11:10:22 OCA PAD AMENDMENT - PROJECT HEADER INFORMATION 07/23/92

Active

Project #: E-18-621 Cost share #: Rev #: 24
Center # : R6136-0A0 Center shr #: OCA file #:
Work type : RES
Contract#: 071341 Mod #: 10 Document : SUBCONT
Prime #: Contract entity: GTRC

Subprojects ? : Y CFDA:
Main project #: PE #:

Project unit: MAT ENGR Unit code: 02.010.112
Project director(s):
SAXENA A MAT ENGR (404)894-2888

Sponsor/division names: GENERAL ATOMICS / SAN DIEGO, CA
Sponsor/division codes: 206 / 005

Award period: 860305 to 920901 (performance) 920901 (reports)

Sponsor amount	New this change	Total to date
Contract value	0.00	390,207.00
Funded	0.00	390,207.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: CRACK GROWTH DATA OF PROG TO DEV AN INTEGRATED APPROACH TO LIFE ASSESS OF BOI

PROJECT ADMINISTRATION DATA

OCA contact: Brian J. Lindberg 894-4820

Sponsor technical contact

R.H RYDER
(619)445-2594

GENERAL ATOMICS
10955 JOHN JAY HOPKINS DRIVE
SAN DIEGO, CALIFORNIA 92121

Sponsor issuing office

HELEN KUSPA
(619)455-2072

GENERLA ATOMICS
10955 JOHN JAY HOPKINS DRIVE
SAN DIEGO, CALIFORNIA 92121

Security class (U,C,S,TS) : U ONR resident rep. is ACO (Y/N):
Defense priority rating : N/A N/A supplemental sheet
Equipment title vests with: Sponsor X GIT

Administrative comments -
CHANGE ORDER NO. 10 EXTENDS PERIOD OF PERFORMANCE THROUGH SEPTEMBER 1, 1992 (FUNDING REMAINS UNCHANGED). ISSUING OFFICE CONTACT CHANGED TO HELEN KUSPA.

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 04/22/93

Project No. E-18-621_____ Center No. R6136-0A0_____

Project Director SAXENA A_____ School/Lab MSE_____

Sponsor GENERAL ATOMICS/SAN DIEGO, CA_____

Contract/Grant No. 071341_____ Contract Entity GTRC

Prime Contract No. _____

Title CRACK GROWTH DATA OF PROG TO DEV AN INTEGRATED APPROACH TO LIFE ASSESS OF

Effective Completion Date 920901 (Performance) 920901 (Reports)

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

CommentsEFFECTIVE DATE 3-5-86. CONTRACT VALUE $390,207._____

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 Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	Y
Project File	Y
Other HARRY VANN-FMD_____	Y
FRED CAIN-OOD_____	Y

NOTE: Final Patent Questionnaire sent to PDPI.

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT (SUBPROJECTS)

Closeout Notice Date 04/22/93

Project No. E-18-621 Center No. R6136-0A0

Project Director SAXENA A School/Lab MSE

Sponsor GENERAL ATOMICS/SAN DIEGO, CA

Project # E-25-M05 PD MCDOWELL D L Unit 02.010.126 T
SUBCONT # 071341 MOD# MENO DTD 890807MECH ENGR *
Ctr # R6136-0A1 Main proj # E-18-621 OCA CO BJL
Sponsor-GENERAL ATOMICS /SAN DIEGO, CA 206/005
CRACK GROWTH DATA OF
Start 860305 End 890916 Funded 39,000.00 Contract 39,000.00

LEGEND
1. * indicates the project is a subproject.
2. I indicates the project is active and being updated.
3. A indicates the project is currently active.
4. T indicates the project has been terminated.
5. R indicates a terminated project that is being modified.

C-15-621

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894-

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

August 1, 1986

Mr. Robert Ryder
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Dear Bob:

Enclosed are the cost performance and technical progress reports on our subcontract for the period of 3-1-86 to 7-31-86. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/lmw
Enclosures
cc: Brian Lindberg, OCA Georgia Tech.

CONTRACTOR COST PERFORMANCE REPORT

GA Technologies Subcontract No. SC 071341

Project Manager: D. A. Roberts/R. Ryder

Period of Performance: 3/1/86 to 8/15/86

	March	April	May	June	July	Aug.
Actual cost (kilo dollars)	0	7.5	7.5	3.7	6.2*	-
Projected cost (kilo dollars)	0	7.5	7.5	3.7	6.2	9.0

*estimated

Prepared by:

(Ashok Saxena)
Professor of Materials Engineering

CONTRACTOR NAME:

Georgia Tech. Research Corporation
Centennial Building
Georgia Institute of Tech.
Atlanta, GA 30332

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894- 2888

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

E-18-621 / SAXENA

November 7, 1986

Mr. Robert Ryder
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Dear Bob:

Enclosed are the cost performance and technical progress reports on our subcontract for the period 8-1-86 to 10-31-86. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena, Professor
Materials Engineering

AS/lmw
Enclosure
cc: Brian Lindberg, OCA Ga. Tech.

Project Objective: To develop material data and models for predicting creep and creep-fatigue crack growth behavior in 2 1/4 Cr-Mo and 1 1/4 Cr-1/2 Mo steam header materials.

Technical Progress:

On October 20 and 21, 1986, we participated in a two day meeting in Palo Alto to discuss progress and future plans for the overall project. The Georgia Tech presentation included a discussion on the finite element results of a compact specimen which included effects of crack growth. The main conclusions of this study are discussed below. These results are also described in two papers presented at the Third International Symposium on Non-Linear Fracture Mechanics at Knoxville October 6-8, 1986.

The mechanics basis of the C_t parameter was explored in the above study. It was concluded that C_t which was originally defined as a parameter which characterizes the stress-power release rate also characterizes the rate of growth of the creep-zone under small-scale creep. It was also shown that in small-scale creep, C_t is not equal to the C-integral or the Ehlers and Riedel C(t) which represent the amplitude of the Hutchinson-Rice Rosengren (HRR) fields at any instant. It was argued that through its connection with rate of growth of the creep zone, C_t captures the history of the relaxing stress field and that is why it is successful in correlating creep crack growth behavior under small-scale-creep.

When load-line deflection rates are measured in test specimens, the measured value of C_t includes any effects from primary creep and the on HRR-type stress fields (Hui-Riedel fields) present at the crack tip. However, both these effects are not included in the current analytical expressions for calculating C_t in components. These expressions were derived on the assumptions that the material constitutive behavior is governed by elastic-power law creep. This short coming will be remedied by the continuing finite element work.

A thorough literature review was conducted to consolidate all available creep crack growth rate data on 2 1/4 Cr-Mo and 1 1/4 Cr-1/2 Mo steels in the open literature. The available data covers weld metals, heat affected zone and fusion line region and the base metal. A sample plot of this data is shown in Fig. 1. A complete summary of data will be presented in an interim project report to be issued through EPRI.

Fatigue crack growth tests on the RB 304 header were initiated. Thus far, two specimens from the cold region of the header and one specimen from the hot region header have been tested at a loading frequency of 1 Hz. The fatigue crack growth rate, da/dN, as a function of the stress intensity parameter range for the specimens from the cold region are shown in Fig. 2. The hot region specimen results are currently being analyzed.

Metallography specimens from the hot and cold regions of the RB 304 header were mailed to Combustion Engineering for determination of the λ parameter.

Work to be Performed During the Next Reporting Period:

The fatigue crack growth testing at slower frequencies (0.01 Hz) and different loading wave forms will be conducted. It is anticipated that is work will now progress rapidly. The finite element analysis incorporating effects of plasticity and primary creep will continue. Testing on the 2 1/4 Cr-1Mo header material will commence as the header becomes available. When the final contract is placed with Georgia Tech, a subcontract with Westinghouse will be placed to start work on fracture toughness testing and long hold time fatigue crack growth testing.

Funds expended to date:	$39,000
Funds expended during reporting period:	$14,000
Allocation for 1986:	$57,000

We expect to completely spend our allocation for 1986.

