H & J Tool and Die is presently working on the die modifications.

- Considerable progress has been made in the interconnect region. Layouts have been made in the following areas:
    a. Space for single phase bellows.
    b. Space for diodes, if required.
    c. Bore tube bellows.
    d. Connections of main lead to flexible lead.

- Discussions were held with FNAL regarding the cryostat and the interconnect region of the long SSC.

3. Tooling and Facilities

a. Coil Fabrication Tooling.

- Completed and released to the Shops all drawings for the 4 cm straight end inner and outer coils.

- Work has continued on lifting rigs for the long coil production.

- Engineering for the quadrupole coil winding tooling is complete.

b. Coil and Yoke Assembly Tooling.

- Considerable progress has been made on the design of tooling for use in Bldg. 924 in the following areas:
  a. Assembly work stations.
  b. Coil compression gauge tests.
  c. Coil handling and transporting tooling.

- Progress has also been made on yoke assembly tooling, such as:
  a. New concept collaring press.
  b. Lifting tongs for the collared coils.
  c. Support tooling for collaring press to minimize pre-stress loss, and an associated test arrangement.

c. Bore Tube and Trim Coil Tooling. Work continues on trim coil tooling in the following areas:

a. Set up and assembly of long coil tooling.
b. Material studies to optimize long coil adhesion bonding to the bore tube.
c. Bumper applicator tooling using laminated Kapton.

d. Magnet Test Facilities. Considerable progress has been made on the MOLE in the following areas:

a. Glass bearing and a flywheel to improve speed stability.
b. Design of a Harmonic Drive.
c. Piezoelectric crystal drive system.
d. Alternate long flex shafts as a backup to the air motor and harmonic drive.

4. Superconductor

a. Cable Procurement.

- During the month of August, 1,400 feet of SSC outer cable were manufactured at New England Electric Wire Corp (NEEW). This cable fulfills Brookhaven's needs for the near term.

- A meeting was held at BNL with representatives of Supercon and Vacuumschmelze to discuss cabling and cable delivery for P.O. 155746.

b. Tooling. The mean thickness measuring device mentioned in last month's report was delivered to NEEW as planned and on schedule.

4. Tests and Measurements. Two 4.5 m long SSC Reference Design D dipoles were tested during August making a total of four magnets of this type tested. The magnets were SLN010 and SLN011 and both performed well. The quench performance of these two magnets was similar to the first two. The first quench in SLN010 was at 5.8 T (5693 A), with a plateau of 6.6 T reached after five quenches. The first quench in SLN011 was at 5.8 T (5651 A), with a plateau of 6.5 T.

The harmonics of all four magnets are somewhat more reproducible than predicted by estimates based on experience with CBA and Tevatron magnets.

5. Cryogenic Systems. A paper entitled "The SSC Cryogenic System," by D. P. Brown, R.I. Louttit, C. Rode, and P. C. VanderArend was presented at the Cryogenic Engineering Conference by D. P. Brown. The conference was hosted by MIT. The paper described the generic SSC Cryogenic system design as it has evolved for Reference Designs C and D.

B. FNAL.

1. Magnet Models

a. 5 cm 824 Dipole Dry Winding. SJ-1005 incorporated a Kapton stainless steel composite inter-coil insulation endeavoring to eliminate inner-to-outer coil shorts. This scheme failed under collaring loads in a similar fashion as previous Kapton only insulated magnets, i.e., layer-to-layer shorts complicated by numerous turn-to-turn shorts created by the buckled stainless Kapton composite. It was obvious that a stiffer separator was required between the inner and outer coil layers at the magnet ends. To this end a 0.030 in. G10 barrier was installed with the end collars bored out to accommodate the increased radial build. The magnet was recollared successfully inasmuch as no layer-to-layer shorts appeared. The turn-to-turn shorts produced by the first collaring still exist and no further work is contemplated for this magnet.

SJ-1006 was wound and collared using the techniques developed from SJ-1005 with complete success. This magnet also incorporated an improved end ground insulation system using G10 which considerably reduced assembly labor as well as guaranteeing a consistent radial build.

SJ-1007 is in process with identical construction as SJ-1005. Scheduled completion is September 9.

Design of quasi-constant perimeter ends is underway with design completion the end of September. This change will tighten the end windings and reduce the cable bulging at the ends.

b. 5 cm 824 Dipole, Wet Winding. SJ-1002 was assembled and collared using somewhat asymmetrical coils produced due to tooling errors. The tooling modifications to remove asymmetries have been completed. Six inner coils have since been produced. Three of the six coils have been measured with good results. Asymmetry is within 2 mils and random. Production will continue for

outer coils with three magnets worth of coils available for assembly by September 13.

c. 4 cm Design D (Dry Winding). Collaring of DA1001 was completed. This magnet uses CBA strand cabled to Design D specifications. The assembly followed the techniques developed in the 5 cm SJ-1005. No turn-to-turn or layer-to-layer shorts occurred. Two ground shorts occurred due to sharp edges on outer key shims which will be repaired. This magnet will be tested as a collared coil only with iron added later. The preload of the outer coil was in excess of 13 ksi resulting in inelastic deformation of the collar during pressing. Testing of cable for A1002 is underway to predict preloads. Cable will be ordered for DA1003 based on these results. DA1002 is scheduled for completion on September 27.

d. Model Testing. The first of the Design B wet wound coils was tested. As had been noted in earlier reports, the coil size was not right due to an error in the tooling which has been corrected. Even with this tooling error the only abnormally large multipole was two units of a_2.

The magnet had a low first quench, 5140 amps, but by the second quench had exceeded the design goal. The ultimate central field of SK1001 after stretching at 3.2K was 6.07T at 4.2K, which is excellent. The new design field (5.5T) was surpassed on the third quench.

