**GA-C19572
(7/19/94)**

PROGRAM STATUS 3rd QUARTER — FY 1994

ITER & TECHNOLOGY

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General Atomics Project 3469**

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is Submitted in Compliance with Sections A and B
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JULY 19, 1994

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**PROGRAM STATUS REPORT
CONTRACT DE-AC03-89ER52153
3RD QUARTER — FY94**

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ITER & TECHNOLOGY

3RD QUARTER FY94

- **Reactor Studies**

- Completed all technical work and documentation of the PULSAR design

- **RF Technology**

- Decision made to fabricate 4"X4" distributed window in lieu of 2"X8" window

- **Plasma Interactive Materials**

- Obtained good agreement between code predictions and measured data for the up-and-down field redeposition of Tungsten in the DiMES-8 experiment

ITER & TECHNOLOGY PROGRAM

Reactor Studies

PROGRAM STATUS
3RD QUARTER — FY 1994

TASK: REACTOR STUDIES

FY94 FUNDING: \$275 K

B/R NO: AT-15-03

FY94 PLAN: \$275 K

CONTRACT NO.: DE-AC03-89ER52153

GA PRINCIPAL INVESTIGATOR: C.P.C. WONG

SAN PROJECT MANAGER: C. BEIGHLEY/M. FOSTER

OFE PROGRAM MANAGER: W. DOVE

PLANNED ACTIVITIES/GOALS		ORIGINAL TARGET	CURRENT TARGET	COMPLETION DATE
1.	Complete conceptual design and evaluation of the PULSAR Tokamak Reactors	2 nd Q FY94	3 rd Q FY94	3 rd Q FY94
2.	Support the definition of the DEMO design project	←	ONGOING	→
3.	Participate in the design of the DEMO power reactor design	←	ONGOING	→

REMARKS:

PROGRAM STATUS

3RD QUARTER — FY1994

REACTOR STUDIES

HIGHLIGHTS:

- Completed all technical work and documentation of the PULSAR design.
 - Participated in DEMO study support activities.
-

1. Shield Thermal Storage Design

Technical work and documenting of the PULSAR outboard shield thermal energy storage system were completed. The issue of tritium inventory in stagnant lithium of the lithium-cooled variant was resolved. Mass transfer calculations indicated that by considering tritium permeation to the coolant resulted in a maximum tritium inventory in the shield of about 70 g, which has minimum impacts on plant safety characteristics.

2. Divertor Design

Technical work and documentation of the divertor designs for PULSAR-I and PULSAR-II were completed. Many critical issues remain, some of which are due to lack of understanding and/or data in the following areas: diverted plasma definition, irradiated and un-irradiated materials properties, (especially on fatigue data, and material sputtering erosion data). Knowledge in these areas can significantly impact the safety and performance of the divertor design.

3. DEMO Study

We assisted UCLA in the planning of the DEMO program. A task called Critical Subsystems Assessment was introduced and accepted. This task will be coordinated by C. Wong. The task goal is to identify and address subsystems that have potential problems of technical feasibility and/or unacceptably high cost. Examples in this category of subsystems are the selection of structural material, first wall design and divertor design. We will be also working on the Work Breakdown Structure (WBS) which will be used to identify critical issues of the DEMO design.

R. Schleicher and F. Silady of GA's gas-cooled reactor division will be joining the DEMO team to work in their respective areas of expertise, *i.e.* power conversion systems, safety and

licensing of fusion power plants. G. Sager was asked to coordinate the assessment of divertor design.

4. U.S. Regulations on Tritium

An investigation was initiated to determine the potential regulations of tritium inventory, production and accountability by different US agencies. Several key persons from the MHTGR-NPR and GA nuclear safety groups were contacted. The MHTGR-NPR was regulated by the DOE, while other GA projects (*e.g.* ICF and Hot Cell) were regulated by the State of California through agreement with and in compliance with the U.S. Nuclear Regulatory Commission. Both the DOE and NRC classify tritium quite distinct from Special Nuclear Material (*e.g.* plutonium, U-235). Safety and security regulations for sites containing various forms of SNM appear to be much more restrictive than those for sites containing tritium but without SNM.