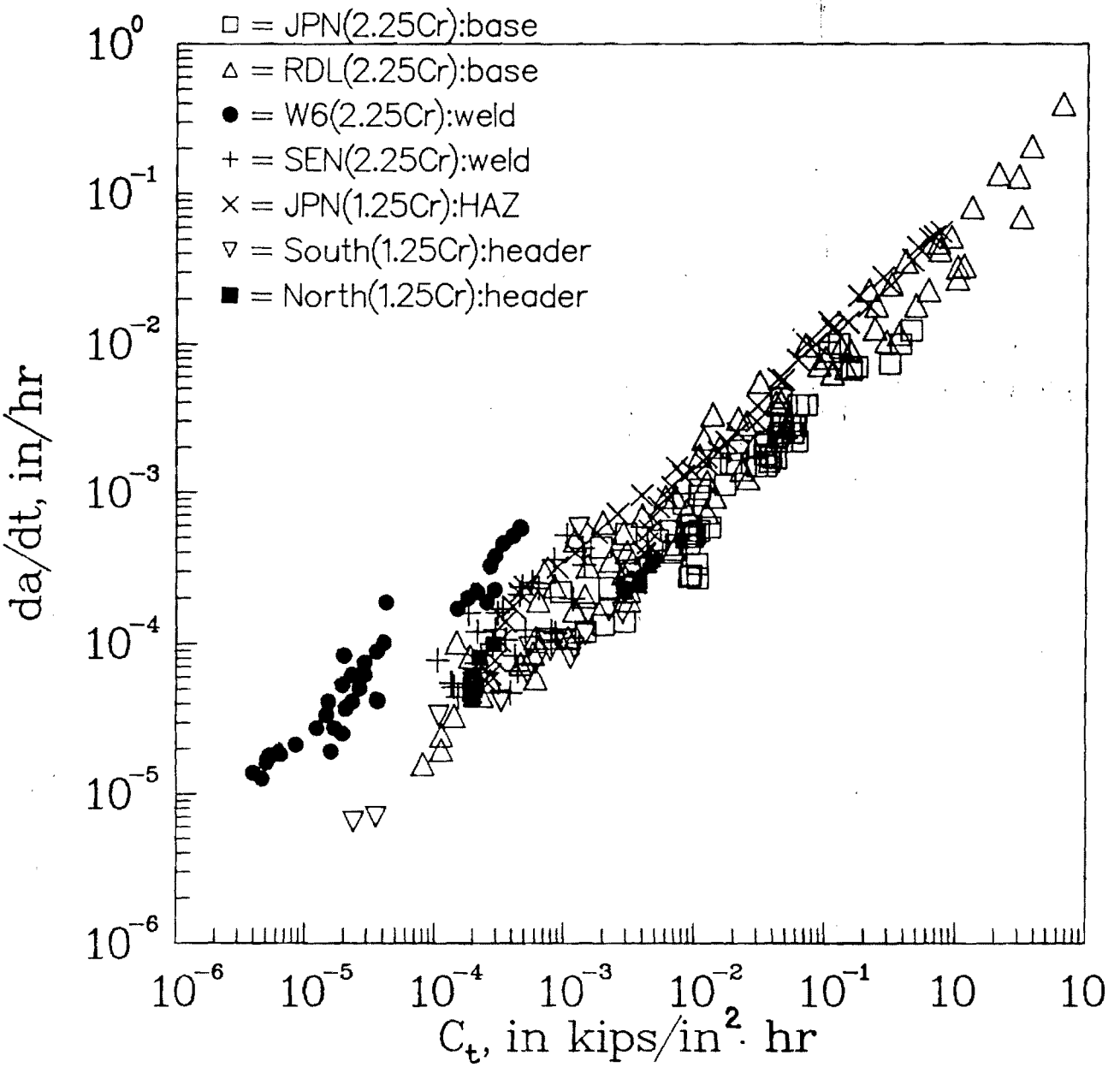

Fig. 1. Summary of creep crack growth data available in the literature on 2 1/4 Cr-1Mo and 1 1/4 Cr - 1/2 Mo materials. The data also includes specimens from weld metal and the heat-affected-zones.

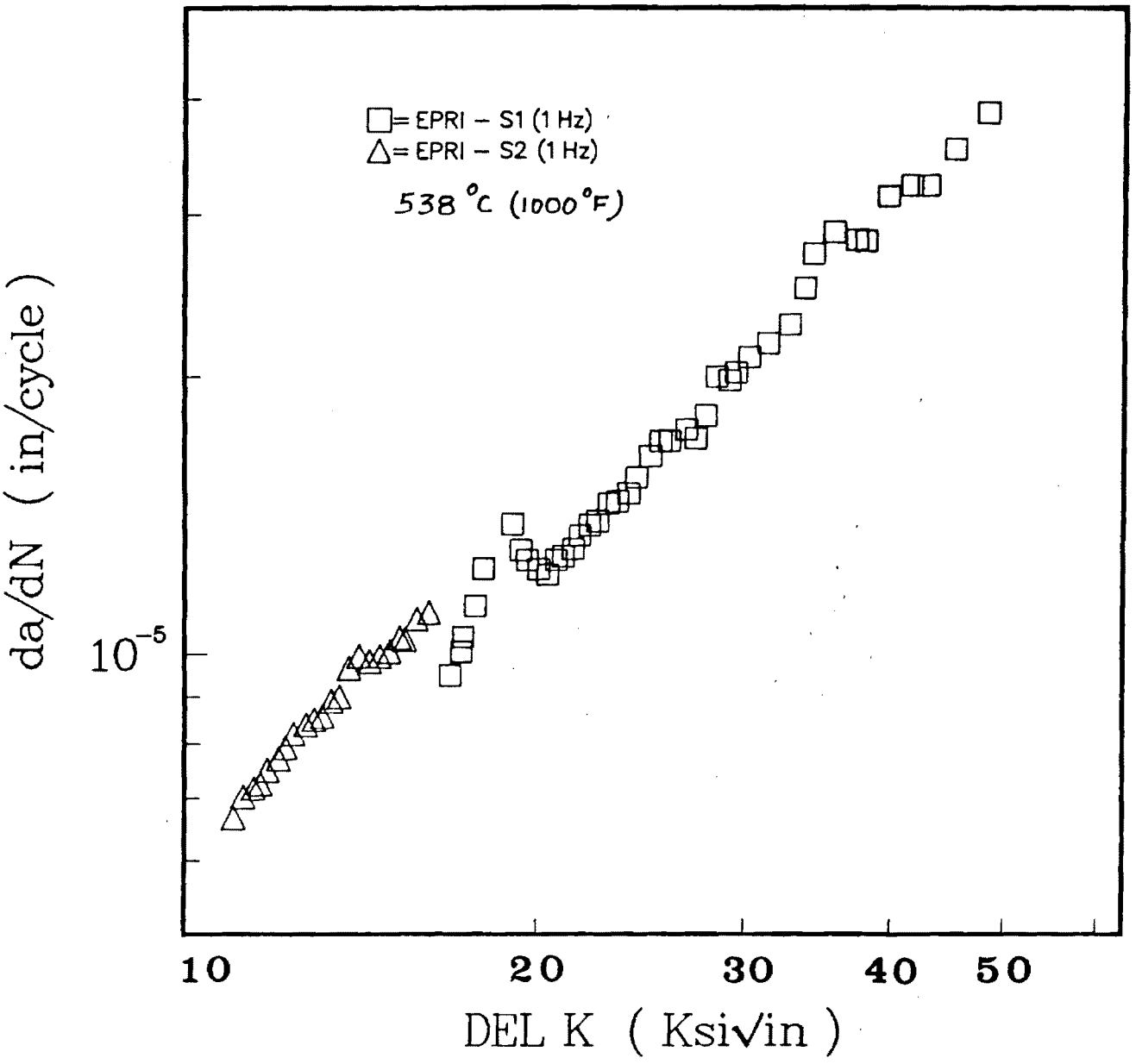

Fig. 2. Fatigue crack growth rate data for 1 1/4 Cr- 1/2 Mo ex-service header material. The specimens were taken from the cold region of the header.

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

Dr. Saxena
Dr. No. 347

February 4, 1987

Mr. Robert Ryder
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Dear Bob:

Enclosed is the cost performance and technical progress report for the months of November and December, 1986. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

Enclosures

cc: Brian Lindberg, OCA-Ga. Tech

Contractor Cost Performance Report

GA Technologies Subcontract No. SC 071341

Project Manager: D. A. Roberts/R. Ryder

Period of Performance: 11/1/86-12/31/86

	Nov.	Dec.	Total 1986
Actual Cost (kilo-dollars)	6.0	6.0	57.1
Projected Cost	6.0	6.0	57.1

Prepared by:

Ashok Saxena
Professor of Materials Engineering

Contractor Name: Georgia Tech Research Co.
Centennial Research Building
Georgia Institute of Technology
Atlanta, Georgia 30332

E-18-621

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332
404/894-

April 9, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period ending 3-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 2-1-87 to 3-31-87

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	0	0
2.3.2 - Creep Crack Growth Testing	0	0
2.3.3 - Finite Element Modeling	20	20
2.3.4 - Creep-Fatigue Crack Growth Testing	25	25

Date:

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10	For EPRI Use Only	Fracture and Fatigue Research Lab Georgia Tech Research Corp. Georgia Institute of Technology Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliott	PERIOD OF PERFORMANCE From 1/1/87 to 3/31/87	

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Prior Year(s) Actual
	58.0

Actual (booked) cost in the current year 19 87

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Actual
7.7	5.5	7.3*										20.5

Forecast to complete the current year 19 87

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast
			10.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	13.5	128.5

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 88	19 89	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast
131	29			160	160

Grand total of lines (1) + (2) + (3) + (4) 360

Remarks: Comments on significant items

*Figures supplied for the current month are best estimates at the time this report was prepared. The final figures will be included in the next month's report.

PREPARED BY

Print name Ashok Saxena Date 4-8-87

Title Professor of Materials Engineering

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102
404/894- 2888

May 11, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period ending 3-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 4-1-87 to 4-30-87

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	0	0
2.3.2 - Creep Crack Growth Testing	0	0
2.3.3 - Finite Element Modeling	30	30
2.3.4 - Creep-Fatigue Crack Growth Testing	35	35

Date:

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10	For EPRI Use Only	Fracture and Fatigue Research Lab Georgia Tech Research Corp. Georgia Institute of Technology Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliott	PERIOD OF PERFORMANCE From 4/1/87 to 4/30/87	

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Actual (booked) cost in the current year 19 87	7.7	5.5	5.3	10.0*									Current Year Actual: 28.5	(2)
Forecast to complete the current year 19 87					16.0	14.0	14.0	14.0	14.0	14.0	14.0	13.5	Current Year Forecast: 120.5	(3)

Prior Year(s) Actual: 58.0 (1)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 88	19 89	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast	
131	29			160	160	(4)

Grand total of lines (1) + (2) + (3) + (4) 360

Remarks: Comments on significant items

*Figures supplied for the current month are best estimates at the time this report was prepared. The final figures will be included in next month's report.

PREPARED BY

Print name Ashok Saxena Date 5-11-87

Title Professor of Materials Engineering

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102
404/894-

June 5, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 5-1-87 thru 5-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 5-1-87 to 5-31-87

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	10	10
2.3.2 - Creep Crack Growth Testing	10	10
2.3.3 - Finite Element Modeling	45	45
2.3.4 - Creep-Fatigue Crack Growth Testing	50	50

Date:

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10	For EPRI Use Only	Fracture and Fatigue Research Lab Georgia Tech Research Corp. Georgia Institute of Technology Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliott	PERIOD OF PERFORMANCE From 5/1/87 to 5/31/87	

Note:
- Instructions for completing this form are on the reverse side.
- All figures are to be shown in U.S. dollars—whole thousands only.
- Show EPRI portion of the contract only. Do not include contractor cost sharing.

