

14:11:38

OCA PAD AMENDMENT - PROJECT HEADER INFORMATION

09/16/91

Active

Project #: E-25-664
Center #: 10/24-6-R6910-0A0

Cost share #:
Center shr #:

Rev #: 6
OCA file #:
Work type : RES
Document : GRANT
Contract entity: GTRC

Contract#: DE-FG05-90ER54078
Prime #:

Mod #: M004

Subprojects ? : N
Main project #:

CFDA: 81.049
PE #: N/A

Project unit:
Project director(s):
STACEY W M JR

MECH ENGR
MECH ENGR

Unit code: 02.010.126
(404)894-3714

Sponsor/division names: US DEPT OF ENERGY
Sponsor/division codes: 141

/ DOE OAK RIDGE - TN
/ 017

Award period: 900306 to 910630 (performance) 910930 (reports)

Sponsor amount	New this change	Total to date
Contract value	0.00	100,000.00
Funded	0.00	100,000.00
Cost sharing amount		0.00

Does subcontracting plan apply ? : N

Title: SUPPORT OF US ITER ACTIVITY

PROJECT ADMINISTRATION DATA

OCA contact: E. Faith Gleason

894-4820

Sponsor technical contact

Sponsor issuing office

H STANLEY STATEN
(301)353-4590

MELISSA Y JOHNSON
(615)576-7599

USDOE
19901 GERMANTOWN RD
GERMANTOWN MD 20875

SPECIAL ACQUISITIONS BRANCH
USDOE
P O BOX 2001
OAK RIDGE TN 37831-8757

Security class (U,C,S,TS) : U
Defense priority rating :
Equipment title vests with: Sponsor

ONR resident rep. is ACO (Y/N): N
DOE supplemental sheet
GIT X

Administrative comments -

AMENDMENT NO. M004 PROVIDES A NO-COST EXTENSION TO JUNE 30, 1991.

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 10/04/91

Project No. E-25-664

Center No. 10/24-6-R6910-OA0

Project Director STACEY W M JR

School/Lab MECH ENGR

Sponsor US DEPT OF ENERGY/DOE OAK RIDGE - TN

Contract/Grant No. DE-FG05-90ER54078 Contract Entity GTRC

Prime Contract No.

Title SUPPORT OF US ITER ACTIVITY

Effective Completion Date 910630 (Performance) 910930 (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	Y	911002
Final Report of Inventions and/or Subcontracts	Y	
Government Property Inventory & Related Certificate	Y	910926
Classified Material Certificate	N	
Release and Assignment	Y	911002
Other	N	

Comments

Subproject Under Main Project No.

Continues Project No.

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Management	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	Y
Project File	Y
Other	N

NOTE: Final Patent Questionnaire sent to PDPI.

Georgia Institute of Technology
Hinman Building
Atlanta, Georgia 30332-0259
404-894-4624; 2629
Fax: 404-894-5519

April 18, 1991

Ms. Melissa Y. Johnson, Contract Specialist
U. S. Department of Energy-Oak Ridge Operations
Special Acquisitions Branch
P. O. Box 2001
Oak Ridge, TN 37831-8758

REFERENCE: Grant # DE-FG05-90ER54078

Dear Ms. Johnson,

Enclosed in triplicate is the Financial Status Report (SF-269A) for Grant No. DE-FG05-90ER54078 covering the period March 6, 1990 through February 28, 1991.

If you should have questions or need additional information, please contact Geraldine Reese or me at (404) 894-2629.

Sincerely,

David V. Welch
Director

DVW/GMR/djt

Enclosures

cc: W. M. Stacey, Jr. Mech Eng 0405
Ms. Mary Wolfe, OCA/CSD 0420 ✓
File: E-25-664/R6910-0A0

FINANCIAL STATUS REPORT

(Short Form)

(Follow instructions on the back)

