GA–C19570
(4/18/95)

PROGRAM STATUS
2nd QUARTER — FY 1995

CONFINEMENT SYSTEMS PROGRAMS

- DIII–D RESEARCH OPERATIONS
- INTERNATIONAL COOPERATION
- TOKAMAK PHYSICS EXPERIMENT
- FUSION PLASMA THEORY
- USER SERVICE CENTER
- ITER JCT SECONDEES
- RF TUNER SYSTEM CAPITAL

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Contract No. DE–AC03–89ER51114
General Atomics Projects 3466/3467/3470/3473/3939/3940/3969/3990/3472

This Quarterly Report Under
DOE Contract DE–AC03–89ER51114
is Submitted in Compliance with Sections A and B
of the REPORTING REQUIREMENTS CHECK LIST

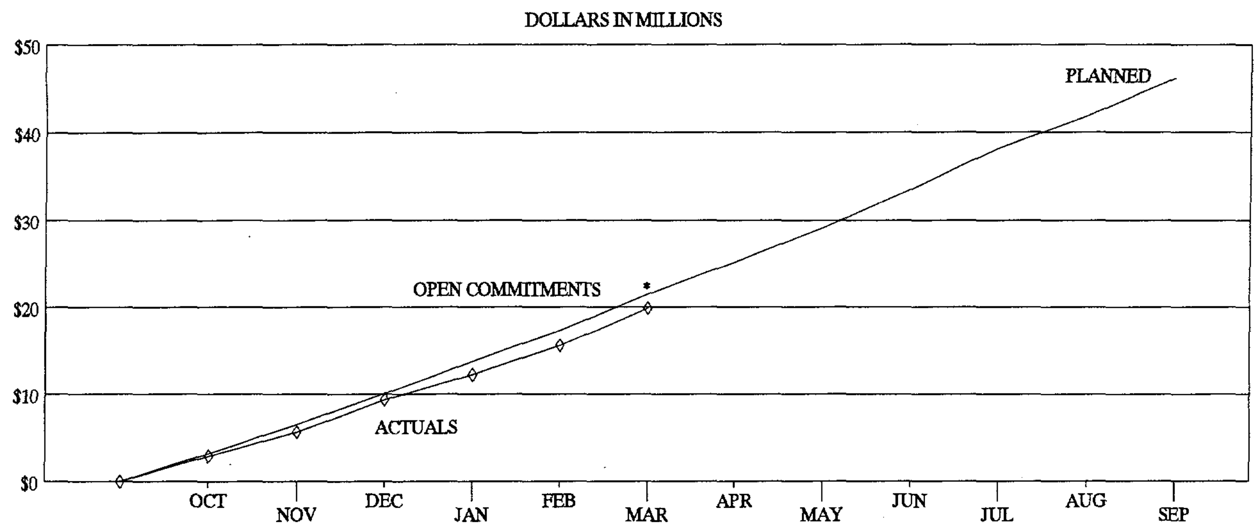
APRIL 18, 1995

MASTER

GENERAL ATOMICS

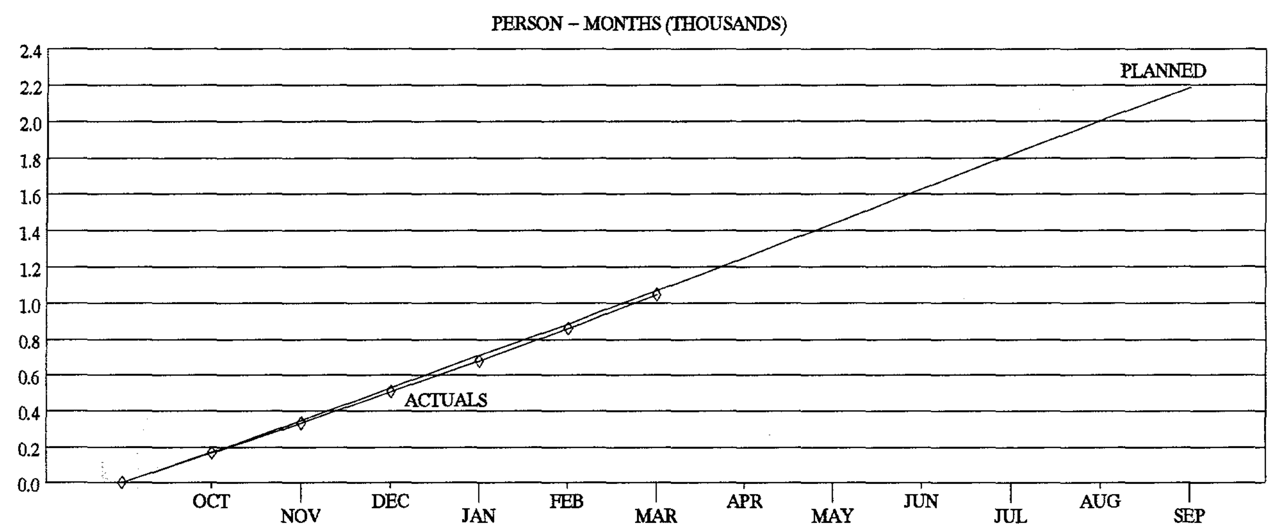
Contract Management Summary Report

TITLE:	DIII–D RESEARCH OPERATIONS & RELATED RESEARCH	**CONTRACT NO.:**	DE–AC03–89ER51114
CONTRACTOR: GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186–9784	**COST & LABOR PLAN DATE:** APRIL 17, 1995	**START DATE:** OCTOBER 1, 1994 **COMPLETION DATE:** SEPTEMBER 30, 1995	



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	$3,226	$3,387	$3,504	$3,632	$3,618	$4,163	$3,706	$3,915	$4,400	$4,651	$3,703	$4,299	$46,204
ACTUAL	$2,932	$2,771	$3,695	$2,894	$3,341	$4,251							$19,884
VARIANCE	$294	$616	($191)	$738	$277	($88)							
CUM VAR	$294	$910	$719	$1,457	$1,734	$1,646							

(IN THOUSANDS)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	171.3	176.1	183.9	179.5	177.6	180.9	182.1	187.3	190.9	189.6	185.6	183.7	2188.5
ACTUAL	165.6	167.9	175.3	170.1	183.5	185.6							1048.0
VARIANCE	5.7	8.2	8.6	9.4	−5.9	−4.7							
CUM VAR	5.7	13.9	22.5	31.9	26.0	21.3							

(PERSON–MONTHS)

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ____________________

DISCLAIMER

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DISCLAIMER

DIII–D RESEARCH OPERATIONS

PROGRAM STATUS
2ND QUARTER — FY 1995

TASK: DIII–D RESEARCH OPERATIONS

B/R NOS: AT101014D (Operating)
35AT10020 (Capital)

CONTRACT NO.: DE-AC03-89ER51114

GA PRINCIPAL INVESTIGATOR: T. SIMONEN

OAK PROJECT MANAGER: M. FOSTER

OFE PROGRAM MANAGER: E. OKTAY

OPERATING

FY95 FUNDING: $37,794K(1)(3)

FY95 PLAN: $37,019K(2)(3)

CAPITAL

FY95 FUNDING: $4,700K(1)

FY95 PLAN: $5,475K(2)

	MILESTONE	LEVEL	APPROVED DATE	TARGET DATE	COMPLETION DATE
98.	Report on ITER R&D tasks	I	10/94		10/94
100.	Report on wall stabilization	I	10/94		10/94
106.	Report on C–coil	I	10/94		10/94
78.	Report on FW expts	I	12/94	2/95	2/95(4,5)
109.	Report on Transport expts	I	12/94		12/94
111.	Evaluate plasma rotation	I	12/94		12/94
96.	Checkout 2nd & 3rd FWCD transmitters	I	2/94	1/95	2/95(4,5)
107.	Real time measurement of q(0)/MSE	I	1/95		2/95
110.	Report on advance tokamak experiments	I	1/95	4/96(4,7)	
112.	Receive 1st 1 MW Russian gyrotron tube	I	1/95	7/95(6)	
76.	Begin ECH 110 GHz 2 MW expts	I	2/95	6/95(6)	
101.	Report on plasma rotation control with C–coil	I	2/95		2/95
102.	Obtain L–H transition data with fast edge CER system	I	3/95	10/95(4,8)	
113.	Evaluate & decide 1 MW tube vendor	I	(4)	6/96(6)	
103.	Obtain initial data on BES with University of Wisconsin	I	9/95		

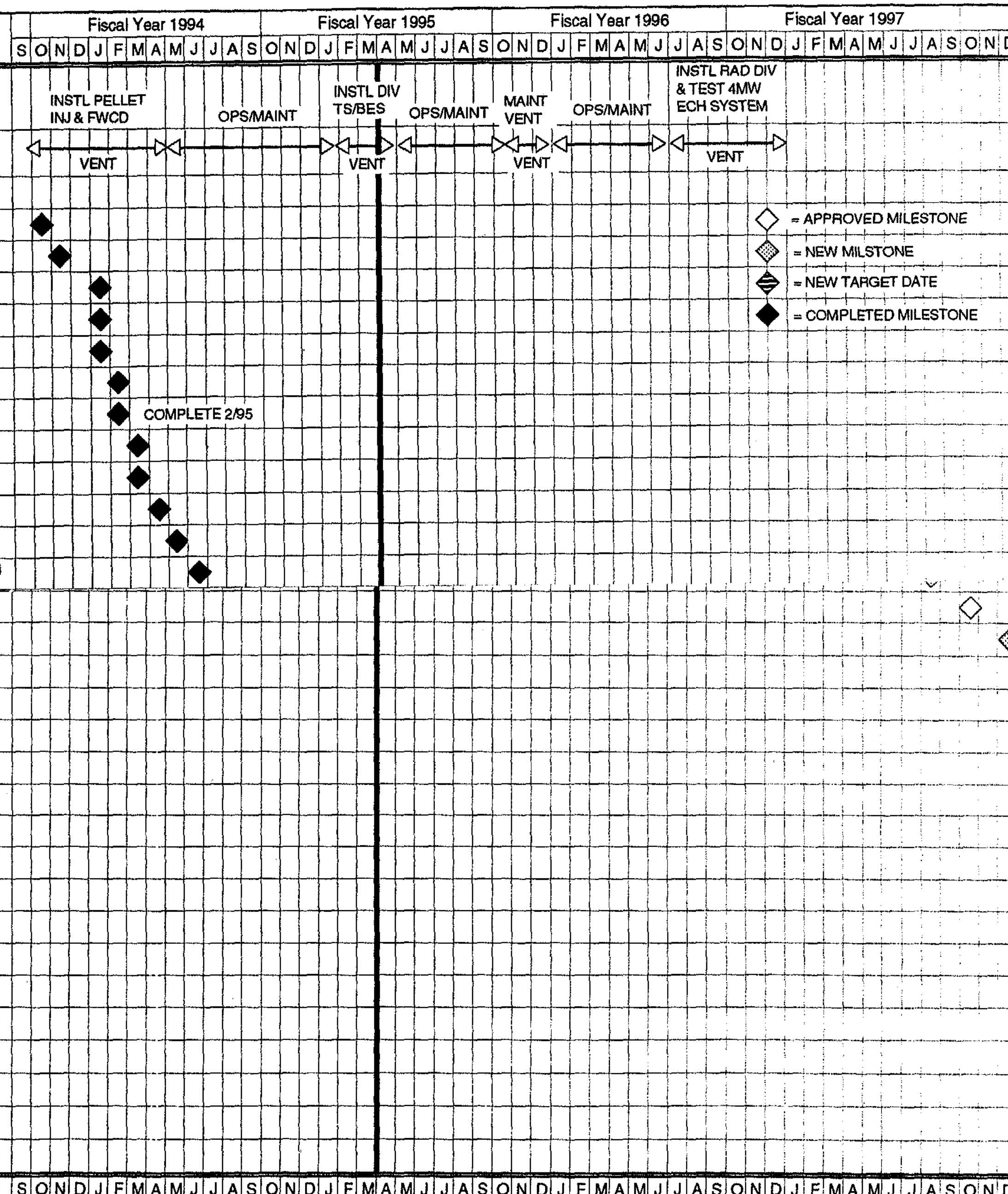
REMARKS:

(1)Anticipated DIII–D funding of $43,050K at beginning of FY95 reduced to $42,494K.
(2)FY95 planned expenditures reflect adjustment for FY94 carry over funds ($–775K Operating/$+775K Capital).
(3)Additional FY95 Operating funding reduction of $281K anticipated for Varian gyrotron development.
(4)Not yet approved by OFE.
(5)Milestone has been impacted by delays in second ABB transmitter acceptance tests (milestone #96).
(6)Delay in delivery of Russian gyrotron.
(7)Milestone has been impacted by lack of FWCD system.
(8)Milestone was impacted by FY94 budget restraints.

DIII-D MILESTONE SCHEDULE

Mar 31, 1995

NO	MILESTONE DESCRIPTION	RESP
	MACHINE STATUS	
	MILESTONES	
94(GA)	COMPLETE REPT ON ITER R&D TASKS	LUXON
25(LLNL)	REPT ON THE DETAILED COLLABORATION PLAN FOR FY94	ALLEN
99(GA)	REPT ON EXPERIMENTS NEEDED TO DESIGN THE RADIATIVE DIVERTOR	STAMBAUGH
(ORNL)	DELIVER PELLET INJECTOR TO DIII-D	HILLIS
26(LLNL)	ISSUE REPT ON SUMMARY OF HEAT FLUX DISTRIBUTION	ALLEN
(ORNL)	DELIVER LONG PULSE FWCD ANTENNAS	HILLIS
96(GA)	COMPLETE CHECKOUT OF THE 2nd & 3rd FWCD TRANSMITTERS	FREEMAN
27(LLNL)	COMPLETE INSTALLATION OF VACUUM HDWR FOR THE EDGE MSE	ALLEN
83(GA)	INSTALL MULTI-ELEMENT ORNL FWCD ANTENNA	FREEMAN
28(LLNL)	REPT ON EXPTS & MEASUREMENTS DURING HIGH BETA POLOIDAL EXPTS	ALLEN
29(LLNL)	COMP INSTALLATION OF HDWR FOR THE DIV MW INTERFEROMETER	ALLEN
95(GA)	REPT ON THE PRELIMINARY RADIATIVE DIVERTOR DESIGN	STAMBAUGH
90(GA)	COMPLETE 10 SECOND TOKAMAK UPGRADE	STAMBAUGH
119(GA)	REPT INITIAL RESULTS OF ECH OFF AXIS CURRENT DRIVE	FREEMAN



PROGRAM STATUS
2nd QUARTER — FY 1995
DIII–D RESEARCH OPERATIONS

DIII–D PROGRAM
COMING ATTRACTIONS
3rd QUARTER — FY 1995

- **Return to Research Operations**
  - First experiments with combined fast wave systems
  - Divertor understanding
  - Disruption studies
  - ITER–modeling
- **The DIII–D program will be presented to the PCAST Fusion Energy Research Panel**
- **Agree on detailed implementation plan for the FY96 PPPL collaboration**

PROGRAM STATUS
2nd QUARTER — FY 1995
DIII–D RESEARCH OPERATIONS

- Conducted physics experiments
  - Record normalized $\beta = 4.9$ achieved in VH–mode
  - β limits of ITER-like configurations evaluated
  - FWCD commissioning
- The tokamak vacuum vessel was opened to atmosphere for six weeks and a number of key diagnostics for understanding the divertor were installed
- The DIII–D Advisory Committee meet in January to review the DIII–D program and plan. They commended us for recent progress and supported the vanadium divertor design
- The U.S./Japan DIII–D Steering Committee met and recommended extending the agreement to the year 2000
- The Field Work Proposal for FY96/97 was presented in Washington on March 29, 1995
- A review of the DIII–D plan to install vanadium structural components as part of the new radiative divertor modification was held in Washington on March 31, 1995 and the panel endorsed the plans
- Preliminary plans were developed with PPPL for collaborations in FY96

INTRODUCTION AND PROGRAM PLANNING

During the second quarter, a wide variety of activities were completed. The quarter began with a brief operating period to obtain some key experimental results. The tokamak was then opened to air for six weeks and a number of new divertor diagnostics were installed which will allow us to get the maximal amount of divertor data out of the present configuration. This vent has been completed and the machine has been closed again. The RF group has been focusing on completing commissioning of the ABB transmitters. Multiple frequency operation has proved difficult with the present hardware, and the plan is to focus on a single frequency to demonstrate the power handling of the transmission system and the effective coupling of power to the plasma. It is presently anticipated that twelve weeks of operation remain in the fiscal year with concentration on the demonstration of rf current drive and better understanding of the divertor region. A plan is being developed with our collaborators to staff DIII–D using increased collaborator help in a wider range of positions than has been used previously. The Field Work Proposal for FY96 and FY97 was presented in Washington. Following the FWP, a presentation of DIII–D's plan to build a component for the upcoming divertor modification out of vanadium was presented to a panel of experts and the plan was enthusiastically endorsed.

The DIII–D Advisory Committee (DAC) and the U.S./Japan DIII–D Steering Committee met in January to review DIII–D program plans. The DAC commended the DIII–D team for outstanding scientific productivity and seminal results. They were pleased with the progress on the radiative divertor design and supported the use of vanadium alloy components in DIII–D. The U.S./Japan DIII–D Steering Committee noted that the DIII–D program objectives very strongly support long range JAERI objectives and they recommended extending the agreement between the two parties until 2000.

A successful but shortened period of research operations was completed during February. Impressive new results were obtained. A normalized beta of $\beta_N = 4.9$ was obtained in a conventional shear VH–mode plasma, and a record value of $\beta\tau = 0.03$ sec was obtained in a VH–mode plasma. Two run days were devoted to determining the β limits of ITER-like plasma configurations and to studying the TAE mode in this configuration. Experiments were also carried out to help commission the new FWCD rf heating system. On one run day, two primary experiments along with four piggyback experiments were successfully completed.

The start of operations was delayed and the run period shortened from fifteen days to eight days by the failure of a set of current limiting line reactors in the AC power system between the motor generator and the ohmic heating DC converter. Three of the six reactors failed in an arc-over, apparently initiated by a bird. The system was reconfigured to run with three reactors. The capability of the ohmic heating system is limited to plasma currents less than 2 MA, but this does not seriously limit the experimental capability. New reactors have been ordered and the first have been successfully tested. It is anticipated that the May operating period will be completed in the three-reactor configuration and the remaining reactors will be replaced during the first maintenance period. A review of the buswork associated with these coils found that the electrical insulation of the (ten year old) system could be improved to minimize the chances of a similar occurrence in the future and to reduce the extent of the damage should an arc occur. Following a review of the proposed plan, these changes were implemented.

The vacuum vessel was vented to atmosphere for six weeks during March and April. Several major divertor diagnostic systems were installed, including a divertor Thomson scattering system, a divertor reflectometer, and the in-vessel components for a beam emission spectroscopy diagnostic. A reciprocating X–point probe was installed, but without its probe tip, which was not received in time. In all, 110 separate tasks were completed. Diagnostic calibrations were carried out on second shift almost every evening during the vent. The machine has been evacuated and is being prepared for experimental operations. However, during testing it was observed that the new divertor Thomson scattering system was experiencing much more stray light than anticipated. Several tests have been run to evaluate the problem. A set of modifications is being developed and it is anticipated that they could be installed during the May maintenance period. The core plasma Thomson scattering system is not impacted by these issues.

Progress continues toward the goal of 4.5 MW of power coupled to the plasma from the fast wave current drive system. During this month's operating period, a total of 3.1 MW was achieved from the three transmitters, but not simultaneously. The modifications proposed by ABB to remove the power-robbing parasitic oscillations in the final amplifier of the transmitter were not successful, and we have developed a plan to proceed with operation at a single frequency chosen to minimize parasitics in order to meet program goals. ABB will continue to work on the problem. February's operation also identified failures in the insulation in the tuners. An R&D plan was carried out to develop a solution and it is being implemented.

Twelve weeks of research operations are planned for the rest of this year (Fig. 1), along with additional time for systems tests, vessel preparation, and calibrations. This schedule is demanding of the present staff and will provide 19 weeks of operation for this fiscal year. It is anticipated that additional operating time will be needed to allow for the conditioning of the FW system into plasma. The present plan is to provide this with additional evening hours using minimal staffing. It is expected that the machine will be vented for a few days at the beginning of the first maintenance period to install modifications for the divertor Thomson scattering system, and that the replacement line reactors for the ohmic heating input power will be installed during this maintenance period.

A schedule of experiments for the May and June operating periods has been developed. In response to uncertainties in the availability of the divertor Thomson scattering and the fast wave rf systems, experiments for which either of these systems is essential have been scheduled later in the year; early in the year is a full program of experiments previously identified as top priority.

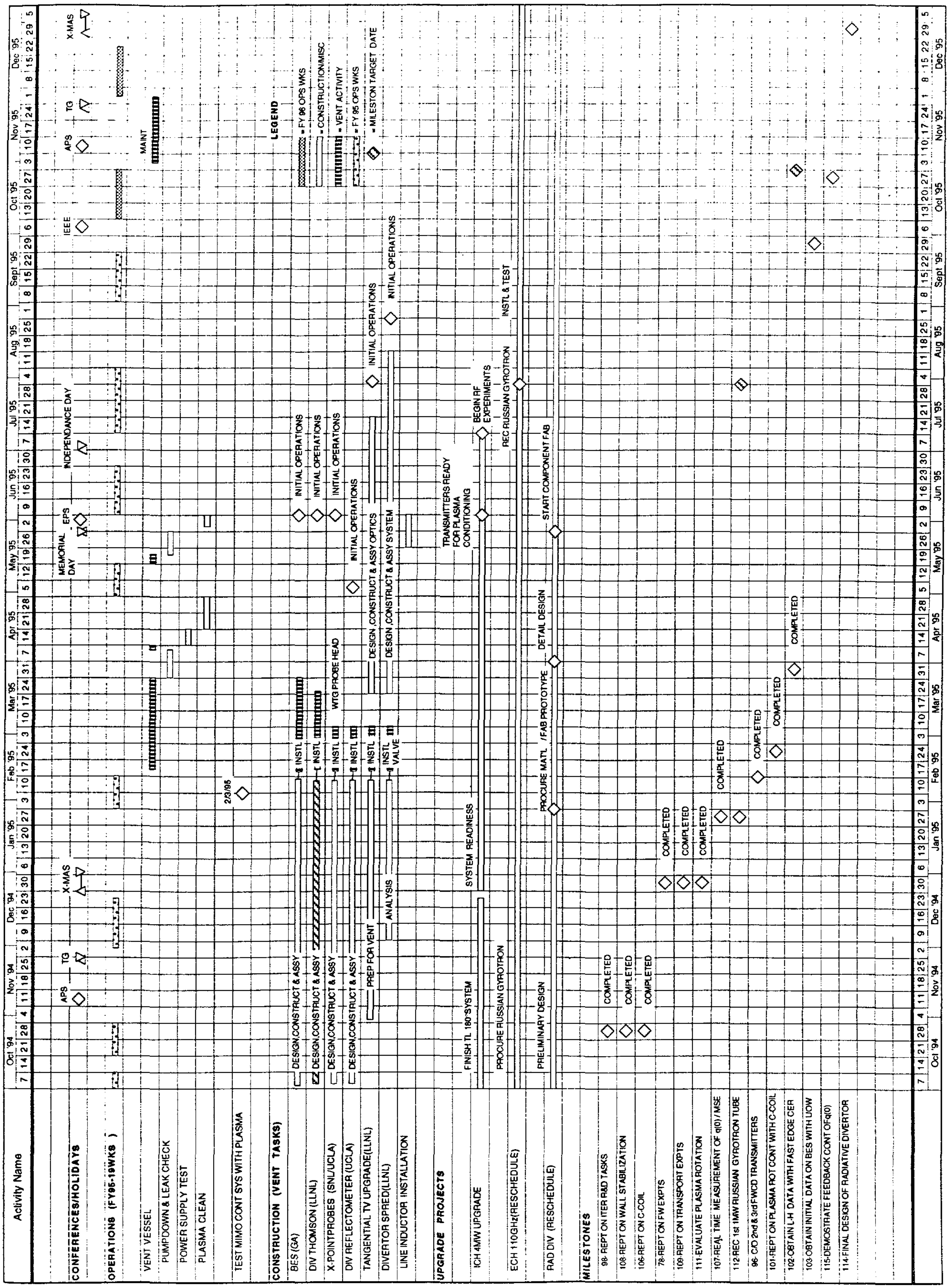
We have been working with our existing and proposed collaborators to develop a FY96 staffing plan for the DIII–D program which would ensure the capability to operate with reduced budgets at GA and LLNL. This plan will require the presence on site of a larger fraction of the collaborator staff, to make them available to critical operations, diagnostic, and analysis tasks. A preliminary plan is being developed with PPPL to identify who will be participating in the DIII–D program during the next fiscal year. A detailed plan for implementation should be available by May 15, 1995, and participants are expected to be selected by July 5, 1995.

The FWP presentations focused on the issue of maintaining future effectiveness in the face of the DOE proposed reductions in funding for on-site personnel provided by General Atomics. Maintaining the development of upgrades of the facility and maintaining the level of operating time is essential for future effectiveness. Under present DOE budget guidance, GA staff would have decreased by 20 people and they would need to be replaced by personnel from collaborating institutions. It would be important that a high fraction of these people be on-site.

Following the FWP presentations, a meeting was held by a committee of experts in materials research to review the plans for the installation of vanadium components as part of the new divertor configuration for DIII–D. This effort would help qualify vanadium, a material which exhibits low levels of activation when subject to irradiation by energetic neutrons, for use in ITER and fusion power plants. The committee overwhelmingly and enthusiastically supported the proposed DIII–D effort.

RON BROWN X3?66
Apr 17, 1995
1:19 PM

FY95 DIII-D OPERATIONS SCHEDULE



RESEARCH PROGRAM

BOUNDARY PHYSICS AND TECHNOLOGY

DIVERTOR DEVELOPMENT

During the second qurater main areas of activity in the divertor development group were: physics design of the Radiative Divertor, DIII–D vent tasks, and MCI code development.

We have ran several thousand EFIT equilibria based upon the RDP shape and divertor geometry to map out plasma parameters accessible to the DIII–D device without exceeding the standard administrative F–coil current levels. We found that plasma within the parameter ranges $0.6 < \ell_i < 1.6$ and $0.4 < \beta_p < 4.0$ can be created safely within DIII–D with some restrictions on plasma current. Current must be reduced as ℓ_i decreases or elongation decreases for F–coil overcurrent reasons, and to access the high β_p region. All plasmas can be controlled to maintain a chosen SOL line (0.5 cm at midplane) grazing the nose of the divertor by either reducing the elongation or adjusting the poloidal field quadrupole moment ("squareness"). Only the hi–ℓ_i, hi–β_p corner of parameter space requires a significant reduction of elongation, but this not expected to significantly limit planned experiments.

We have estimated the core particle source due to neutrals escaping through gaps in the baffle structure using a combination of analytic, UEDGE, and DEGAS code calculations. The results were used to specify the maximum conductance through each of the four baffle structure to be less than 2500 ℓ/s.

A new concept for deuterium injection through the existing 16-outlet boronization manifold was developed. Such a system would be very useful in active impurity control experiments.