	Prior Year(s) Actual	
	58.0	(1)

Actual (booked) cost in the current year 19 87

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Actual	
7.7	5.5	5.3	9.7	13.8*								28.5	(2)

Forecast to complete the current year 19 87

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast	
					15.0	15.5	14.0	14.0	14.0	14.0	13.5	120.5	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 88	19 89	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast	
131	29			160	160	(4)

Grand total of lines (1) + (2) + (3) + (4) 360

Remarks: Comments on significant items

*Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name Ashok Saxena Date 6-5-87

Title Professor of Materials Engineering

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102
404/894-2888

July 7, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 6-1-87 thru 6-30-87. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 6-1-87 to 6-30-87

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	15	15
2.3.2 - Creep Crack Growth Testing	10	10
2.3.3 - Finite Element Modeling	50	50
2.3.4 - Creep-Fatigue Crack Growth Testing	60	60

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	For EPRI Use Only	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10			Fracture and Fatigue Research Lab Georgia Tech REsearch Corp. Georgia Institute of Technology Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliott	**PERIOD OF PERFORMANCE** From 6/1/87 to 6/30/87		

Note:
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- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Prior Year(s) Actual	
	58.0	(1)

Actual (booked) cost in the current year 19 87

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Actual	
7.7	5.5	5.3	9.7	13.8	13.5							28.5	(2)

Forecast to complete the current year 19 87

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast	
						15.5	15.0	14.5	14.0	14.0	13.5	120.5	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 88	19 89	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast	
131	29			160	160	(4)

Grand total of lines (1) + (2) + (3) + (4) 360

Remarks: Comments on significant items

*Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name Ashok Saxena Date 7-7-87

Title Professor of Material Engineering

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

August 11, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 7-1-87 thru 7-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 6-1-87 to 6-30-87

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	25	25
2.3.2 - Creep Crack Growth Testing	20	20
2.3.3 - Finite Element Modeling	65	65
2.3.4 - Creep-Fatigue Crack Growth Testing	75	75

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	For EPRI Use Only	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10			Fracture and Fatigue Research Lab Georgia Tech Research Corp Georgia Institute of Technology Altanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliot	**PERIOD OF PERFORMANCE** From 7/1/87 to 7/31/87		

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Prior Year(s) Actual	
	58.0	(1)

Actual (booked) cost in the current year 19 87

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Actual	
7.7	5.5	5.3	9.7	13.8	15.5	12.0						69.5	(2)

Forecast to complete the current year 19 87

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast	
							15.0	15.0	15.0	14.0	13.5	142.0	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 88	19 89	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast	
131	29			160	160	(4)
				Grand total of lines (1) + (2) + (3) + (4)	360	

Remarks: Comments on significant items

*Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name Ashok Saxena Date 7-7-87

Title Professor of Material Engineering

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

September 3, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 8-1-87 thru 8-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 6-1-87 to 6-30-87

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	30	30
2.3.2 - Creep Crack Growth Testing	20	20
2.3.3 - Finite Element Modeling	75	75
2.3.4 - Creep-Fatigue Crack Growth Testing	80	80

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	For EPRI Use Only	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10			Fracture and Fatigue Research Lab Georgia Tech Research Corp Georgia Institute of Technology Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliot	**PERIOD OF PERFORMANCE** From 7/1/87 to 7/31/87		

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Prior Year(s) Actual	
													58.0	(1)
Actual (booked) cost in the current year 19 ____	7.7	5.5	5.3	9.7	13.8	15.5	9.0	22.0					Current Year Actual: 69.5	(2)
Forecast to complete the current year 19 ____									14.0	14.0	13.0	12.5	Current Year Forecast: 142.0	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 88	19 89	19 ____	19 ____	Remaining Years(s)	Future Year(s) Forecast	
131	29			160	160	(4)
				Grand total of lines (1) + (2) + (3) + (4)	360	

Remarks: Comments on significant items

*Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name Ashok Saxena Date 7-7-87

Title Professor of Materials Engineering

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

October 1, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 9-1-87 thru 9-30-87. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 9-1-87 to 9-30-87

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	30	30
2.3.2 - Creep Crack Growth Testing	20	20
2.3.3 - Finite Element Modeling	75	75
2.3.4 - Creep-Fatigue Crack Growth Testing	80	80

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	For EPRI Use Only	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10			Fracture and Fatigue Research Lab Georgia Tech Research Corp Georgia Institute of Technology Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliot	**PERIOD OF PERFORMANCE** From 9/1/87 to 9/30/87		

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Prior Year(s) Actual	
													58.0	(1)
Actual (booked) cost in the current year 19 ____	7.7	5.5	5.3	9.7	13.8	15.5	9.0	22.0	12.0				Current Year Actual: 69.5	(2)
Forecast to complete the current year 19 ____										15.0	14.0	12.5	Current Year Forecast: 142.0	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 88	19 89	19 ____	19 ____	Remaining Years(s)	Future Year(s) Forecast	
131	29			160	160	(4)
				Grand total of lines (1) + (2) + (3) + (4)	360	

Remarks: Comments on significant items

*Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name Ashok Saxena Date 7-7-87

Title Professor of Materials Engineering

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

November 23, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 10-1-87 thru 10-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 9-1-87 to 9-30-87

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	60	60
2.3.2 - Creep Crack Growth Testing	20	20
2.3.3 - Finite Element Modeling	90	90
2.3.4 - Creep-Fatigue Crack Growth Testing	80	80

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2 2 5 3 – 1 0	For EPRI Use Only	Fracture and Fatigue Research Lab Georgia Tech Research Corp Georgia Institute of Technology Atlanta, GA 30332
EPRI PROJECT MANAGER Name	PERIOD OF PERFORMANCE From 9/1/87 to 9/30/87	

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Prior Year(s) Actual	
	58.0	(1)

Actual (booked) cost in the current year 19 ____

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Actual	
7.7	5.5	5.3	9.7	13.8	15.5	9.0	22.0	12.0	13.0			69.5	(2)

Forecast to complete the current year 19 ____

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast	
									13.0	5.0	13.5	142.0	(3

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 ____	19 ____	19 ____	19 ____	Remaining Years(s)	Future Year(s) Forecast	
					160	(4

Grand total of lines (1) + (2) + (3) + (4) 360

Remarks: Comments on significant items

PREPARED BY

Print name Ashok Saxena Date 7-7-87

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

6,8:9

January 5, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 11-1-87 thru 12-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 11-1-87 to 12-31-87

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	85	85
2.3.2 - Creep Crack Growth Testing	40	40
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	80	80

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

EPRI 177 9/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10	For EPRI Use Only	Fracture and Fatigue Research Lab Georgia Tech Research Corp Georgia Institute of Technology Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliot	PERIOD OF PERFORMANCE From 11/1/8 to 12/31/87*	

Note: • Instructions for completing this form are on the reverse side.
• All figures are to be shown in U.S. dollars—whole thousands only.
• Show EPRI portion of the contract only. Do not include contractor cost sharing.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Prior Year(s) Actual	
														(1)
Actual (booked) cost in the current year 19 ___	7.7	5.5	5.3	9.7	13.8	15.5	9.0	12.0	12.0	14.9	14.6	13.5	Current Year Actual: 133.5	(2)
Forecast to complete the current year 19 ___													Current Year Forecast: 133.5	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 88	19 89	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast	
139.5	29			169.5	169.5	(4)

Grand total of lines (1) + (2) + (3) + (4) 360

Remarks: Comments on significant items

*Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name Ashok Saxena Date 7-7-87

Title Professor of Materials Engineering

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 1-1-88 to 1-31-88

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	85	85
2.3.2 - Creep Crack Growth Testing	50	50
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	80	80

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	For EPRI Use Only	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2 2 5 3 - 1 0			Fracture and Fatigue Research Lab Georgia Tech. Research Co. Georgia Institute of Tech. Atlanta, Ga 30332
EPRI PROJECT MANAGER Name J. Elliot	**PERIOD OF PERFORMANCE** From 1/1/88 to 1/31/88		

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Prior Year(s) Actual	
	200	(1)

Actual (booked) cost in the current year 19 88

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Actual	
10.0	10.0	10.0	12.0	12.0	12.0	12.0	10.0	10.0	12.5	10	10	130.5	(2)

Forecast to complete the current year 19 ____

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast	
10.0												130.5	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 89	19 ____	19 ____	19 ____	Remaining Years(s)	Future Year(s) Forecast	
30.0					30.0	(4)

Grand total of lines (1) + (2) + (3) + (4) 360.5

Remarks: Comments on significant items

Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name A. Saxena Date 2/25/88

Title Professor of Materials Eng.

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894-

March 11, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 2-1-88 thru 2-29-88. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 2-1-88 to 2-29-88

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	85	85
2.3.2 - Creep Crack Growth Testing	50	50
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	80	80
2.3.5 - Simulated Thermal Mechanical Fatigue Testing	20	20

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	For EPRI Use Only	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10			Fracture and Fatigue Research Lab Georgia Tech. Research Co. Georgia Institute of Tech. Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliot	PERIOD OF PERFORMANCE From 2/1/88 to 2/29/88		

Note:
- Instructions for completing this form are on the reverse side.
- All figures are to be shown in U.S. dollars—whole thousands only.
- Show EPRI portion of the contract only. Do not include contractor cost sharing.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Prior Year(s) Actual	
													200	(1)
Actual (booked) cost in the current year 19 ___	10.0	10.0											Current Year Actual 20.0	(2)
Forecast to complete the current year 19 ___	10.0	10.0	10.0	12.0	12.0	12.0	12.0	10.0	10.0	12.5	10.0	10.0	Current Year Forecast 130.5	(3)

Forecast to complete the future year(s)	19 89	19 ___	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast	
	30.0					30.0	(4)
					Grand total of lines (1) + (2) + (3) + (4)	360.5	

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Remarks: Comments on significant items

Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name A. Saxena Date 2/25/88

Title Professor of Materials Eng.