Work is almost complete on the "long" (0.75 m) short sample cable testing fixture. This will increase the measuring sensitivity to a few parts in 10^{-13} cm resistivity for the SSC cables. It can measure J_c (H) as a function of angle to magnetic field as well.

2. Conductor Development.

a. Cable Measuring. Modifications to improve the consistency of measurements on the conductor gauge continue. Meaningful data will start to be taken by September 27.

3. Cryostat Development

a. Suspension R&D. The planned measurements of the effectiveness of the thermal intercept linkage of the Magnetic Effects and the Heat Leak Models in the Suspension Heat Leak Dewar have been completed. The data are being analyzed to add to the understanding of the Heat Leak Model performance. Preliminary data evaluation indicates that the linkage's resistance to heat flow for this measurement is larger than that experienced in the Magnetic Effects Model. Measurements along the linkage indicate that the major thermal impedance is in the woven strap; i.e., $\Delta T=15K$ across the strap. The measurements indicated that the thermal performance of the support post is unchanged from the previous measurements.

Work continues on the fabrication of a re-entrant post for structural and thermal testing. The test fixture for the flexural testing of the re-entrant post is being constructed. Thermal measurements on an existing re-entrant post will begin in September.

Measurements continue on the the creep characteristics of shrink fitted joints. Data have been entered into a data bank. Steps have begun to analyze the data and to predict long term creep effects. The test rig for the creep G10 tubes in compression has been completed and initial data taking has begun.

b. Cryostat Design. Work continues on the optimization of the Design D cryostat. Components being optimized are the suspension post and the single phase assembly mount. The support post will accommodate an integral shipping restraint. The restraint will provide protection during shipping and handling, will not penetrate shields, MLI, etc., and will be configured to permit efficient thermal performance after removal of the restraint. A working model of the single phase position adjustment mechanism is being constructed.

Work continues on the specification of the interconnections. Interfacing continues with BNL to establish requirements of the single phase assembly and its connections.

Detailed planning for the production of long magnets has begun. The planning includes identification of long lead items and development of a suitable procurement plan. Also included is a detailed factory layout for the receiving, inspection, and storage of components and fabrication of the magnet assemblies. The factory layout corresponds to the Fermilab Industrial Center Building.

4. Accelerator Physics

a. The Photodesorption Experiment at NSLS for the SSC. The second run with the cold beam tube on August 8 and 9, 1985, differed from the first run in that one of the gas analyzers, RFQ B, which had monitored neutrals emerging from the top strip of the chamber, had been moved to a new position. In the new position, RFQ B was inserted into the downstream end of the beam pipe in an effort to gain a much larger signal than the one obtainable behind the 5mm hole through the wall of the beam pipe. As it turned out, the onslaught of the synchrotron light and the resulting photoelectrons made RFQ B inoperable in that location.

Precautions were also taken to reduce the background pressure in the analyzer environment by baking everything except the beam tube itself to approximately 100°C, and by baking the analyzers themselves in a separate vessel to 350°C.

The resulting limits are listed in the table below which is taken from a draft report by Hans Jostlein, Dejan Trbojevic, David Bintinger, and Peter Limon, and given to the CDG management.

The beam tube pressure in the SSC is estimated as

$$P(\text{beam tube})_{SSC} = [(P_{on} - P_{off})_{in} - (P_{on} - P_{off})_{out}]/[R \times \alpha]$$

$$P(CO) = (7.0 - 0.0) \times 10^{-12} \times 150/10 = 1 \times 10^{-10} \text{ Torr}$$

$$P(CO_2) \quad (1.6 - 0.0) \times 10^{-12} \times 150/10 = 3 \times 10^{-11} \text{ Torr}$$

For hydrogen with the most conservative interpretation of the data, we get - for the largest measurements:

$$P(H_2) = (12.6 - 6.9) \times 10^{-10} \times 150/10 = 8.6 \times 10^{-9} \text{ Torr}$$

In our next run planned for September 28, 1985, we expect to have a light chopper and ion counting system operational in order to increase our sensitivity and our discrimination against heating effects.

C. LBL.

1. Magnet Models. Magnet D12C6 was completed in early August and tested in the Bldg. 58 cryostat. This magnet was the last in a series of all Kapton insulated 1-m long dipoles that will be constructed this fiscal year. D12C7 and D12C8, presently under construction and scheduled for completion by Sept. 30, utilize the BNL insulation scheme of Kapton plus glass/epoxy. The results for D12C6 are presented in section 3 below.

Good progress has been made in the fabrication of parts for both D12C7 and D12C8. The design and construction of these two magnets are identical and are very similar to the 4.5 m dipoles series presently under construction and test at BNL. The main difference being the yoke construction, LBL using yoke blocks rather than the punched laminations used at BNL.

a. D12C7. In August, the following tasks were completed:

- Winding and curing of inner and outer layer coils.
- Mechanical size measurements of coils under a loading of 10,000 psi.
- Assembly of inner and outer coil layers on the assembly mandrel.
- Assembly and recalibration of coil load cells.

Collaring of this magnet will be completed in early September and the mechanical assembly of the magnet is scheduled for completion by mid-September at which time cold testing will start.

b. D12C8 Status. In August, the following tasks were completed:

- Fabrication of G-10 end islands for inner and outer coils.
- Insulation of coil wedges.
- Fabrication of coil assembly cones.
- Molding of coil end wedges.
- Forming of Kapton interlayer coil insulation.
- Fabrication of G-10 coil end saddles.
- Winding and curing of inner and outer layer coils.
- Mechanical size measurements of inner layer coils under a loading of 10,000 psi.