1. Federal Agency and Organizational Element to Which Report is Submitted U. S. DEPARTMENT OF ENERGY		2. Federal Grant or Other Identifying Number Assigned By Federal Agency DE-FG05-90ER54078		OMB Approval No. 0348-0039		Page 1 of 1 pages	
3. Recipient Organization (Name and complete address, including ZIP code) GEORGIA TECH RESEARCH CORPORATION P. O. BOX 100117 ATLANTA, GA 30384							
4. Employer Identification Number 58-0603146		5. Recipient Account Number or Identifying Number E-25-664/R6910-0A0		6. Final Report <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		7. Basis <input checked="" type="checkbox"/> Cash <input type="checkbox"/> Accrual	
8. Funding/Grant Period (See Instructions) From: (Month, Day, Year) March 6, 1990		To: (Month, Day, Year) February 28, 1991		9. Period Covered by this Report From: (Month, Day, Year) March 6, 1990		To: (Month, Day, Year) February 28, 1991	
10. Transactions:				I Previously Reported	II This Period	III Cumulative	
a. Total outlays				-0-	87,792.29	87,792.29	
b. Recipient share of outlays				-0-	-0-	-0-	
c. Federal share of outlays				-0-	87,792.29	87,792.29	
d. Total unliquidated obligations						7,528.71	
e. Recipient share of unliquidated obligations						-0-	
f. Federal share of unliquidated obligations						7,528.71	
g. Total Federal share (Sum of lines c and f)						95,321.00	
h. Total Federal funds authorized for this funding period						100,000.00	
i. Unobligated balance of Federal funds (Line h minus line g)						4,679.00	
11. Indirect Expense							
a. Type of Rate (Place "X" in appropriate box) <input type="checkbox"/> Provisional <input type="checkbox"/> Predetermined <input type="checkbox"/> Final <input checked="" type="checkbox"/> Fixed							
b. Rate SEE BELOW		c. Base MTDC		d. Total Amount 33,766.28		e. Federal Share 33,766.28	
12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation. <div style="text-align: right;"> Questions pertaining to this report should be directed to: Ms. Geraldine Reese (404) 894-2629 </div>							
13. Certification: I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.							
Typed or Printed Name and Title David V. Welch, Director, Grants and Contracts Accounting					Telephone (Area code, number and extension) (404) 894-2629		
Signature of Authorized Certifying Official					Date Report Submitted April 18, 1991		

SN 7540-01-218-4387

Direct Costs

@ 62.5% 22,387.29
 @ 62.5% 31,638.72

Indirect Costs ²⁶⁹⁻²⁰¹

13,992.07
 19,774.21

Standard Form 269A (REV 4-88)
 Prescribed by OMB Circulars A-102 and A-110

Georgia Institute of Technology
Lyman Hall/Emerson Building
Atlanta, Georgia 30332-0259
404•894•4624; 2629

September 23, 1991

Ms. Melissa Y. Johnson, Contract Specialist
U. S. Department of Energy-Oak Ridge Operations
Special Acquisitions Branch
P. O. Box 2001
Oak Ridge, TN 37831-8758

REFERENCE: Grant # DE-FG05-90ER54078

Dear Ms. Johnson,

Enclosed in triplicate is the final Financial Status Report (SF-269A) for Grant No. DE-FG05-90ER54078 covering the period March 6, 1990 through June 30, 1991.

If you should have questions or need additional information, please contact Geraldine Reese or me at (404) 894-2629.

Sincerely,

David V. Welch
Director

DVW/GMR/djt

Enclosures

cc: W. M. Stacey, Jr., Mechanical Engr 0405
Ms. Mary Wolfe, OCA/CSD 0420 ✓
File: E-25-664/R6910-OA0

"FINAL"

FINANCIAL STATUS REPORT

(Short Form)

(Follow instructions on the back)