E-11-6-1

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 2-1-88 to 2-29-88

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	85	85
2.3.2 - Creep Crack Growth Testing	60	60
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	80	80
2.3.5 - Simulated Thermal Mechanical Fatigue Testing	25	25

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2153-10	For EPRI Use Only	Fracture and Fatigue Research Lab Georgia Tech. Research Co. Georgia Institute of Tech. Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliot	PERIOD OF PERFORMANCE From 3/1/88 to 3/31/88	

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Actual (booked) cost in the current year 19 ___	10.0	10.0	10.0										Prior Year(s) Actual	(1)
													Current Year Actual	300.0 (2)
Forecast to complete the current year 19 ___				12.0	12.0	12.0	12.0	10.0	10.0	12.5	10.0	10.0	Current Year Forecast	130.5 (3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked

Forecast to complete the future year(s)

19 89	19 ___	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast
30.0					30.0 (4)

Grand total of lines (1) + (2) + (3) + (4) 360.5

Remarks: Comments on significant items

Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name A. Saxena Date 4/6/88

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 4-1-88 to 4-30-88

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	85	85
2.3.2 - Creep Crack Growth Testing	70	70
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	80	80
2.3.5 - Simulated Thermal Mechanical Fatigue Testing	35	35

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	For EPRI Use Only	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2153-10			Fracture and Fatigue Research Lab Georgia Tech. Research Co. Georgia Institute of Tech. Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliot	PERIOD OF PERFORMANCE From 3/1/88 to 3/31/88		

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

Actual (booked) cost in the current year 19 ____

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Prior Year(s) Actual	Current Year Actual
10.0	10.0	10.3	11.7										42.5

Forecast to complete the current year 19 ____

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast
				12.0	12.0	12.0	10.0	10.0	12. 5	10.0	10.0	130.5

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked

Forecast to complete the future year(s)

19 89	19 ____	19 ____	19 ____	Remaining Years(s)	Future Year(s) Forecast
30.0					30.0

Grand total of lines (1) + (2) + (3) + (4) 360.5

Remarks: Comments on significant items

Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name A. Saxena Date 4/6/88

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894-

16:17

June 9, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 5-1-88 thru 5-31-88. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 5-1-88 to 5-31-88

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	90	90
2.3.2 - Creep Crack Growth Testing	70	70
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	85	85
2.3.5 - Simulated Thermal Mechanical Fatigue Testing	45	45

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2 2 5 3 - 1 0	For EPRI Use Only	Fracture and Fatigue Research Lab Georgia Tech. Research Co. Georgia Institute of Technology Atlanta, GA 30332
EPRI PROJECT MANAGER Name J. Elliott	PERIOD OF PERFORMANCE From 5/1/88 to 5/31/88	

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Prior Year(s) Actual														(1)
Actual (booked) cost in the current year 19 ___	10.0	10.0	10.3	12.0									54	(2)
Forecast to complete the current year 19 ___						12.0	14.0	14.0	14.0	10.5	8.0	8.0	76.5	(3)

	19 ___	19 ___	19 ___	19 ___	Remaining Years(s)	
Future Year(s) Forecast	30.0					30.0 (4)
					Grand total of lines (1) + (2) + (3) + (4)	360.5

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

Remarks: Comments on significant items

Figues supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name A. Saxena Date 6/8/88

Title Professor of Materials Engineering

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894-

July 15, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 6-1-88 thru 5-30-88. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 6-1-88 to 6-30-88

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	100	100
2.3.2 - Creep Crack Growth Testing	75	75
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	85	85
2.3.5 - Simulated Thermal Mechanical Fatigue Testing	45	45

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10	For EPRI Use Only	
EPRI PROJECT MANAGER: Name J. Elliot	PERIOD OF PERFORMANCE: From 6/1/88 to 6/30/88	

Note:
- Instructions for completing this form are on the reverse side.
- All figures are to be shown in U.S. dollars—whole thousands only.
- Show EPRI portion of the contract only. Do not include contractor cost sharing.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Prior Year(s) Actual	
														(1)
Actual (booked) cost in the current year 19 ___	10.0	10.0	10.3	11.7	11.0	11.0							Current Year Actual: 64.0	(2)
Forecast to complete the current year 19 ___							12.0	11.0	11.0	12.5	10.0	10.0	Current Year Forecast: 130.5	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 89	19 ___	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast	
30.0					30.0	(4)
				Grand total of lines (1) + (2) + (3) + (4)		

Remarks: Comments on significant items

Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name A. Saxena Date 7/15/88

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894-

August 10, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 7-1-88 thru 7-31-88. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 7-1-88 to 7-31-88

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	100	100
2.3.2 - Creep Crack Growth Testing	80	80
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	90	90
2.3.5 - Simulated Thermal Mechanical Fatigue Testing	45	45

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	For EPRI Use Only	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10			
EPRI PROJECT MANAGER	PERIOD OF PERFORMANCE		
Name J. Elliot	From 7/1/88 to 7/31/88		

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Prior Year(s) Actual	
														(1)
Actual (booked) cost in the current year 19 ___	10.0	10.0	10.3	11.7	11.0	11/0	12.0						Current Year Actual	(2)
Forecast to complete the current year 19 ___								11.0	11.0	12.5	10.0	10.0	Current Year Forecast 130.5	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 89	19 ___	19 ___	19 ___	Remaining Years(s)	Future Year(s) Forecast	
30.0					30.0	(4)
				Grand total of lines (1) + (2) + (3) + (4)		

Remarks: Comments on significant items

Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name A. Saxena Date 8/10/88

Georgia Tech

School of Materials Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0245
(404) 894-

October 14, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 8-1-88 thru 9-30-88. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 8-1-88 to 9-30-88

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	100	100
2.3.2 - Creep Crack Growth Testing	80	80
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	90	90
2.3.5 - Simulated Thermal Mechanical Fatigue Testing	50	60

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10	For EPRI Use Only	
EPRI PROJECT MANAGER: Name J. Elliott	PERIOD OF PERFORMANCE: From 8/1/88 to 9/30/88	

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Actual (booked) cost in the current year 19 ____	10.0	10.0	10.3	11.7	11.0	11.0	12.0	11.0	8.64	8.0	8.0	8.86	
Forecast to complete the current year 19 ____													120.5

	Prior Year(s) Actual	Current Year Actual	Current Year Forecast
	(1)	(2)	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 ____	19 ____	19 ____	19 ____	Remaining Years(s)	Future Year(s) Forecast
40.0					30.0 (4)

Grand total of lines (1) + (2) + (3) + (4)

Remarks: Comments on significant items

Figures supplied for the current month are best estimates at the time of this report. The final figures will be included in next month's report.

PREPARED BY

Print name A. Saxena Date 10/14/88

Georgia Tech

School of Materials Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0245
(404) 894-

E-18-621

April 3, 1989

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 10/1/88 thru 3/31/89. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 10/1/88 to 3/31/89

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	100	100
2.3.2 - Creep Crack Growth Testing	90	90
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	90	90
2.3.5 - Simulated Thermal Mechanical Fatigue Testing	60	60

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2 2 5 3 - 1 0	For EPRI Use Only	Georgia Tech Research Co. (404)894-2888
EPRI PROJECT MANAGER: Name J. Elliott	PERIOD OF PERFORMANCE: From 1/1/89 to 3/1/89	

Note:
- **Instructions for completing this form are on the reverse side.**
- **All figures are to be shown in U.S. dollars—whole thousands only.**
- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

Actual (booked) cost in the current year 19 89

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Actual
1.5	1.50	3.0										6.0 (2)

Forecast to complete the current year 19 ____

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast
			3.0	2.0	6.0	6.0	6.0	6.0	2.0	2.0	1.0	34.0 (3)

Prior Year(s) Actual
320.0 (1)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 ____	19 ____	19 ____	19 ____	Remaining Years(s)	Future Year(s) Forecast
					0 (4)

Grand total of lines (1) + (2) + (3) + (4) 360.0

Remarks: Comments on significant items

PREPARED BY

Print name A. Saxena Date 4/3/89

Title Professor

Georgia Tech

School of Materials Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0245
(404) 894-

June 9, 1989

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 4/1/89 thru 5/31/89. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 4/1/89 to 5/31/89

Agency: GA Technologies Inc.
P.O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	100	100
2.3.2 - Creep Crack Growth Testing	90	90
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	95	95
2.3.5 - Simulated Thermal Mechanical Fatigue Testing	100	100

Prepared by:

Ashok Saxena
Professor of Materials Engineering

EPRI

CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10	For EPRI Use Only	Georgia Tech Research Co. (404)894-2888
EPRI PROJECT MANAGER: Name J. Elliott	PERIOD OF PERFORMANCE: From 4/1/89 to 3/1/89	

Note:
- Instructions for completing this form are on the reverse side.
- All figures are to be shown in U.S. dollars—whole thousands only.
- Show EPRI portion of the contract only. Do not include contractor cost sharing.

	Prior Year(s) Actual	
	320.0	(1)

Actual (booked) cost in the current year 19 89

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Actual	
1.5	1.50	3.0	2.0									11.0	(2)

Forecast to complete the current year 19 ____

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast	
					6.0	6.0	6.0	6.0	2.0	2.0	1.0	29.0	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked.