Assembly of D12C8 will start in mid-September and is scheduled for mechanical completion by the end of the month. Cold testing will start at the beginning of October.

2. Analysis

a. Magnet Cross-Section Design Program. The program PARTIAL KEYSTONE has been used to design and analyze several cross sections for the SSC dipoles.

The microcomputer program mentioned previously has been modified to model partially keystoned conductors more accurately, and has been thoroughly debugged. Using, as starting points, rough designs produced by analytical methods, having non-integer numbers of turns in the various blocks, the program is used to home in on a corresponding integer-turn design rapidly, permitting a large number of designs to be investigated rapidly. An investigation of a large number of possible designs has been started. There remains the problem of calculating the local maximum field in each layer and folding that with the I vs. B characteristics of the cable. Development of the mechanics for doing that rapidly has been started.

3. Instrumentation and Measurements

SSC model dipole D12C6 was tested from August 15 to August 24, 1985. The first quench in HeI occurred at 6.4 tesla and the maximum central field of 6.7 tesla was reached on the seventh quench. In HeII, at 1.84K, a central field of 8.3 tesla was reached. Extensive magnetic measurements were taken, especially to compare the room temperature low current values with the cold high current values. Hardware changes are being considered to improve the accuracy of room-temperature measurements.

4. Superconductor

a. Superconductor Developments. A workshop on the Fabrication of Superconductor Cables for the SSC was held at LBL on August 27 and 28. The workshop focussed on three topics. First, representatives from LBL, BNL,

FNAL, and TAC presented the requirements for SSC Design D and Design C cables. Next, cabling technology was discussed with inputs from J. Royet (LBL) and R. Meserve (NEEW); this was followed by a demonstration on the LBL experimental cabling machine and a discussion of additional cabling experiments. The final topic was a preliminary discussion of a manufacturing plan to meet the SSC requirements. Approximately 30 people attended, with equal participation from the U.S. superconductor wire industry, U.S. cable industry, and from laboratories involved in the SSC program.

Progress continues on the R&D efforts aimed at fine filament NbTi. IGC completed Phase I of their contract and began Phase II with the extrusion of two first-stage billets. This material will be cold drawn and restacked into second-stage billets for extrusion. Delivery of wire is expected by December.

Material for Phase I of the hydrostatic extrusion experiment was completed and sent to Batelle. Three small billets will be extruded in order to define the parameters for three production-size billets to be extruded in a commercial press in November. This experiment will provide data on the technical quality and yields of fine filament NbTi that can be achieved via hydrostatic extrusion.

D. TAC.

Three magnets were measured this month. The magnet errors are reasonable; however, the skew quadrupole term is systematic and larger than desired. The modulus of the coil pack was less than expected and permitted a shifting of the coils by 3 mils. This has been corrected by adding 10 mils of kapton to the coil package.

The cold mass of the long magnet (28 meters) at General Dynamics has been assembled. It is straight both vertically and horizontally to +/- 12 mils; +/- 40 mils is acceptable. The tilt angle of the magnet varied over a larger than acceptable range, with an r.m.s. value of 1.9 milliradians. This was due largely to a faulty weld procedure. The weld procedure has been improved and should result in magnets with tilt angles substantially less than 1 milliradian. Methods of reducing tilt after the welds are completed are also being explored.

C. Project Cost Data

(Index)

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TABLE C-1

CENTRAL DESIGN GROUP - SUPERCOLLIDER

AUGUST 1985 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.1	ADMINISTRATION	76	95	-160	11	2054	1935
1.2	PROGRAM PLANNING & MANAGEMENT	17	1	8	26	273	380
1.3	ACCELERATOR R & D	108	23	64	195	1114	1680
1.4	CONVENTIONAL SYSTEMS DEVELOP.	15	107	9	131	593	1130
	PROGRAM COSTS	216	226	-79	363	4034	5125
	COMMITTMENTS					366	

TABLE C-2

BROOKHAVEN NATIONAL LABORATORY - SUPERCOLLIDER

AUGUST 1985 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
2.1	GENERAL	22	23	18	63	805	915
2.2	MAGNET MODELS	81	14	39	134	1811	2075
2.3	TOOLING	26	7	14	47	713	802
2.4	MAGNET MEASUREMENT & DEVEL.	19	11	12	42	415	453
2.5	POWER SUPPLIES & QUENCH PROT.	9	1	4	14	209	271
2.6	CRYOGENIC TESTING	28	5	12	45	508	569
	PROGRAM COSTS	185	61	99	345	4461	5085
	COMMITMENTS					225	
	EQUIPMENT						497

TABLE C-3

FERMI NATIONAL ACCELERATOR LABORATORY - SUPERCOLLIDER

AUGUST 1985 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
3.1	GENERAL	2.2	3.6	1.9	7.7	146.5	340
3.2	MAGNET MODELS	112.5	50.8	52.7	216	3386.2	3320
3.3	FACILITY DEVELOPMENT	3	2.9	1.9	7.8	266.3	340
	PROGRAM COSTS	117.7	57.3	56.5	231.5	3799	4000
	COMMITMENTS					17.6	
	EQUIPMENT					25	25

TABLE C-4

LAWRENCE BERKELEY LABORATORY - SUPERCOLLIDER

AUGUST 1985 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
4.1	GENERAL	3	2	2	7	106	115
4.2	MAGNET MODELS	9	40	4	53	353	395
4.3	ANALYSIS	4	0	2	6	121	125
4.4	INSTRUMENTATION/MEASUREMENTS	9	2	5	15	103	155
	PROGRAM COSTS	25	44	13	81	683	790
	COMMITMENTS					98	