Data from an unusally strong vertical displacement episode (VDE) disruption from C–Mod was reviewed and compared with DIII–D results, in order to help set disruption specifications for divertor hardware for TPX and the DIII–D Radiative Divertor. The main difference between DIII–D and C–Mod disruptions appears to be that DIII–D has greater toroidal electrical conductance in coils near the disrupting plasma, which absorb much of the vertical force and reduce the violence of the disruption.

A theoretical model was developed to examine limits on the fraction of core plasma power that could be radiated by various impurities. Applying the model to ITER, it was found that with low to moderate Z impurities only a small fraction of the Alpha power could be radiated by line emission before Bremsstrahlung radiation from the central region dominates. On the other hand, line radiation from krypton could conceivably reach ≃ 50% of the total power. Krypton radiation is limited by thermal stability of the core plasma. The same model predicts that in typical DIII–D plasmas neon could radiate as high as 80%–90% of the power. The model will be used to guide radiative divertor experiments.

Post vent inspection showed that the latest version tile current monitors survived well in all respects save one: in some cases the Cu-Stainless current conductor sheets had melted open. A minor design modification was developed and implemented. Installation, testing, and calibration of the new DIII–D TCA sensor elements went very well.

Damage to the divertor bias electrode was discovered during the recent vent. The damage was new in both nature and mechanism. Possible failure mechanisms were theorized which were used to guide the repair and modification work.

Work on using the Monte Carlo impurity code (MCI) to look at the sensitivity of carbon impurity distribution as a function of background plasma parameter variations was initiated. The new MCI release, with fully implemented variance estimation algorithms, has been tested and is now ready for general usage. A variance estimator algorithm has been implemented in the MCI code. Preliminary tests for the algorithm have proven very successful. Work has started on implementing a standard output file for diagnostic post-processing. A detailed plan was finalized for implementing convergence algorithms for each of the MCI cells. We also plan to keep records of tally statistics in each cell and make plots of these quantities available as part of our standard output package.

DIVERTOR ENGINEERING

Design and fabrication efforts continued on various diagnostics for the DIII–D vent including tile current monitors, CER light source modification, charge exchange, and demountable surface coupons. Assistance was provided to the operations group, reviewing and overseeing vent tasks.

IMPURITY STUDIES

Helium Transport and Exhaust. In order to increase the maximum baffle pressure at which the helium partial pressure can be measured, the Penning Gauge has been modified to allow differential pumping. The background pressure in the vacinity of the gauge will now be a factor of 15 lower than the DIII–D divertor baffle pressure, allowing accurate helium, deuterium, and neon partial pressures to be determined at baffle pressures up to 30 mtorr.

IDL routines specifically designed to make the transport analysis of the helium (and other impurities) easier are nearly ready for use. The use of IDL will allow significantly more visualization of the results and should both improve and accelerate the analysis process. Routines to obtain and fit impurity density profiles as measured by CER are now available within 4D, the new DIII–D data review program available on the UNIX workstations.

Spectroscopy. Preliminary results from the Z_{eff} verification day have shown hollow profiles of neon during ELM-free periods. These experiments were designed to provide spectroscopically measured impurity profiles in the core during ELM free VH–mode operation, and to compare these meaasured profiles with the Z_{eff} profile obtained from visible bremstrahlung. These hollow neon profiles are in contrast to flat helium profiles previously measured on similar discharges. Similar hollow (flat) profiles have been observed on JET for neon (helium).

During the course of the recent vent of DIII–D, routine calibrations of many of the optical diagnostic systems were completed.

Operation of the REAL TIME FOMA module, allowing spectroscopic signals to be available real time for feedback control, was successfully demonstrated. The module will now be installed in the SPRED CAMAC crate and its output signal will be brought from the Machine Pit to the Control Room Annex for input to DIII–D's digital control system.

New Initiatives: Divertor SPRED. The design phase of the Divertor SPRED spectroscopic diagnostic support structure is underway. Performance tests of the detector MCP (micro-channel plate) in magnetic fields up to 1000 gauss are complete. An increase in the relative gain of the MCP was observed in transverse magnetic fields. A 50% increase in gain was observed at fields of ~300 gauss, at 1000 gauss the MCP gain increased about a factor of 4. The MCP performance is relatively unchanged in axial magnetic field. The installation of this instrument on top of the DIII–D vessel in a field of 100–300 gauss, indicates that some magnetic shielding will have to be provided. Further tests were completed to investigate the size and thickness needed to shield the MCP.

Divertor Visible SPRED. Detailed design and integration is progressing smoothly. The details of the individual components under preparation by three collaborators appear to mesh well, and all three collaborators appear to be on schedule.

Divertor RGA. A conceptual design review for modifying the existing ORNL RGA system on the 105R-2 plenum was held. No major problems were identified in the proposed modification. A revised 93:01 project summary and tracking form was submitted.

Lithium Pellet Injector. A lithium pellet injector will be installed on DIII–D for wall conditioning and particle control. Detailed discussions have begun with personnel involved in lithium pellet injection at both PPPL and MIT (J. Strachan and D. Mansfield at PPPL; E. Marmar, J. Terry, and D. Garnier at MIT). Tentative plans are to duplicate the C–Mod injector with minor modifications and have it operational this year.

JHU Multilayer Mirror XUV Spectroscopy. The multi-layer mirror diagnostic from JHU was re-visited during M. Finkenthal's visit to GA. Now configured as a compact diagnostic to measure resonance line radiation of key impurity charge states in the divertor, a prototype is proposed for installation in an R-1 port, followed by under-the-baffle installation when the slot is changed to 43 cm.

DiMES—Erosion and Redeposition. On February 10, 1995 a Be-coated sample was successfully exposed to three DIII–D plasma shots. The exposed sample, supplied by Sandia National Laboratories (SNL), has two Be and W coatings arranged in the radial direction. The experiment was performed under strict health and safety guidelines to protect the DIII–D personnel from exposure to Be-dust. After the experiment, no Be contamination was discovered and the vessel was declared safe for general entry.

During the DIII–D vessel vent in March, the poloidal erosion experiment material coupons were installed around the vessel. At the same time, the DiMES system was serviced in preparation for the next set of experiments for the up-coming DIII–D run period.

Analysis of the exposed V, Mo coating sample and the Be, W coating sample was continuing at SNL–New Mexico. Plasma parameters for these exposures will be supplied to ANL for modeling work

Analysis of the results from the disruption experiment performed in the last quarter continues. Results reported by SNL–L show that the directional flux of neutral deuterium to the sample was isotropic, the incident particle energy was lower at the more glancing view angles and the incident particle energy spectrum was not strictly monoenergetic, but had a higher energy component.

NEWT1D Modeling. In collaboration with ORNL, improvements in the radial sources and sinks, and in the gas puffing sources, that conform more realistically to the new flux tube geometry have been made in NEWT1D, a 1D divertor plasma model including impurities. We believe that the code is now in a "standard" form, and transport studies can begin. Initial comparisons to ASDEX–Upgrade spectroscopic data on boron are promising.

DIVERTOR MODELING

During this quarter we have worked on improvements in both the SOL/Divertor modeling codes, and in data analysis for the edge database.

We have completed the automation of our ELM analysis and applied it to approximately 200 time slices of earlier data in the BNDY database. The analysis performed to date is restricted to examination of the photo diode date (H_α emission) and hence is relevant to quantifying particle recycling effects associated with ELM activity rather than energy loss associated with ELMs. Preliminary analysis indicates that ELM activity does broaden the SOL density profiles, but have little effect on the temperature profile. This conclusion is consistent with earlier, single shot analysis.

In addition to analysis of ELM data, we have upgraded analysis of Thomson scattering data which is used to determine the separatrix density, temperature, and radial scale lengths of the density and temperature. The improvements we have developed are aimed at removing spurious effects associated with the Thomson timing relative to ELM activity, and taking advantage of more detailed calibration for the density measurements. These improvements are expected to make relatively minor changes in the data in the database, but we will re-analyze much of the older data.

UEDGE/DEGAS analysis of the radiative divertor indicate that 10% to 20% of the molecular deuterium gas that leaks from the gaps in the RDP baffle and shelf fuel the core plasma. The most effective gap for core fueling is between the shelf and the vacuum vessel. Leakage from gaps in the private flux baffle show very low core fueling efficiency. These results will be used to determine the requirements for baffling in the radiative divertor.

Code validation studies which compare UEDGE simulations against DIII–D data indicate it is very important to properly determine the particle flux across the separatrix in modeling the SOL plasma. This is very difficult to determine experimentally, but we have found that a small increase in the particle flux can lead to a thermal collapse at the inner leg, with an ionization front moving several centimeters up the separatrix toward the X–point. The long mean free path plasma which forms below the ionization front permits penetration of the neutral recycling gas into the private flux region, and yields better agreement between the measured and simulated H_α emission.

We have begun simulations of the JET SOL with the UEDGE code. Initial simulations were aimed at exploring the boundaries for thermal collapse/detachment. We find detachment boundaries in power and upstream density which are qualitatively similar to those found for DIII–D. The electron temperature of the collapsed solution are similar to those measured in the C–MOD experiment, but significantly lower than indicated in the JET and DIII–D experiments.

We continue to improve the physics model in the UEDGE code. We have upgraded the model for the electrical potential within the closed flux surfaces, so the potential is determined by a toroidal momentum balance equation. Preliminary results produce potential profiles which are more consistent with experimental results than earlier simulations. Further work is needed to improve the numerical reliability of this model. We have also implemented the improved impurity model formulated by S. Hirshman of ORNL. This improved model now permits us to model multi-charge impurity states in UEDGE. Preliminary results with a DIII–D configuration were presented at the Sherwood meeting.

DIVERTOR PHYSICS

During this past quarter the divertor physics group continued its work on diagnostic installation and repair while DIII–D was at air. The installation of the divertor Thomson scattering diagnostic was completed and the X–point probe drive mechanism was mounted on the machine. The waveguides for the UCLA X–point reflectometer was also installed. The optics for the tangential X–point TV were significantly improved and parts were installed in the divertor baffle Penning gauge to allow us to measure divertor neon gas concentration during radiative divertor experiments. New spatial calibration heat sources for the IR TV cameras were installed; this should significantly reduce uncertainty in determining the location of the peak heat flux relative tothe separatrix. Repairs to the divertor neutral pressure gauges, divertor Langmuir probe array, and divertor interferometer were completed. We did not manage to install the fixed Langmuir probe in the boron nitride tile in the pump throat due to unresolved questions about potential failure modes.

In parallel with the diagnostic work, data analysis continued on a number of subjects. Further study of the ability to maintain density control during Partially Detached Divertor conditions with deuterium injection was completed and analysis of hybrid neon/deuterium puffing was extended. The weak variation of neutral pressure under the baffle during radiative divertor experiments was more fully documented and a number of hypotheses were considered to try to explain why the dependence is so much weaker than that of attached plasmas. It is thought that ELMs, which have a very broad profile, may be responsible for the bulk of the pressure rise during these conditions. Further study of the data from the divertor interferometer shows a good correlation between the fast divertor H_α signal and the line-average density in the divertor, but we are awaiting planned upgrades to see if the instrument can track the density changes observed during plasma detachment. We also carried out a fully nonlinear 2d thermal analysis of tile heating in order to see if the accuracy of our present IR TV data reduction program was suffering due to longer neutral beam heating pulses or higher temperatures of the divertor tiles. Under typical conditions the peak heat flux measurement is good to within 20% (depending on the camera calibration), but with very narrow heat flux profiles, the peak could be as much as 40% low. However, this should not affect our power balance significantly.

Experimental planning continued with the submission of two miniproposals: one to examine heat flux reduction in double-null discharges and another to characterize the effect of ELMs on the edge and divertor plasma.

H–MODE PHYSICS

During an experiment looking at the effect of externally applied error fields on energy confinement, a target density scan was performed in 1.3 MA, 1.7 T, standard shape double null discharges. These discharges have the same q_{95} as standard 1.6 MA, 2.1 T VH–modes. At high target density the discharges showed the typical VH–mode behavior with a transition to an improved confinement regime following the spin-up and cessation of the momentum transfer events (MTEs). At lower density no spin-up was observed. Although we have observed other discharges in which there is no sudden spin-up but instead the rotational shear continuously develops from the L–H transition, these low density discharges have greatly reduced shear in the toroidal rotation in the region near ρ=0.7 where the VH–mode discharges show their greatest transport reduction. The energy confinement in these discharges is very similar to the VH–mode discharges at higher density. There is some evidence that MTEs may be present in the low density discharges. These low density high performance discharges may represent a new confinement regime or point to a different interpretation of the confinement improvement in VH–mode. Transport, and electric field shear analysis of these discharges is in progress.

An experiment was performed to produce good VH–mode discharges with $q_{95} < 4.5$. In pervious experiments, discharges with $q_{95} = 3.5$ had a maximum $\tau_N = \tau_E^{TH} / \tau_{JET/DIII-D}$ of about 1.6 (H ≈ 2), compared to $\tau_N \approx 2$ for good VH–mode discharges. Confinement in the old discharges appeared to be limited by sawteeth or other events associated with $q_0 = 1$. In the recent experiment central q was maintained above 1 with neutral beam injection into the plasma during current ramp up. We were successful in obtaining a good VH–mode at $q_{95} = 3.5$ with this technique in a standard double null shape at $I_P = 2.0$ MA and $B_T = 1.7$ T. Discharges without early beam injection had sawteeth and degraded confinement. The good VH–mode discharge reached $\beta_T \times \tau_E^{TH} = 3 \times 10^{-2}$ sec compared to the previous best result of about 2×10^{-2}, and $\beta_N \times H = 9$. An attempt to reproduce this good confinement discharge was unsuccessful.

In order to support the ITER work on H–mode power thresholds, we also want to search for correlations between local edge parameters and the occurrence of the L to H transition. A computer code (EDGE_NEW) is being developed to analyze edge Thomson and CER data for use in the TRAN (transition) database. Significant progress has been made towards the goal of fitting edge Thomson and CER data. An algorithm has been developed to fit spline functions to these data. The spline fit can simultaneously include data from both inside and outside the separatrix. The algorithm uses a least squares procedure to vary both the knot locations and the coefficients of the spline. In addition, the number of knots is varied to meet certain criteria specified for χ^2. For cases tested so far, which are a random sample of typical data, the procedure has been automatic and robust and has produced very high quality fits. The spline routines being used allow convenient evaluation of derivatives of the fit. For test data from H–mode discharges, the first derivative of Thomson temperature and density profiles highlights the transport barrier far more dramatically than the raw data alone do.

Neutral beams may be required to make the plasma rotate in ITER or in a power plant. Beam access between toroidal field coils may dictate fairly perpendicular injection. In this case, most of the fast ions will be trapped. Since the time-average toroidal velocity of a trapped ion may be much smaller than the neutral particle's toroidal velocity, the neutral's toroidal momentum can not be transferred to the plasma by collisions, in general. The mechanism for the momentum transfer must be a $\mathbf{j} \times \mathbf{B}$ torque due to a fast ion radial current. This has been demonstrated by an analysis starting with the drift kinetic equation for fast ions. It was shown that, when both collisional and $\mathbf{j} \times \mathbf{B}$ torques are included, the rate of toroidal momentum input to the plasma, from either trapped or untrapped fast ions, is equal to the incident toroidal momentum input rate from the beam , in a steady state, as required by momentum conservation. Thus, not only are $\mathbf{j} \times \mathbf{B}$ torques real, they are necessary to get the neutral beam momentum transferred to the plasma.

The momentum transfer during a startup transient was also calculated. For injection into trapped ion orbits, the torque was shown to appear immediately following beam turn-on, and to be constant and equal to the steady state torque, assuming the fast-ion creation rate to be constant. Injection into untrapped ion orbits was shown to result in a torque on the plasma which is initially small, but which increases during a slowing down time to the steady state value.

The between-shot wavelength calibration light sources for the charge exchange recombination spectroscopy system were installed on the 345 R0 port. There are two systems, one providing wavelength calibration for the CER chords viewing the 330 beam (TANG8 to TANG16), and the other for CER chords viewing the 30 beam (TANG5 to TANG7). Wavelength calibration for the chords viewing from 330 R+1 (VERT7 to VERT16) was already installed in June, 1994. The absolute wavelengths are determined from neon spectra obtained from neon lamps housed in the light enclosures.

Spatial and intensity calibrations were performed for the charge exchange recombination spectroscopy system and for the lithium-beam-based beam emission spectroscopy system at the beginning and the end of the recent vent of DIII–D.

Installation and check out of the divertor reflectometer were completed during the just-concluded vent of DIII–D. This system will be used to measure plasma density in the divertor region.

CORE PHYSICS

CONFINEMENT

Analysis of our of dimensionally similar set of experiments continued this quarter. The ρ^* scaling of ions seems to fit the pattern that discharges with broad density and current profiles (low q, H–mode) have gyro-Bohm scaling while discharges with peaked density and current profiles have Goldston scaling (high q, L–mode). The one intermediate case (low q, L–mode) has Bohm scaling. The electron scaling is uniformly gyro-Bohm for every case examined. While this picture for the ions is compelling, attempts to verify it quantitatively by plotting χ/χ_{Bohm} versus the gyroradius normalized to various scale lengths fail to order the data appropriately. Further work is necessary; however, this heuristic picture allows us to predict the outcome of future experiments.

In a separate set of experiments aimed at testing the basis of dimensionally similar experiments, a collaborative effort with C–Mod was begun. In this study, discharges in DIII–D and C–Mod will be run with essentially identical dimensionless parameters including ρ^*. The first experiments were performed on C–Mod this quarter where they obtained single null L–mode discharges with up to 1.5 MW of RF power at two different densities. This will likely be attempted again in C–Mod with both RF systems available to obtain higher power levels. The DIII–D experiments are scheduled for late next quarter.

A database of transport quantities was formed for DIII–D discharges. Procedures were created to rerun ONETWO to produce the transport data in the proper format for this database. This work also facilitates our submission of data to the ITER transport database. Nine cases from our ρ^* series of experiments have been placed in our transport database and will soon be submitted to the ITER database. Other specific types of discharges to be submitted were discussed at the recent ITER workshop on database and modeling activities held at the San Diego ITER joint work site.

Termination of Reversed Central Shear Discharges

In recent reversed central shear discharges, the collapse of the strongly peaked temperature profile is precipitated in some cases by a rapid global MHD event, which often (but not always) coincides with the onset of ELMs. This instability appears to be the same as in the termination of ordinary VH–mode discharges, where the buildup of bootstrap current near the plasma edge destabilizes a low-n kink-ballooning mode. Shot 83729 with strongly reversed central shear shows a typical signature for this instability, an n=2 mode which grows on an ideal MHD time scale of 50 microseconds or less, and is localized near the plasma edge. Preliminary stability analysis using GATO for this case indicates that an n=2 ideal mode is marginally unstable, consistent with the experimental observation. In shot 84736 which reached a normalized beta of 4, the event occurs about 150 msec after the onset of ELMs, demonstrating that the instability is distinct from an ordinary ELM.

Analysis of Reversed Magnetic Shear Experiments

A time-dependent transport analysis using the full measured kinetic profiles of a strongly inverted q discharge has been completed. The results indicate a low ion thermal diffusivity within a few times the neoclassical value in the region of reversed magnetic shear $r/a < 0.5$, although the uncertainty is large due to low plasma density. A more accurate calculation using the latest version of the transport code with rotational improvement is underway. Ideal ballooning analysis shows that the discharge has access to the second stable regime over most of the plasma volume except for a narrow region with $0.8 \le r/a < 0.9$. Ideal kink analysis at the time of peaked $\beta_N \sim 2.7$ shows that it is stable to the n=1 and n=3 mode but is marginally stable to the n=2 mode. This n=2 mode is largely localized near the edge and is likely responsible for the ELM-like MHD event which occurred 50 ms later, has a fast growing magnetic precursor and halts the rise of β. A convergence study is underway to clarify the stability to the n=2 mode.

$\beta_N > 4.7$, H > 3.5 VH–mode Discharge

In a recent experiment, a VH–mode discharge with recorded value of $\beta_N \sim 5$ and H > 3.5 has been obtained. The high performance phase was sustained for nearly 300 ms until $q(0)$ drops below 1. The discharge has a lower target density and the neutral beams were injected earlier than in the usual VH–mode discharge. A preliminary evaluation of the stability using kinetically reconstructed equilibria with T_i data near the peaked β time shows that it is strongly unstable to the n=1 ideal kink mode without a conducting wall and is stable with a wall located at the DIII–D vessel. High n ideal ballooning analysis suggest that a broad region of weak magnetic shear near $r/a \sim 0.5$ may play a role in its enhanced stability by allowing it to have a much wider region of second stability access than the usual VH–mode discharges.

Analysis of TPX Reverse Central Shear Discharge

Systematic computation using published TPX design data shows the stabilization of the n=1,2 external kink induced resistive wall mode using twice the flow speed observed in a recent DIII–D advanced tokamak simulation experiment. These results were presented at the MHD workshop at the Sherwood theory meeting..

Resistive Analysis of DIII–D Discharges with MARS Code

A new version of the CHEASE code (an equilibrium code which includes rotation) has been obtained from Lutjens and coupled with MARS to perform resistive stability analysis for DIII–D experiments. Preliminary results indicate a weakly unstable double pitched MHD mode in the advanced tokamak simulation experiment could be stabilized by sheared plasma rotation and dissipation. Analysis was also carried out on DIII–D ITER shaped discharges. 1/1, 2/1 and 3/2 modes were found that correspond to experimental by observed signature. These findings await confirmation by further refinement of the computation.

Analysis of the Beta Limit in Long Pulse ITER Shape Discharges

Previously we thought the 2,1 tearing mode went unstable at higher β_N ITER-like shots as a result of current profile evolution on the long resistive time. However it was recognized that the line density in these shots was abnormally low for ELMing H–mode probably because these were the first plasmas with freshly boronized walls (but no cryopump.) The 2,1 Mirnov onset was similar to 1993 shots with density lowered at high β_N using the cryopump. The speculation then and now is that lower density raises the edge electron temperature which increases the edge Spitzer conductivity and thus drives more 2,1 destabilizing edge current. Increasing beta drives more edge bootstrap current which does the same thing. Thus either higher beta or lower density is predicted to modify the current profile to one which goes unstable to 2,1 tearing and limits beta or induces locking and disruption. Careful analysis of experimental equilibria does show an increased edge current density with a steeper current density at q=2. A controlled experiment of β_N versus G is planned for early May.

Control of Low Density Locked Modes with the New Error Compensation Coil (C–coil)

Analysis of C–coil locked mode data shows that for highly shaped DND ohmic plasmas the locked mode critical density scales as the square root of the relative error field. This is much weaker than the 3/2 power expected for low density ohmic plasmas from the simplest theory and previous experiments on DIII–D (in low κ, low triangularity SND at 0.95 MA), COMPASS–C (circular, limited) and JET (limited with κ=1.3 and a two point scan). The difference may be that the natural rotation frequency and tearing stability parameter at q=2 in ohmic discharges are explicit functions of density. Unlike the older experiments, the newer plasmas are highly shaped and are not in an Alcator scaling, *i.e.*, τ_E is not a function of density. The recent discharges have very low collisionality with $\nu_{ei}^* \simeq 0.03$ at q=2.

The best fit values of the 2,1 error fields from the B–, F–, and E–coils are now incorporated into the plasma control system for determining the real time C–coil currents for optimal error cancellation.

DIII–D Plasma Control

Version 10 of the digital Plasma Control System (PCS) software was brought on line during the first quarter of 1995. It was used for control during a test of digital plasma vertical position control and for power supply testing. A software design review was held on March 24, 1995 to summarize methods which have been implemented to ensure PCS software reliability and maintainability. These included:

- Controlling changes to source code.
- Providing written documentation for end users, for algorithm programmers, and for PCS programmers.
- Structuring of software for ease of maintenance.
- Providing procedures for implementing new plasma control algorithms.
- Test capabilities for algorithm programmers as well as PCS programmers.
- Operator training.

A model-based, multivariable digital vertical stability control algorithm was tested on DIII–D on Monday February 6, 1995. During the experiment, the plasma was stabilized by the new control algorithm acting along with the PCS shape control in three shots.

RF PHYSICS AND TECHNOLOGY

RF PHYSICS

The initial operation of the second ABB transmitter, ABB2, for experiments on plasma heating and fast wave current drive (FWCD) took place. All three fast wave systems (ABB1, ABB2, and the FMIT system) were operated simultaneously into plasma for the first time, thereby making progress towards the goal of injecting 4.5 MW into the plasma. The maximum power coupled to the plasma with the ABB2 system was about 0.6 MW in its first day of operation. On separate shots, a power in excess of 1.6 MW was coupled to the plasma with the FMIT system and 0.9 MW coupled with the ABB1 system. It was not possible to combine these three power levels at the same time in a single discharge, which would have provided a total power of 3.1 MW.

One difficulty in operating the ABB systems was spark down in the coaxial transmission lines. This was found to be due to the voltage standoff of the pushrods that control the electrical lengths of the tuners. The original pushrods were made of G-11 fiberglass composite, which was susceptible to breakdown along the fibers. Subsequent rf tests of pushrods of Delrin showed excellent resistance to breakdown. This improvement will be applied to all of the tuners with high electrical stress.

The FWCD antennas were inspected when the DIII–D vessel was vented. The area of the 285/300° antenna Faraday shield that had been seen with the TV system to eject particles into the plasma was damaged. For reasons that are not understood, only this area of the antenna was damaged. The two newer antennas showed minor melting on various locations on their Faraday shields. The tiles surrounding the 0° antenna were replaced with a set similar to the ones around the 180° antenna, which protrudes from the wall to provide improved protection of the antenna. The most damaged Faraday shield rods were replaced with spares and some damaged thermocouples were removed. The design by ORNL of a new Faraday screen for the 285/300° antenna was reviewed. This Faraday screen will use untilted rods of Inconel, and its principal advantage over the present screen is that it will be coated with boron carbide instead of bare metal. This should reduce the impurity problems that have been associated with the present screen.

Further analysis has been performed on discharges related to experiments on fast wave current drive (FWCD) from last quarter. The experiments were performed under a variety of conditions, including L–mode, reversed shear, and high-βp VH–mode. Initial estimates indicate that centrally peaked, rf driven currents are present, and that the direction of the driven current depends on the fast wave antenna phasing. The efficiency of current drive estimated by integrating the non-inductive current is comparable to, but slightly higher than, previously determined efficiencies based on loop voltage measurements on the boundary of the plasma. A more complete analysis based on kinetic efits and CER determination of the Z_{eff} profile is underway. Modeling of the dynamics of the evolution of the current density profile is also underway using the ONETWO transport code.

Comparisons of the heating efficiency of the new antennas at 0° and 180° at about 90 MHz with that of the old antenna at 285° at 60 MHz, all with current drive phasing, show that much better absorption takes place using the old antenna when no other auxiliary heating is applied. This is reasonable since the wave at 90 MHz is too fast to match the parallel thermal velocity of electrons. The effectiveness of the new antennas should increase dramatically when more electron heating is available.

A decision was made to implement a digital control system for the FWCD systems which is based on the control system developed for DIII–D. The first real-time test is targeted to be feedback protection control of the FMIT transmitter. The ultimate use will be full control over the operating point of all of the transmitters, as well as interface with the control system for DIII–D for carrying out activities like profile control for Advanced Tokamak applications.