Forecast to complete the future year(s)

19 ____	19 ____	19 ____	19 ____	Remaining Years(s)	Future Year(s) Forecast	
					0	(4)

Grand total of lines (1) + (2) + (3) + (4) 360.0

Remarks: Comments on significant items

PREPARED BY

Print name A. Saxena 6/3/89

Georgia Tech

School of Materials Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0245
(404) 894-

August 15, 1989

Mr. Jim Elliott
GA Technologies, Inc.
P. O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Cost and % C&C Reports GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the monthly cost (EPRI form 177) and the % C&C Reports for the period 6-1-89 through 7-31-89. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/gef

cc: OCA Reports Coordinator

Monthly Percent Complete and Cost Report

AN INTEGRATED APPROACH TO LIFE ASSESSMENT
OF BOILER PRESSURE PARTS (RP2253-10) - Task 2.3

Period of Performance: 6-1-89 to 7-31-89

Agency: GA Technologies Inc.
P. O. Box 85608
San Diego, CA 92138

Attn. Mr. Jim Elliott

Sub-Task No. and Name	% Complete	% Cost
2.3.1 - Fracture Toughness	100	100
2.3.2 - Creep Crack Growth Testing	100	100
2.3.3 - Finite Element Modeling	100	100
2.3.4 - Creep-Fatigue Crack Growth Testing	90	90

Prepared by:

Astok Saxena
Professor of Materials Engineering

EPRI

CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 5/84R

EPRI CONTRACT NUMBER	EPRI DIVISION NUMBER	CONTRACTOR NAME, ADDRESS AND TELEPHONE NUMBER
RP 2253-10	For EPRI Use Only	Mechanical Properties Res. Lab. Georgia Tech. Res. Co. Georgia Institute of Technology Atlanta, Georgia 30332
EPRI PROJECT MANAGER Name Jim Elliott	PERIOD OF PERFORMANCE From 6-1-89 to 7-31-89	

Note:
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- **Show EPRI portion of the contract only. Do not include contractor cost sharing.**

	Prior Year(s) Actual	
	321	(1)

Actual (booked) cost in the current year 19 ____

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Actual	
1.5	1.5	3.0	3.0	3.0	4.9	3.6						20.5	(2)

Forecast to complete the current year 19 ____

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Current Year Forecast	
							6.0	6.0	3.0	2.5	2.0	19.5	(3)

Unbooked liability

Please list dollar amount, description of cost, and month/year in which costs are expected to be booked

Forecast to complete the future year(s)

19 ____	19 ____	19 ____	19 ____	Remaining Years(s)	Future Year(s) Forecast	
					0	(4)

Grand total of lines (1) + (2) + (3) + (4) 361

Remarks: Comments on significant items

PREPARED BY

Print name Ashok Saxena Date 8-11-89

SCHEDULE D (Subcontract to Georgia Tech Research Institute)

COST ESTIMATE Si_3N_4 COMPOSITE FABRICATION			Twelve Months
DIRECT SALARIES AND WAGES (DSW) (see Note 1)			$9,917
Principal Research Engineers/Scientists			
0.50 months @ avg. $7,385 per mo. x	1.040	$3,840	
Technicians			
1.75 months @ avg. $2,515 per mo. x	1.040	$4,577	
Project Management Costs-PMC (see Note 2)		$1,111	
Allocated Project Level Costs (see Note 3)		$ 389	
FRINGE BENEFITS			$2,222
22.3 % of DSW excluding students and APLC		$2,125	
APLC		$ 97	
COMPUTER			$ 24
APLC		$ 24	
MATERIALS AND SUPPLIES			$ 828
Actual		$ 500	
APLC		$ 328	
TOTAL DIRECT COST			$12,991
INDIRECT EXPENSES: 54.4% of MTDC	$12,991		
Based on OMB Circular A-21 modified total direct cost base - includes all items above except equipment (if any), other than any contractually required deliverable hardware/equipment, and except amounts over $25,000 of each subcontract (if any) - rate approved by Cognizant Government Agency for period 1 July through 30 June of each year and is subject to adjustment thereafter.			$ 7,067
TOTAL ESTIMATED PROJECT COST:			$20,058

Note 1. Direct salary and wage rates are based on actual average labor rates by category 1 July 1988 to 30 June 1989. Direct salaries and wages for this project for months past the end of the present Fiscal Year are factored by 4.0% as calculated on a pro-rata basis.

The formula for this calculation is:

$$1.040 = \frac{\text{FY89: } 0 \text{ mo.} \times 1.00 + \text{FY90: } 12 \text{ mo.} \times 1.04}{12}$$

Note 2. Project Management Costs include actual costs for various laboratory level project management personnel required to support this research project. Different skilled personnel will be utilized to support the project as appropriate during the different phases of the project.

Note 3. APLC is the pro-rated actual cost for various support services and supplies required to support research within GTRI not otherwise directly or indirectly charged to the project (office supplies, equipment/instrument maintenance and calibration, printing costs, etc.).

TECHNICAL PROGRESS REPORT

Sponsor: G.A. Technologies, Inc.

Project Manager R. Ryder

Period of Performance 3/1/86 to 7/31/86

PROGRESS BY MONTHS

April, 1986 -

- Attended the International Conference on Creep in Tokyo and presented a paper based on RP 2253 project
- Finalized the scope of the three year program to be conducted at GTRC including the Westinghouse subcontract

May, 1986 -

- Prepared for the Industrial Advisory Group meeting
- Completed the negotiation for the letter subcontract
- Started preparation for the test set-up

June 1986 -

- Attended the Industrial Advisory Group Meeting and the kick-off meeting for 2253-10 project.

July 1986

- Defined a test matrix to be completed in 1986. Laid out the specimen and sent the order for machining. The machined specimens are due-in anytime. The test matrix is attached.
- Initiated work on the finite element analysis to validate the C_t parameter. A path-independent integral which can be identified as C_t has been formulated. In the future months, the integral will be further evaluated by finite element analysis.

Test Matrix for 1986 ($1\frac{1}{4}$ Cr. $\frac{1}{2}$ Mo Header Material)

Spec. location	No. of Tests	Freq. (Hz)	Waveform
south end	2	1	balanced triangular
north end	2	1	balanced triangular
south end	1	0.01	balanced triangular
south end	1	0.01	negative saw tooth
south end	1	0.01	positive saw tooth
north end	1	0.01	balanced triangular
north end	1	0.01	negative saw tooth
north end	1	0.01	positive saw tooth

For Technical Progress Report for the period 8-1-86 to 10-31-86, see Cost Performance Reports.

Technical Progress Report

Sponsor: GA Technologies, Inc.

Project Manager: R. Ryder

Period of Performance: 11/1/86-12/31/86

Progress by Months

Nov. 1986 - Fatigue crack growth testing of 1¼ Cr - ½ Mo steel continued at a cyclic frequency of 0.01 Hz and 1000°F.

The data reduction for the literature survey continued during this month.

Finite element analysis with creep laws including primary creep were performed

Dec. 1986 - Fatigue crack growth testing of 1¼ Cr - ½ Mo steel continued.

The literature search for creep crack growth data was completed and summarized in a report. The report is currently under review at GA Technologies and at EPRI.

E-18-621

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332
404/894-

April 2, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 3-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 2-01-87 to 3-31-87

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

A subcontract was offered to Westinghouse Research and Development Center to conduct creep crack growth testing and fracture toughness testing. This contract is currently under negotiation.

Preparation of a manuscript is underway which details our primary creep characterization of the CCT specimen. The paper will be submitted for publication in a suitable mechanics journal. From this work, the importance of inclusion of primary creep in the analytical calculation of C_t is clear.

Creep-fatigue crack growth tests on hot and cold ends of the RB 304 header are continuing. In the past two months, two more tests have been completed. the results do not show significant differences in the FCGR behaviors between the hot and cold ends of the header even at cycle times of 100 sec.

A one day review meeting with GA project monitors was conducted on February 19 at GTRC. We also participated in an overall project meeting at EPRI on March 24, 1987.

Comments from GA and EPRI were received on the creep crack growth literature survey report. Additional creep crack growth data on 2 25Cr-1Mo weldments is being added to the previous data. The report will be re-issued shortly with the changes.

PLANS FOR THE NEXT REPORTING PERIOD

Fracture toughness and creep crack growth specimens will be machined from the RB 304 header. A topical report on the creep crack growth data literature survey will be completed. The report on the influence of primary creep on the magnitude of C_t will be completed. Creep-fatigue crack growth testing will continue.

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102
404/894- 2888

May 11, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 4-30-87. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 4-1-87 to 4-30-87

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

A subcontract was placed with Westinghouse Electric Co.-Research and Development Center to conduct fracture toughness and creep-fatigue crack growth tests.

A paper summarizing the influence of primary creep on the magnitude of C_t was prepared and sent to the International Journal of Fracture for publication. A copy will be mailed to GA shortly.

Creep-Fatigue crack growth testing on the RB 304 header material is continuing. We are currently evaluating alternate crack tip parameters for representing the data.

Preparation was made to attend the Industrial Advisory Group Meeting in Baberton, Ohio. The view graphs were prepared and mailed to GA.

Sketches of the RB 304 header material were mailed to GA and we are currently waiting for the test material from GA to initiate fracture toughness tests.

PLANS FOR THE NEXT REPORTING PERIOD

Fracture toughness test specimens will be machined from the RB 304 and Shawville header materials. Creep-fatigue crack growth testing will continue. Primary creep analysis of compact specimens will commence.

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102
404/894-2888

June 4, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 5-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 5-1-87 to 5-31-87

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

An oral briefing of the progress in the project was provided at a two-day meeting of the EPRI Industry Advisory Group on May 6 and 7, 1987.

The second draft of the literature review report and a paper assessing the influence of primary creep on the magnitude of C_t were sent to GA Technologies for review.

Test material pieces from the RB 304 header and the Shawville headers have been received. The layout of the fracture toughness and fatigue crack growth specimens from the various regions of the header is currently being done.

Creep-fatigue crack growth testing of the RB 304 header materials is continuing. Figure 1 shows the results from tests completed to date.

PLANS FOR THE NEXT REPORTING PERIOD

Specimen machining should be completed for fracture toughness and creep-fatigue crack growth tests during the next month.

Analysis of the creep-fatigue crack growth rate data will continue. Further finite element analysis runs on compact type specimens including primary creep will be made.