TABLE C-5

TEXAS ACCELERATOR CENTER - SUPERCOLLIDER

AUGUST 1985 COST AND COMMITTMENT REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
5.1	GENERAL	0	94.5	40.8	135.3	877.6	825
5.2	SHORT MAGNET MODELS	55.7	22.4	20.4	98.5	974.3	1150
5.3	LONG MAGNET MODELS*	55.7	0	0	55.7	448.9	1660
5.4	TOOLING	0	0	0	0	0	630
5.5	THEORETICAL ANALYSIS	55.8	0	0	55.8	266.4	130
5.6	FACILITY DEVELOPMENT	0	0	0	0	219.8	605
	PROGRAM COSTS	167.2	116.9	61.2	345.3	2787	5000

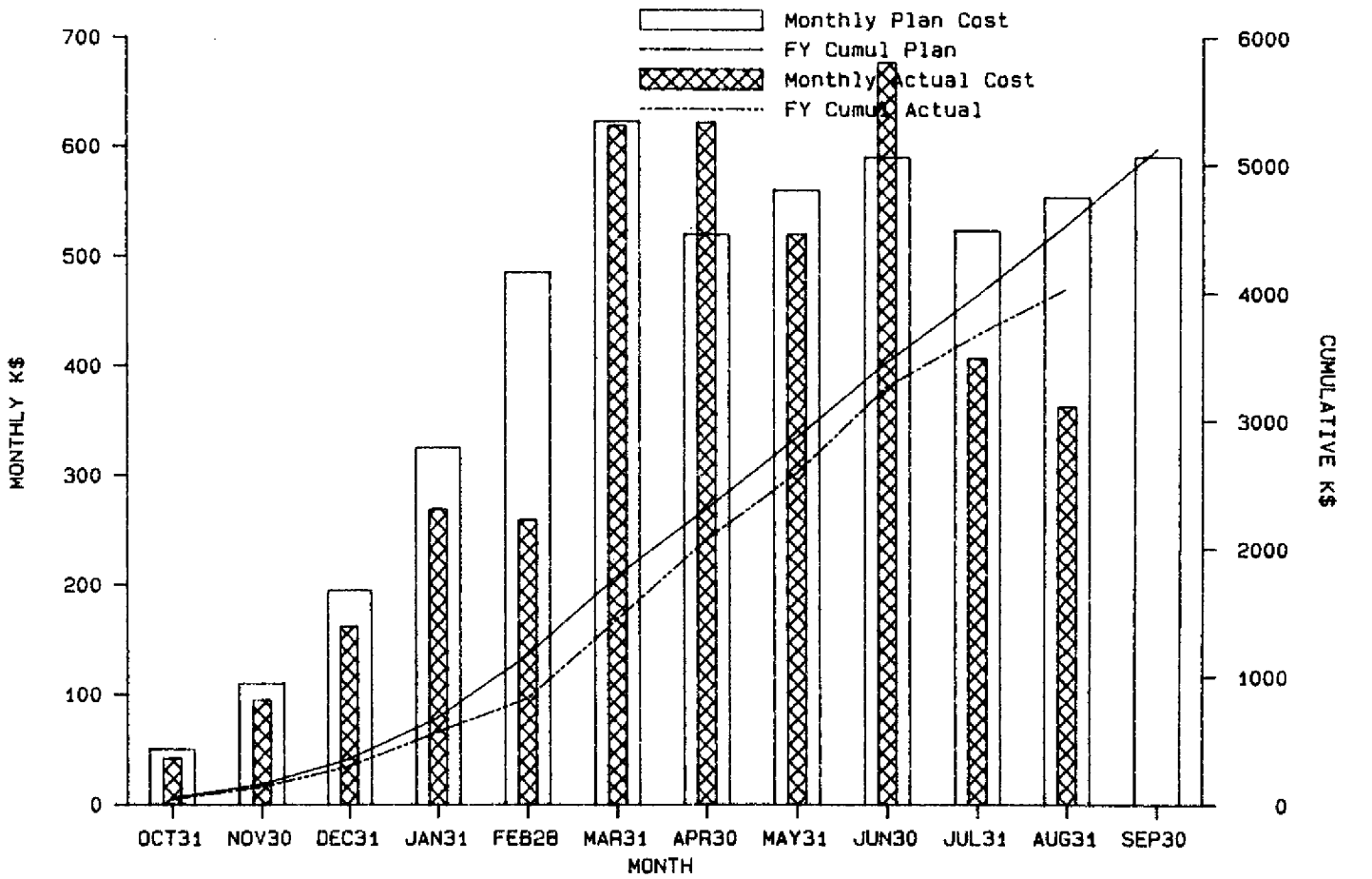
*Does not include 1062 K$ obligation to General Dynamics Corp. for fabrication of long magnets
Facility Development total does not include 15 K$ equip. costs

TABLE C-6

PROGRAM SUMMARY - SUPERCOLLIDER

AUGUST 1985 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.	CDG PROGRAM	216	226	-79	363	4034	5125
2.	BNL SSC PROGRAM	185	61	99	345	4461	5085
3.	FNAL SSC PROGRAM	118	57	57	232	3799	4000
4.	LBL SSC PROGRAM	25	44	13	82	683	790
5.	TAC SSC PROGRAM	167	117	61	345	2787	5000
	TOTAL SSC PROGRAM COSTS	711	505	151	1367	15764	20000



	FISCAL YEAR 1985											
	OCT31	NOV30	DEC31	JAN31	FEB28	MAR31	APR30	MAY31	JUN30	JUL31	AUG31	SEP30
Monthly Plan	50	110	195	325	485	623	520	560	590	523	553	590
FY Cumul Plan	50	160	355	680	1165	1788	2308	2868	3458	3981	4535	5125
Monthly Actual	42	95	162	269	259	619	622	520	677	407	363	
FY Cumul Actual	42	137	299	568	827	1446	2068	2588	3265	3672	4035	