Further work on the dimensionless scaling of transport has been performed. Initial analysis of the L–mode, ρ^* scans from December indicates that the electrons are gyro-Bohm, as always, but that the ions are Bohm-like. If this analysis holds up, this means that we have three cases in which the ion ρ^* scalings changes from gyro-Bohm (ITER demonstration H–mode) to Bohm (high power L–mode) to Goldston (low power L–mode). It is hoped that this variety will enable us to identify the appropriate scale length with which to normalize the gyroradius.

A newly recognized aspect of the dimensionless transport paradigm is the importance of the Bremsstrahlung loss for ITER. This loss does not scale in the appropriate way to be accounted for in the standard dimensionless projections. The loss due to Bremsstrahlung is about 70 MW for ITER, which (by conservative estimate) increases the power necessary to sustain the similar profiles to about 110 MW. This reduces the projected H factor from 5.4 to a more practical level of 3.2.

The Varian 110 GHz gyrotron was successfully operated into the DIII–D vessel for 0.5 sec pulses. The exact power level is uncertain, but the power through the gyrotron window was of the order of 300 kW. No evidence was found for breakdown in the waveguide under these conditions.

OPERATIONS

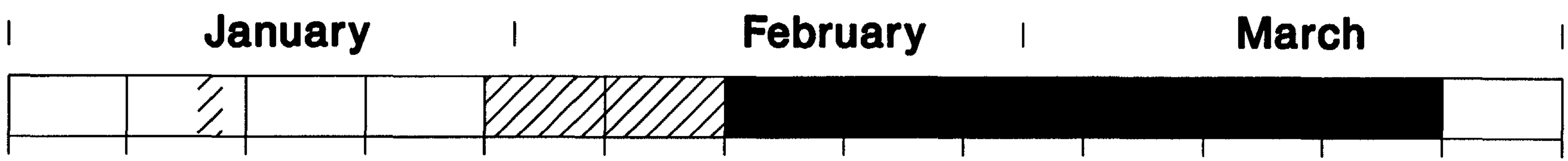
TOKAMAK OPERATIONS

The major activities for the second quarter of FY96 were two weeks of tokamak operation in February and a six week vent for new diagnostic installation from mid-February until the end of April. There was no operations in January because a failure of the line reactors on the output side of the motor generator delayed operations for approximately two weeks. Following completion of the vent, systems checkout is proceeding in preparation for the start of experimental operations in May. A chronology of events for the second quarter is shown in Fig. 1.

The tokamak was operated for eight days in February with an availability of 87.4% (Fig. 2). There was no major source of downtime. There were two additional operations days prior to the run period to perform diagnostic calibrations, neutral beam shinethrough calibrations, plasma control system software testing, and checkout of the power systems following the line reactor failure at the end of January. Because of the long lead time on construction of new line reactors, the three remaining good line reactors (there are normally six on the ohmic system) were used in February. This limits the plasma current to less than less than 2 MA, however, this did not affect the experiments scheduled for the February run period.

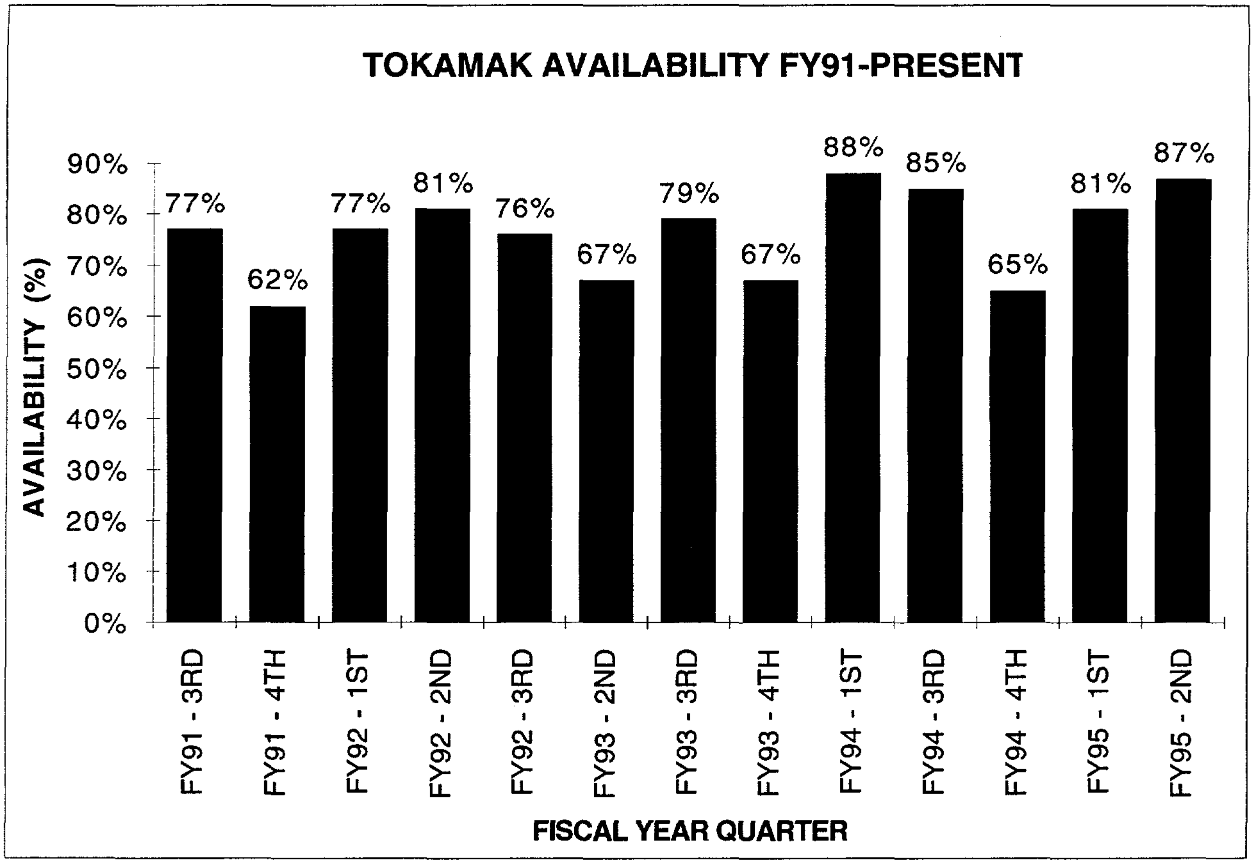
The vessel was vented on February 14 and remained open for six weeks until March 24. Over 110 separate tasks were completed during this vent including the installation of the divertor

DIII-D FY95 Second Quarter Operations



- Line reactors failed
  Ops delayed 2 weeks
- Vent
  - Install divertor Thomson
  - Install BES
  - Install divertor reflectometer
  - Upgrade tile current array
  - Repair ADP ring
- Pumpdown
- β limits and TAE modes in ITER-like plasmas
- MIMO tests
- RF ops with 3 antennas
- DIMES Be erosion study

= Maintenance
= Operations
= Vent


TOKAMAK AVAILABILITY FY91-PRESENT
AVAILABILITY (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
77%
62%
77%
81%
76%
67%
79%
67%
88%
85%
65%
81%
87%
FY91 - 3RD
FY91 - 4TH
FY92 - 1ST
FY92 - 2ND
FY92 - 3RD
FY93 - 2ND
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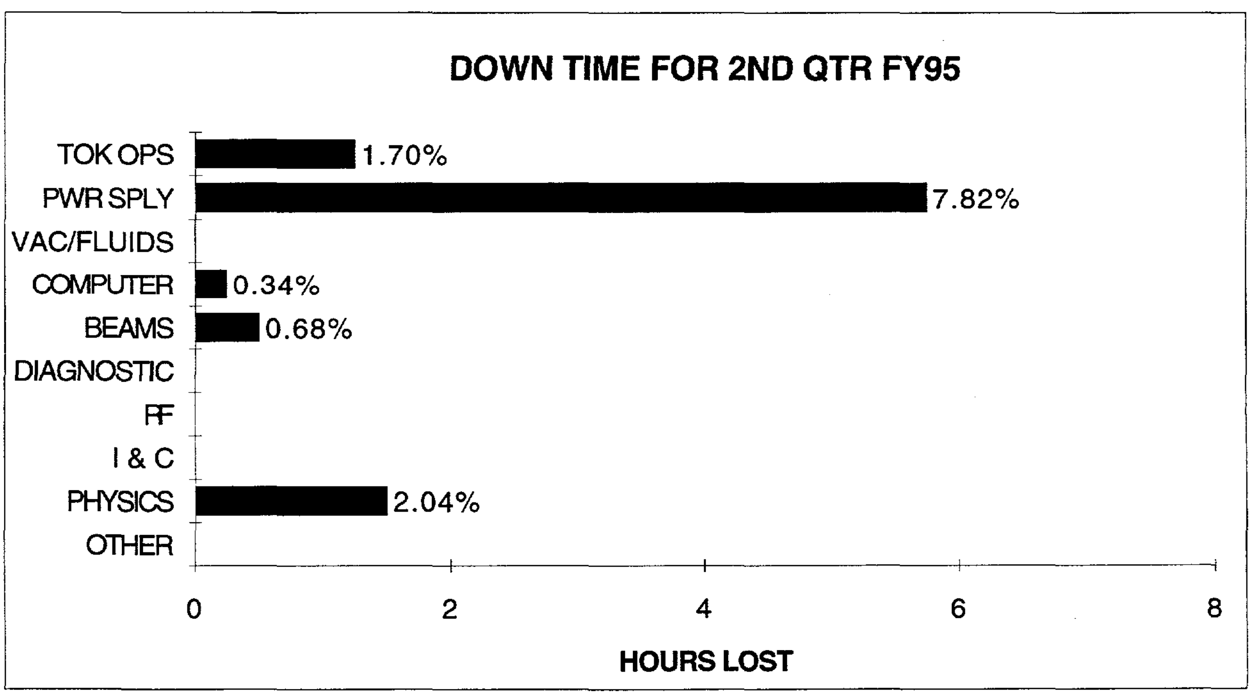
FY95 - 1ST
FY95 - 2ND
FISCAL YEAR QUARTER


DOWN TIME FOR 2ND QTR FY95
TOK OPS
1.70%
PWR SPLY
7.82%
VAC/FLUIDS
COMPUTER
0.34%
BEAMS
0.68%
DIAGNOSTIC
RF
I & C
PHYSICS
2.04%
OTHER
0
2
4
6
8
HOURS LOST

Thomson system, Beam Emission Spectroscopy diagnostic, divertor reflectometer, IR camera calibration diagnostic, upgrade of the tile current array, and installation of a raised graphite tile set around the 0° antenna. The reciprocating X–point probe was installed without the graphite probe tips because they have not been delivered yet. The tips can be installed in a future vent. Diagnostic calibration was performed on second shift almost every day throughout the vent.

Inspection of the vessel interior identified a number of damaged components, including melting on each of the three Faraday shields, a damaged divertor baffle plate, arcing between the ADP ring and the cryopump, and two cracked graphite tiles. To better protect the Faraday shields from damage, a new set of graphite tiles was installed surrounding the 0° antenna that are 0.5 cm higher than the original set. In addition, a nearby bumper limiter was raised by 2 mm. All repairs and appropriate modification of affected systems were completed during the vent.

Tests of the stray light level on the new divertor Thomson system performed immediately after vessel closure and pumpdown indicated that the levels are too high for proper operation of the system. The vessel has been reopened to test various baffle, beam and viewing dump modifications to determine the best way to reduce the stray light.

Analysis of material samples removed during the vent, indicated that the boron coating on the vessel is not being deposited uniformly. Subsequent investigation of the flow from the 16 in-vessel diborane delivery lines indicated that four of the lines had little or no flow. The restrictions were caused by either physical damage to the tubes or deposits within the tubes. Both types of problems were repaired. Analysis of the deposits inside the tubes show 85% boron and 15% oxygen. Loose deposits inside all tubes were blown out using high pressure gas.

Analysis of surface samples also indicated a higher carbon and oxygen content and lower boron content in the deposited layer during the boronization sessions at the end of the fall. RGA traces from the past four boronizations showed that during the last two sessions in the fall, the levels of D_2 increased and the B_2D_6/H_20 ratio decreased. Both of these observations are consistent with a lower diborane concentration in the process gas and one possible reason for this could be an air leak into the boronization lines. This might also account for the deposits found inside the in-vessel boronization lines. Modifications to the external system were performed to improve the quality of the vacuum of all the lines. In addition, new in-vessel samples were received from Sandia and reinstalled in the vessel.

A number of operations systems upgrades were performed during this vent period. The impulse tester for the ohmic heating coil and F–coils was modified to make it more reliable and easier to use. In addition, data from an impulse test will now be acquired as a test shot with the new E–coil high voltage probes at the patch panel. The power supply for testing the toroidal field belt bus resistance has also been rewired to include interlocks to prevent it from being on the bus when the main toroidal field supply is energized. In the process of these upgrades, the patch panel area has been noticeably cleaned up.

A proposal was investigated to combine an upgrade of the operations RGA system with a new RGA for studying the gas in the divertor private flux region. Based on ease and speed of maintenance, data quality and interchangability with existing machine RGAs the study concluded that the combination was not desirable. Calculations also showed that the magnetic shielding required for the RGA would produce unacceptable error fields in the plasma. The alternative that is being pursued is to leave the operations RGA at it present location and upgrade its user interface using our own software on the new AEG computer. A secondary operations RGA will be moved to a new port to allow it to be used for analysis of the gas species in the divertor region under the baffle and in the outer strikepoint region. New hardware is being purchased to permit both systems to operate simultaneously. The final system should provide most of the desired functionality for both operations and physics at a reduced cost.

DISRUPTIONS

Analysis of disruption experiments from last year's operating period is continuing. During disruption of a high beta shot with a normalized beta of 3 and q_{95}~2.3, MSE data shows the axial safety factor is slightly below 1 until the thermal quench and the Te profiles from Thomson scattering again show the outer edge of the plasma cooling first at the start of the thermal quench. Alan Janos from PPPL has analyzed a high density disruption from the December experiment and has identified what appears to be a "cold-bubble" like feature which sweeps across the plasma during the disruption. This was identified on the multi-channel (32) ECE diagnostic. The mode crosses the plasma in approximately 2 ms and is similar to the (m,n) = (1,1) precursor mode that has been observed on TFTR and other devices during high density disruptions. Reanalysis of the current profile evolution during the radiative disruptions was performed using a new version of EFIT that allows sub-millisecond data to be used in the fit. This data shows that the current profile flattens more rapidly (1–2 ms) than earlier estimates and corresponds with the start of the current quench.

Following upgrades to the analysis codes and completion of all fiducial timing measurements on the IR camera system, details of the disruption heat flux are able to be measured and analyzed properly. The heat flux distribution and the total energy deposited on the divertor floor (assuming toroidal symmetry) for the radiative collapse shot and a high beta shot were obtained. In the radiative collapse disruption, the ratio of energy deposited on the outboard to inboard part of the floor is ~2:1 during the thermal quench and ~1:2 during the current quench. Initial results from the high beta discharge indicates that the distribution is reversed during the thermal quench and is twice as high on the inboard side.

A first cut at a power balance was done for the radiative collapse disruption. Of a total of 6 MJ of stored thermal and magnetic energy at the start of the thermal quench, approximately 1.4 MJ is unaccounted for. The thermal energy of 1.2 MJ appears to be nearly accounted for with ~1.1 MJ on heat to the floor and the radiated power fraction during the thermal quench would account for the rest. Detailed investigations of the plasma magnetic energy and where it is dissipated during a disruption have been started. The PLOTMED code has been modified to calculate the magnetic energy in the region between plasma and the vessel or the PF coil cage.

During the vent, the Tile Current Monitor system to measure the halo currents has been partially upgraded. We now have 25 upgraded channels; one poloidal and two toroidal arrays. An initial investigation of the bandwidth of the data channels revealed that the system was capable of 15 KHz but not all channels were operating at this level. Repairs on this system are being pursued to be ready for the start of the operating period. Analysis of existing data from the radiative collapse disruption showed that at the peak of the toroidal distribution of scrape-off layer current the SOL current is 5% of the pre-disruption current and has a toroidal peaking factor (peak to average) of 1.7.

Collaboration with PPPL on disruption analysis is beginning and progressing well. Allan Reiman of PPPL visited for a week to start work on disruption database analysis. It was found that the previous analysis of the disruptivity when all know limits are avoided was incorrect and the reported 7% disruptivity was incorrect. Reiman is working on improving this analysis. A calculation of the statistical sampling error was incorporated in the disruption frequency analysis along with an interface to a program to plot probabilities and error-bars.

Alan Janos (PPPL) is putting together a proposal for an array of Fast IR Detectors for disruption studies. This is an modification of a proposal distributed at GA earlier this year and will use standard, off-the-shelf optics. The advantages are lower cost and faster parts acquisition. This improvement is possible due to the low neutron level on DIII–D (compared to TFTR) and the use of only one wavelength operation (compared to the present system on TFTR).

Stan Luckhardt (UCSD) will lead the effort to form a common disruption database for all tokamaks. Stan will also modify the DIII–D disruption database to provide the required data for the combined machine database.

Pete Taylor attended the ITER "Disruption/VDE Characterization Workshop/Technical Meeting" on February 13–17 at the ITER Joint Work Site in Garching, Germany and presented a paper entitled "DIII–D Disruption Studies." (Taylor)

Work has begun on with ORINCON to develop a high beta disruption alarm. Approximately 120 shots have been identified and are now included in a high beta disruption database that will be used for the initial neural network training. An EFIT study determined that a minimum of 18 flux loops and 10 magnetic probes is required for reasonable equilibrium reconstruction including the internal inductance. These magnetic signals plus approximately 20 other signals will be used in the disruption alarm. Initial work has produced a neural network locked mode detector with a time resolution of 128 ms and an accuracy of 90%. Discussions with J. Ferron and Gary Jahns (ORINCON) have concluded that the disruption alarm should be implemented in the Plasma Control System (PCS) rather than as a stand alone system. A design review of this new proposal will be held in early April.

RADIATION MANAGEMENT

Radiation Health Physics

The total neutron radiation at the site boundary in the 2nd quarter was 0.44 millirem, the total gamma radiation was 0.12 millirem, giving a total for the quarter of 0.56 millirem. This is below the SAN DOE annual guideline limit of 40 millirem and below the California annual limit of 100 millirem. Following ALARA principles, radiation operations follows an internal guideline of 20 millirem until plans for a quarter indicate a need for the increased radiation allotment.

Two DIII–D radiation refresher classes were given in January and attended by 135 people. A radiation training class was given by Health Physics in February and attended by 16 fusion related workers.

The ALARA subcommittee met on January 23, 1995. The latest data summaries of the site boundary dose, facility dose, and personnel dose were presented and reviewed. The ALARA goals for the past year were met and the same goals were chosen for 1995: a total collective dose of 0.15 person-rem per millirem of site boundary dose and a maximum individual dose of 350 millirem from work in the vessel.

The vessel was vented on February 14, 1995, and the usual radiation monitoring was performed (alpha, beta airborne samples; alpha, beta, and tritium wipe samples; dose rate and activity levels). The alpha and beta airborne samples were well below the regulatory MPC (maximum permissible concentration) levels. The tritium wipe samples were typical with one exception. The wipe samples ranged from 200 to 7,200 DPM/100 cm^2 (release level is 1000 DPM/100 cm^2) except for a reading of 41,000 DPM/100 cm^2 on the 315 bumper limiter. This limiter also showed visible signs of being the primary limiter in the machine. Tritium samples at the 315 limiter above and below the two mid-plane tiles had only 2000 DPM/100 cm^2. This limiter was covered with plastic to prevent contact. Bioassay samples of the first two people to enter the vessel showed no tritium contamination of the personnel.

A total of 82 people received doses in the second quarter from pit runs or vessel entries; the highest accumulated dose was 265 millirem.

A small amount (~5 gal.) of mixed waste (tritium contaminated oil) accumulated over the past year has been picked up by the waste yard. The total activity was approximately 33 microcurie.

The periodic site boundary survey continued with data from the next position taken during the quarter. The dose at this position relative to the permanent site station is unchanged from past measurements.

Fusion Product Physics

A solution to the high count rate problem on the plasma neutron detectors was found. The maximum count rate test in the analysis software was lowered for the usual detectors used in the analysis and the code switches to the less sensitive fission detectors at high counting rates.

Calibration of the plasma monitoring neutron detectors was done at the end of the vent. All of the 45 electronic modules in the pit sent out for refurbishment, repair, and calibration were reinstalled and adjusted prior to the two day neutron calibration. The californium source was used to cross calibrate the less sensitive detectors to the more sensitive detectors and then to absolutely calibrate the more sensitive detectors.

After a very successful campaign, the horizontal charge-exchange analyzer was removed to accommodate the new BES diagnostic. Work on relocation of the horizontal charge exchange analyzer and on installation of a vertical array of three analyzers commenced.

Andre Jaun of CRPP completed predictions of the expected fluctuation amplitude and phase of the poloidal probe array during n=1 TAE activity. Initial comparison with the data indicates poor agreement between experiment and theory.

Two student analysis projects began; one project is to modify the $E_{||}B$ charge-exchange analysis software for use with the new compact analyzers and the other project is to compile a database to compare the measured neutron emission with the predicted emission in high-performance discharges. Modification of the TEXAS code for analysis of the charge-exchange data continued.

An experiment to determine the effect of beam voltage on Alfvén activity and to project TAE stability in ITER was conducted in February and the data is being analyzed. Alfvén activity was present in many shots, but was much weaker than expected at 0.7–1.0 T. Fast-ion losses also seemed relatively weak.

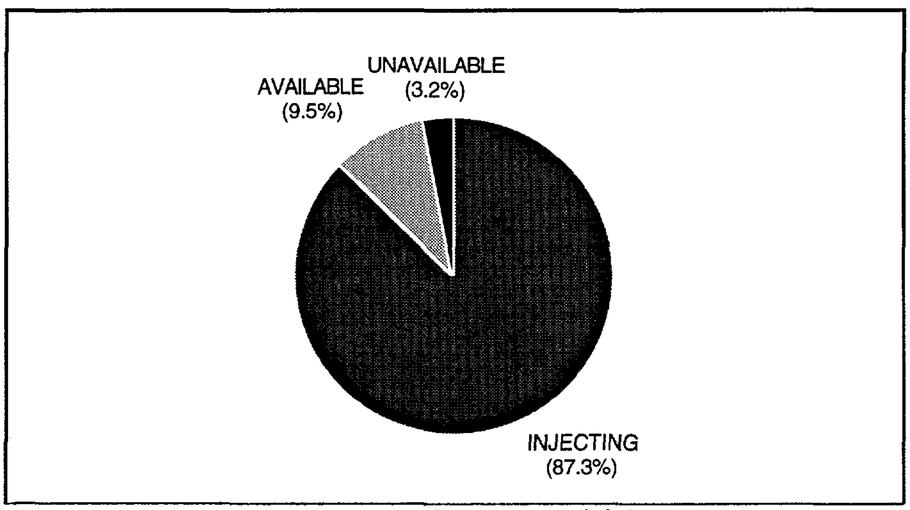
NEUTRAL BEAM OPERATIONS

Operational Summary. Eight beam systems were operated to support 8 days of physics experiments in this quarter, all in February. Neutral beam systems were not required to support plasma experiments in January due to delay in the experimental schedule, but beam systems were operated for ion source conditioning, beam shine-through calibrations, and beam physics study. Major maintenance was performed on the beam systems during the DIII–D vent period, from mid-February to the end of March.

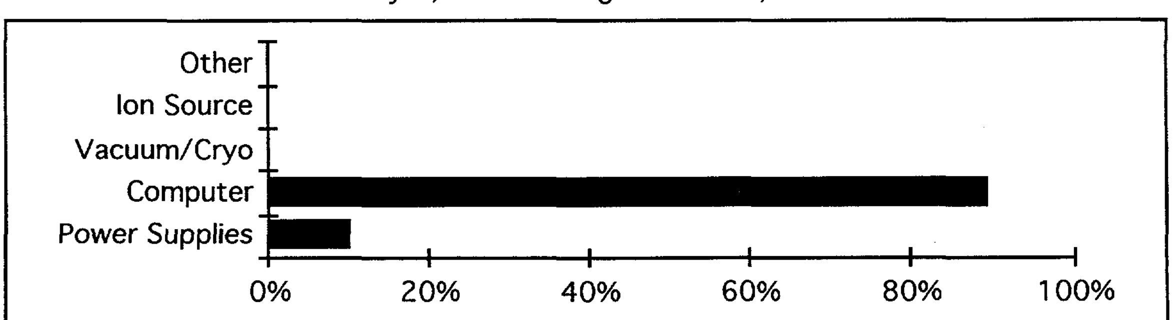
Four ion sources (150° R, 210° R&L, and 330° L) were requested to operate at beam energy greater than 80 keV to support TAE mode of the ITER-like plasma experiment which required beam energy scan from 40 to 90 keV. Two sources (330° L and 210° R) ran very well at 90 keV, but the other two sources only achieved stable beam operation at 86 keV, and 86 keV beams from these four sources were used in the experiment.

It was found, during the preventive maintenance in January, that the 150° left ion source filament plate was shorted to the insulator plate due to melted nickle plating at one corner of the insulator plate. A small area of copper is exposed after repair, but the area is mostly not in the line of sight to the arc discharge and no difficulty in operation is expected.

System Availability. Overall availability was excellent at 96.8% during the 8 days of plasma experiments; with 87.3% of the time all requested beams were injected into the plasma, and 9.5% of the time beams were available but were not used for injection.



Average Neutral Beam Availability
for DIII-D shots 84632 through 84920
January 1, 1995 through March 31, 1995



Unavailability by cause

Maintenance and Inspections.

Major neutral beam maintenance and repair tasks were scheduled and completed during the DIII–D vent period in February and March. These tasks included torus isolation valve (TIV) and source isolation valve (SIV) maintenance, beamline internal components inspection, drift duct inspection, ion source external inspection and resistance measurement, pyrometer alignment check-out, photodiode system calibration, and control station PLC watchdog upgrade.

Several instrumentation and control tasks were completed. Connectors were installed in the wiring of the TIV limit switches, eliminating the need to remove the limit switches when the TIVs are pulled. Two Granville-Phillips ion gauge controllers were repaired by the replacement of a bad transformer. Eight new controllers (for the RGA system and spare) were received and bench tested. Two had defects and were returned to the manufacturer for warranty repair. Air filters and attachment method (to reduce rate of failure) were designed for the thermocouple ice point references. The project awaits arrival of materials on order. Neutral beam mode control panels were serviced. The causes of some of the problems experienced during operations were discovered and rectified.

The pumping system of the portable RGA system has been re-worked with new turbopump and controller, and the system is now functional and available for use in ion source leak troubleshooting or other system leak-check and identification of gas in pressurized bottles.

Activities. A failed plasma grid module of an ion source accelerator was sectioned, and a micrograph was then taken for analysis. No sign of corrosion was observed, indicating that vibration induced by the cooling water at higher flow rate was most likely the cause of failure.

Results of our accelerator grids vibration test and photos of the sectioned plasma grid module were forwarded to Ken Wright of PPPL. We are waiting for a set of drawings from PPPL for the special furnace brazing fixtures that have been developed over the years.