1. Federal Agency and Organizational Element to Which Report is Submitted U. S. DEPARTMENT OF ENERGY		2. Federal Grant or Other Identifying Number Assigned By Federal Agency DE-FG05-90ER54078		OMB Approval No. 0348-0038	Page 1	of 1 pages
3. Recipient Organization (Name and complete address, including ZIP code) GEORGIA TECH RESEARCH CORPORATION P. O. BOX 100117 ATLANTA, GA 30384						
4. Employer Identification Number 58-0603146		5. Recipient Account Number or Identifying Number E-25-664/R6910-OAO		6. Final Report <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		7. Basis <input checked="" type="checkbox"/> Cash <input type="checkbox"/> Accrual
8. Funding/Grant Period (See instructions) From: (Month, Day, Year) March 06, 1990		To: (Month, Day, Year) June 30, 1991		9. Period Covered by this Report From: (Month, Day, Year) March 06, 1990		To: (Month, Day, Year) June 30, 1991
10. Transactions:		<input type="checkbox"/> Previously Reported	<input type="checkbox"/> This Period	<input type="checkbox"/> Cumulative		
a. Total outlays		100,000.00	-0-	100,000.00		
b. Recipient share of outlays		-0-	-0-	-0-		
c. Federal share of outlays		100,000.00	-0-	100,000.00		
d. Total unliquidated obligations				-0-		
e. Recipient share of unliquidated obligations				-0-		
f. Federal share of unliquidated obligations				-0-		
g. Total Federal share (Sum of lines e and f)				100,000.00		
h. Total Federal funds authorized for this funding period				100,000.00		
i. Unobligated balance of Federal funds (Line h minus line g)				-0-		
11. Indirect Expense		a. Type of Rate (Place "X" in appropriate box) <input type="checkbox"/> Personnel <input type="checkbox"/> Predetermined <input type="checkbox"/> Final <input type="checkbox"/> Fixed				
b. Rate SEE BELOW		c. Basis MTDC		d. Total Amount 33,423.28		e. Federal Share 33,423.28
12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation. <div style="text-align: right;"> Questions pertaining to this report should be directed to: Ms. Geraldine Reese (404) 894-2629 </div>						
GEORGIA TECH FISCAL YEAR ENDS JUNE 30.						
13. Certification: I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.						
Typed or Printed Name and Title David V. Welch, Director, Grants & Contracts Accounting					Telephone (Area code, number and extension) (404) 894-2629	
Signature of Authorized Certifying Official					Date Report Submitted September 23, 1991	

Previous Editions not Usable

	Direct Costs	Indirect Costs	
FY90 @ 62.5%	22,387.29	13,992.07	Equipment 13,099.60
FY91 @ 62.5%	44,189.43	19,431.21	

Standard Form 289A (REV 4-86)
Prescribed by OMB Circulars A-102 and A-110

Foreign Trip Report

**John Mandrekas
Georgia Institute of Technology**

Itinerary:

**July 16, 1990 to July 20, 1990
Max Planck Institut für Plasmaphysik
Garching bei München, FRG**

Purpose of trip: Participation in the ITER Burn Control Workshop

DATE: July 30, 1990
TO: Distribution
FROM: John Mandrekas
SUBJECT: Foreign Trip Report of John Mandrekas

This report gives a brief description of my participation in the ITER workshop on Burn Control from July 16, 1990 to July 20, 1990 at the Max Planck Institut für Plasmaphysik in Garching bei München, FRG.

This meeting was part of a series of workshops on ITER Operational Control (Density Control, Burn Control and Current Profile Control), and its purpose was to assess the state of knowledge on the controllability of the thermonuclear burn conditions in ITER, and to lead to recommendations for associated hardware and diagnostic systems for operating point control, burn stability control, and emergency shutdown. L. John Perkins (LLNL, USA) was the Chairman of the Burn Control Workshop.

During this meeting, I gave two presentations summarizing the work of the Georgia Tech group in support of the ITER project in the area of Operating Point Control and Burn Control. The first presentation, entitled *ITER Fractional Power Operation*, summarized our recent results on transitions to and from fractional power in ITER with programmed variation of the neutral beam heating source and of the fueling rate. Estimates of the required reserve neutral beam power for these transitions were also reported. In the second presentation, *A Full Transport Treatment of ITER Burn Control Scenarios*, I presented a series of simulations with the 1-1/2 D code WHIST. The goal of these simulations was to compare the 1-1/2 D results with previous predictions obtained with 0-D codes, and to assess the feasibility of operation of ITER at a subignited, high- Q , thermally unstable operating point with neutral beam power modulation. Our findings indicate that such operation is feasible, provided the average electron density is kept below $1.7 \times 10^{20} \text{ m}^{-3}$. At higher densities, the 1.3 MeV ITER beams cannot penetrate to the center of the plasma and as a result control is difficult, specially of negative temperature perturbations.