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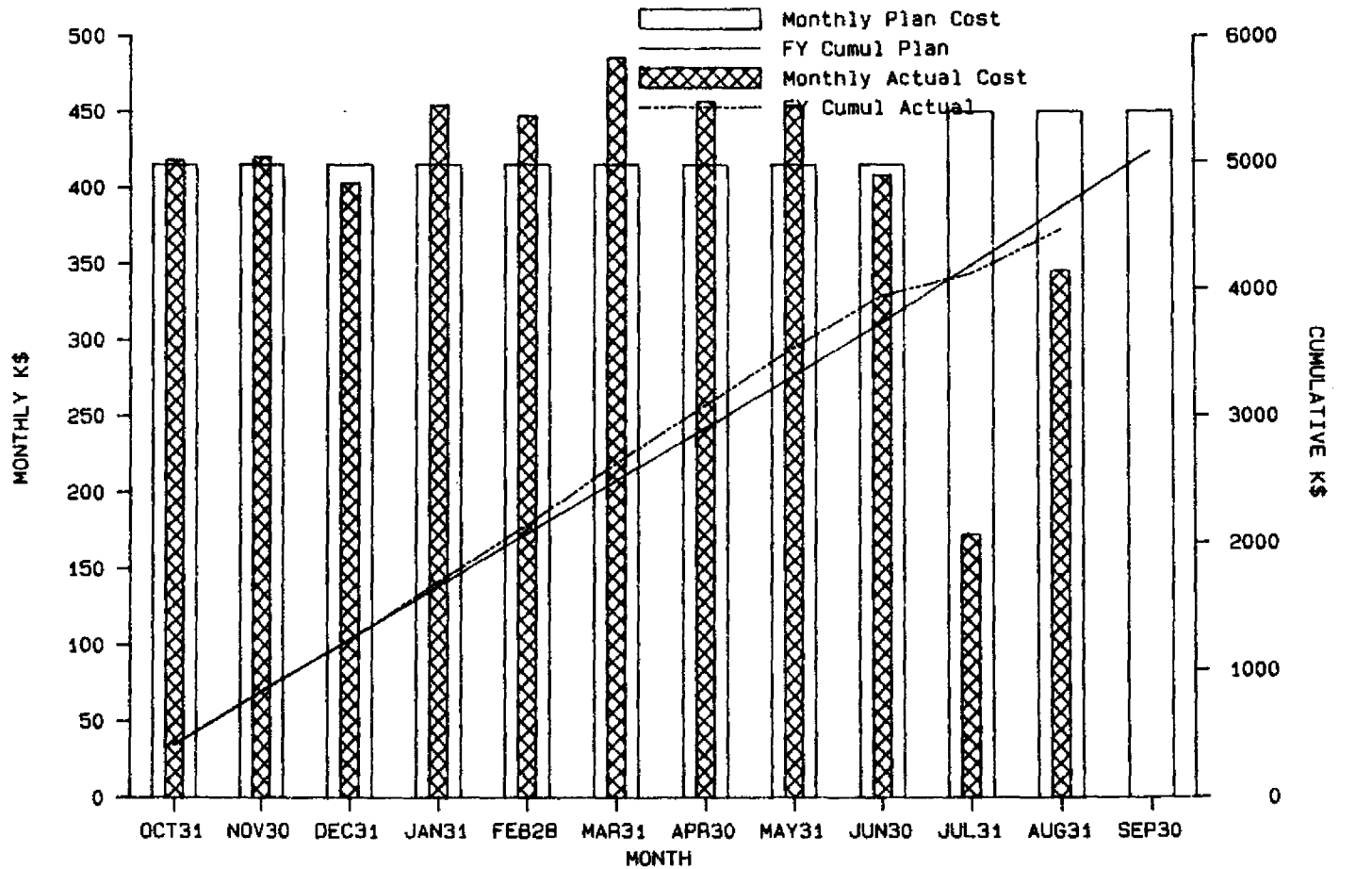
Fig. 1



	FISCAL YEAR 1985											
	OCT31	NOV30	DEC31	JAN31	FEB28	MAR31	APR30	MAY31	JUN30	JUL31	AUG31	SEP30
Monthly Plan	415	415	415	415	415	415	415	415	415	450	450	450
FY Cumul Plan	415	830	1245	1660	2075	2490	2905	3320	3735	4185	4635	5085
Monthly Actual	418	420	403	454	447	466	457	454	408	172	345	
FY Cumul Actual	418	838	1241	1695	2142	2628	3085	3539	3947	4119	4464	