A request for quote is being prepared for nine interface plates between the arc chamber and the accelerator ion source. The plate was originally fabricated of aluminum, but has caused us maintenance problems due to the interaction of dissimilar metals and of water and aluminum causing corrosion which leads to water and vacuum leaks.

Two spare ion source collimator plates have been ordered after having the drawings updated and officially released. Our only spare plate was installed on 30° left beamline to replace the severely damaged one.

The neutral beam 1995 database was created with appropriate modifications for shine-through beam power calculations. The NB Modcomp's real-time database and the shot summary display were also modified to calculate shine-through power using newly calibrated parameters and to show the calculated values on the plot of injected beam power.

Tagging of the neutral beam system cables (inside the machine hall) which are connected to equipment that can be energized to 100 volts or more has been completed. This tagging is for the purpose of reminding personnel of the electrical hazards.

ECH OPERATIONS

110 GHz ECH OPERATIONS

The Varian 500 kW 110 GHz was operated into dummy load with 440 kW pulses up to 400 ms and a few 250 kW shots into plasmas.

ICH OPERATIONS

There were two days of rf physics operations this reporting period. ABB Thomcast sent an engineer to assist in the troubleshooting of ABB#1 and system checkout of ABB#2. With his help we were able to increase the output power to 1.6 MW at 89 MHz but are still below the expected output of 1.75 MW. It is possible that the lower output has been caused by the modifications recently installed to increase the tube protection. Communications with the tube mfg. have been started to see if the protection circuitry might be changed slightly.

All three transmitters were operated into plasmas for the first time. The antenna connected to the FMIT transmitter developed problems with injecting impurities into the plasmas and was operated at reduced power. ABB#1 which is connected to the 0° antenna was operated at power levels up to ~1.4 MW, where screen current caused the transmitter to roll back in power. ABB#2 which feeds the 180° antenna was only able to operate at very low power levels due to what looks like arcing in the transmission system somewhere between the matching system components on mezzanine #1 and the directional couplers on mezzanine #2. Inspection of the tuners showed no signs of arcing. Further inspection of the tuners will be done soon.

Due to the poor performance of the new ABB transmitters, ABB/Thomcast sent two engineers to implement fixes to the transmitters. They estimate that the total time to implement the fixes and complete acceptance testing on both transmitters would be from 6 to 10 weeks. The first major modification to ABB transmitter #1 was completed and initial testing has shown no noticeable improvement in performance. One primary frequency has been chosen for each transmitter and the major emphasis for transmitter performance will be concentrated at these frequencies.

A task force headed by Robert Pinsker was established with the charter of improving the power and reliability of the FMIT transmitter. The first results of the task force have been to implement a screen current feedback circuit which lowers the drive when screen current exceeds a pre-determined value. Dummy load testing has validated the circuitry but plasma loading will be necessary to confirm the true performance of the circuit.

COMPUTER DATA SYSTEMS

Support was provided for testing and calibration shots during this DIII–D vent period.

Much work was done to accelerate the upgrades of the old MODCOMP computers on the existing Machine Control and Neutral Beam Control computers. A plan was developed and approved internally, purchase orders for the various pieces of hardware and software were written, and arrangements were made to acquire the ACCESSWARE software (on loan until the purchase orders are official). In addition, the DOE ADP plan for the computer upgrade was written and approved. Work was done with the ACCESSWARE software to see how it can be applied to the needs of these systems. Some user training sessions were held and the existing databases were examined to see what portions are no longer needed. Various software tasks, which will be needed later, were started. The tasks include handling of interrupts, conversion routines for display of data and CAMAC interfaces to ACCESSWARE.

Selection of vendors for hardware and installation of cables for the DIII–D building network upgrade is underway. A best and final request has been sent out, and it is hoped to have work start on this upgrade in May. The existing network will continue running while the new equipment is installed. This will correct the existing overloaded situation and will allow for future expansion.

The existing UNIX data acquisition system was tested with a second CAMAC highway. Almost twice as much data can be collected in the same time period, which makes it feasible to add additional magnetics and soft X–ray data without impacting the shot cycle and ability to analyze data.

Projects in progress which are planned for user implementation during the May operations period include a new shot logger program, a new timing interface program, and a more stable interface to 4D display code. All of these programs use the X facilities of the IDL language.

IDL representatives met with users on March 2. They presented information on the next update, listened to users suggestions, and answered questions. IDL has become the standard interactive graphics program used by DIII–D. Although the current version is 3.6, there are several programs, including some of ORNL's, that rely on version 1. Due to the retirement of the USC's VAX-8650, the version 1 license was relocated to one of the remaining VAXes.

The performance of the HP T500 server has been very good. All three CPUs are usually fully subscribed with processes waiting to compute. The turnaround time for jobs is still very acceptable, but as the number of users increases it will not remain so. There are currently over 150 user accounts on this system. User disk space is always at a premium. A new cleanup script, originally developed to help users deal with limited space on the NERSC Crays, has been distributed to all users. This script, totally configuable by an individual, will target certain files for removal. Along with the conservation steps, the user disk space has been increased by 1 GigaByte with another 4 to be added soon. In addition, 4 GigaBytes of disk have been added to the HP T500 for online shot data.

MECHANICAL ENGINEERING

FLUID SYSTEMS

Water

Installation of the replacement cooling tower for MG#2 was completed. The tower was successfully checked-out and is currently being readied for operational use in April.

The design and installation of the cooling system for the 1 MW Russian Gyrotron including the necessary ECH vault modifications were completed. Operation of the system including instrumentation and associated interlocks was demonstrated and accepted by the customer. Final connections to the gyrotron await arrival of the tube from Gycom.

Delivery of the fifth, 125 hp pump for the Low Pressure Cooling Water System is expected in early April. The reduced voltage, motor starter was received and installed. Pump installation will commence immediately upon receipt of the pump. The pump will increase the capacity of this system that services neutral beam and rf components to about 6500 gpm.

The investigation into the waterhammer (pressure transient) vibration in the Low Pressure Water Cooling System that has occurred on loss of off-site power, *i.e.*, instantaneous shut-down of all pumps is continuing. More detailed analysis has been requested on the pressure-shock, dampening devices proposed by the equipment manufacturers.

B–coil, water cooling hose modifications were completed to allow installation of the LLNL, UCLA and Sandia divertor diagnostics and the Asdex pressure gauge.

The first series of tests performed to evaluate the irregularities observed in the thermocouple readings on the vessel's inner wall during baking operations indicated a possible over-cooling in three channels of the wall. During the January maintenance period, the orifices (used for balancing flowrates) in these three channels were inspected and found to be in excellent condition. Additional tests and thermocouples are currently being considered.

Cryogenics

The cryogenic system was restarted on January 9 and operated smoothly throughout the month of January. The system was shut down on February 9 for the machine vent. The neutral beam cryopanels experienced no flow instabilities during this report period. The system was restarted during the week of March 27 in support of post-vent operations.

Repair work on the remote control circuits for the two Sullair helium compressors was completed. This will allow for improved remote operation and monitoring.

The ECH 110 GHz magnet was warmed to room temperature as rf operations were temporarily suspended pending installation of equipment for the Russian 1 MW gyrotron system.

A preliminary design review for the Radiative Divertor Project (RDP) was held on the January 10 and included a discussion of the ex-vessel cryogenic system. Analysis is continuing on the impact that the RDP and future cryogenics related projects will have on the present cryosystem.

Work has started on assembly of the RDP test setup including major modifications to the feedthrough, flow test chamber. Work is continuing to support a test startup in early April.

The helium liquefier has been experiencing occasional power failures in its programmable logic controller. This has been traced to transient events occurring when the ECH, MFTF power supply crowbar is triggered and the gyrotron arcs. Work performed on improving the ECH local grounding has greatly reduced the occurrence of power failures in the logic controller but large disturbances still affect the controller. Further shielding work is planned.

Vacuum

The first part of a multi-year plan addressing the aging vacuum pumps used by DIII–D and the Neutral Beam has begun. Five used Leybold 1500 L/s turbo pumps were collected from GA storage and sent to Leybold for refurbishing. Two controllers for these turbos were ordered as were four new cables. Total cost for this work is about $25K. Identical Leybold turbo pumps have provided reliable main pumping for the Neutral Beam lines for over eight years. A RFQ was sent to Balzers and Varian to cost nineteen new turbomolecular pumping stations and spares.

Eight new ion gauge cables and five new Granville Phillips ion gauge controllers were installed and put into service. These new systems are for the DIII–D tokamak to replace the aging Varian systems.

All eight Neutral Beam Source Isolation Valves (SIV), all four Neutral Beam Torus Isolation Valves (TIV) and all three DIII–D turbo pump Torus Isolation Valves (TIV) were overhauled making the valves helium leak tight.

The new viton O–rings that were installed in each of the eight Neutral Beam Source isolation valves to lower air leakage across the seals during vents. These are the large 630 mm diameter valves manufactured by VAT. This is the first maintenance work done on the seals since these valves were first installed over eight years ago.

Bakeout jackets were ordered for three systems attached to DIII–D (Divertor RGA, Divertor Thompson, and Fast Probe). Bakeout jackets for Core Thompson are on order. Bakeout jackets for the Pellet Injector are currently being installed.

A new Balzers RGA system was ordered. It will be used for gas purity testing, outgas testing and calibration and repair of existing Balzers RGA equipment used on the DIII–D tokamak and Neutral Beam Lines.

Bearing overhauls on both spare TMP5000 Balzers turbo pumps were completed in the DIII–D vacuum lab. One of these turbo pumps had a new motor assembly installed with a new heavy duty connector repairing a standard duty connector that overheated during boronization operations last year.

Vacuum calculations were completed on the proposed design for the Charge Exchange Vertical and Tangential diagnostic. The system can meet the DIII–D vacuum requirements with some slight changes to the vacuum design.

Several meetings were held to determine a low cost method to collect RGA data from the divertor region during the upcoming operating period. The present plan is to attach a spare DIII–D, Balzers RGA system to the vacuum system previously installed at 105R-2 by ORNL. On a day when divertor RGA data is desired, the regular DIII–D RGA will be switched off line and the divertor RGA will use its data acquisition digitizers. This low cost plan will allow collecting some divertor RGA data which will provide insight as to whether a future $120K dedicated system is worthwhile.

The DIII–D vessel was pumped down after a six week vent. Three leaks have been found thus far. At 75R-1B, a pinched conflat was replaced. At 105R-2, the torus isolation valve has been forced closed until a leak in the diagnostic can be fixed. At 30 V-1, secondary pumping was installed as a temporary fix for a leaking wave guide assembly. The pump down will continue for a couple of weeks with additional leak checking and baking to 350°C.

TOKAMAK ENGINEERING

Beam Emission Spectroscopy (BES)

The detail design of the revised shutter and shielding was completed and the final design was reviewed and approved. Modification of the port is in work as is the fabrication of the shutter details. The port modifications were completed during the vent along with installation of the window, shutter and shield box, and optics table. In-vessel calibrations were completed and the cryogenic and vacuum systems for the detectors were installed.

ITER Magnetic Diagnostic

The final design was completed for a magnetic probe that will be inserted into a fission reactor at Brookhaven National Lab. Procurement of hardware has started. ORNL is coordinating the testing, GA is responsible for the design and fabrication of the probe. The ITER project has requested the fabrication and testing of this magnetic probe.

X–point Probe

A final design review was held January 26th. Analysis of the disruptive forces provided by Arnie Kellman and Mike Schaffer determined that the carbon-carbon probe shaft and Inconel tubes should survive the low probability event of the probe being inserted during a disruption. Fabrication of the carbon-carbon probe tip and the graphite components to be Boron-Nitride coated is in progress. The probe assembly will be shipped to GA without the tip to allow for installation in the pit. The probe tip will be shipped after assembly and testing at Sandia. The X–Point Probe was installed at the 60°, V-1 location over the period of March 16–23. This probe will help to characterize conditions in the scrape-off layer. Sub-tasks included:

1. Mounting the probe base to the pit basement floor.
2. Modifying water lines adjacent to the probe to ensure clearance.
3. Aligning the probe within its port.
4. Providing lateral support with struts bolted to I–beams.
5. Optimization of the chain-driven system which raises and lowers the probe in its port.
6. Hi-potting the installed probe to ensure its electrical isolation with the vessel. This procedure was performed under vacuum which included a leak check.
7. The installed probe was also successfully operated.

Thomson Calibration Tool

A ruler assembly used to measure the verticle location of Thomson fiber optics within the vessel was designed, manufactured and installed. Support tabs were welded in the V+2 and V-2 ports at 120° to hold this assembly. Measurements of fiber locations were made by back-lighting images onto the face of the ruler which extends between the two ports. These measurements are being compared with 1991 measurements of the same nature. Based on conclusions from the measurements, modifications to the fiber optics mounting assembly are expected to be made. In addition, design and fabrication of viewing optics to be mounted on the R+2 port at 120° was completed. The R+2 port optics will assist in determining the Thomson fiber optic's location within the plasma once the vessel is evacuated and the ruler assembly has been removed.

Multi-year Pump Procurement

An Inquiry Requisition for various turbo pumps for the Neutral Beam and Tokamak systems has been prepared and sent out for competitive bid. The IR reflects our pump needs for the next several years. Significant cost savings should be realized by this type of procurement rather than single unit purchases.

CER Light Source Modification

The existing CER assembly at 345 degrees R-0 was modified to install a light source for calibration purposes. The source consists of a standard quartz-tungsten lamp, plus a neon lamp. They are contained in a "Spectralon" reflective surface enclosure and mounted on the port to allow the installed fibre optics to "see" the source for calibration purposes during diagnostic operations. This task has been completed except for final documentation which is currently in progress.

Charge Exchange Analyzer

The redesign of the existing charge exchange to be reinstalled on the lower port at 105° R-0 has been initiated. A port bellows which provides a 25°–30° arc movement for the Charge Exchange diagnostic has been designed. Additionally, the design to support the drift duct, diagnostic, and vacuum system has been completed. The bellows and torus isolation valve were installed during the vent.

B–Coil Diode Switch

A. Neren chaired a meeting to assess the need for the switch. He determined that a ROM cost estimate for the switch; whether purchased from the Russians or designed and fabricated at GA, would be in the range of \$200K–\$300K. There was an action item on A. Neren to evaluate the cost benefit of the switch.

150° Access Platform

Design has begun on an access platform which is to go from the 6'×8" platform to the existing plywood platform in front of the 150° neutral beam injector. Besides the 18" wide, 7' long access platform; this concept also includes an approach platform, two support structures, and two new, small platforms at the end of the access platform. These end platforms will allow personnel to stand at two different levels to work on experiments near the DIII–D machine. A preliminary design review meeting was held on this concept. Stresses in the components have been analyzed and found to be acceptable. The design was refined to eliminate horizontal electrical loops.

In-vessel Work Floor

Portions of the new in-vessel work floor were used successfully in the vessel during the February and March 1995 vent period. Modifications were completed to six of the floor panels and all 24 of the R-1 cover plates. Due to the press of vent activities, and the need to close the vessel in a timely manner, a final fitup of all parts in the vessel was not performed. All floor panels and supporting parts and structure have been cleaned and stored for use during the next vent as required.

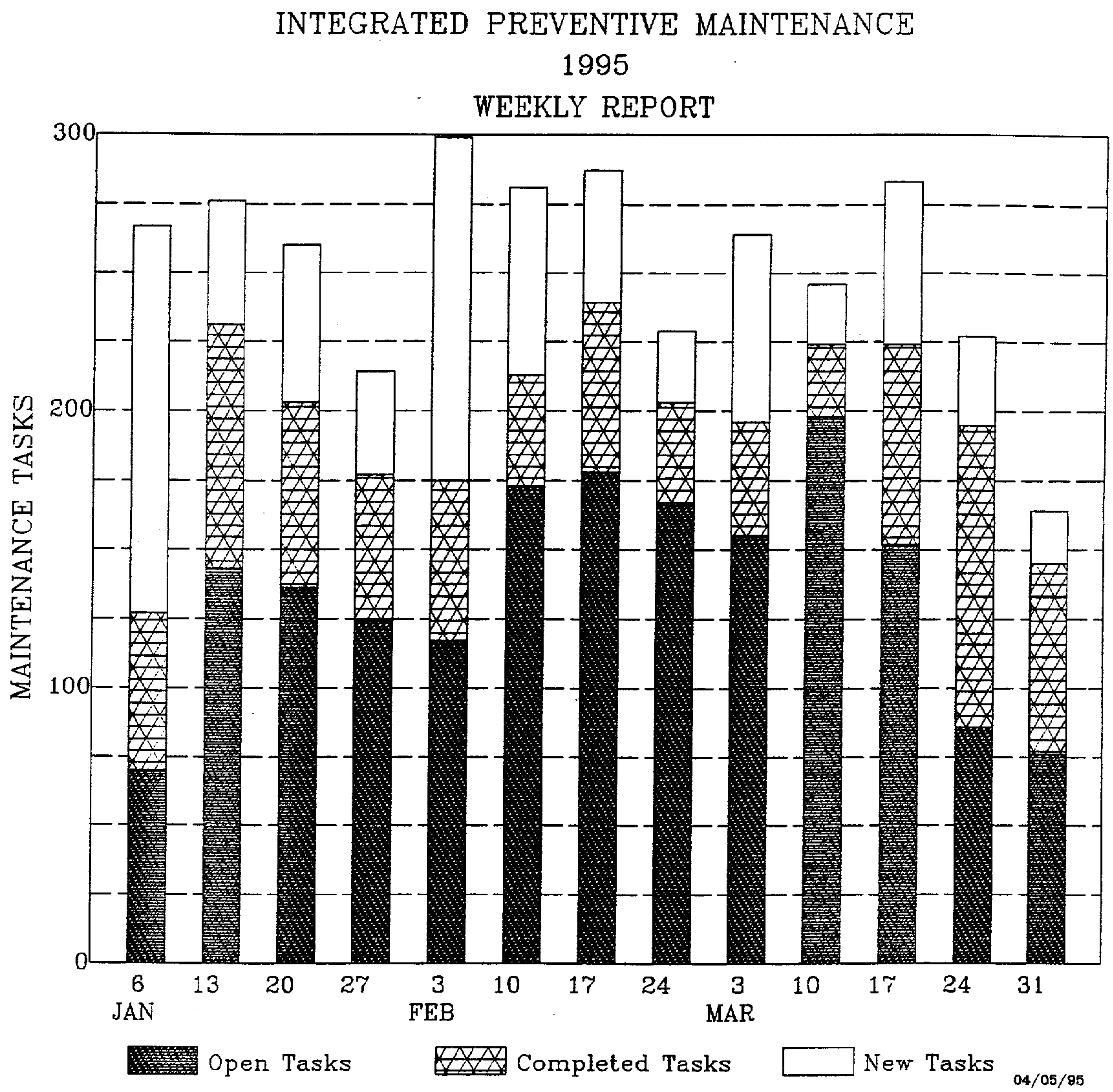
Neutral Beam Spare Collimator Plate

Because of some problems with the drawing for the replacment collimator, a new drawing was produced on the CAD system. This will insure proper fit and reduce manufacturing problems. A purchase order was placed for two spare collimator plates with a completion date of May 1st.

INTEGRATED PREVENTIVE MAINTENANCE PROGRAM (IPMP)

There were 852 maintenance tasks identified during this quarterly report period for an average of 284 tasks per month. Of this number 691 PM and 84 CM tasks were completed with an average turnaround time of 17 days and 25 days respectively. There remain 47 PM and 29 CM outstanding tasks. Of the outstanding tasks, there are 12 priority "1" tasks (affects machine operation), and 19 priority "2" tasks (may affect machine operation). The remaining 45 outstanding tasks are priority "3" which do not have any affect on machine operation. There are currently 1402 components entered in the IPMP. This represents an increase of 44 components over the previous quarter.

The following plot shows the number of completed and new maintenance tasks per week ending on each of the dates shown. The open (outstanding) tasks is the total number of maintenance tasks up to each of the dates shown.



ELECTRICAL ENGINEERING

Electrical Engineering support of plasma operations and new diagnostic installation continued this quarter. Machine downtime and equipment damage occurred due to a short in the line reactors feeding the E–coil power supply. Repairs were made that allowed operation with two of four E power supply modules. The model-based vertical position control algorithm was used on DIII–D and a new digital integrator was tested. Important upgrades were completed in Power Systems and HV Systems.

Electrical Preventive Maintenance

The group completed 394 preventive maintenance tasks in this quarter. Ten (10) tasks were open as of 3/30/95.

Power Systems

The master gate driver boards in the poloidal field supply were replaced during this quarter. The new design, tested to withstand vibration in excess of the environment, has been in operation in the toroidal field supply for one year.

All sixteen HX-choppers have been modified, relocating the grid resistor to prevent radiated heat from affecting varistors.

Due to a manufacturer testing error, line reactors to replace those damaged January 12 will not be installed until after the next run period.

INSTRUMENTATION AND CONTROL AND HV SYSTEMS

A digital integrator prototype demonstrated two orders of magnitude improvement in long term stability compared to existing analog integrators.

The new operator interface to the vacuum control system is supporting current activities and will be ready for plasma operations.

The vertical position control algorithm was successfully tested on February 6. The analog vertical position control system has been fully characterized with intent to duplicate its functionality within the digital plasma controller.

UPGRADE PROJECTS

110 GHZ ECH UPGRADE PROJECT

The Varian 1 MW internal mode converter gyrotron has worked very well this quarter. Peak power of 1 MW has been reached for 2 msec 6% duty, and 106 kW cw operation for several hours has been obtained. Using an infrared camera to monitor the output window temperature high power pulses of 680 kW, 530 kW and 350 kW for 0.5, 2.0 and 10.0 seconds respectively have been obtained. Significant is the 350 kW for 10 seconds, which is a new world record for energy throughput (3.5 megajoules) for the 100+ GHz gyrotron class above the 200 kW level.

In all the pulsed high power tests the window temperature is the limiting factor on gyrotron performance. To improve the performance of this tube a GA distributed window needs to be installed, a understanding has been agreed upon between the Gyrotron Development Program and the DIII–D Program where the DIII–D program will provide $281K to cover the cost of the installation and test of a distributed window on S/N4.1R2 assuming the external distributed window test (funded by Gyrotron Development Program) is satisfactory. The decision to proceed with the installation of the distributed window will be made after review of the external test data and consultation between DOE/OFE, MIT, Varian, and General Atomics representatives.

In addition to the distributed window for S/N4.1R2, DIII–D will also provide a distributed window for S/N3 and a superconducting magnet to be used at DIII–D for S/N4.1R2. Testing at Varian will be limited, by their power supply, to 625 kW, cw, so final testing to the 1 MW, 10 sec level will be conducted at DIII–D; the GA staff and facility costs of this testing will also be covered by DIII–D. Varian staff support at General Atomics during final testing will be funded by the Gyrotron Development Program.

Even though the testing at GYCOM of the 1 MW 2 second gyrotron achieved over 800 kW the efficiency dropped above this level such that 1 MW was not achievable. GYCOM has informed us that the tube cavity had to be rebuilt and that tests are now scheduled from April 18 to May 10th. The external mirror optical unit (MOU) has been redesigned to meet GA's needs and GYCOM is ready for GA to send mirror blanks to them. Preparations are well in hand for having the equipment ready at GA for testing the gyrotron once it gets here, all the hardware has been fabricated and has passed initiation inspection tests. Installation of the hardware has been delayed to allow for repair of the ICRF tuners located in the ECH vault area.

FAST WAVE CURRENT DRIVE 6 MW UPGRADE PROJECT

The 0° system was completed and made to operate at full power specifications at 90 MHz. Some spurious oscillations are being encountered when the power level exceeds 90% of full power. Further adjustments to the transmitters maybe required to completely eliminate this condition.

The 180° system has completed its initial checkout and power levels of 1 MW at 67 MHz has been obtained. The spurious oscillations encountered in the 0° system are also present but at a lower power threshold. There is also a concern about the regulation stability of the high voltage power supplies; however since this is the first time this system has been energized it is felt that fine tuning of the system will correct these problems. Even though antenna conditioning went well into vacuum, the 180 ° antenna was only able to operate at very low power levels into plasma, due to what looks like arcing in the transmission system somewhere between the matching system components on mezz. #1 and the directional couplers on mezz. #2. However; inspection of the tuners showed no signs of arcing.

Due to several problems with each of the ABB transmitters all testing has stopped until ABB is able to determine the cause and fix. Neither transmitter is able to pass final acceptance testing at this time. Two engineers from ABB arrived in the middle of March, they brought with them some waveguide traps that they plan to install in the cavity of the Final Power Amplifier. These waveguide traps were intended to damp the high parasitic frequencies (600 MHz to 1.2 GHz) generated by the power tube. However when these traps were installed the difference in the detected high frequencies was not noticeable. This lack of improvement has put the repair efforts on hold as ABB re-evaluates the cause of the oscillations. During this hold time the transmitters will be optimized to operate at one frequency near 80 MHz, which should provide the maximum coupled power to a plasma.

RADIATIVE DIVERTOR PROJECT

Good progress was made on the design of the radiative divertor for DIII–D during the last quarter. An (internal) preliminary engineering design review was held in January. The overall project, including the diagnostic plan, was reviewed by the DIII–D Executive committee in January. They felt that the design was progressing well and had several suggestions. They particularly liked the fact that the project had implemented their (1994 DEC meeting) suggestions on flexibility of slot width and length. During the last quarter, a diagnostic planning document was produced which outlines the implementation of the divertor diagnostics by GA and its collaborators. Conceptual designs of all the diagnostics, along with cost and schedule information, were presented.

In addition, a plan to implement the upper half of the RDP with vanadium supports was developed during the last quarter. Information was gathered from several sources, including ORNL, ANL, SNL, and others. A review of the vanadium RDP was held March 31 at DOE. The review committee is currently working on written recommendations, but the overall consensus was that the plan was sound, and should be undertaken.

Finally, we have started the process of identifying the critical requirements for the RDP design. This will be presented in a General Requirements Document, and will include details of the design, including EFIT files for the plasma shape, halo current requirements, heat flux requirements, and other physics and engineering details. We plan to have this document completed in about a month.

There has been considerable progress on each WBS element of the RDP. In WBS element 1.0, the baffles, we are examining the impact of increasing our design specifications on the halo current loads. The current DIII–D specification is a toroidally-symmetric current that is 20% of the plasma current. MIT results (which have been adopted by TPX) are 40% of the plasma current, with a toroidal peaking factor of 2. We are looking at these requirements from the standpoint of DIII–D physics and engineering. Material for the prototype has been procured. We are currently soliciting bids from several companies on the construction of a prototype RDP ring. This will test the construction techniques required for the RDP.

In WBS element 2.0, in-vessel cryosystems, dynamic analysis of the loads has been completed. A test of the feed line has been planned, and will be carried out in April. Orders are ready to be placed for the cryopump tubing. In WBS element 3.0, ex-vessel cryosystems, the total loads on the system have been estimated. We will be examining the influence of various requirements on DIII–D operations (*i.e.*, beams, pellet injectors, *etc.*) in the near future.

In WBS element 4.0, diagnostic integration, we are working on getting better definitions of the various divertor diagnostics, particularly those that require penetrations through the water-cooled structures. A detailed map of all of the port allocations is being developed.