At the end of the second day a discussions session was held in which, based on the presentations of the workshop participants, several recommendations were made regarding ITER Burn Control issues. Some of the most important ones are:

- Burn Control, to the extent possible, should be integrated with other ITER control scenarios (density, current-profile, electromagnetic, etc).
- Auxiliary power modulation was selected as the primary method of burn stability control for ITER. Fueling control (based on the fuel mix) should be the main back-up method. Other back-up methods deserving further analysis, include density control (edge and central), impurity injection, minor radius compression, etc.
- The current limit on the heating power ramp rate (10 MW/s) will be used in future simulations, it remains however an open issue. The group responsible with the design of the hardware components of the heating system will be consulted regarding the possibility of raising this limit.
- Sawteeth oscillations (including monster sawteeth) appear to be important since they affect the credibility of the perturbations that we observe.
- The importance of a credible emergency shutdown scenario was stressed.

A very interesting joint meeting between the Diagnostics and Burn Control participants was held on July 18, to discuss Plasma Diagnostics requirements from the point of view of Burn Control needs. It appears that neutron flux should be one of the primary observables. A set of poloidally arranged detectors in the outer blanket, should measure the global neutron flux with 10% absolute and 5% relative accuracy. Including detectors in the inner blanket, would improve the relative resolution to about 1%. The spatial resolution (from collimated, spatially resolved detectors) is expected to be 15–20 %. Other observables, relevant to Burn Control, are the ion temperature from neutron spectroscopy, the diamagnetic signal for τ_E , etc.

Finally, on Friday, July 20, the participants of the U.S. Burn Control group held a review meeting in which further work in modelling and analysis was identified for the remainder of the ITER CDA.

NOTICE OF ENERGY RD&D PROJECT

1. Descriptive TITLE of work
(150 characters including spaces)

Support of U.S. ITER Activity

2. CONTRACT or
grant number DE-FG05-90ER54078

2A. MASTER contract number
(GOCO's) _____

2B. Responsible PATENT office Oak Ridge, Tenn.

4. Original contract start date _____

4A. Current contract start date 4/1/89

5. Work STATUS

☐ Proposed ☐ Renewal
☒ New ☐ Terminated

5A. Manpower (FTE) _____

3. Performing organization CONTROL
number (internal) E25-664

3A. Budget and Reporting code _____

3B. Funding YEAR for this award _____

FY90

4B. Current contract close date _____

4C. Anticipated project termination
date _____

5B. CONGRESSIONAL district 5

5C. STATE or Country where work is being
performed Georgia

5D. COUNTRY sponsoring research USA

6. Name of PERFORMING organization Georgia Tech Research Corp

6A. DEPARTMENT or DIVISION
Nuclear Engineering Program

6B. Street Address
Cherry & Ferst Streets
ESM Building

6C. City, State, Zip Code
Atlanta, Georgia 30332

7. Circle only one code for TYPE of Organization Performing R&D:

☒ CU - College, university, or trade school

☐ FF - Federally funded RD&D centers or laboratory operated for an agency of the U. S.
Government

☐ IN - Private industry

☐ NP - Foundation or laboratory not operated for profit

☐ ST - Regional, state or local government facility

☐ TA - Trade or professional organization

☐ US - Federal agency

☐ XX - Other

☐ EG - Electric or gas utility

8A. Contractor's PRINCIPAL INVESTIGATOR/s or project manager
Name/s (Last, First, MI) Stacey, Weston M.

8B. PHONE/s (in order of PI names with commercial followed by FTS)

Comm. 404-894-3714

; FTS _____

; Comm. _____

; FTS _____

8C. PI's address (if different from that of Performing Organization)

9. DOE SUPPORTING Organization (DOE Assistant Secretary and office sponsoring the work; technical monitor; and administrative monitor).

9A. PROGRAM division or office
(full name) Office of Fusion Energy

141/017

Program Office Code

9B. TECHNICAL monitor (Last, First, MI) Staten, S.

9C. Address Department of Energy

9D. Phone

Comm. _____

FTS _____

9E. ADMINISTRATIVE monitor (Last, First, MI) Johnson, Melissa Y.