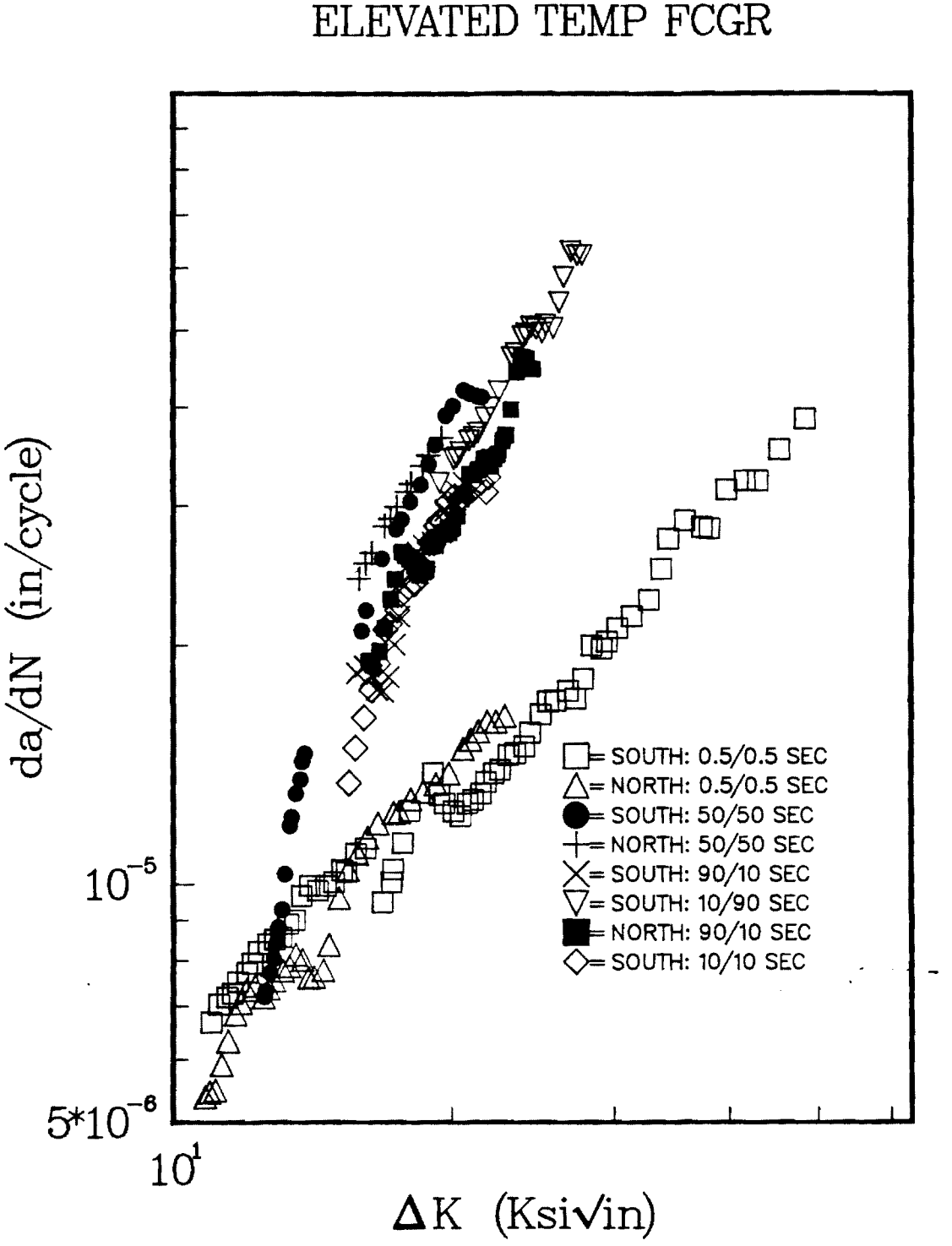


Figure 1 - Creep-fatigue crack growth data for 1¼Cr-0.5Mo steel at 1000F for various loading frequencies and waveforms.

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102
404/894-2888

July 6, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 6-30-87. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 6-1-87 to 6-30-87

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

A completed version of the literature review report on creep crack growth data was mailed to EPRI for publication.

Test specimens from the Shawville header are being machined. both creep-fatigue and fracture toughness testing are expected to commence soon.

Finite element analysis of a compact specimen including primary creep deformation model has been initiated.

PLANS FOR THE NEXT REPORTING PERIOD

Creep-fatigue crack growth data will be analyzed using a cyclic version of the C_t parameter. Work on the mathematical description of the creep-fatigue data will begin during this month. The finite element analysis of the compact specimen will also continue.

Fracture toughness tests on the RB 304 header are due to begin.

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

August 11, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 7-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 7-1-87 to 7-31-87

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

Creep-fatigue testing and data analysis of the 1¼Cr-½Mo header material was continued. The B&W report on finite element analysis of headers was reviewed and used to establish creep-fatigue and fracture toughness test conditions. Efforts to include primary creep in finite element analysis of compact type specimens were continued. Fracture toughness specimens were received after machining and are currently being precracked.

PLANS FOR THE NEXT REPORTING PERIOD

Mettallography of specimens tested under creep-fatigue conditions will be initiated. Fracture toughness tests will be conducted and finite element analysis of compact specimens will continue.

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

September 3, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 8-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 8-1-87 to 8-31-87

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

Creep-fatigue testing and data analysis of the 1¼Cr-½MO header material was continued. The specimens from the 2¼Cr-1MO header material were machined. The overall status of the creep-fatigue tests is described in Table 1. A plot of all creep-fatigue data obtained to this point is shown in Fig. 1.

Work is continuing on the inclusion of primary creep in the calculation of the C_t parameter and the influence of primary creep in CT-type specimen. Special attention is being denoted to obtaining accurate results.

All fracture toughness test specimens and longtime creep-fatigue crack growth test specimens have been machined. Approximately one half of these specimens have been precracked.

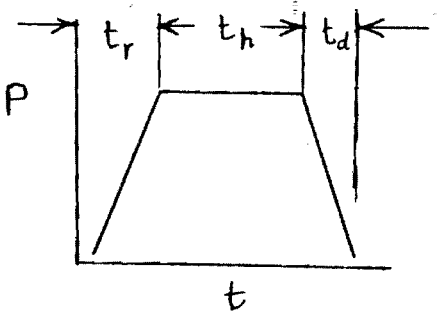
PLANS FOR THE NEXT REPORTING PERIOD

Creep-fatigue crack growth tests and fracture toughness tests will continue. Data analysis of results from creep-fatigue tests will continue. The finite element analysis results will be analyzed and a report will be provided in the next month.

Table 1. Summary Status of the Creep-fatigue Tests

erial & Condition	Test Temp (F)	Cycle Time (sec) t_r	t_d	t_h	No. of tests Proposed	finished
1¼Cr - ½MO	1000	0.5	0.5	0	2	2
BM/cold		50	50	0	2	2
		90	10	0	1	1
		10	90	0	1	1
		0.5	0.5	900	2	*
		0.5	0.5	57,600	3	*
		10	10	0	0	1
		1	1	98	0	1
	1100	0.5	0.5	0	1	*
	1100	0.5	0.5	900	1	*
1¼Cr-½MO	1000	0.5	0.5	0	1	2
BM/HOT		50	50	0	1	1
		0.50	0.50	900	1	1
1¼Cr-½MO	1000	50	50	0	1	*
Sim. HAZ		0.5	0.5	900	1	*
2¼Cr-1MO	1100	0.5	0.5	0	2	*
BM/Hot		50	50	0	1	*
		0.5	0.5	900	1	*
	1050	0.5	0.5	900	1	*
2¼Cr-1MO	1100	0.5	0.5	900	1	*
HAZ						

*yet to be completed



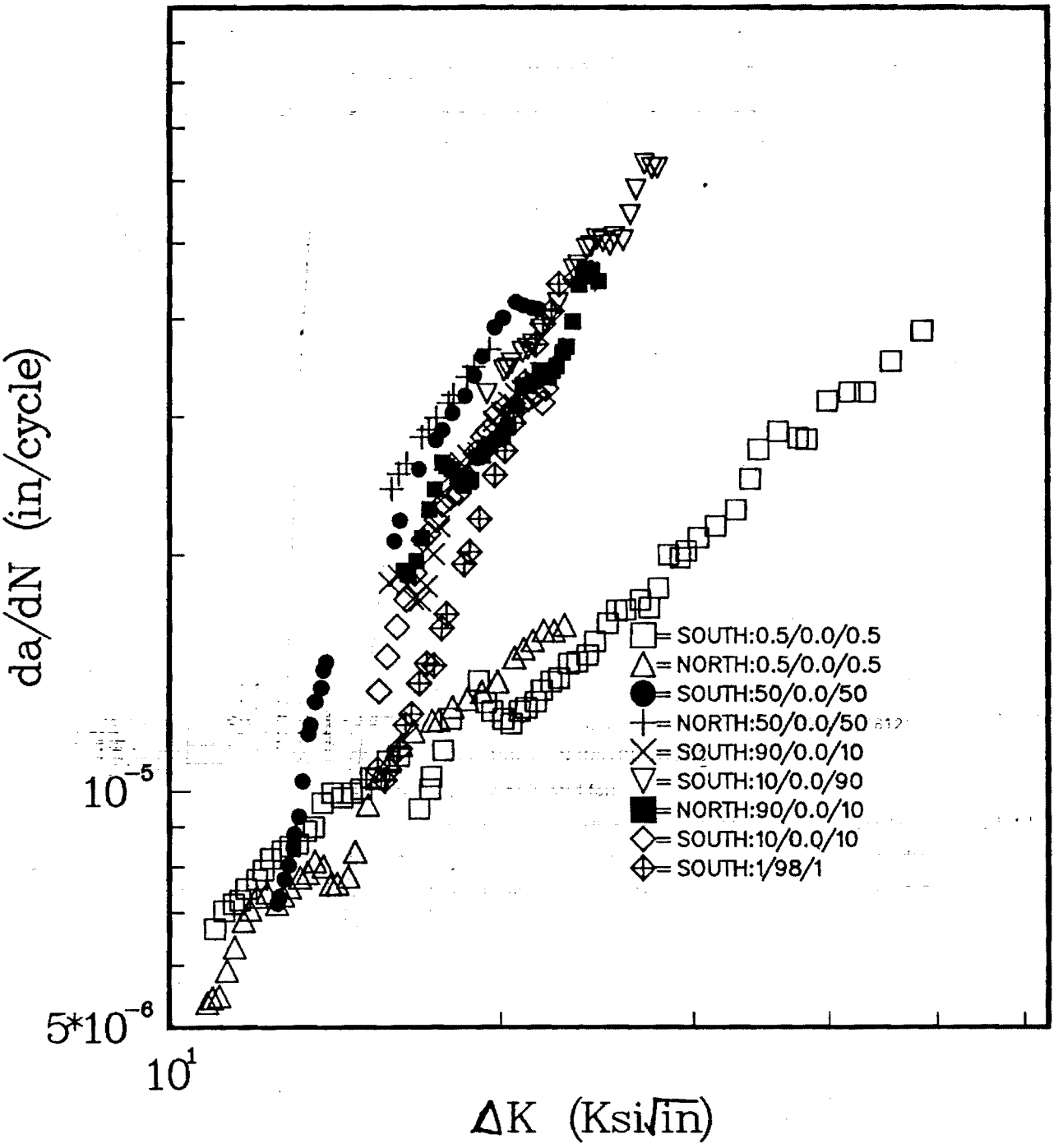


Figure 1 - Creep-fatigue crack growth results from 1¼Cr-½MO material at 1000°F

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

October 3, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 9-30-87. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 9-1-87 to 9-30-87

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

Fracture toughness tests on RB304 material are being conducted at elevated temperature (1000 F). Specimens for creep-fatigue crack growth tests with long hold times have been precracked. The tests are scheduled to commence in the month of October. The modeling of creep-fatigue crack growth data is continuing.