OPERATIONS SUPPORT

PLANNING

Services including storekeeping, materials handling, quality assurance, plant engineering, inspection, safety monitoring and control, scheduling, cost control, procurement control, status reporting, and engineering services such as document control, design integration, space allocation and CAD support were provided to DIII–D under "Operations Support."

FUNDING

Anticipated FY95 funding levels are indicated in the following table.

Table 1
FY95 Funding/Obligations

	Anticipated FY95 Funding	FY95 Obligated Funds
Research Operations	37,794(1)	36,200
Capital	4,700	3,400
International Cooperation	775	755
Theory (from AP&T)	460	450
User Service Center (from AP&T)	300	250
Tokamak Physics Exp.	100	0
ITER JCT Secondees (from I&T)	1,850	1600
RF Tuner System Capital (from I&T)	280	280
	46, 259	42,935

(1)FY95 DIII–D R/O funding to be reduced by $281K for use on Varian gyrotron development.

DIII–D RESEARCH OPERATIONS/CAPITAL FY95 2ND QUARTER EXPENDITURE STATUS

- Operating expenditures are approximately $1M under plan due to delayed receipt of procured materials, services and subcontracts. Open commitments total $1.3 M.

- Capital Equipment/"Captial Project" expenditures are approximately $500K under plan due to $300K capital equipment open commitments awaiting receipt and $200K "capital project" labor shortfall. Open commitments total $1.6M including ECH gyrotron/magnet of $700K and ICH transmitter final payment of $371K
- Staffing is currently at levels required to carry out the program for the balance of the year.

DIII–D POSSESSORY INTEREST AND SALES TAX ACTIVITY

POSSESSORY INTEREST TAX

2nd Quarter FY94: Appeal to U.S. 9th Circuit Court approved by Department of Justice Solicitor General. The U.S. government has filed the brief and is awaiting San Diego County's filing.

3rd Quarter FY94: All briefs filed. Awaiting court date.

4th Quarter FY94: No activity this quarter. Awaiting court date.

1st Quarter FY95: No activity this quarter. Awaiting court date.

2nd Quarter FY95: Arguements presented in court on April 7th. Decison not expected for a while.

SALES TAX

No activity 2nd Quarter FY95. The next audit is expected in early 1996 for the period 7/1/92 through 6/30/95.

SAFETY

TRAINING

Two radiation training classes were conducted this quarter providing DIII–D specific radiation safety information to the attendees. Seven confined space safety class were conducted maximizing the allowable work inside the DIII–D vessel. Nineteen individuals received a safety indoctrination which included one individual from the People's Republic of China and various other temporary and permanent employees.

INSPECTIONS/REVIEWS

Preparations were made for the DOE/OAK safety visit. This included preparing presentations, reviewing past action items for completeness, and conducting the regular site inspection.

Rich Haddock (DOE/OAK) visited GA on January 10–11, 1995 to review the DIII–D Safety Program. The agenda included a presentation on DIII–D operations and hardware progress and plans and GA/DIII–D safety "happenings" since the last DOE review in February 1993, an inspection tour of the facility, and a review of training, procedures and "safety findings" documentation and resolution.

Fourteen "findings" were identified on the safety inspection and Rich expressed the following during a debriefing:

- "Excellent" program
- Good attention to detail
- Active program, constant safety promotion
- Doing things safely has been made easy (signs and equipment accessible)
- Number of "safety findings" identified on monthly inspections might indicate not enough safety attention/responsibility being exercised by area managers, supervisors and technicians

Work is in progress on the fourteen items that were identified as needing attention. In our continuing safety effort, another monthly inspection was conducted of the outside areas of the DIII–D site. Twenty-five items were noted requiring attention and corrective action is in progress.

Due to a series of back strains (injuries) by DIII–D technicians, we retained the services of an ergonomic consultant in February to assess the situation and make recommendations for "ergonomic" improvements. A report was submitted to the Fusion Safety Committee and is in review. Additionally, new tools, such as air assisted torque wrenchs, are being investigated.

ACCIDENTS

There were three accidents this quarter. An electrical technician received a pinched finger on a cabinet door. Ten stitches were required. A physicist received a serious abrasion while enlarging the hole of a copper lug. The lug was clamped in a vise, but as the bit in the hand drill got caught in the lug, the lug snapped out of the vise and cut the individual on the top of the right hand. An electrical technician strained his back (again) getting ready to lift an item. None of these were lost time accidents.

MEETINGS—INTERNAL

The Fusion Safety Committee met six times this quarter to discuss various safety issues, review accidents, and review and approve Hazardous Work Authorizations (HWA's). Examples of topics discussed were:

Beryllium Sample Injection into the Tokamak Utilizing the DiMES System
Thompson Profile Laser HWA
DIII–D 110 GHz ECH Project HWA
Inspection Findings
Accidents/Incidents

MEETINGS—EXTERNAL

The Sr. Fusion Safety Officer (and the other members of the U.S. Joint Work Group on Safety–JWG), in a continued effort to ensure the safety of international collaborators, met at PPPL with the Russian JWG. This was the first of a series of meetings with the Russians modeled after the successful meetings that were conducted with the Japanese. Each U.S. JWG member gave a presentation on their respective lab's safety program and explained in general the differences between the labs. The Russian JWG also gave a presentation of their safety program. The meeting was a huge success in terms of laying the ground work for laboratory visits and the making of an english version of the Russian safety manual. U.S. JWG members are planning a visit to Russian laboratories in mid-June. This will be followed by a Russian JWG visit to U.S. facilities.

DIII–D ENVIRONMENTAL ASSESSMENT

Comments received from DOE Oakland on the January submittal were received in March, incorporated and resubmitted for final comments to DOE/OAK on April 7. A final version will be completed in April.

MISCELLANEOUS

All portable O2/Comb monitors were tested and calibrated prior to the start of the vent.

COLLABORATIVE EFFORTS

LLNL — The LLNL Collaboration contributes to both the divertor and Advanced Tokamak missions on DIII–D. During the last quarter, we completed three milestones on schedule: 1) Report on initial results from divertor microwave interferometer, 2) Complete report on feasibility of using MSE for feedback control of central safety factor q_0, and 3) Complete fabrication of divertor Thomson Scattering Hardware. We also completed our Field Work Proposal in March. The major points of our proposal were presented in the DIII–D presentation at DOE at the end of March.

In the Divertor area, we completed several diagnostic jobs during the winter 1995 vent. The tangential TV camera system has been redesigned so that the video camera can be located away from the machine. This eliminates the problem of magnetic field pickup by the camera. We have also made progress in the analysis of these video data. An inversion matrix has been calculated (utilizing parallel processing on many machines); now the data can be inverted by a simple multiplication with this matrix. These results will be compared with DEGAS and MCI modeling results. Preparations for the mounting and calibration of the divertor SPRED EUV spectrometer have also been progressing well. The calibration at NIST will take place the week of April 24; the divertor SPRED will then be installed on DIII–D. We have also worked on improving the operation of the divertor interferometer. In past operation, we have seen problems with measuring the density during ELMs. Tests done in the vessel during the vent indicate that this is probably due to a loss of transmitted power. We are now developing a plan to improve this diagnostic, and several changes will be implemented over the summer. We also continue to improve the IR heat flux measurements in the divertor. A spatial calibration system was installed during the vent. This will provide a continuous check of the spatial calibration (previously, a bake was needed to bring out "landmarks" in the divertor tiles).

Our largest task during this period was the installation of the divertor Thomson scattering diagnostic. The laser input and transport system, collection optics, and laser dump were all installed on schedule before the end of the vent. The installation of this diagnostic went very smoothly. We are currently checking out the effectiveness of our baffle system on DIII–D using the actual system. We have found that some modifications are necessary, but we will still be able to take data during the first run period in May.

Most of the progress in the Divertor Modeling effort was focused on design of the Radiative Divertor baffles. We are currently finalizing the angle of the divertor support structures, and the allowed leakage rate through the gaps in the structure. The DEGAS modeling work is playing an important role in these tasks. The modeling and database work was represented by G. Porter at the February ITER experts meeting.

In the Advanced Tokamak area, we continue to focus on measurement and control of the plasma current profile. In February, the MSE data was acquired by the control computer and a real-time (every 600 μsec) estimate of the on-axis safety factor, q_0, was obtained during the discharge. The q_0 was obtained by estimating the central elongation, κ_0, and calculating the on-axis slope of the MSE signal. As current drive systems become available, this signal will be used in a feedback loop. We are also planning experiments this summer on J(r) measurements in reverse-central shear operation.

ORNL— The ORNL collaboration includes work in the areas of the Advanced Divertor Program, boundary physics, FWCD, plasma shaping studies, and pellet injection.

ORNL Helium Transport Studies and CER Spectroscopy

During this quarter modifications have been made to the ORNL penning gauge installation at 105° R-2, such that differential pumping at the gauge location is possible. This installation consists of a turbopump and aperture such that a 15:1 pressure differential is obtained between the pressure in the baffle and the pressure at the gauge location. This allows the penning gauge to operate at baffle pressures up to 30 mTorr. Previously, the penning gauge suffered from non-linearities at baffle pressures above 2 mTorr. This upgrade should provide measurements of the He and Ne fraction in the baffle in radiative divertor and high density divertor conditions.

Calibrations of the DIII–D CER system, H_α, and Multichord Divertor Spectrometer (MDS) were carried out during the February–March vent period. Both spatial and intensity calibrations were performed on both of these systems, including “back” and "forward" calibrations. Also, software has been added to the 4D analysis package such that impurity density profiles are now available from CER measurements.

Boundary Physics and Particle Control

Recently, a model that estimates baffle pressure from measured density, temperature, and particle flux from the divertor floor Langmuir probes has been developed. The key ingredients to this model are: (a) Calculation of the geometric line-of-sight probability for scattering into the baffle, (b) divertor attenuation due to ionization and charge exchange, and (c) separate consideration of Franck-Condons and reflected particles. Recent experimental data from DIII–D are qualitatively reproduced by this model, which indicates that SOL ionization is minimal at the lower density and dominant at the higher density. In addition the model indicates that the pressure peaking at the MARFE onset is due to an outward shift of the peak particle flux as previously reported in papers. Currently, a Nuclear Fusion paper is in progress describing this modeling effort. This model is easily applicable to future pumping configurations of present or future tokamaks. In addition simple considerations indicate that the baffle pressure rise during high-frequency ELMs is small compared with the rise between ELMs because the baffle equilibration time constant is much longer than the ELM pulse length.

During the February–March vent period all ASDEX gauges were fixed and tested and a conceptual design was completed for a Divertor RGA installation.

Impurity Spectroscopy

Atomic physics modeling to understand impurity radiation in the divertor region has begun using the STRAHL code to investigate MARFES, which were observed last year in DIII–D, and using the one-dimensional NEWT1D code to simulate divertor conditions. STRAHL was modified so that the MARFE could be simulated with a high-density, low-temperature edge region. Although it is rather artificial to employ a radial transport code for detailed analysis of the data, it was possible, by employing a range of carbon transport coefficients, to determine limits on the radiated power from the MARFE region based the 4650Å line of C III which was the only impurity transition monitored during the experiments. It was concluded that carbon contributed only a small amount to the radiative losses determined by the bolometer if the absolute calibration of the MDS system were correct. However, it appears that severe problems with the image intensifier were beginning to develop at the time the data was acquired. Since the radiative image of the MARFE observed with a CCD camera employing a 4650Å filter agrees well with the bolometer reconstruction of the power-loss region, the present assessment is that the MDS sensitivity had deteriorated following the original calibration Analysis of the H_α radiation from the independent monitors also indicated that hydrogen emission was not a major contributor to the power losses.

We have also started examining the use of the NEWT1D code which is basically a one-dimensional transport code that calculates particle temperature and densities along scrape-off layer flux tubes running from the divertor target plate up to the top of the main plasma. The main purposes of these studies are (1) to determine if this code might be useful for analyzing experimental data, and (2) to see what sort of impurity densities and radiated power the code predicts for various input parameters as a preliminary step to radiative divertor experiments. We have begun by investigating situations where carbon sputtered from the divertor target plates is the only impurity considered. The results from this code serve as input to a stand-alone code (BALRAD) which is then used to calculate the intensities of individual spectral lines for each ionization stage as well as the total radiated power from each stage. At this time, it appears that the NEWT1D code overestimates the radiation from C II, C III, and C IV by a factor of almost 2. It may be necessary to reexamine the atomic physics package (ADPACK) used in this program since there is good reason to believe the BALRAD results represent the best available atomic physics.

This quarter marked the beginning of various hardware related activities associated with the new diagnostic referred to as the Divertor Visible SPRED. This diagnostic is an important addition to the DIII–D divertor diagnostic set. It will enable a simultaneous survey of most of the visible range of the emission spectrum (a 4000Å range) and with some spatial scanning capability. This is a three-party collaborative effort, in which the TRINITY group at Troitsk, Russian Federation, provides a custom spectrometer, an image transformer and adapter for a fast, high dynamic range CCD camera system, which is the responsibility of ORNL. General Atomics will provide an optical fiber commutator, which will allow spatial scanning, by switching between optical fibers and imaging each onto the entrance of the spectrometer sequentially. At ORNL, the main activities were testing of the camera system and data acquisition/control software development. In addition, extensive discussions with GA have lead to a conceptual design of the commutator system and a concept for the type of control software required to drive this system. This software will have to assure synchronization with the detection system (camera). The goal is to have the entire system available for the divertor studies planned in the Fall.

ORNL Fast Wave Current Drive and RF Physics Program

The installation of the transmission line system for the 180° antenna was completed, and the antenna was operated briefly into plasma. A frequency of 93.84 MHz was selected so as to avoid high voltages on the resonant loop tuner drive rods. Vacuum conditioning of the antenna proceeded rapidly to about 20 kV. All three antennas were operated into plasma in February with a combined output of slightly over 3 MW, although the antennas were not energized simultaneously.

Work resumed on commissioning of the second Thomcast transmitter, which feeds the 180° antenna. ORNL has the responsibility for bringing this transmitter on line, and has been working with engineers from Thomcast to troubleshoot the power supply and to make modifications imposed by the manufacturer for tube protection. Both transmitters are being readied for acceptance testing, which is to be conducted during the next quarter.

A design for a replacement Faraday shield for the 285°–300° antenna has been completed. The replacement features a modular structure with horizontal rod elements, unlike the present shield with a 120 tilt. The construction of the replacement is expected to be completed in this fiscal year, with ORNL and General Atomics dividing the fabrication tasks; tentatively, ORNL will issue the drawings, electroplate, and assemble the shield, with General Atomics contracting for the material, machining, and boron carbide coating.

RF modeling and experimental comparison have continued for the DIII–D fast wave heating and current drive experiments. The PICES 2D full wave code is now incorporated with the RANT3D antenna modeling to improve the accuracy of the antenna structure model. The tangential electric fields calculated by RANT3D is used the boundary conditions at the outer most flux surface in the PICES code. The RANT3D-PICES combination has been applied to the new DIII–D four-strap antenna at both 60 and 90 MHz, and the current drive efficiencies compared for the two frequencies. Preliminary modeling results show the driven currents on the order of 100 kA for shot #84280. Modeling with the RANT3D code was used to evaluate a possible impact of changing the divertor configuration in the RDP on antenna/plasma loading. The studies show that installation of the 43 cm shelf for the radiative divertor will reduce the loading of the FWCD antennas by about 40%. An increase of 20% in the voltage limit antennas can compensate for this, provided that dissipation in the resonant loops does not become too large.

The pointnames for the new ECE heterodyne receiver can now be accessed in REVIEW either by channel number or by approximate major radius. The ECE data in response to the RF power turn-off (or interrupts) were analyzed to determine deposition profiles of 60 MHz (on 285°–300° antenna) and 90 MHz (on 0° antenna) RF power in the FWCD experiments in December, although accuracy was limited by statistical fluctuation levels in ECE signals. An *in-situ* calibration of the AM reflectometer was performed in the early part of the February down-time. This absolute calibration allows more detailed comparison with Thomson scattering density measurements at the plasma edge.

Shaping Studies

The initial stages of developing an experiment to test the importance of the Mercier criterion to the development of a VH–mode are underway. (Lazarus, Murakami, Burrell, Petty, Osborne, Zarnstorff). The idea is to develop a target by growing the plasma at constant q, creating a large $q<1$ region. Then stabilize sawteeth with ICRF, then try to create VH–mode performance in this target, maintaining $q<1$ but the absence of sawteeth. As part of this investigation we need to calculate the ICRF requirements for sawtooth stabilization. This will be done at PPPL and the easiest way to do this is to run our cases through TRANSP. Which finally brings me to recent progress.

To facilitate this, and additionally expand our analysis capabilities TRANSP has been installed on three workstations: USCWS8, USCWSE, and FEDA34. The fitting code BYTHELEE, previously used only for generating total pressure in a format suitable for kinetic EFITs has been expanded and reworked to provide an interface (create the appropriate U–files). The assistance of Ted Terpstra was critical in this effort. In one test, the total time for setting up a TRANSP run for the time evolution of a VH–mode case of nine time slices was less than an hour. We (Petty, Murakami, Lazarus) are now engaged in benchmarking against ONETWO with a well-studied DIII–D case (82205), a single-null H–mode plasma.

Pellet Injector Program

A new computer workstation(Integraph TD-5 dual Pentium) has been installed at DIII–D to replace the pellet injector operating PC. This new system will be networked to the other DIII–D computers for better experimental coordination and automation.

Data from the last run period have begun to be analyzed with the TRANSP code to look at particle transport from pellet perturbations to the density profile. Cases with partial pellet penetration in ELM free and ELMing H–modes are being analyzed and show that up 100 ms are required for the perturbation to fully evolve. Initial results indicate similar transport coefficients to that derived for helium in the same configuration.

Pellet injection into the startup phase of VH–mode discharges has begun to test the possibility of reducing the gas puff magnitude in order to avoid loading the walls with gas this enabling longer VH–mode discharges. Initial results were very promising with gas reductions of 20% to 30% being achieved. During these discharges peaked density profiles were produced which lasted the order of 200 ms. One potential problem was that locked modes were often observed several 100 ms after the pellet was injected. It is hoped that auxiliary plasma heating (either rf or beams) may alleviate this problem.

JAERI — S. Konoshima contributed to a paper titled "Confinement and Stability of VH–mode Discharges in the DIII–D Tokamak," (Nuclear Fusion, Vol. 35, No. 1 (1995)) as a co-author.

Y. Kawano has started his stay of six months period at GA on January 20, 1995 to participate in the DIII–D experiment.

UCLA — *New Divertor Reflectometer System*: The new divertor reflectometer system was successfully installed on DIII–D during the February vent. The system is located at the bottom of the tokamak and will initially probe the plasma directly up into the X–point of the divertor. This is currently the only U.S. reflectometer experiment being performed in the important divertor region.

Distance calibration data for profile measurements were successfully obtained with the system after installation. The next phase of the project is to complete the installation of the microwave source in the machine hall area as well as the necessary waveguide runs.

FIR Scattering Measurements: Modeling experimentally observed turbulence spectra using assumptions of gradient driven turbulence and shear decorrelation reproduce many of the qualitative features and changes which are routinely observed in the experimental data.

Low q VH–mode discharges have interesting core turbulence characteristics. In some cases, core spin-up in H–mode appears to occur immediately after the L–H transition, so L–, H–, and

VH–mode can all be seen within 200 msec. In contrast, reverse central shear discharges appear to have a different time evolution of the rotation, apparently the result of the early beam used in these discharges. The rotation develops more slowly over a longer time interval.

ECE Electron Temperature Fluctuation Measurements: Design of components for the ECE fluctuation system is near complete, and most of the items required to measure T_e fluctuations via ECE have been ordered. The longest lead time is 120 days, so data ought to be available this summer.

Collaboration with Tsukuba: E.J. Doyle visited the Plasma Research Center, University of Tsukuba, Japan, from January 27–February 12 as part of a U.S./Japan exchange. The project involved reflectometer measurements on the GAMMA–10 tandem mirror with host Prof. Mase. The main areas of activity were as follows: a) Reflectometer density profile measurements: we obtained data at different sweep rates. UCLA will analyze this data using the codes we developed over the last few years, b) Cross-polarization scattering from magnetic fluctuations: a first attempt at such an experiment on Gamma–10 was performed during my visit, using the magnetic component of coherent Alfvén instabilities and driven RF waves. The preliminary results from this experiment indicate that it was quite easy to see the cross-polarization signal, and that the signal was not generated by at least one potential spurious mechanism. However, it was not possible to check all potential sources of spurious signal, c) We attended a meeting on ITER divertor diagnostics at JAERI, Naka, February 6–7 and presented a talk on potential interferometer and reflectometer measurements in the divertor. The interferometer section was provided by R. James of LLNL.

Inside Lanuch Reflectometer System: This system was upgraded during the recent DIII–D vent. The previous fixed frequency microwave source (Gunn diode) was replaced by a frequency tunable system using a 33–50 GHz BWO. At present, the BWO is that used in the profile system, *i.e.* it is shared. However, the new solid state source for the profile system should free up the BWO.

Reflectometer RF Wave Measurement System: The relative radial profile of of the FW electric field at a toroidal position10 cm away from the 285°–300°. FW antenna has been determined through both shot-to-shot scans of reflectometer probing frequency (65–73 GHz) and a density scan. The results indicate that the FW electric field decays towards the plasma edge, which is consistent with preliminary calculations of the FW electric field pattern at that spatial location.

<u>MIT</u>— The Phase Contrast Imaging (PCI) diagnostic was operated during several experimental runs in the last quarter. New results were obtained from analysis of existing data on ELMs. ELMs are always accompanied by bursts of fluctuations which PCI can detect. Some systematic

differences were found between type-III and giant ELMs, which should aid in discerning the underlying physics. In particular, semi-coherent, outward propagating modes were observed to coexist with a broad-band turbulence spectrum during type-III ELMs, whereas only the latter is seen during giant ELMs.

UCSD/SNL— *Disruption Research:* In the first quarter of 1995, UCSD staff participated in the preparation of miniproposals for disruption experiments, began implementation of an expanded DIII–D disruption database, worked with the ITER Joint Central Team on assembling a multi-tokamak disruption database, and have designed a power supply, preamplifier, and data acquisition system to be used with a special DiMES probe head to make triple probe measurements during disruptions. These triple probe measurements will have high enough time resolution to follow the evolution of the electron density and temperature during the thermal quench. This system consists of a straightforward adaptation of the existing X–point probe hardware and will be available during operations in the coming year.

Fast Reciprocating Probe Measurements: Progress was made in the first quarter of 1995 in L–mode to H–mode transition physics, turbulence measurements, and installation of the SNL/UCSD X–point reciprocating probe, as summarized below:

L– to H–mode Transition Physics:

A complete sensitivity analysis of E_r shear and curvature profiles to the choice of sheath potential model has been completed. The calculated E_r shear and curvature profiles are insensitive to the choice of sheath potential model, but is determined primarily by the third derivitive of the accurately measured floating potential, and not the less well known sheath potential.

Turbulence measurements:

In response to recent interest in the wavelet bicoherence analysis technique, UCSD staff have modified the existing wavelet fluctuation analysis package to perform wavelet bicoherence analysis. First results using this new analysis tool on PISCES data were presented by Ron Lehmer at the U.S.–European Transport Task Force in March, 1995.

Divertor X–point probe installation:

The X–point probe drive has been installed on the DIII–D vacuum vessel and has passed a series of tests, including test firing, high voltage isolation, and vacuum leak testing. The instrumentation rack and isolated primary power have been installed in the DIII–D machine pit. The data acquisition hardware and the swept probe power supplies have also been installed. The computer system upgrade is complete and is fully integrated into the DIII–D VAX cluster. The dedicated ethernet LAN for the probe data acquisition systems is operational. Fabrication of the X–point probe control system and preamplifiers is continuing, and is expected to be complete prior to the next physics operations in early May.

DIII–D RESEARCH OPERATION
GA OPERATING

	FY95 BUDGET		FY95 ACTUALS	
	FTE's	TOTAL $000	FTE's	TOTAL $000
BASE OPERATIONS	43.0	10,149	43.8	4,970
PHYSICS	38.9	8,450	39.7	4,324
DATA SYSTEMS	9.7	2,365	9.1	1,092
DIAGNOSTICS	13.6	3,100	15.6	1,647
HEATING				
NBI HEATING	13.5	2,930	11.5	1,162
RF HEATING	11.2	2,650	9.6	1,239
OPERATIONS SUPPORT	20.0	5,075	17.5	1,875
COLLABORATION	4.3	2,150	3.8	906
SPECIAL TASKS				
TAXES	0.0	150	0.0	0
TOTAL	154.2	37,019(1,2)	150.6	17,215(3)

(1)Operating expenditure plan increased by $94K to reflect funding increase.

(2)FY95 operating funding reduction of $281K anticipated for Varian gyrotron development.

(3)Does not include $1,300K of commitments.

GA CAPITAL

	FY95 BUDGET		FY95 ACTUALS	
	FTE's	TOTAL $000	FTE's	TOTAL $000
BASE OPERATIONS	0.0	300	0.0	155
PHYSICS	0.0	15	0.0	0
DATA SYSTEMS	0.0	250	0.0	0
DIAGNOSTICS	0.0	54	0.0	20
NBI HEATING	0.0	80	0.0	23
RF HEATING	0.0	90	0.0	15
UPGRADE PROJECTS				
RADIATIVE DIVERTOR	10.5	2,658	7.4	564
110 GHz ECH – 2 MW	2.6	1,737	3.5	405
ICRF 4 MW UPGRADE	0.8	291	1.4	(4)
TOTAL	13.9	5,475(1)	12.3	1,178(1)

(1)FY95 Capital expenditure plan reduced by $100K to reflect funding reduction

(2)Does not include 41,600K of commitments.

DIII–D RESEARCH OPERATION
LLNL OPERATING

	FY95 BUDGET		FY95 ACTUALS	
	FTE's	TOTAL $000	FTE's	TOTAL $000
BASE OPERATIONS	0.0	0	0.0	0
PHYSICS	11.5	2,630	11.5	1,342
DATA SYSTEMS	3.0	584	3.0	282
DIAGNOSTICS	5.8	1,424	5.0	655
HEATING				
NBI HEATING	0.0	0	0.0	0
RF HEATING	1.0	256	1.0	128
OPERATIONS SUPPORT	0.0	0	0.0	0
COLLABORATIONTRAVEL	0.0	0	0.0	0
SPECIAL TASKS				
TAXES	0.0	0	0.0	0
TOTAL	21.3	4,894	20.5	2,407

LLNL CAPITAL

	FY95 BUDGET		FY95 ACTUALS	
	FTE's	TOTAL $000	FTE's	TOTAL $000
BASE OPERATIONS	0.0	0	0.0	0
PHYSICS	0.0	0	0.0	0
DATA SYSTEMS	0.0	0	0.0	0
DIAGNOSTICS	0.0	100	0.0	25
NBI HEATING	0.0	0	0.0	0
RF HEATING	0.0	0	0.0	0
UPGRADE PROJECTS				
RADIATIVE DIVERTOR	0.0	0	0.0	0
110 GHz ECH – 2 MW	0.0	0	0.0	0
ICRF 4 MW UPGRADE	0.0	0	0.0	0
TOTAL	0.0	100	0.0	25

DIII–D RESEARCH OPERATION
ORNL OPERATING

	FY95 BUDGET		FY95 ACTUALS	
	FTE's	TOTAL $000	FTE's	TOTAL $000
BASE OPERATIONS	1.3	339	1.00	141
PHYSICS	6.5	1,325	4.35	507
DATA SYSTEMS	0.6	81	0.35	32
DIAGNOSTICS	1.7	518	1.00	140
HEATING				
NBI HEATING	0.0	0	0.00	0
RF HEATING	2.3	603	1.72	175
OPERATIONS SUPPORT	0.0	0	0.00	0
COLLABORATION/TRAVEL	0.0	184	0.00	95
SPECIAL TASKS				
TAXES	0.0	00	0.00	0
TOTAL	12.4	3,050	8.42	1,090(1)

(1) Does not include $180K of commitments. Physics and RDP diagnostic effort will increase in the second half of the year.