10. FUNDING in thousands of dollars (KS). Funds represent budget obligations for operating and capital equipment (FY runs October 1 – September 30).

Funding organization(s)	Current FY <u>90</u>	Next FY <u>91</u>
A. DOE	75,000	25,000* 129,989**
B.		
C.		

- 10D. Does the current FUNDING cover more than one year's work?

Yes _____

No X

E. If yes, provide dates (from when to when). _____

11. Descriptive SUMMARY of work. Enter a Project Summary using complete sentences limited to 200 words covering the following: Objective(s), state project objectives quantifying where possible (e.g., "The project objective is to demonstrate 95% recovery of sulphur from raw gas with molten salt recycling at a rate of one gallon per minute."); approach, describe the technical approach used (how the work is to be done); expected product/results, describe the final products or results expected from the project and their importance and relevance.

It is proposed to support ITER by performing calculations in three areas - burn control, neutral beam current drive, and plasma sheath and sputtering. In each area we have an unique capability which has been established in previous work.

*Incremental request dated 10/1/90

**2nd Full year funding request dated 11/13/90

12. PUBLICATIONS available to the public. List the five most descriptive publications that have resulted from this project in the last year that are available to the public. (Include author, title, where published, year of publication, and any other information you have to complete full bibliographic citation.) Use the back of this form or additional sheets if necessary.
- W. M. Stacey, G. Pautasso, and J. Mandrekas, "NBI Current Drive Sensitivity Study for TIBER II, ITER-US and INTOR", Fusion Tech., 15, 1395 (1989).
- W. M. Stacey, and J. Mandrekas, "Evaluation of Different Burn Control Methods for the International Thermonuclear Experimental Reactor", Proc. 13th IEEE Symp. Fusion Engr. Knoxville, Tenn. (1989).
- W. M. Stacey and J. Mandrekas, "Evaluation of Different Control Methods for the Thermal Stability of ITER", Fusion Tech., to be published (1990).
- W. M. Stacey, et. al., "Active Control of Thermonuclear Burn Conditions for the International Thermonuclear Experimental Reactor", Fusion Tech., to be published (1990).
- W. M. Stacey, J. Mandrekas and H. He, "A Full Transport Treatment of ITER Burn Control Scenarios", Georgia Tech report GTFR-99 (October 1990).

3. KEYWORDS (Listed five terms describing the technical aspects of the project. List specific chemicals and CAS number, if applicable.)

Tokamak Burn Control

4. RESPONDENT. Name and address of person filling out the Form 538. Give telephone number, including extension (if you have FTS number, please include it) at which person can be reached. Record the date this form was completed or updated. The information in Item 14 will not be published.

Respondent's Name: Weston M. Stacey Phone No.: 404-894-3714 Date: 11/27/90

Street: 620 Cherry Street

City: Atlanta State: GA Zip: 30332

U. S. DEPARTMENT OF ENERGY

UNIVERSITY CONTRACTOR, GRANTEE, AND COOPERATIVE AGREEMENT
RECOMMENDATIONS FOR ANNOUNCEMENT AND DISTRIBUTION OF DOCUMENTS

See Instructions on Reverse Side

1. DOE Report No.	3. Title	
2. DOE Contract No. DE-FG05-90ER54078	Support of U.S. ITER Activity	
4. Type of Document ("x" one) <input type="checkbox"/> a. Scientific and technical report <input type="checkbox"/> b. Conference paper: Title of conference _____ Date of conference _____ Exact location of conference _____ Sponsoring organization _____ <input checked="" type="checkbox"/> c. Other (Specify) <u>Final Technical Report</u>		
5. Recommended Announcement and Distribution ("x" one) <input checked="" type="checkbox"/> a. Unrestricted unlimited distribution. <input type="checkbox"/> b. Make available only within DOE and to DOE contractors and other U. S. Government agencies and their contractors. <input type="checkbox"/> c. Other (Specify) _____		
6. Reason for Recommended Restrictions		
7. Patent and Copyright Information: Does this information product disclose any new equipment, process, or material? <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes If so, identify page nos. _____ Has an invention disclosure been submitted to DOE covering any aspect of this information product? <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes If so, identify the DOE (or other) disclosure number and to whom the disclosure was submitted. Are there any patent-related objections to the release of this information product? <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes If so, state these objections. Does this information product contain copyrighted material? <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes If so, identify the page numbers _____ and attach the license or other authority for the government to reproduce.		
8. Submitted by		
Name and Position (Please print or type) W. M. Stacey, Jr., Professor Organization Georgia Institute of Technology, Atlanta, GA 30332 School of Mechanical Engineering, Nuclear Engineering Programs		
Signature	Phone 894-3714	Date 5-31-91