5. Project Coordination

L. Stewart completed the task of project coordination for the PULSAR project.

6. Russian Collaboration

During this quarter thermal-hydraulic and thermal-stress calculations were performed for a helium-cooled divertor design. Co-axial tube bank with liquid metal filled gap was evaluated. Lithium was used as a contacting medium between tubes, while maintaining the two coolant barriers approach, and to control helium impurities of hydrogen and oxygen. Various heat loads and cooling tube diameters were considered. Mechanical analysis was performed for restricted bending boundary conditions. From these analyses it is seen that maximum permissible heat load was limited to 3 MW/m² but some improvements could be introduced. Design re-directions were provided to our Russian colleagues to focus on the helium-cooled co-axial tubular divertor design, and to aim for a capability of removing a maximum surface loading of 5 MW/m².

7. People's Republic of China Collaboration

Contacts were made with our PRC colleagues. An engineer from SWIP will come to GA to work on the DEMO study for six months beginning September 1994.

ITER & TECHNOLOGY PROGRAM

RF Technology

PROGRAM STATUS
3RD QUARTER — FY 1994

TASK: RF TECHNOLOGY

FY94 FUNDING: \$170 K

B/R NO: AT-15-04-01C

FY94 PLAN: \$390 K*

CONTRACT NO.: DE-AC03-89ER52153

GA PRINCIPAL INVESTIGATOR: R.W. CALLIS

SAN PROJECT MANAGER: C. BEIGHLEY/M. FOSTER

OFE PROGRAM MANAGER: T.V. GEORGE

PLANNED ACTIVITIES/GOALS	ORIGINAL TARGET	CURRENT TARGET	COMPLETION DATE
1. Coordinate U.S./Japan RF Technology Exchange.	4 th Q FY93		1 st Q FY94
2. Produce 4"x4" gyrotron distributed window	2 nd Q FY94	1 st Q FY95	
3. Design and fabricate a FWCD combline antenna	4 th Q FY94		

REMARKS:

*Includes \$220K carryover from prior year.

PROGRAM STATUS

3RD QUARTER — FY1994

RF TECHNOLOGY

HIGHLIGHTS:

- Dr. Richard Callis participated in a exploratory review of the rf technology activities with in the Peoples Republic of China, as part of a bilateral exchange program set up between the U.S. and the PRC.
-

The final fabrication drawings for the rectangular copper waveguide, and the port flange for the gyrotron distributed window were prepared for release, and quotes were obtained. While flushing the water channels with water preparatory to etching the 2x8 window, a leak was discovered between a water channel and the microwave region of the window. The flaw is clearly visible in a bright light, and is clearly the result of a pilot hole which was mislocated and which wandered from perpendicular. Upon inspection, at least five other cooling channels were found to have thin walls caused by misguided pilot holes.

This large number of questionable cooling channels has resulted in the decision to rebuild the window frame rather than repair the existing unit. Since the gyrotron development program has changed directions away from a rectangular window it was decided to build a 4x4 inch window as the next distributed window. GA is working with the cooling channel manufacturer to improve the quality of their product. Extra inspection steps have been added and process prototyping is now in progress. The sapphire for the new window has been ordered as well as new niobium plate. It is anticipated that a new window could be ready for installation by November 1994.

Before ending testing of the internal mode converter gyrotron, Varian was able to test our 2x2 distributed window aluminum mockup. At a 50 kW throughput level 96% or better throughput was observed with little or no observable affect on the operating conditions of the gyrotron. This result is consistent with our expectations. Plans are in place to test the 2x2 prototype window at the JAERI Naka site using their Collector Potential Depression gyrotron, which has operated at 350 kW for 5 sec. The tests are scheduled for the third week in July.

ITER & TECHNOLOGY PROGRAM

Plasma Interactive Materials

PROGRAM STATUS
3RD QUARTER — FY 1994

TASK: PLASMA INTERACTIVE MATERIALS

FY94 FUNDING: \$253 K

B/R NO: AT-15-04-01E

FY94 PLAN: \$160 K*

CONTRACT NO.: DE-AC03-89ER52153

GA PRINCIPAL INVESTIGATOR: C.P.C. WONG

SAN PROJECT MANAGER: C. BEIGHLEY/M. FOSTER

OFE PROGRAM MANAGER: M. COHEN

PLANNED ACTIVITIES/GOALS	ORIGINAL TARGET	CURRENT TARGET	COMPLETION DATE
1. Perform erosion/redeposition experiments on different base and coated materials.	4 th Q FY94		
2. Perform material studies in accordance with the U.S./Russia, U.S./Japan, U.S./PRC exchanges ⁽¹⁾ .	4 th Q FY94	FY95	
3. Perform disruption studies.	4 th Q FY94	FY95	
4. Fabricate and install the fiber optics reflectometer in-situ measurement experiment ⁽²⁾ .	4 th Q FY94		

REMARKS:

*Accounts for \$93K overrun of FY93 funding.