ORNL CAPITAL

	FY95 BUDGET		FY95 ACTUALS	
	FTE's	TOTAL $000	FTE's	TOTAL $000
BASE OPERATIONS	0.0	0	0.0	0
PHYSICS	0.0	0	0.0	0
DATA SYSTEMS	0.0	0	0.0	0
DIAGNOSTICS	0.0	0	0.0	0
NBI HEATING	0.0	0	0.0	0
RF HEATING	0.0	0	0.0	0
UPGRADE PROJECTS				
RADIATIVE DIVERTOR	0.0	0	0.0	0
110 GHz ECH – 2 MW	0.0	0	0.0	0
ICRF 4 MW UPGRADE	0.0	0	0.0	0
TOTAL	0.0	0	0.0	0

DIII–D RESEARCH OPERATION OPERATING (GA, LLNL, ORNL)

	FY95 BUDGET		FY95 ACTUALS	
	FTE's	TOTAL $000	FTE's	TOTAL $000
BASE OPERATIONS	44.3	10,488	44.8	5,111
PHYSICS	56.9	12,405	55.6	6,173
DATA SYSTEMS	13.3	3,030	12.5	1,406
DIAGNOSTICS	21.1	5,042	21.6	2,442
HEATING				
NBI HEATING	13.5	2,930	11.5	1,162
RF HEATING	14.5	3,509	12.3	1,542
OPERATIONS SUPPORT	20.0	5,075	17.5	1,875
COLLABORATION/TRAVEL	4.3	2,334	3.8	1,001
TAXES	0.0	150	0.0	0
TOTAL	187.9	44,963	179.5	20,712(1)

(1)Does not include $1,480K of commitments.

CAPITAL (GA, LLNL, ORNL)

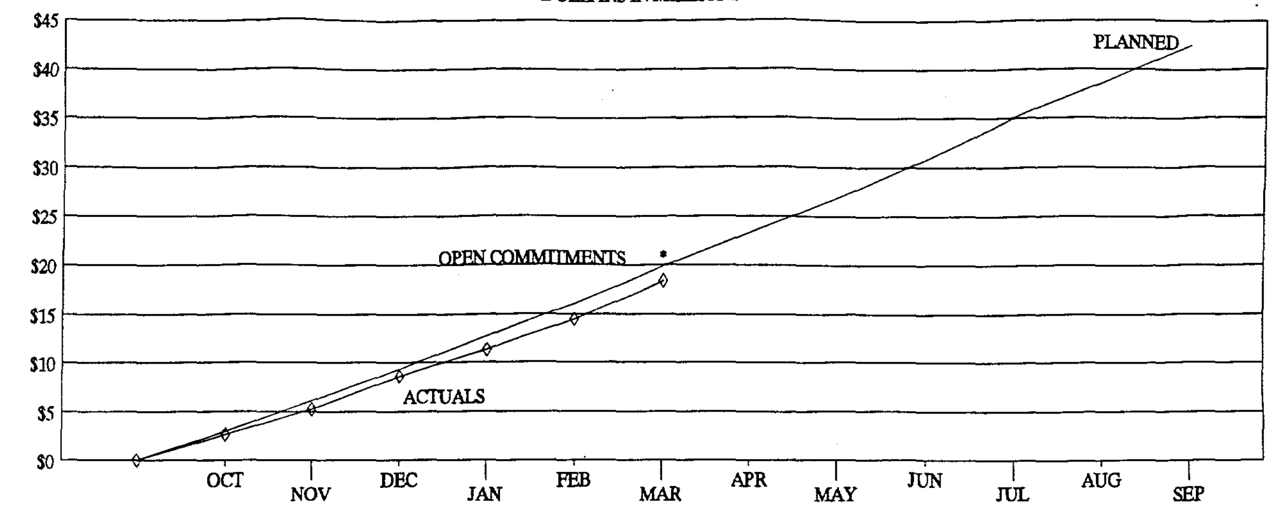
	FY95 BUDGET		FY95 ACTUALS	
	FTE's	TOTAL $000	FTE's	TOTAL $000
BASE OPERATIONS	0.0	300	0.0	155
PHYSICS	0.0	15	0.0	0
DATA SYSTEMS	0.0	250	0.0	0
DIAGNOSTICS	0.0	154	0.0	45
NBI HEATING	0.0	80	0.0	23
RF HEATING	0.0	90	0.0	15
CAPITAL PROJECTS				
RADIATIVE DIVERTOR	10.5	2,658	7.4	564
110 GHz ECH – 2 MW	2.6	1,737	3.5	405
ICRF 4 MW UPGRADE	0.8	291	1.4	(4)
TOTAL	13.9	5,575	12.3	1,203(1)

(1)Does not include $1,600K of commitments.

Contract Management Summary Report

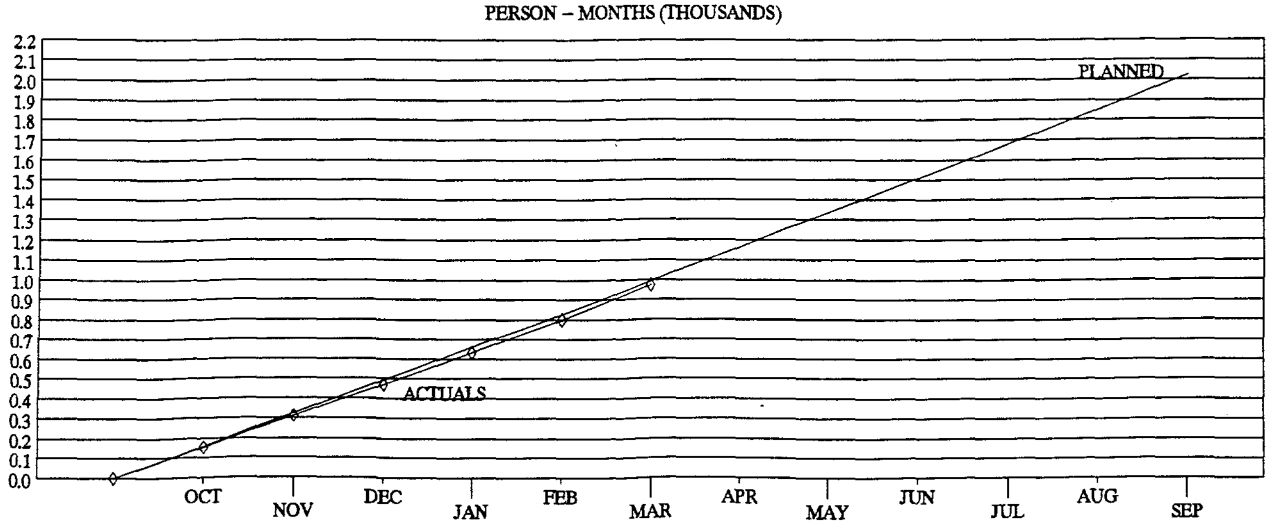
TITLE:	DIII-D RESEARCH OPERATIONS & CAPITAL	**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR:	GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** APRIL 17, 1995	**START DATE:** OCTOBER 1, 1994 **COMPLETION DATE:** SEPTEMBER 30, 1995

DOLLARS IN MILLIONS



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	$2,981	$3,177	$3,194	$3,371	$3,358	$3,846	$3,445	$3,536	$3,938	$4,295	$3,414	$3,939	$42,494
ACTUAL	$2,674	$2,566	$3,393	$2,701	$3,126	$3,933							$18,393
VARIANCE	$307	$611	($199)	$670	$232	($87)							
CUM VAR	$307	$918	$719	$1,389	$1,621	$1,534							*(IN THOUSANDS)*

PERSON - MONTHS (THOUSANDS)

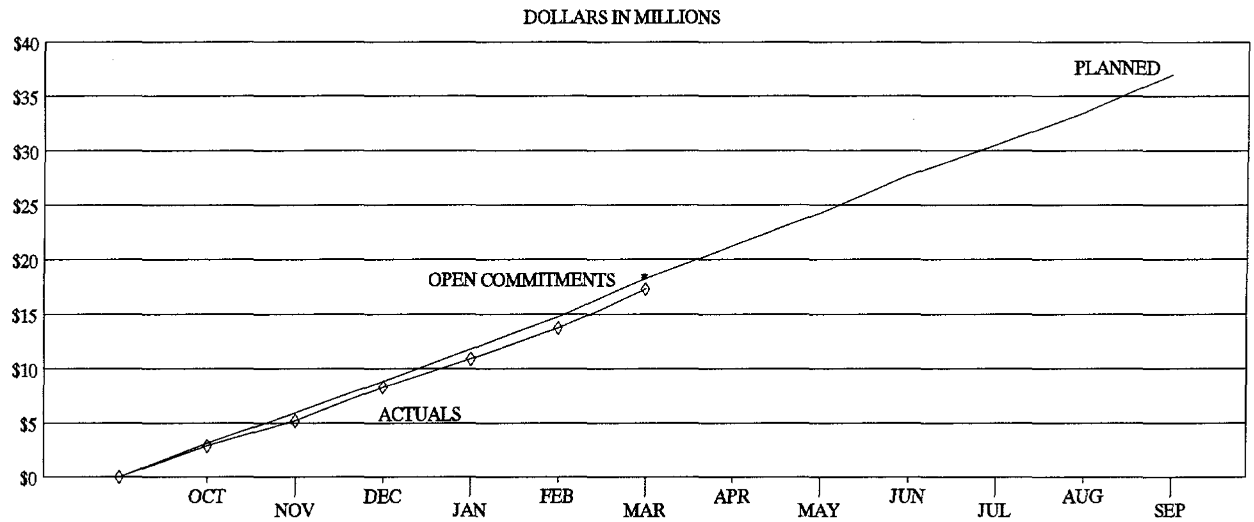


	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	157.8	164.8	168.9	167.5	166.0	169.3	170.3	170.5	172.2	172.3	171.7	170.1	2021.4
ACTUAL	152.4	156.5	161.2	159.0	171.8	173.3							974.2
VARIANCE	5.4	8.3	7.7	8.5	-5.8	-4.0							
CUM VAR	5.4	13.7	21.4	29.9	24.1	20.1							*(PERSON-MONTHS)*

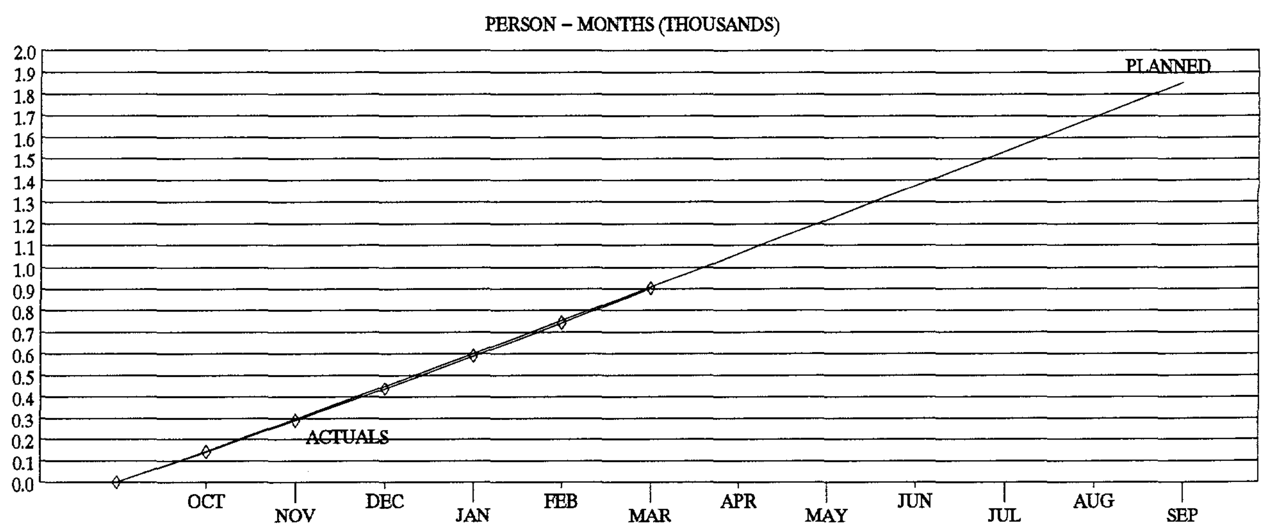
SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ____________________

Contract Management Summary Report

TITLE:	DIII-D RESEARCH OPERATIONS B\R NO: AT101014D	**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR: GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** APRIL 17, 1995	**START DATE:** OCTOBER 1, 1994	**COMPLETION DATE:** SEPTEMBER 30, 1995



													TOTALS
PLANNED	$3,085	$2,820	$2,873	$2,980	$2,988	$3,489	$2,990	$3,000	$3,460	$2,850	$2,950	$3,534	$37,019
ACTUAL	$2,832	$2,354	$3,076	$2,571	$2,821	$3,561							$17,215
VARIANCE	$253	$466	($203)	$409	$167	($72)							
CUM VAR	$253	$719	$516	$925	$1,092	$1,020							*(IN THOUSANDS)*



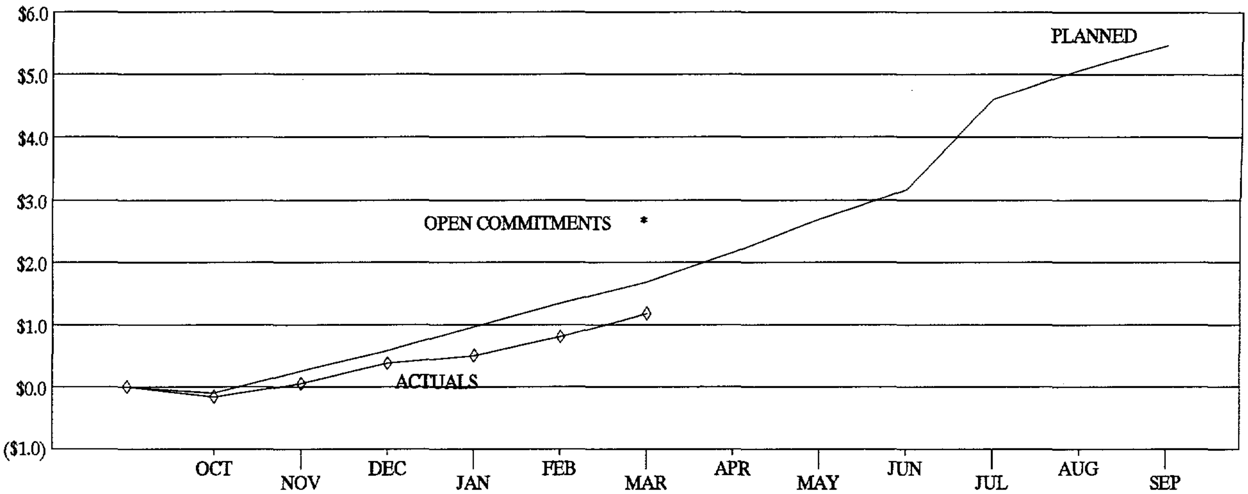
													TOTALS
PLANNED	146.3	149.0	153.0	152.7	152.4	154.5	154.1	154.8	158.9	158.8	159.6	159.6	1853.7
ACTUAL	143.8	145.2	147.9	153.0	153.0	158.2							901.1
VARIANCE	2.5	3.8	5.1	-0.3	-0.6	-3.7							
CUM VAR	2.5	6.3	11.4	11.1	10.5	6.8							*(PERSON-MONTHS)*

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ______________________

Contract Management Summary Report

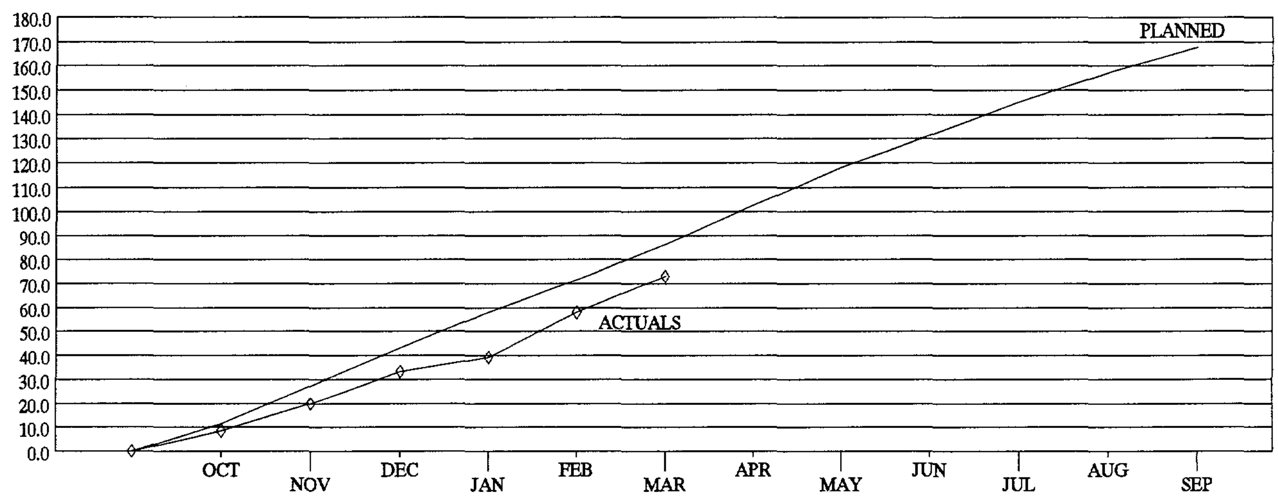
TITLE:	DIII-D CAPITAL SUMMARY B\R NO: AT1010140	**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR: GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** APRIL 17, 1995	**START DATE:** **COMPLETION DATE:**	OCTOBER 1, 1994 SEPTEMBER 30, 1995

DOLLARS IN MILLIONS



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	($104)	$357	$321	$391	$370	$357	$455	$536	$478	$1,445	$464	$405	$5,475
ACTUAL	($158)	$212	$317	$130	$305	$372							$1,178
VARIANCE	$54	$145	$4	$261	$65	($15)							
CUM VAR	$54	$199	$203	$464	$529	$514							*(IN THOUSANDS)*

PERSON-MONTHS

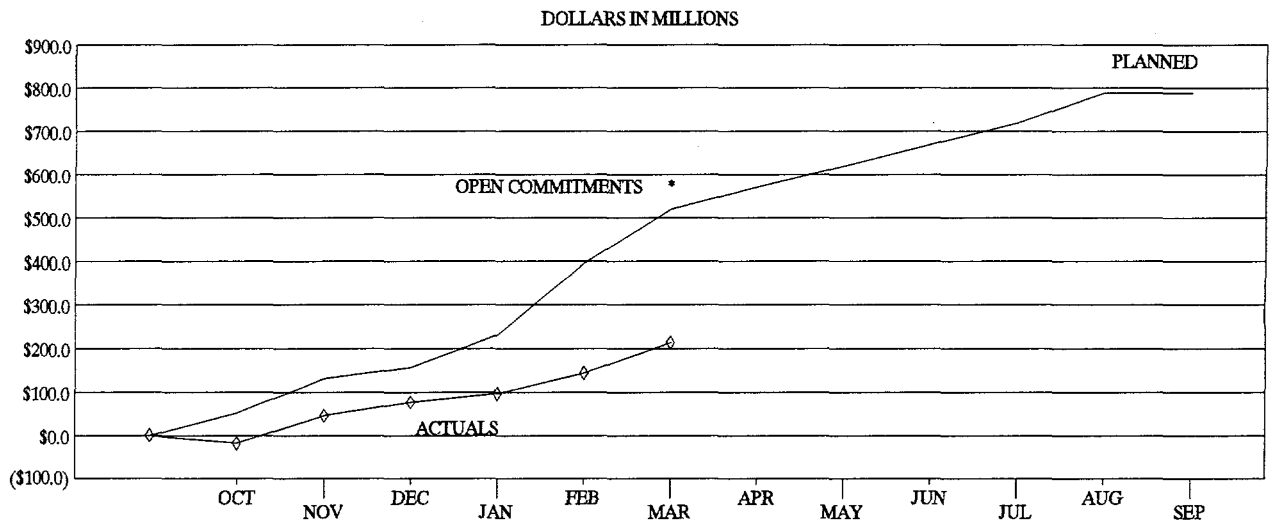


	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	11.5	15.8	15.9	14.8	13.6	14.8	16.2	15.7	13.3	13.5	12.1	10.5	167.7
ACTUAL	8.6	11.3	13.3	6.0	18.8	15.1							73.1
VARIANCE	2.9	4.5	2.6	8.8	-5.2	-0.3							
CUM VAR	2.9	7.4	10.0	18.8	13.6	13.3							

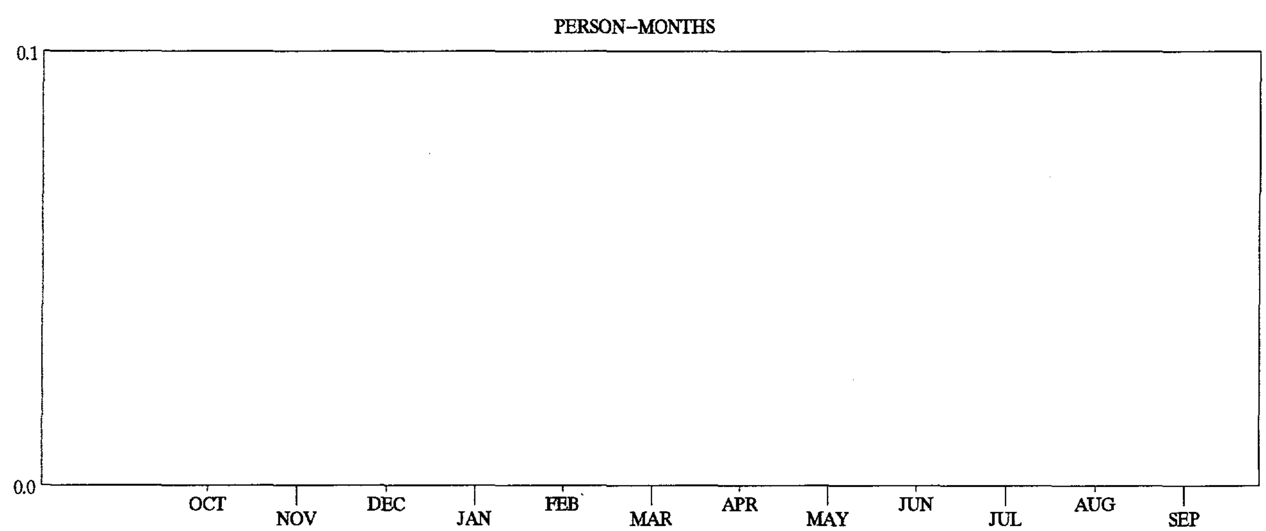
SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ______________________

Contract Management Summary Report

TITLE:	DIII-D CAPITAL EQUIPMENT B\R NO: AT1010140	**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR:	GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** APRIL 17, 1995	**START DATE:** OCTOBER 1, 1994 **COMPLETION DATE:** SEPTEMBER 30, 1995



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	$50	$80	$25	$75	$165	$125	$50	$50	$50	$50	$69	$0	$789
ACTUAL	($19)	$64	$31	$20	$47	$70							$213
VARIANCE	$69	$16	($6)	$55	$118	$55							
CUM VAR	$69	$85	$79	$134	$252	$307							*(IN THOUSANDS)*

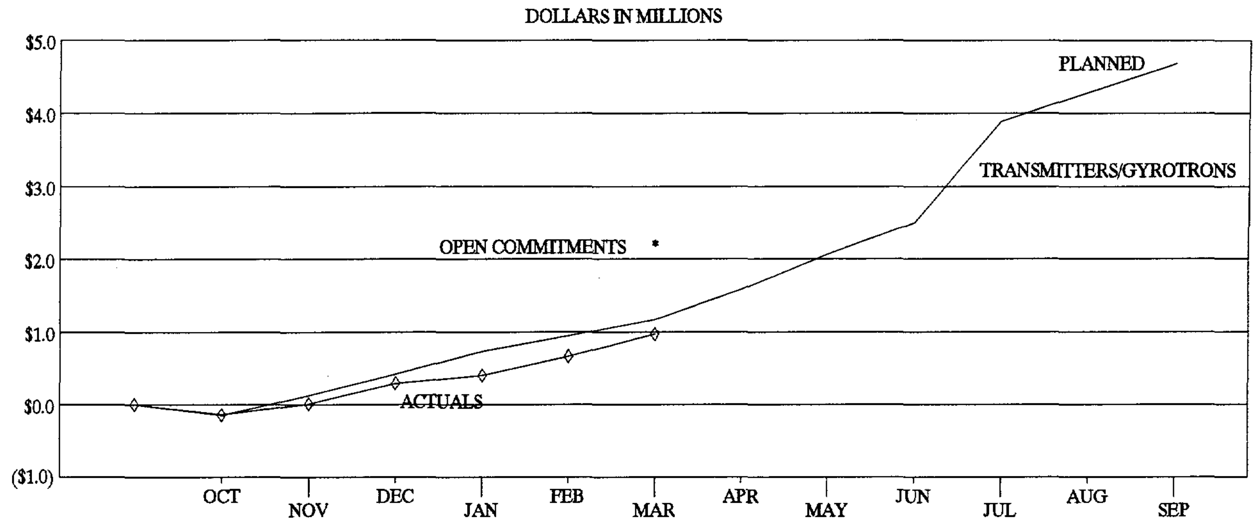


	TOTALS
PLANNED	0.0
ACTUAL	0.0
VARIANCE	
CUM VAR	

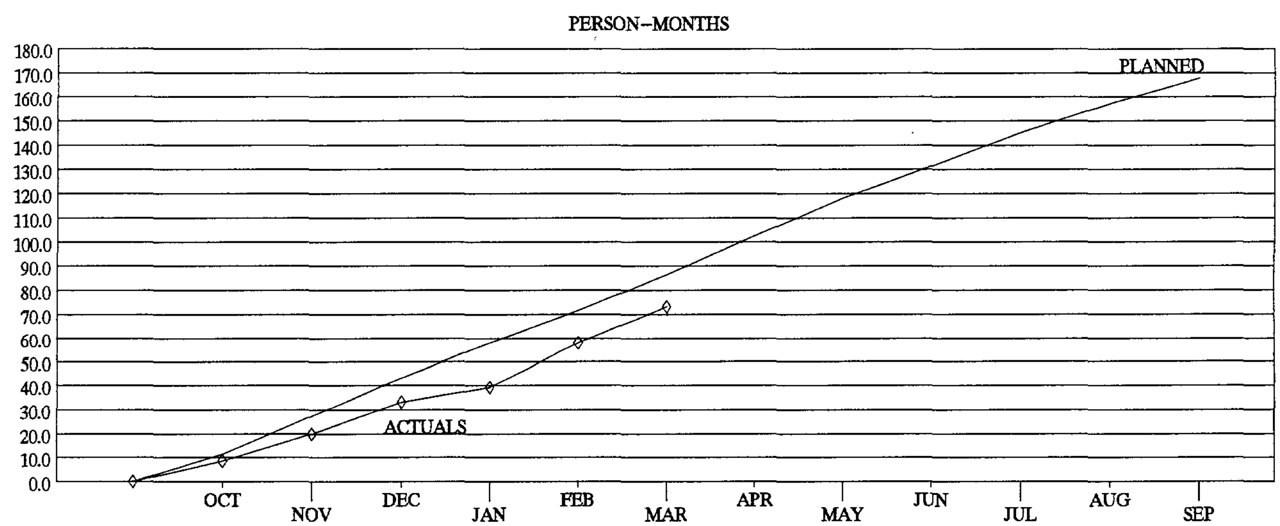
SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ______________________

Contract Management Summary Report

TITLE:	DIII-D CAPITAL PROJECTS B\R NO: AT1010140	**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR: GENERAL ATOMICS, P.O. BOX 85608, SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** APRIL 17, 1995	**START DATE:**	OCTOBER 1, 1994
		COMPLETION DATE:	SEPTEMBER 30, 1995



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	($154)	$277	$296	$316	$205	$232	$405	$486	$428	$1,395	$395	$405	$4,686
ACTUAL	($139)	$148	$286	$110	$258	$302							$965
VARIANCE	($15)	$129	$10	$206	($53)	($70)							
CUM VAR	($15)	$114	$124	$330	$277	$207							*(IN THOUSANDS)*



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	11.5	15.8	15.9	14.8	13.6	14.8	16.2	15.7	13.3	13.5	12.1	10.5	167.7
ACTUAL	8.6	11.3	13.3	6.0	18.8	15.1							73.1
VARIANCE	2.9	4.5	2.6	8.8	-5.2	-0.3							
CUM VAR	2.9	7.4	10.0	18.8	13.6	13.3							

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ______________________

INTERNATIONAL COOPERATION

PROGRAM STATUS
2ND QUARTER — FY 1995

TASK: INTERNATIONAL COOPERATION | **FY95 FUNDING:** $775 K(1)

B/R NO: AT101014Z | **FY95 PLAN:** $830 K(2)

CONTRACT NO.: DE-AC03-89ER51114

GA PRINCIPAL INVESTIGATOR: D. BAKER

OAK PROJECT MANAGER: M. FOSTER

OFE PROGRAM MANAGER: E. OKTAY

ASDEX/WS 7a (Germany)

Plans are in progress for a short exchange between Asdex and DIII–D in the area of plasma interaction with the divertor target plate and or a pellet for the production of a vapor shielding effect to reduce erosion and heat loads on the divertor plate.