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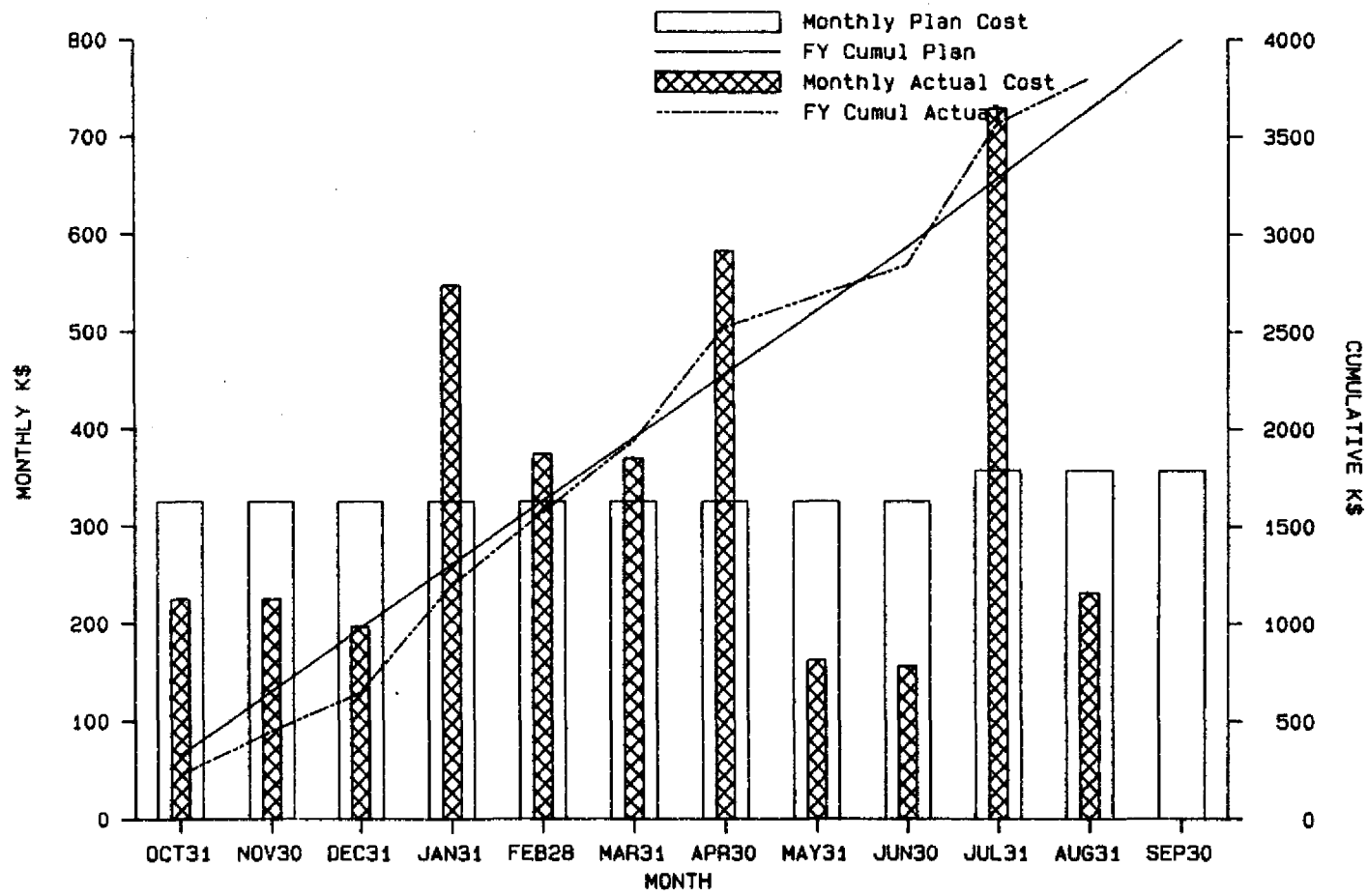
Fig. 2



	FISCAL YEAR 1985											
	OCT31	NOV30	DEC31	JAN31	FEB28	MAR31	APR30	MAY31	JUN30	JUL31	AUG31	SEP30
Monthly Plan	325	325	325	325	325	325	325	325	325	357	357	357
FY Cumul Plan	325	651	976	1302	1627	1953	2278	2603	2929	3286	3643	4000
Monthly Actual	225	225	197	547	374	370	582	162	156	729	232	
FY Cumul Actual	225	450	647	1194	1568	1938	2520	2682	2839	3568	3799	

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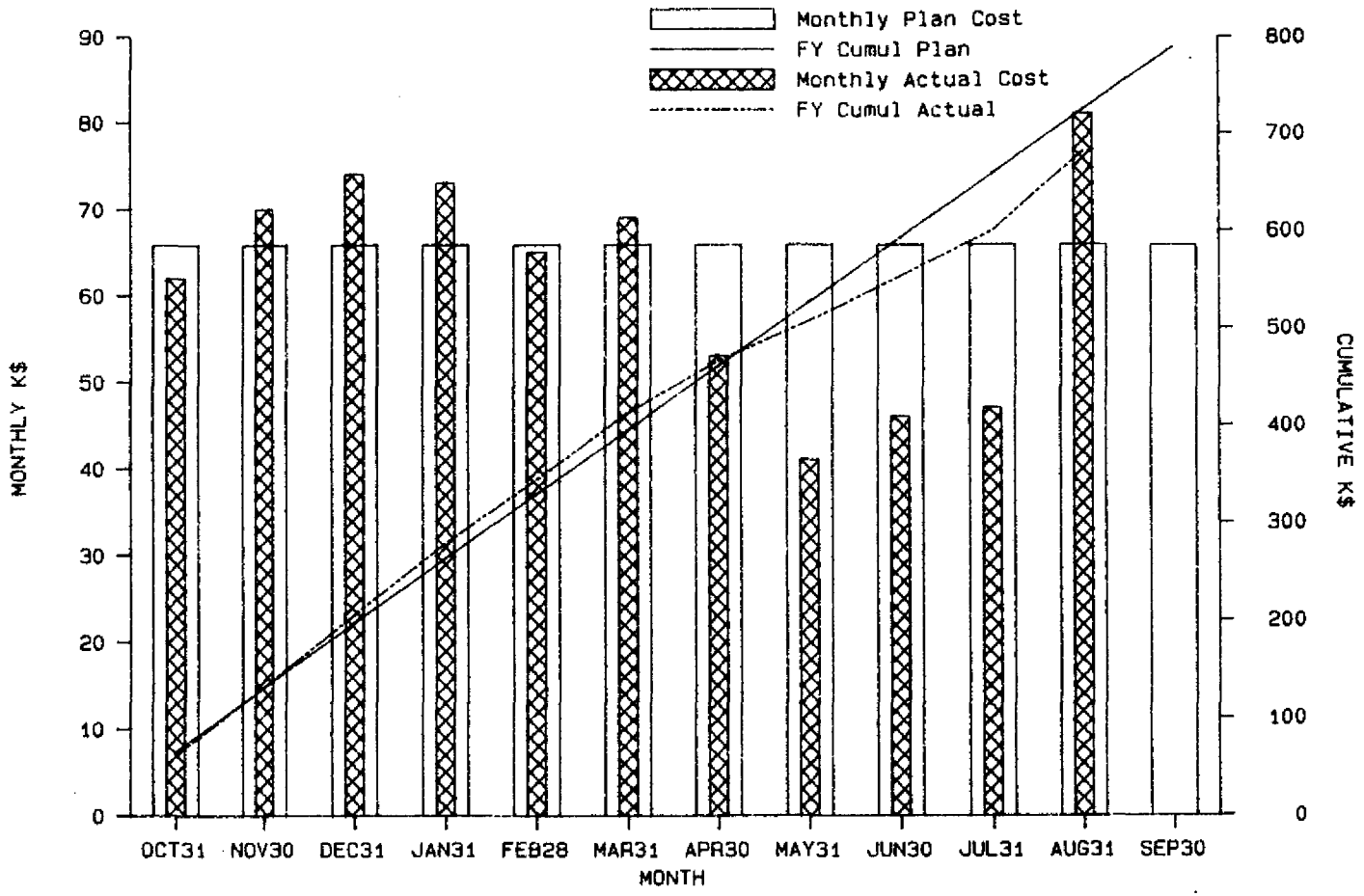
Fig. 3