Work is continuing on the inclusion of primary creep in the calculation of the C_t parameter and the influence of primary creep in a CT-type specimen. The goal is to perform calculations with both secondary and primary-secondary creep constitutive equations to evaluate the plausibility of a multiplicative modification of the transient part of the C_t experession, i.e.

$$C_t = C^* + \underbrace{\left[\dot{r}_c^a/\dot{r}_c^{sc}\right]}_{\psi}\left(C_t^{ssc} - C_t^{ssc}\,\middle|\,\dot{v}_c = \dot{v}_{ss}\right)$$

where $\dot{r}_c^a$ is the actual creep zone size and $\dot{r}_c^{sc}$ is the size corresponding to a secondary creep assumption. With particular assumed forms of actual primary-secondary creep response, the coefficient ψ may be determined, either analytically or numerically. This concept is currently being examined.

PLANS FOR THE NEXT REPORTING PERIOD

Fracture toughness results at 1000 F should be available. Creep-fatigue tests with long hold time will be initiated. A more complete result on incorporating primary creep into the calculation of C_t will be available.

E-18-621

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

November 23, 1987

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 10-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 10-1-87 to 10-31-87

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

Side-grooving of eight fracture toughness specimens made from the Shawville header (2-1/4Cr-1Mo steel) has been completed. Six fracture toughness tests at 1100°F have been completed on the 2-1/4Cr-1Mo steel: two tests on the base metal machined from the cold region of the header, two tests on the base metal from the hot region, and two tests on the head-affected-zone (HAZ) metal from the cold region. Based on the literature data (1) of 2-1/4Cr-1Mo steel, yield strength and ultimate tensile strength at 1100°F were 25 and 47.5 ksi, respectively. Using these values of material strengths, the results of fracture toughness (J_{Ic}) are listed in Table 1. The average values of fracture toughness for the base (cold region) metal, the base (hot region) metal, and the HAZ (cold region) metal were 738, 767 and 774 in.-lbs/in.^{2}, respectively. The base metals machined from the cold and hot regions of the header seem to exhibit comparable fracture toughness. Moreover, the toughness value of the base metal fabricated from the cold region is essentially equivalent to that of the HAZ metal.

Creep-Fatigue crack growth tests with long hold times were initiated. One 1Hz fatigue crack growth test on the Shawville header material was completed. More tests are currently running. The data analysis work is also continuing.

The finite element analysis for inclusion of primary creep on a compact specimen was completed. Excellent agreement between predicted and observed deflection rate behavior is obtained when primary creep is included. A detailed topical report is currently being prepared.

Plans for Next Month

Eight fracture toughness tests will be completed on 1-1/4Cr-1/2Mo steel. Creep and creep-fatigue crack growth tests on both 2-1/4Cr-1Mo and 1-1/4Cr-1/2Mo steels will be initiated. Creep-fatigue crack growth testing with long hold times will continue. Work on the topical report on the inclusion of primary creep in the formulation of C_t will continue.

TABLE 1

FRACTURE TOUGHNESS RESULTS OF 2-1/4Cr-1Mo STEEL

Specimen Number	Status	Filename	Material Identification	Material Type	Location	Temperature °F	J_{Ic} (in.-lb/in.^{2})	K_{Ic} (ksi-in.^{5})
WCBIA-J1	Tested	WC1	2-1/4Cr-1Mo	Base	Cold Region	1100	673	128
WCBIA-J2	Tested	WC2	2-1/4Cr-1Mo	Base	Cold Region	1100	803	140
WHB1-J1	Tested	WH1	2-1/4Cr-1Mo	Base	Hot Region	1100	745	135
WHB1-J2	Tested	WH2	2-1/4Cr-1Mo	Base	Hot Region	1100	790	139
WCW1A-J1H	Tested	W1H	2-1/4Cr-1Mo	HAZ	Cold Region	1100	711	132
WCW1A-J2H	Tested	W2H	2-1/4Cr-1Mo	HAZ	Cold Region	1100	837	143

(1) J. Foulds, Private Conversation, GA Technology Inc., San Diego, CA.

FRACTURE AND FATIGUE RESEARCH LABORATORY
Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332-0102

3,4,5:7

January 5, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 12-31-87. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

11/1/87 - 12/31/87

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 11-1-87 to 12-31-87

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

Tables 1 and 2 summarize the status of the fracture toughness tests during the reporting period. The results of the tests are summarized in Figs. 1 and 2 for 1¼ Cr-1/2 Mo and 2¼Cr-Mo materials, respectively.

A creep-fatigue crack growth test on 2¼Cr-1Mo with 100 seconds hold time was completed.

An expression for incorporating primary creep into the C_t estimate was developed on the basis of the finite element results. A complete topical report of these results is currently under preparation.

PLANS FOR THE NEXT REPORTING PERIOD

Creep and creep-fatigue crack growth testing will be continued on both header materials. Preparation will be made to attend the Industrial Advisory Group meeting in the first week of February.

Table 1

FRACTURE TOUGHNESS TEST MATRIX AND TEST STATUS OF 1-1/4Cr-1/2Mo STEEL

pecimen Number	Material Type	Location	Temperature °F	Test Status
2A1-J1B	Base	Hot Region	75	Completed
2A1-J2B	Base	Hot Region	75	Completed
2A1-J3B	Base	Hot Region	1000	Completed
2A1-J4B	Base	Hot Region	1000	Completed
A3-J1B	Base	Cold Region	1000	Completed
A3-J2B	Base	Cold Region	1000	Completed
2A1-J1H	HAZ	Hot Region	1000	Completed
2A1-J2H	HAZ	Hot Region	1000	Completed

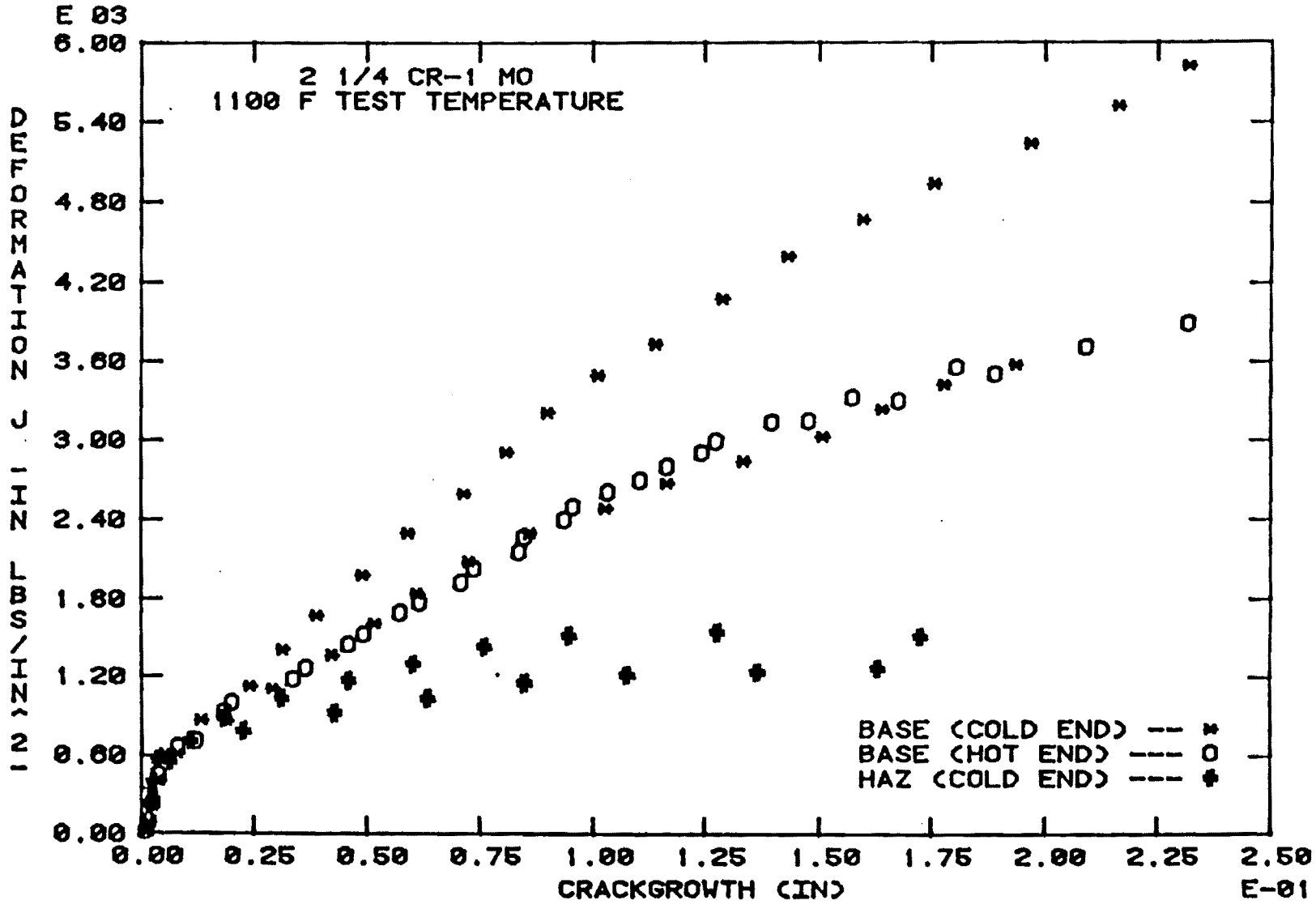

E 03
6.00
5.40
4.80
4.20
3.60
3.00
2.40
1.80
1.20
0.60
0.00
DEFORMATION J-INTEGRAL (LBS/IN)
2 1/4 CR-1 MO
1100 F TEST TEMPERATURE
BASE (COLD END) -- *
BASE (HOT END) --- O
HAZ (COLD END) --- *
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
CRACKGROWTH (IN)
E-01