NETHERLANDS

Dr Joop Konings from F.O.M. in the Netherlands is on a one year exchange working with DIII–D. His primary interest is performing transport modeling of DIII–D plasmas.

JAPAN

Three meetings concerned with the DOE/Japan collaboration were held at GA at the end of January: The DOE/JAERI Technical Planning Meeting is a forum for the discussion of results from the tokamaks in Japan and the U.S.; the U.S./Japan DIII–D Steering Committee discusses the program for the JAERI/DIII–D collaboration agreement; and the U.S./Japan Fusion Physics Planning Committee prepared the list of proposed U.S./Japan exchanges for Fusion Year 1995.

Dr Kawano from Jaeri's JT–60U began a six month exchange on DIII–D. His prime area of interest is high beta poloidal experiments and the study of reverse central shear plasmas.

REMARKS:

(1) FY95 funding increased by $20K to $775K. Current FY95 obligation (to DIII–D contract) $755K.

(2) $55K of FY94 carry over to be used in FY95 efforts.

RUSSIA

Theory

Dr Polevoy from the Kurchatov Institute is at GA for one month for participation in a theory exchange.

Dr Bob Harvey just returned from a short exchange to Russia for scientific and programatic discussions with scientists involved with the GA/Russian theory collaboration. He visited Kurchatov Institute, Moscow University and Keldysh Institute. The purposes of the trip were: to review work done under the first General Atomics/Russian Theory Collaboration; to discuss plans for a second contract; and to develop comparisons between Russian Fokker-Planck modeling of electron cyclotron current drive and the U.S./GA CQL3D code. An incidental purpose of this trip was to view the 110 GHz, 1 MW gyrotron constructed for GA by GYCOM, and being tested at Kurchatov Institute.

CHINA

Dr. Wang Zhanhe He from the Southwest Institute of Physics in Chengdu and Dr. Guang Zhao Sheng from the Institute of Plasma Physics, Academia Sinica have completed their six month exchanges with DIII–D. Dr. Wang was working on the Electron Cyclotron Emission diagnostic and Dr. Sheng was asssigned to the Thomson Scattering diagnostic.

There are presently two scientists from the Republic of China on assigment at DIII–D: Dr. Jiarong Luo and Dr. Jun Zhang.

Dr. Zhang from the Institute of Plasma Physics Academia Sinica in Hefei visited GA on his way to the EC9 conference. He discussed the possibility of a two way exchange program with GA fusion.

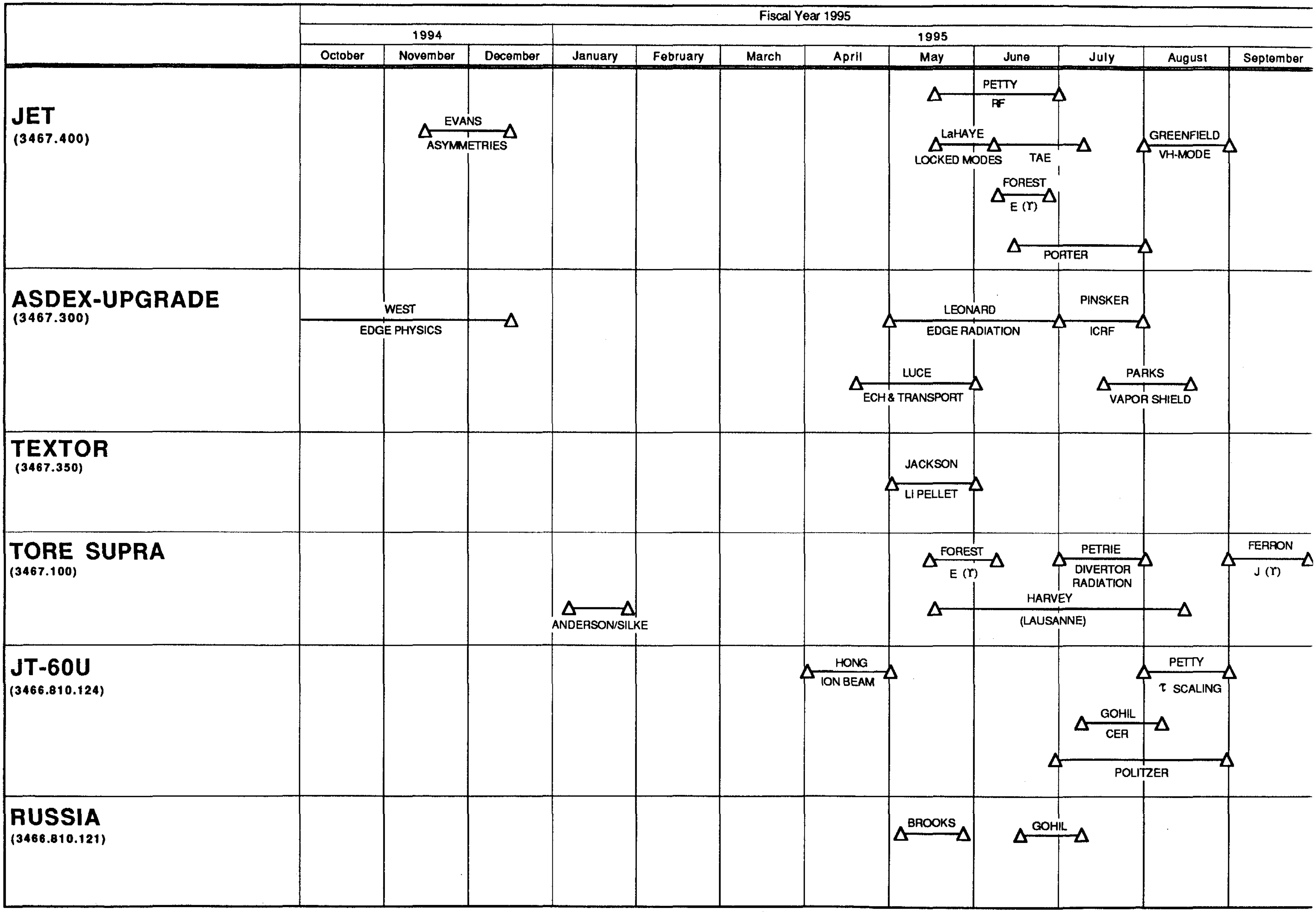
ARIES (PULSAR) SUPPORT

A draft set of plasma core and plasma facing component (PFC) interface parameters was defined and transmitted to the Demo physics group for review and comment. The NEWT-1D one-dimensional Scrape Off Layer (SOL) transport code has been obtained to support analysis of power exhaust in the Demo SOL. Test cases were successfully run. An associated code, SOLCALC, has also been obtained. SOLCALC determines the connection length from the SOL stagnation point to the strike point based on magnetic equilibrium data obtained from a standardized EQDSK file. Work has commenced with D. Post (ITER-JCT) and P. West (GA) to extend Post's analytic modeling of power exhaust in ITER to Demo and DIII–D.

INTERNATIONAL COOPERATION

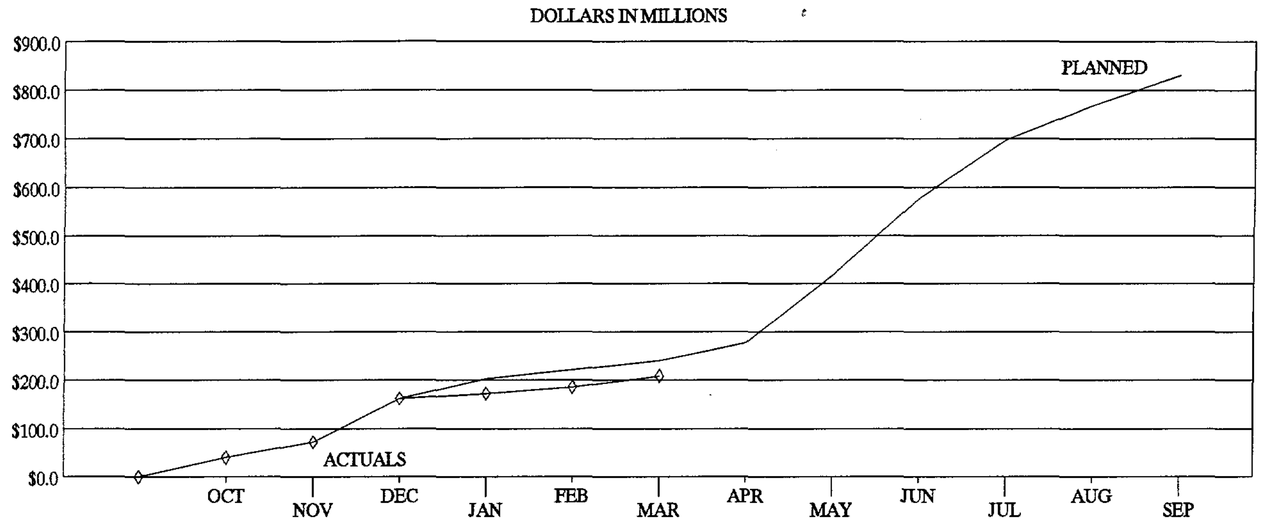
	FY95 BUDGET		FY95 ACTUALS	
	FTE's	TOTAL $000	FTE's	TOTAL $000
JET	0.8	250	0.2	39
ASDEX	0.8	228	0.6	92
TORE SUPRA	0.6	168	0.1	15
RUSSIAN SUB–CONTRACT	–	134	–	49
ARIES SUPPORT	0.2	50	0.1	14
TOTAL	2.4	830	1.0	209

DIII-D INTERNATIONAL COOPERATION TRAVEL
- FY 95 -

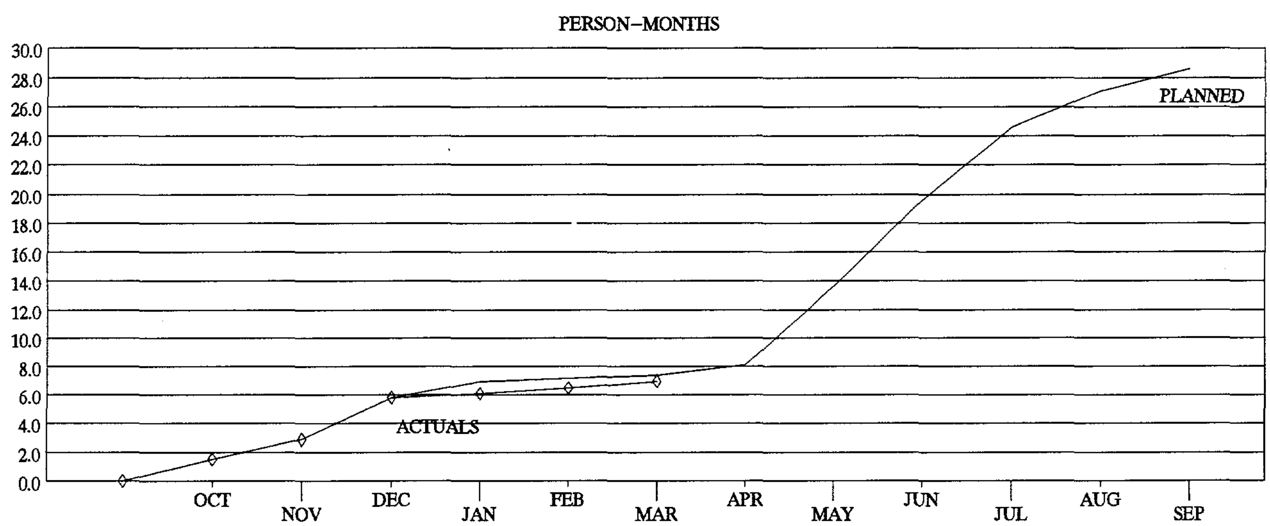


Contract Management Summary Report

TITLE:	INTERNATIONAL COOPERATION B/R NO: AT101014Z	**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR:	GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** MARCH 13, 1995	**START DATE:** OCTOBER 1, 1994 **COMPLETION DATE:** SEPTEMBER 30, 1995



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	$40	$32	$90	$41	$19	$20	$35	$140	$160	$120	$70	$63	$830
ACTUAL	$40	$32	$90	$11	$13	$23							$209
VARIANCE	$0	$0	$0	$30	$6	($3)							
CUM VAR	$0	$0	$0	$30	$36	$33							*(IN THOUSANDS)*



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	1.5	1.4	2.9	1.2	0.2	0.2	0.7	5.5	6.0	5.0	2.5	1.5	28.6
ACTUAL	1.5	1.4	2.9	0.3	0.4	0.5							7.0
VARIANCE	0.0	0.0	0.0	0.9	−0.2	−0.3							
CUM VAR	0.0	0.0	0.0	0.9	0.7	0.4							

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ______________________

TOKAMAK PHYSICS EXPERIMENT

PROGRAM STATUS
2ND QUARTER — FY 1995

TASK: TOKAMAK PHYSICS EXPERIMENT	**FY95 FUNDING:** $100 K(1)
B/R NO: AT1010190	**FY95 PLAN:** $130 K(2)
CONTRACT NO.: DE-AC03-89ER51114	

GA PRINCIPAL INVESTIGATOR: P. POLITZER

OAK PROJECT MANAGER: M. FOSTER

OFE PROGRAM MANAGER: J. HOY

Work has continued on the development of a TPX reversed shear scenario using 110 GHz ECCD to maintain the off-axis peaking of the current profile. Several equilibria have been developed, and are being examined for consistency with experimentally observed transport coefficients. Also, we have agreed to undertake additional work to provide physics operations input to the definition and development of the TPX plasma control system. Many of the issues currently being addressed in the development and implementation of the DIII–D plasma control system are also being faced by TPX. TPX will benefit from the combination of plasma operations experience and control system expertise at DIII–D. Details of this effort are being worked out.

In addition, in January GA hosted the regular Physics Meeting. We also hosted a meeting to assess the TPX needs for divertor diagnostics. These provided a mechanism for broad participation in the TPX effort by the DIII–D research staff.

REMARKS:

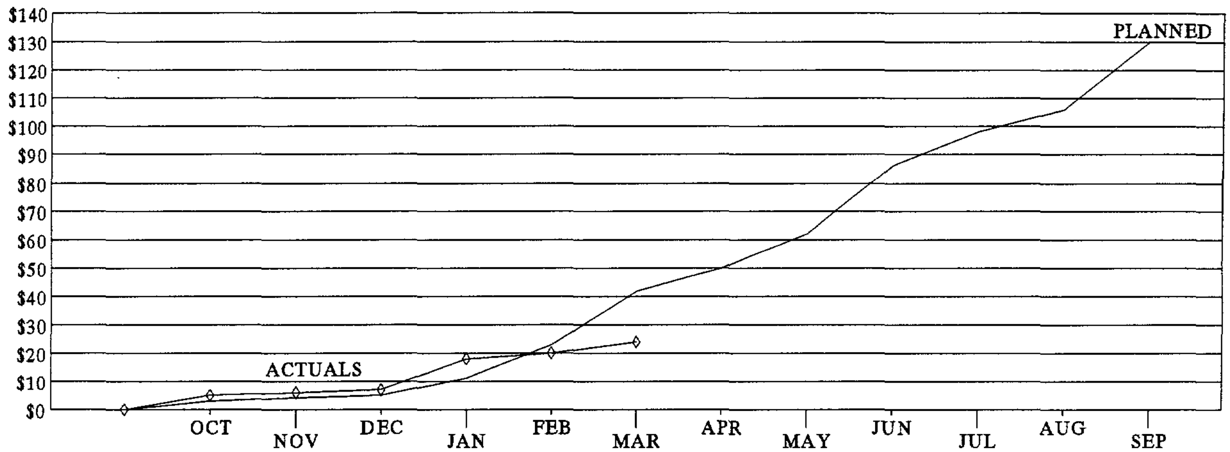
(1)Current FY95 obligation (to DIII–D contract) $0.

(2)$30K of FY94 carry over to be used in FY95 efforts.

Contract Management Summary Report

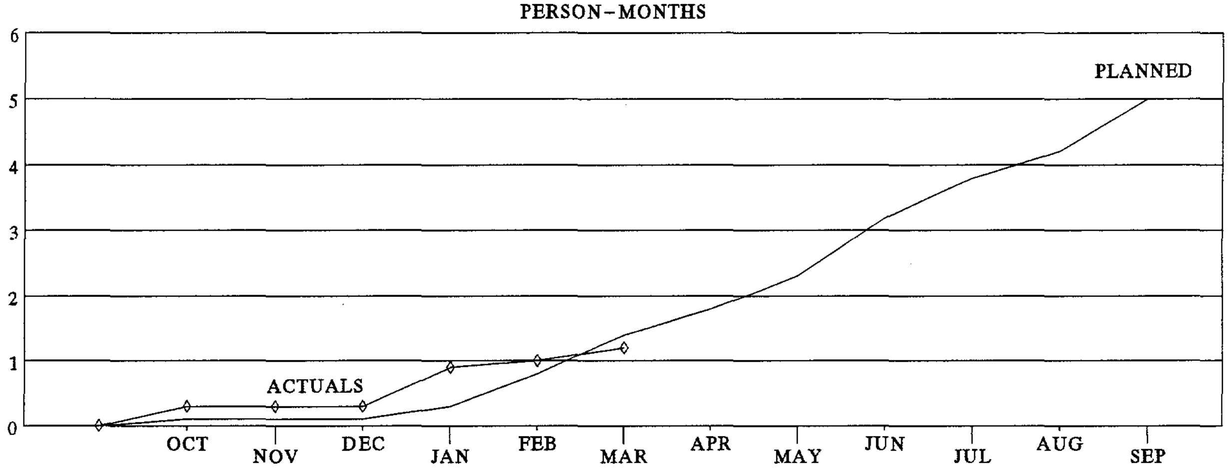
TITLE: TPX PHYSICS SUPPORT B&R NO: AT1010190		**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR: GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** JANUARY 18, 1995	**START DATE:** **COMPLETION DATE:**	OCTOBER 1, 1994 SEPTEMBER 30, 1995

DOLLARS IN THOUSANDS



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	$3	$1	$1	$6	$12	$19	$8	$12	$24	$12	$8	$24	$130
ACTUAL	$5	$1	$1	$11	$2	$4							$24
VARIANCE	($2)	$0	$0	($5)	$10	$15							
CUM VAR	($2)	($2)	($2)	($7)	$3	$18							

PERSON-MONTHS



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	0.1	0.0	0.0	0.2	0.5	0.6	0.4	0.5	0.9	0.6	0.4	0.8	5.0
ACTUAL	0.3	0.0	0.0	0.6	0.1	0.2							1.2
VARIANCE	−0.2	0.0	0.0	−0.4	0.4	0.4							
CUM VAR	−0.2	−0.2	−0.2	−0.6	−0.2	0.2							

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ______________________

FUSION PLASMA THEORY

PROGRAM STATUS
2ND QUARTER — FY 1995

TASK: FUSION PLASMA THEORY — **FY 95 FUNDING:** $460 K(1)

B/R NO: AT0520210 — **FY95 PLAN:** $500K(2)

CONTRACT NO.: DE-AC03-89ER51114

GA PRINCIPAL INVESTIGATOR: V. CHAN/R. WALTZ

OAK PROJECT MANAGER: M. FOSTER

OFE PROGRAM MANAGER: W. SADOWSKI

HIGHLIGHTS:

- An invited talk was given by X. Garbet at the recent TTF Meeting in Marina Del Ray on "Turbulence Propagation." Dr. Garbet is a long term GA visitor from Cadarache working with R. Waltz on fundamental problems of turbulent transport.
- Dr. Ken Kupfer gave an invited talk at the recent Sherwood Theory Conference on "Kinetic Modeling of the SOL." Dr. Kupfer is a DOE Postdoctoral Fellow working with R. Harvey and G. Staebler on divertor problems.
- Systematic computation using the published TPX design shows that stabilization of the n=1,2 external kink induced resistive wall mode required twice the flow speed observed in a recent DIII–D advanced tokamak simulation experiment. This was one of the result presented at the recent Sherwood meeting along with ten other posters.

Fusion Theory efforts at GA are funded via Grant ($1200K–FY95) and DIII–D Contract ($450K–FY95). The workscope and progress reported reflect the total theory program funded from both sources.

(1)FY95 funding increased by $10K to $460K for Russian Theory support. Current FY95 obligation (to DIII–D contract) $450K.

(2)$40K of FY94 carry over to be used in FY95 efforts.

STATEMENT OF WORK

1. Improve on existing models and codes leading to improved understanding of experiments.
2. Conduct theoretical physics development of advanced concepts with application to present and future experiments.

The object of the theoretical plasma physics research at GA is to support the DIII–D and other tokamak experiments and to significantly advance our ability to design a commercially-attractive fusion reactor. We categorize our efforts in three areas: magnetohydrodynamic (MHD) equilibria and stability, plasma transport with emphasis on H–mode, divertor and boundary physics, and radio frequency (RF) heating current drive.

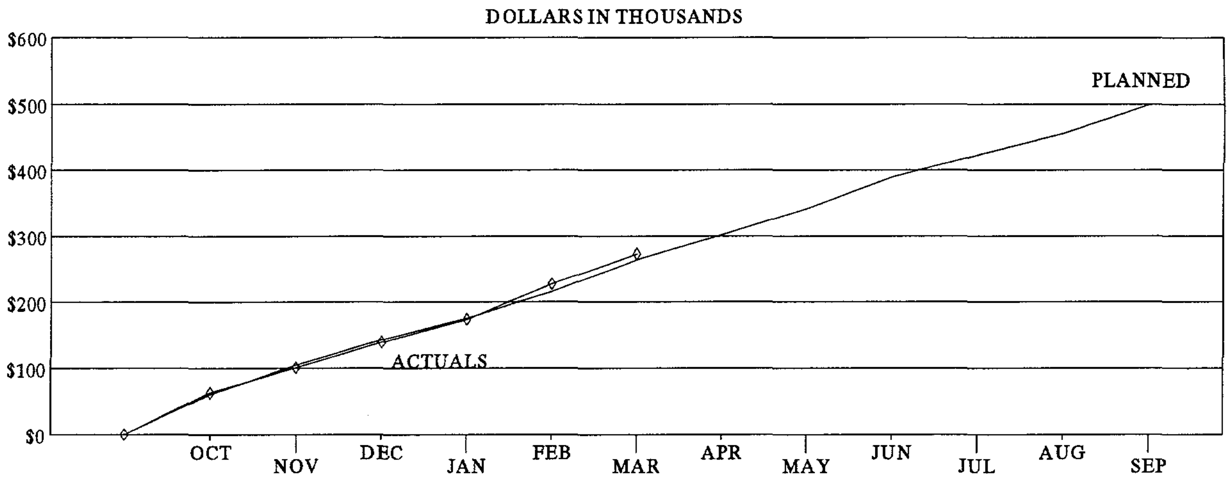
PROGRESS

Dr. Xavier Garbet (long term GA visitor from Cadarache) has been working with us since October to apply the 2D inhomogeneous turbulence code started at GA in 1993. Many new features have been added to the code such as radially odd finite-n modes which allow a more physical generation of n=0 radial modes. The code has been used to demonstrate radial propagation of turbulence and action at a distance outside a correlation length. Toroidal coupling is the key to these effects and an intuitive rule for radial propagation or action at a distance length has resulted: $L_{prop} = V_{curve}/\gamma_{damp}$ where V_{curve} is the curvature drift velocity and γ_{damp} is the dissipation rate for the turbulence (close to the driving rate). Significant L_{prop} is found only for damping rates about an order of magnitude less than the physical rates. Contrary to earlier speculations by N. Mattor as well as Garbet, this suggests that radial propagation of turbulence may not be important. More recent work with physical damping strength have lead to an interesting possibility for obtaining Bohm scaling. If the longest wave length of the radial modes is allowed to scale with the device size as they should (rather than the gyroradius), Bohm scaling of transport results even though the long time radial correlation lengths (as would be measured by experiments such as BES) are short and scale with the gyroradius. Thus radial modes, which have no intrinsic localization, may be the source of Bohm-like scaling. More work is needed to verify this and ultimately a 3D code test is needed.