	FISCAL YEAR 1985											
	OCT31	NOV30	DEC31	JAN31	FEB28	MAR31	APR30	MAY31	JUN30	JUL31	AUG31	SEP30
Monthly Plan	66	66	66	66	66	66	66	66	66	66	66	66
FY Cumul Plan	66	132	198	263	329	395	461	527	592	658	724	790
Monthly Actual	62	70	74	73	65	69	53	41	46	47	81	
FY Cumul Actual	62	132	206	279	344	413	466	507	553	600	681	

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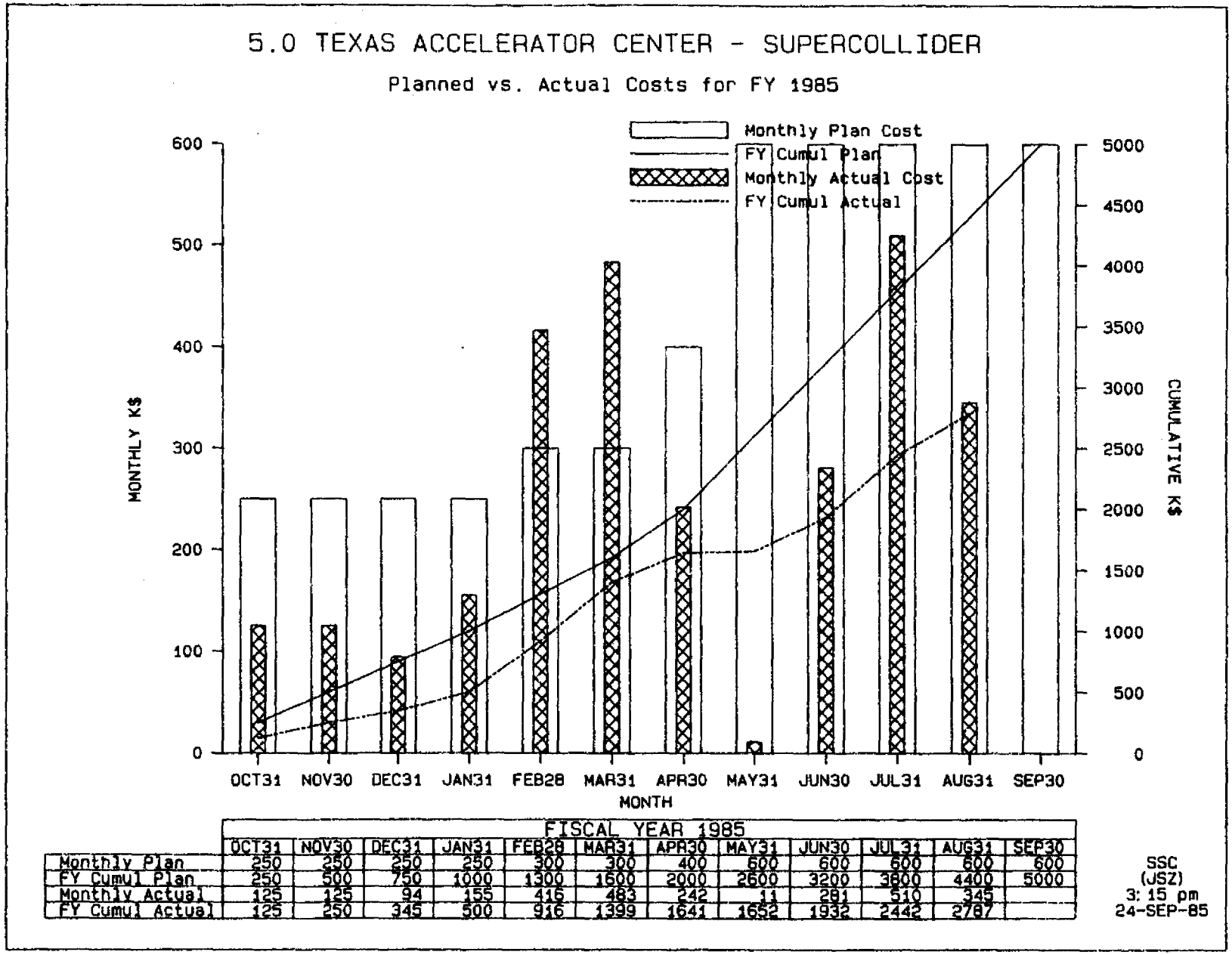
Fig. 4