⁽¹⁾Pending conversion of the 1993 and 1994 capital to operation budget.

⁽²⁾Pending potential re-instatement of the original 1994 budget of \$400K.

PROGRAM STATUS

3RD QUARTER — FY1994

PLASMA INTERACTIVE MATERIALS

HIGHLIGHTS:

- Completed the first round of safety evaluations for the planned Be experiment in DIII-D.
 - Repaired a leak between the secondary and primary vacuums of the DiMES sample changer.
-

EXPERIMENTAL PLANNING

Material sample exposure experiments are being planned for the next three months. These materials include 29-Si doped ATJ graphite, Russian B₄C and SiC coated, and Si-wafer samples.

DIMES SAMPLE CHANGER SYSTEM

Mechanical System

The DiMES sample insertion mechanism was removed from DIII-D to repair a leak between the secondary and primary vacuums. The bellows was returned to GA following repair by the manufacturer. Misalignment in the top flange of the mechanism was fixed in-house and carefully documented by QA. The telescoping shaft assembly is now operating satisfactorily.

DIMES EXPERIMENTS

Erosion and Redeposition

J. Brooks (ANL) has obtained good agreement between code predictions and measured data for the up-and-down field redeposition of tungsten in the DiMES-8 experiment. Additional surface measurements closer to the tungsten spot did not confirm a change in slope of the redeposition profile predicted within a couple of millimeters of the spot. W. Wampler (SNL) reported he detected a significantly higher concentration of implanted deuterium in the DiMES-9 sample than in DiMES-8.

Disruption Experiment

A DiMES sample was exposed to three successive discharges, each containing a disruption. The sample was sent to Sandia NM for Nuclear Reaction Analysis (NRA) of the implanted

deuterium in the silicon crystal of the sample. If the NRA analysis reveals a sufficient deuterium abundance in the four radial bands exposed to charge exchange neutral flux, SIMS will be used to measure the depth profile of the implanted atoms.

Be-Erosion Experiment

Working closely with SNL and ANL, and making use of the available volumetric and surface concentration limit/guideline for Be-dust, a possible scenario exists for the exposure of Be in DIII-D, while assuring the health and safety of all personnel. The approach is to expose a thin (0.1 micron) coating of Be to an ELM-free H-mode plasma as a last experiment before a dirty vent of DIII-D so affected tiles can be removed. This will give us information on Be erosion and re-deposition in a diverted plasma and assure the rest of the machine will not be contaminated. A draft plan submitted to the DIII-D safety committee was reviewed and favorably received. We are planning to perform the Be-experiment in December, and are also looking into the use of surrogate metallic coating for the trial Be-exposure experiment.

INTERNATIONAL COLLABORATION

Germany

Dr. F. Weschenfelder finished designing the mounts for the camera, the lens and the light source. The camera and the filter wheel were set up in the DiMES lab. The first pictures of the test sample through the three (red, green and blue) filters were recorded. With brightness of the blue picture being very low. To avoid possible problems, an additional broad band filter with a center wavelength of 750 nm was ordered and will be placed in the fourth position in the filter wheel. Further testing will be performed.

Bob Bastasz will return some old Si samples which have been coated during earlier boronization. These samples will be used to determine the optical constants of the films. This information is an important input for the colorimetry. We are planning to do exposure of another sample during the boronization on July, 9.

Russia

A draft report of the tritium quality factor review work was completed by Dr. N. Smirnova of Kurchatov Institute and copies were distributed by Gene Nardella of DOE/OFE for community review. A seminar was also given by Dr. Smirnova at GA.

People's Republic of China

Professor C. You of SWIP will be at GA for nine weeks. She will be working on the *ex-situ* ellipsometer experiment, the TRIM code, and reviewing sputtering data of different materials.