FOR DOE OR OTHER AUTHORIZED
USE ONLY

9. Patent Clearance ("x" one)
- ☐ a. DOE patent clearance has been granted by responsible DOE patent group.
- ☐ b. Report has been sent to responsible DOE patent group for clearance.

SUPPORT OF U.S. ITER ACTIVITY

Fusion Research Center — Georgia Tech

Final Report

May 31, 1990 — May 31, 1991

ABSTRACT

Georgia Tech continued its participation in the Conceptual Design Activity (CDA) of the International Thermonuclear Experimental Reactor as part of the US ITER System and Operational Studies group. Our main contribution has been in the areas of burn control, impurity-seeded scenarios, and SUPERCODE development. In addition, the PI has provided support to DOE on the organization of the ITER Engineering Design Activity.

Summary of Technical Activities

During the second part of 1990, our main task was the implementation of the WHIST 1-1/2 D code for a full transport treatment of ITER burn control scenarios [1]. The results of our work were presented at the US ITER Burn Control Workshop (Georgia Tech, June 6-7, Atlanta, GA) which we organized and hosted, and at the International Workshop on ITER Burn Control (Garching, July 16-18). The results of our work, along with those from the other participants in the US Burn Control studies group, helped to define the recommendations for a primary and secondary control scheme for ITER [2-3].

At the same time we started working on transport simulations of impurity-seeded operating scenarios for ITER. A multi charge-state impurity transport routine has been implemented in the WHIST transport code, for a more consistent calculation of the effect of the injected impurities. Preliminary results of this work were presented at the 32nd Annual APS meeting [4].

During the first part of 1991, while continuing our work on ITER burn control and impurity seeding transport simulations, our main activity has been in the development of the new systems and operational code (SUPERCODE) for the ITER Engineering Design

Activity [5]. Our group will contribute modules in the areas of neutral beam (NB) heating and current drive, impurity transport and radiation losses, and fueling. The first module (NB heating and current drive) is almost complete and ready to be implemented in the SUPERCODE.

ITER Support to DOE

The PI provided support to DOE in the review and preparation for the next phase of ITER. He participated in several DOE meetings devoted to the development of the Terms of Reference for the ITER EDA and to the initial Task Sharing in the ITER EDA. He was a participant in the US National Review of the ITER CDA design.

References:

1. J. Mandrekas, H. He, W.M. Stacey, "1-1/2D Transport Studies of ITER Burn Control Scenarios," accepted for publication in *Fusion Technology*, 1991
2. L. J. Perkins, S.W. Haney, J. Mandrekas, S.K. Ho, *et. al.*, "U.S. Studies in Thermonuclear Burn Control for the International Thermonuclear Experimental Reactor (ITER)," Lawrence Livermore National Laboratory report, to be published (1991)
3. K. Borrass, S. Cohen, F. Engelmann,...J. Mandrekas,..."Plasma Operation Control in ITER," IAEA-CN-53/F-3-6, *presented at the 13th International Conf. on Plasma Physics and Contr. Nucl. Fus. Research*, International Atomic Energy Agency, Wash. D.C., October 1990
4. J. Mandrekas, H. He, W.M. Stacey, and L.J. Perkins, "Impurity-Seeded Operating Scenarios for ITER," Bull. Am. Phys. Soc., **35**, 1923 (1990)
5. L.J. Perkins, J. Galambos, S. Haney, "The SUPERCODE: A Fast Time-dependent 1-1/2D Systems Code for Comprehensive Design and Operational Analysis for the ITER EDA" Lawrence Livermore National Laboratory, June 1990.