	FISCAL YEAR 1985											
	OCT31	NOV30	DEC31	JAN31	FEB28	MAR31	APR30	MAY31	JUN30	JUL31	AUG31	SEP30
Monthly Plan	250	250	250	250	300	300	400	600	600	600	600	600
FY Cumul Plan	250	500	750	1000	1300	1600	2000	2600	3200	3800	4400	5000
Monthly Actual	125	125	94	155	416	483	242	11	281	510	345	
FY Cumul Actual	125	250	345	500	916	1399	1641	1652	1932	2442	2787	

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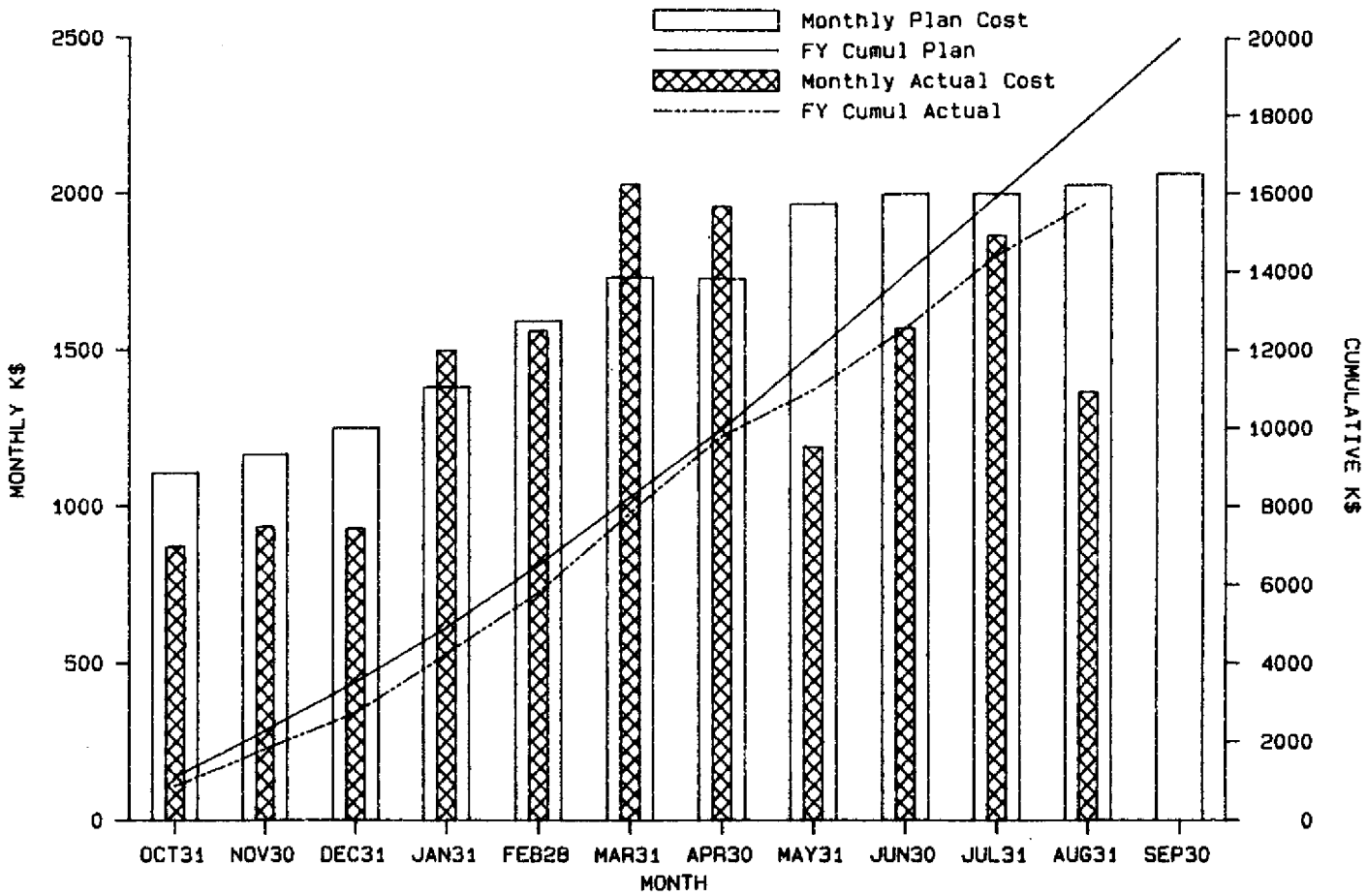
Fig. 5



	FISCAL YEAR 1985											
	OCT31	NOV30	DEC31	JAN31	FEB28	MAR31	APR30	MAY31	JUN30	JUL31	AUG31	SEP30
Monthly Plan	1106	1166	1251	1381	1591	1729	1726	1966	1996	1996	2026	2063
FY Cumul Plan	1106	2273	3524	4905	6496	8226	9952	11918	13914	15910	17937	20000
Monthly Actual	872	935	930	1498	1561	2026	1956	1188	1568	1865	1366	
FY Cumul Actual	872	1807	2738	4236	5797	7823	9780	10968	12536	14400	15766	

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Fig. 6