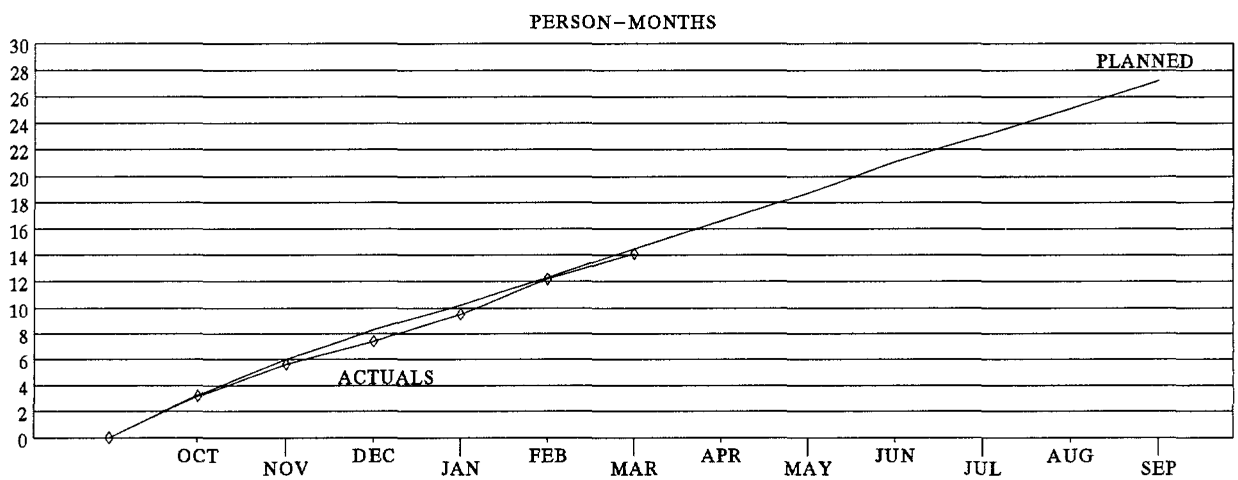
The study of kinetics of divertor fluxes is a very important topic for present and future divertor machines, especially ITER. Machines of DIII–D size and larger have SOL parameters such that the mean free path of mildly suprathermal electrons exceeds the field line length to the divertor plate. A U.S. National Committee of senior theorists completed "A Survey of Problems in Divertor and Edge Plasma Theory," available from the Courant Institute. They identified a kinetic model for the heat flow in the long and intermediate mean free path regime as a key problem in the edge physics. This problem can be fully addressed with the CQLP Fokker-Planck code, a new generalization of the CQL3D Fokker-Planck code normally used in RF heating studies. The CQL3D code has been modified to explicitly include the dimension parallel to the magnetic field, by removal of the bounce averaging from the collisional operator and by addition of the parallel streaming term to the Fokker-Planck equation. The new code is 2D in velocity space and 1D along the magnetic field. This enables study of electron parallel transport in mixed collisionality regimes (from collisionless banana regime to the collision dominated regime). A solution of a modified Poisson equation for self-consistent electric fields in the parallel Fokker-Planck code allows self-consistent calculations of SOL distributions. This algorithm appears to work excellently for the presheath region, and it is a significant step forward in solving of SOL transport problems. Recent results have been expressed in terms of the upstream flux limit flow parameter $q/(n_e T_e v_e)$. When this is small, classical fluid behavior is expected, and when large, there are severe non-Maxwellian distortions producing an energetic election tail downstream. This increases the sheath transmission factor, lowers the divertor temperature, and reduces the sheath potential drop which in turn can significantly lower the ion sputtering. The tail can cause dramatic effects on the local radiation and ionization processes. It was found that the classical sheath conditions can be suitably modified so that classical thermal conduction still holds. Much of this work has been done in collaboration with Olivier Sauter (CRPP, Lausanne) who started the project while a visiting Swiss Government postdoctoral fellow, and Ken Kupfer, who is working at GA as a DOE Fusion postdoctoral fellow.

Contract Management Summary Report

TITLE:	THEORY B\R AT0520210		**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR:	GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** JANUARY 18, 1995	**START DATE:** **COMPLETION DATE:**	OCTOBER 1, 1994 SEPTEMBER 30, 1995



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	$60	$45	$38	$33	$39	$49	$38	$39	$48	$34	$33	$44	$500
ACTUAL	$63	$38	$38	$35	$53	$46							$273
VARIANCE	($3)	$7	$0	($2)	($14)	$3							
CUM VAR	($3)	$4	$4	$2	($12)	($9)							



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	3.3	2.7	2.3	1.9	2.1	2.2	2.1	2.1	2.4	2.0	2.0	2.1	27.2
ACTUAL	3.2	2.4	1.8	2.1	2.7	1.9							14.1
VARIANCE	0.1	0.3	0.5	−0.2	−0.6	0.3							
CUM VAR	0.1	0.4	0.9	0.7	0.1	0.4							

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ______________________

USER SERVICE CENTER

PROGRAM STATUS
2ND QUARTER — FY 1995

TASK: USER SERVICE CENTER **FY95 FUNDING:** $300 K(1)

B/R NO: AT0540420 **FY95 PLAN:** $300 K(2)

CONTRACT NO.: DE-AC03-89ER51114

GA PRINCIPAL INVESTIGATOR: K. KEITH

OAK PROJECT MANAGER: M. FOSTER

OFE PROGRAM MANAGER: M. CRISP

	PLANNED ACTIVITIES/GOALS	ORIGNAL TARGET	CURRENT TARGET	COMPLETION DATE
1.	Operate and maintain the User Service Center.	←	**ONGOING**	→
2.	Provide archival and retrieval services for DIII–D data.	←	**ONGOING**	→
3.	Maintain ESnet communication.	←	**ONGOING**	→
4.	Provide local support for NERSC users.	←	**ONGOING**	→
5.	Provide user consulting services for the GA Fusion group, including all collaborators.	←	**ONGOING**	→
6.	Provide additional computer support and resources for new collaborators.	←	**ONGOING**	→
7.	Upgrade cycle server with additional cpu and memory.	**3rd Q FY95**		
8.	Upgrade DIII–D/Bldg. 34 Local Area Network.	**3rd Q FY95**		
9.	Monitor and trouble shoot entire Local Area Network.	←	**ONGOING**	→
10.	Provide server performance management reports.	←	**ONGOING**	→
11.	Port and tune general physics and systems codes for cycle server.	←	**ONGOING**	→

(1)Current FY95 obligations (to DIII–D contract) $250K.

(2)≈ $700K additional funding provided by DIII–D Research Operations to support User Service Center.

HIGHLIGHTS

- The VAX -8650 was removed from the USC cluster.
- The ESnet T3 installation to GA was completed.
- The ESnet Site Coordinators Committee meeting was hosted by GA. A Town Meeting for NERSC users was arranged during this time.
- Considerable support was provided for local users of the NERSC computers, particularly the Crays.
- Efforts have intensified to install recommended vendor patches for potential security vulnerabilities.

The USC's VAX-8650 has been retired. Major configuration changes were needed before this task could be accomplished. The removal of this VAX is consistent with the long term goals of the USC to migrate the user population away from the proprietary-based operating systems and to the more open platforms based on the UNIX operating systems.

The ESnet T3 installation was completed in early February. A Cisco 7000, a high powered network router, and it's management workstation were supplied by LLNL and installed by the USC staff. This installation was a major milestone for the ESnet backbone. Further support was provided for the ESnet equipment when updated firmware was installed on various boards in the production router.

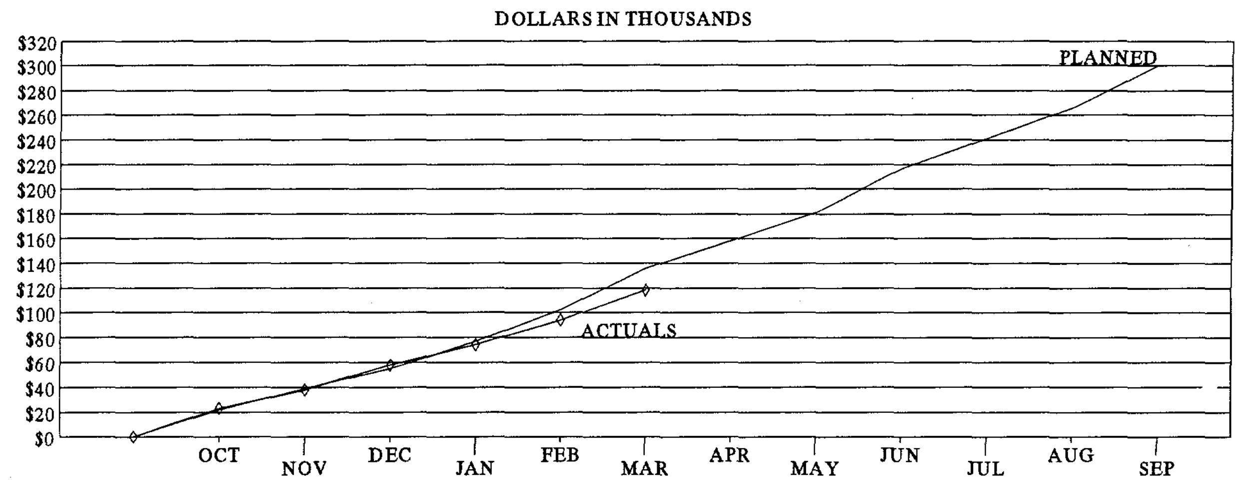
GA/Fusion hosted the ESnet Site Coordinators' Committee (ESCC) and the Distributed Computing Coordinating Committee (DCCC) meetings during the week of Feb. 13, 1995. The meetings were well attend (75 registered) with all the major Energy Research sites and the DOE well represented. The meetings were broadcast using desktop video conferencing software on the MBONE to interested parties on the ESnet including DOE staff at the Office of Scientific Computing. A three hour "Town Meeting" for NERSC users was arranged, taking advantage of the NERSC staff attendance at the ESCC/DCCC meetings. Various topics covered included email compatibility between sites, World Wide Web and Internet browsers, and how to make the most of NERSC resources.

Considerable support is routinely provided for local users of the NERSC facilities. During the current report period this support included added access to GA's printers on the NERSC machines, updating several local tools to run in the NERSC environment and thereby providing the look of seamless computing, and individual help in getting started with AFS on the Crays. To further the seamless computing environment between GA and NERSC, an AFS license was purchased. It is the intent to set up a small AFS cell using NERSC as the server so that the GA theorists will more easily be able to use the local workstation for intensive interactive tasks and the Crays for computational tasks. The AFS cell will be brought up early next quarter.

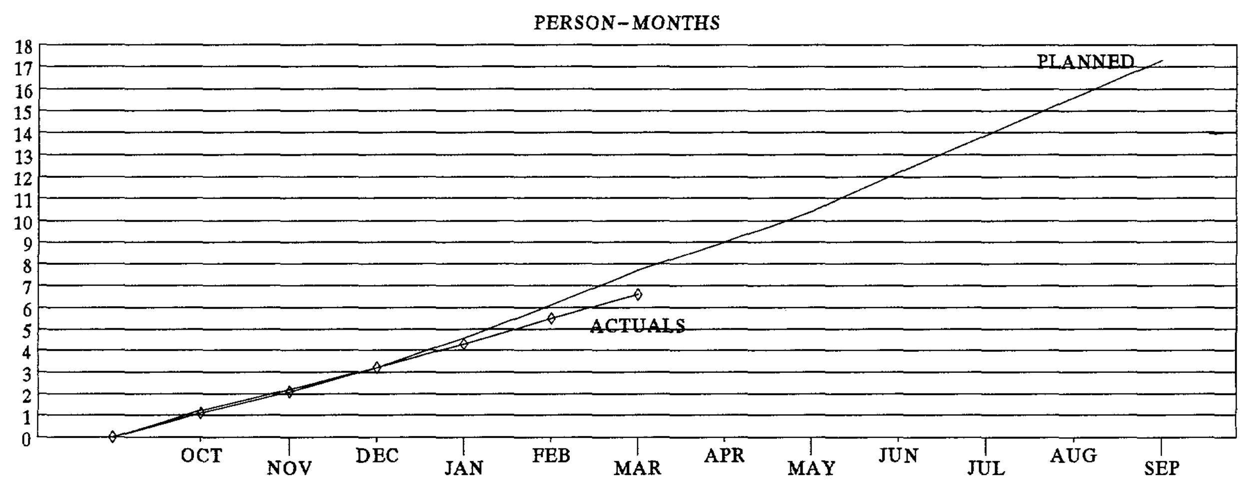
The USC has always attempted to diligently install vendor recommended security patches in a timely manner. These efforts have intensified in the recent weeks due to the release of the SATAN network management tool. This tool, available in the public domain, can be used by a network manager or a hacker to identify weaknesses.

Contract Management Summary Report

TITLE:	USER SERVICE CENTER B\R AT0540420	**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR:	GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** JANUARY 18, 1995	**START DATE:** OCTOBER 1, 1994 **COMPLETION DATE:** SEPTEMBER 30, 1995



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	$22	$17	$16	$22	$25	$34	$22	$23	$35	$25	$25	$34	$300
ACTUAL	$23	$15	$20	$16	$20	$24							$118
VARIANCE	($1)	$2	($4)	$6	$5	$10							
CUM VAR	($1)	$1	($3)	$3	$8	$18							



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	1.2	1.0	1.0	1.4	1.5	1.6	1.3	1.4	1.8	1.7	1.7	1.7	17.3
ACTUAL	1.1	1.0	1.1	1.1	1.2	1.1							6.6
VARIANCE	0.1	0.0	−0.1	0.3	0.3	0.5							
CUM VAR	0.1	0.1	−0.0	0.3	0.6	1.1							

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ______________________

ITER JCT SECONDEES

PROGRAM STATUS
2ND QUARTER — FY 1995

TASK: ITER JCT SECONDEES — **FY95 FUNDING:** $1850 K(1)

B/R NO: AT150403A — **FY95 PLAN:** $1950 K(2)

CONTRACT NO.: DE-AC03-89ER51114

GA PRINCIPAL INVESTIGATOR: C. HAMILTON

OAK PROJECT MANAGER: M. FOSTER

OFE PROGRAM MANAGER: W. MARTON

PERSONNEL

- Current ITER secondees and their nominal assignments include:

San Diego Co–Center

John Wesley — Physics Analysis

Fred Puhn — Systems Integration

Peter Smith — Automation of Design Activities

Julie Van Fleet — External Relations
Continuing ITER projects from GA

Marshall Rosenbluth — Chief Scientist
Half-time work through GA started January 2, 1995.

Garching Co–Center

Doug Remsen — Radio Frequency Heating Systems
Assignment terminated February, 1995.

Naka Co–Center

Bob Bourque — Cryogenic Systems

Randy Hager — Remote Handling

Doug Holland — Fusion Safety Analysis
Employment with GA initiated on February 1, 1995.

NOTES: Remy Gallix has received an appointment to the JCT (Naka Co-Center) and is scheduled to arrive in mid-April, 1995.

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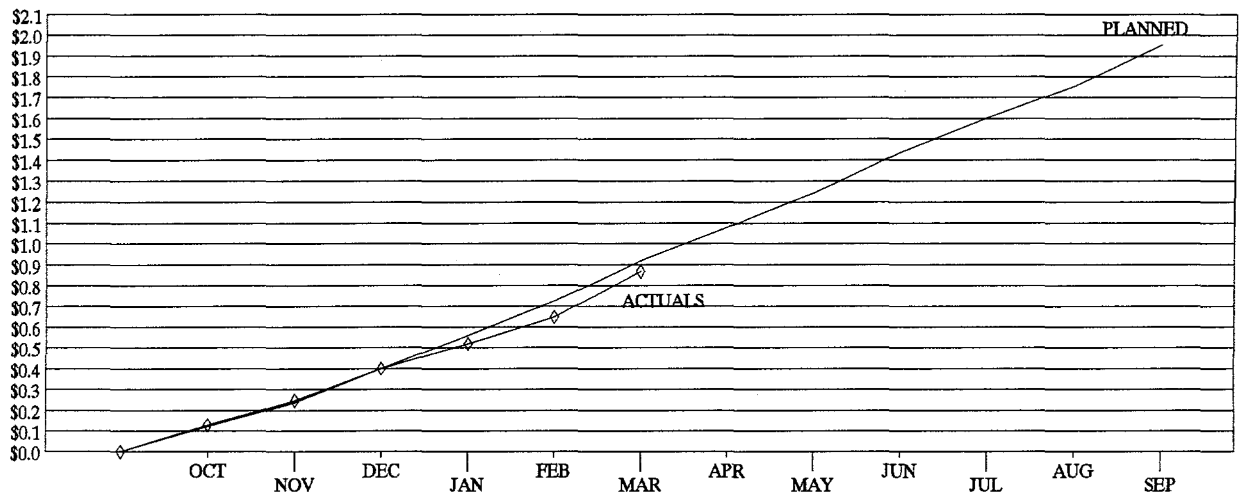
(1)Current FY95 obligations (to DIII–D contract) $1600K.

(2)$100K of FY94 carry over to be used in FY95 efforts.

Contract Management Summary Report

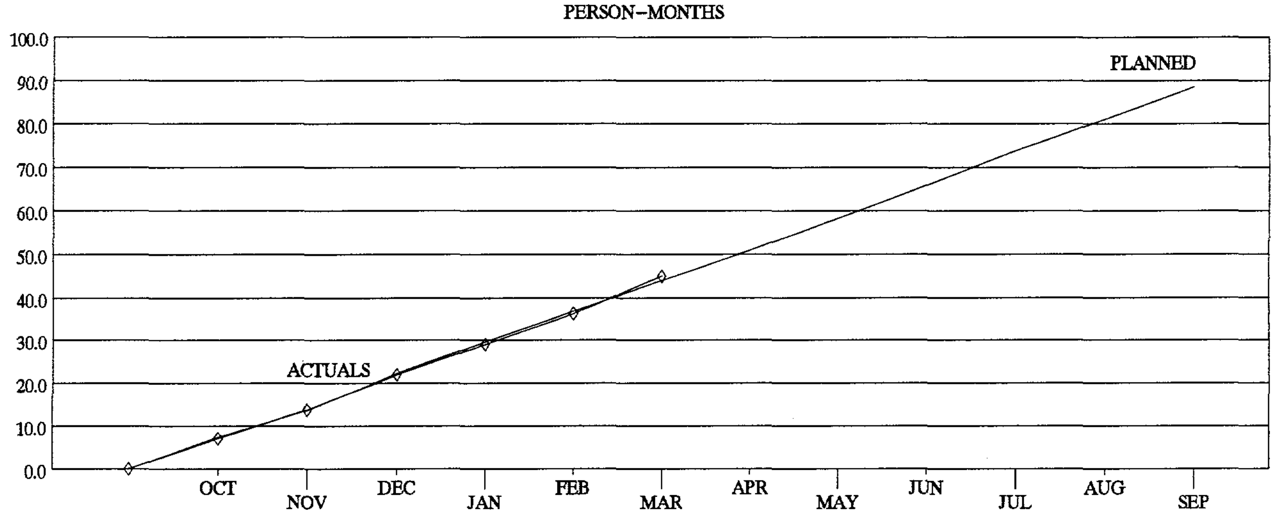
TITLE:	ITER JCT SECONDEES B/R NO: AT150403C	**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR:	GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** JANUARY 18, 1995	**START DATE:** OCTOBER 1, 1994 **COMPLETION DATE:** SEPTEMBER 30, 1995

DOLLARS IN MILLIONS



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	$120	$115	$165	$159	$165	$195	$158	$165	$195	$165	$153	$195	$1,950
ACTUAL	$127	$119	$153	$120	$127	$221							$867
VARIANCE	($7)	($4)	$12	$39	$38	($26)							
CUM VAR	($7)	($11)	$1	$40	$78	$52							*(IN THOUSANDS)*

PERSON-MONTHS



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTALS
PLANNED	7.3	6.2	8.8	7.3	7.3	7.0	7.0	7.3	7.6	8.0	7.3	7.5	88.6
ACTUAL	7.1	6.6	8.3	7.0	7.3	8.6							44.9
VARIANCE	0.2	−0.4	0.5	0.3	0.0	−1.6							
CUM VAR	0.2	−0.2	0.3	0.6	0.6	−1.0							

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ______________________

RF TUNER SYSTEM CAPITAL

PROGRAM STATUS
2ND QUARTER — FY 1995

TASK: RF TUNER SYSTEM CAPITAL | **FY95 FUNDING:** $280 K(1)

B/R NO: AT15040035 | **FY95 PLAN:** $0 K(2)

CONTRACT NO.: DE-AC03-89ER51114

GA PRINCIPAL INVESTIGATOR: R. CALLIS

OAK PROJECT MANAGER: M. FOSTER

OFE PROGRAM MANAGER: T.V. GEORGE

FY95 Planned Activities:

PURPOSE

The purpose of this task is to develop, test, and evaluate novel methods for increasing the efficiency and effectiveness with which radio frequency (rf) power is delivered to fusion plasma for fast wave heating and current drive. This requires dynamic feedback control of the tuning/phase control system with response times approaching 5 msec. The dynamic matching conditions are plasma load specific, and include not only efficient power transfer, but also equal strap current and proper toroidal phase among straps during various plasma conditions throughout the experimental pulse duration. Examples of these conditions include plasma startup, L–mode, H–mode (or VH–mode), as well as transitions between modes, ELM, and the transition from electron heating mode to current drive phasing.

REMARKS:

(1)Current FY95 obligation (to DIII–D contract) $280K.

(2)Funds to be used for FY96 hardware delivery.

APPROACH

Building on the experience of the lower power tests that were supported by DOE I&T, we plan a high power evaluation of an Advanced Ferrite Technology (AFT) fast ferrite tuner (FFT) prototype.

The FFT prototype will be able to handle 2.5 MW of power at the frequency range of 60 MHz, for pulse lengths of 10–20 seconds. The instantaneous band width of the FFT will be ±4 MHz and have a <5 msec response time over the range of application (covers about one third of the Smith Chart), and a <1 msec response time over a small section (≈ 40%) of the application range.

GA's plan is that the FFT first be inserted in the DIII–D ICRF system high power dummy load leg as a Proof of Principle (POP) test. The high voltage and current integrity of the FFT prototype will be evaluated for different simulated L–mode and H–mode resistances, as well as intermediate cases. The test plan consists of creating the desired mismatch and then tuning out this mismatch with the FFT as seen by a network analyzer. Then, the transmitter is connected to the FFT input and high power tests for voltage breakdown and overheating problems in the FFT are performed.

Once the high power FFT is validated off-line under worst-case voltage and current conditions, the FFT will be inserted between the transmitter and the antenna. The FFT is then tested to demonstrate that it not only protects the transmitter by maintaining less than a 1.4:1 VSWR, but that it also reflects power returning from the antenna, thereby maximizing the efficiency of the rf coupling to the plasma. During these tests the FFT will also be validated for sub-millisecond time response.

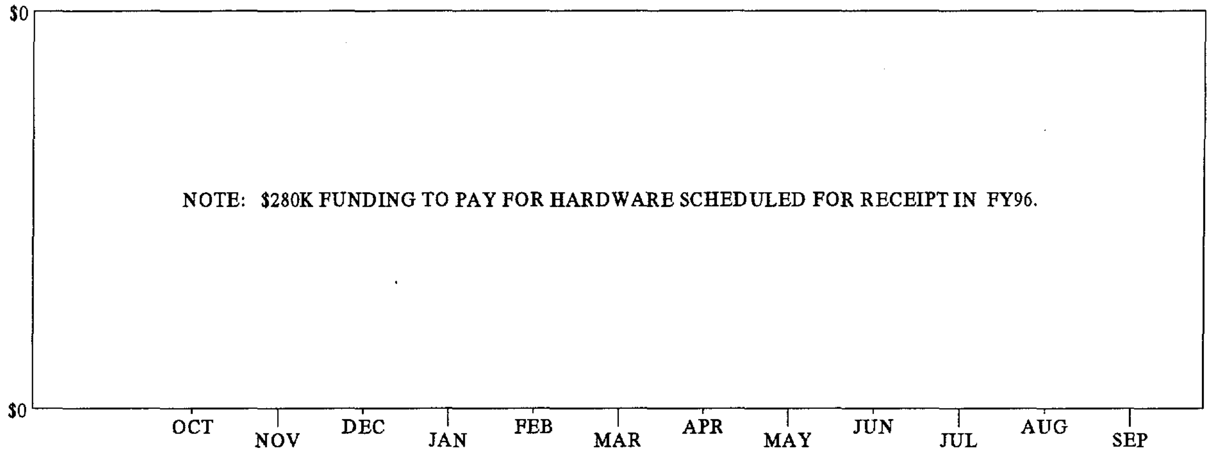
FY95 2nd QUARTER ACTIVITY

The contract for the procurement of the FFT from AFT was approved by DOE-OAK on February 20th with a delivery date of April 1996.

Contract Management Summary Report

TITLE:	RF HYBRID TUNER SYSTEM CAPITAL EQUIPMENT — B&R NO: AT35AT15040	**CONTRACT NO.:**	DE-AC03-89ER51114
CONTRACTOR:	GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92186-9784	**COST & LABOR PLAN DATE:** JANUARY 18, 1995	**START DATE:** OCTOBER 1, 1994 **COMPLETION DATE:** SEPTEMBER 30, 1995

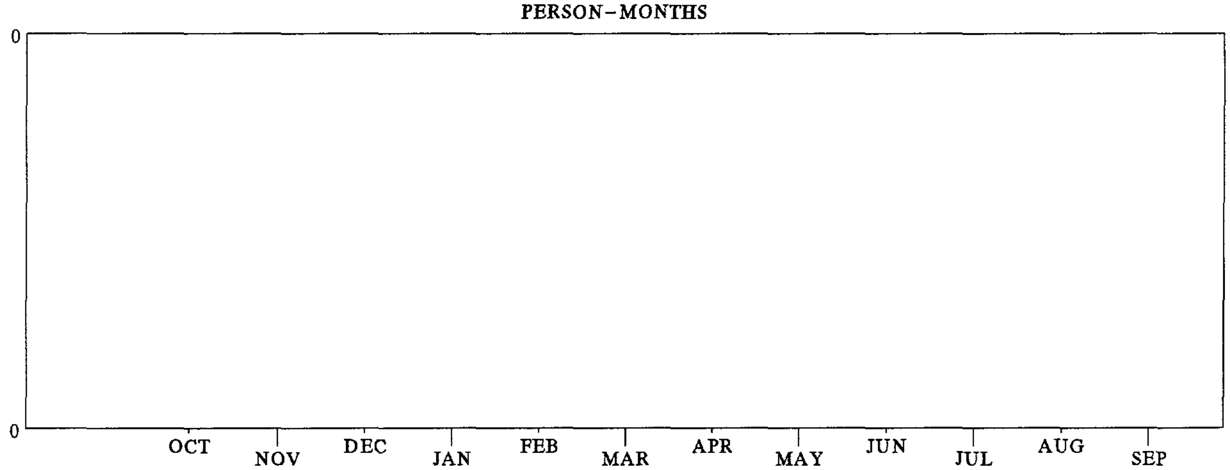
DOLLARS IN THOUSANDS



TOTALS

PLANNED
ACTUAL
VARIANCE
CUM VAR

PERSON-MONTHS



TOTALS

PLANNED
ACTUAL
VARIANCE
CUM VAR

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: ____________________