Fig. 2

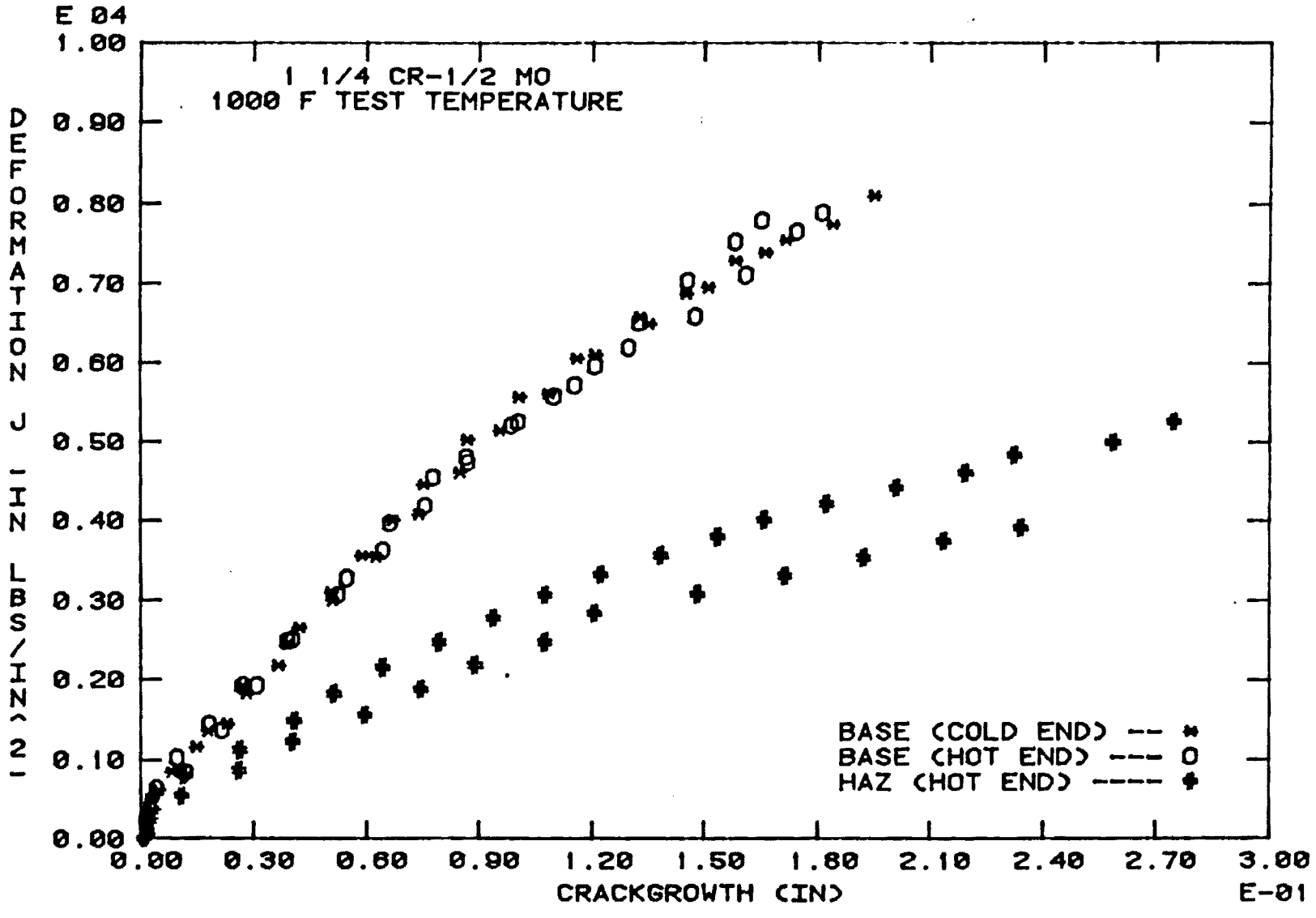

E 04
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
DEFORMATION J -IN LBS/IN^2-
1 1/4 CR-1/2 MO
1000 F TEST TEMPERATURE
BASE (COLD END) -- *
BASE (HOT END) --- O
HAZ (HOT END) ---- *
0.00
0.30
0.60
0.90
1.20
1.50
1.80
2.10
2.40
2.70
3.00
CRACKGROWTH (IN)
E-01

Fig. 1

Table 2

FRACTURE TOUGHNESS TEST MATRIX AND TEST STATUS OF 2-1/4Cr-1Mo STEEL

pecimen Number	Material Type	Location	Temperature °F	Test Status
/CB1A-J1	Base	Cold Region	1100	Completed
/CB1A-J2	Base	Cold Region	1100	Completed
/HB1-J1	Base	Hot Region	1100	Completed
/HB1-J2	Base	Hot Region	1100	Completed
/CW1A-J1H	HAZ	Cold Region	1100	Completed
/CW1A-J2H	HAZ	Cold Region	1100	Completed
/CB1A-J3	Base	Cold Region	?	To be Tested
/CB1A-J4	Base	Cold Region	?	To be Tested

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 1-1-88 to 1-31-88

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

Two creep-fatigue tests on 2¼Cr-1Mo steel specimens were completed. Preparations were made to attend the Industry Advisory Group meeting in San Diego.

Creep crack growth tests and creep-fatigue tests were continued. Preliminary data from these tests was presented at the IAG meeting.

Two creep-fatigue crack growth tests simulating the stress history of a cold start were performed. Results are currently being analyzed.

PLANS FOR THE NEXT REPORTING PERIOD

Creep and creep-fatigue crack growth testing will be continued on both header materials. Preparation will be made to attend the Industrial Advisory Group meeting in the first week of February.

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 2-1-88 to 2-29-88

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

Presentations on the progress of the work were made at the Industry Advisory Group meeting in San Diego. Creep and creep-fatigue crack growth testing is continuing. The $(C_t)_{avg}$ parameter for characterizing time-dependent crack growth during hold time is being evaluated at the present time with appropriate expressions for including primary crap behavior.

PLANS FOR THE NEXT REPORTING PERIOD

The B&W stress-time plots for various sections of the header will be analyzed to determine if fatigue crack growth testing with remote compressive stresses is necessary. This is in response to discussions during the Project Coordination Committee meeting held in San Diego. The work on a topical report including results from finite element analysis studies will continue. The draft report will be available by the end of April. The subcontract with Westinghouse for FY88 will be finalized.

L-11-681

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 3-1-88 to 3-31-88

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

The long-term creep and creep-fatigue tests at Westinghouse are continuing according to plans. The report on fracture toughness results including data from the literature is under preparation. The B&W stress analysis was used to determine loading waveforms for simulating cracking in headers. A report was prepared from these calculations and will be sent to GA Technologies shortly for review. The subcontract with westinghouse for work to be performed in this year finalized.

PLANS FOR THE NEXT REPORTING PERIOD

Creep and creep-fatigue tests will continue and the work on the report on fracture toughness data will also continue. Test fixtures for conducting creep-fatigue tests with compressive loading waveforms will be machined and specimen designs will be evaluated.

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 4-1-88 to 4-30-88

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

The preliminary creep crack propagation rate results of da/dt versus C_t for the HAZ metal of 2-1/4Cr-1Mo steel are presented in Figure 1. The creep crack propagation rates of the base metal of 1-1/4Cr-1/2Mo steel are also included for comparison. Note that the 2-1/4Cr-1Mo steel was machined from the Shawville header while the 1-1/4Cr-1/2Mo steel was from the RB304 Header. In the figure, the HAZ metal exhibits greater creep crack growth rates than the base metal.

Fracture surfaces of tested fracture toughness specimens of 1-1/4Cr-1/2Mo steel were carefully investigated using scanning electron microscopy. For the -40°F test of the base metal, beyond the fatigue precrack region, cleavage was found to be the dominant mode of fracture. In some areas, especially near the precrack region and at the middle section of the specimen, limited dimpled fracture was observed to precede the cleavage fracture. For the 1000°F test of the base metal, ductile fracture was observed, and dimpled fracture was the primary mode of fracture. In the HAZ metal, the fracture characteristics were, however, brittle in nature, and intergranular fracture was found to be present. The brittle fracture in the HAZ area corresponded to the lower J_R curve, as compared to the base metal. In contrast, the ductile fracture in the base metal gave the higher J_R curve relative to that in the HAZ metal.

It was shown that the $(da/dt)_{avg}$ during the hold time following an overload correlated well with the $C(_t)_{avg}$ for hold times ranging from 10 seconds to 600 seconds. A plot of this data will be included in the next monthly report.

PLANS FOR THE NEXT REPORTING PERIOD

Creep and creep-fatigue tests will continue and the work on the report on fracture toughness data will also continue. Test fixtures for conducting tests with compressive loading waveforms will be machined. The work on models for creep and creep-fatigue crack growth will be further developed. Work on the primary creep finite element analysis report will continue.

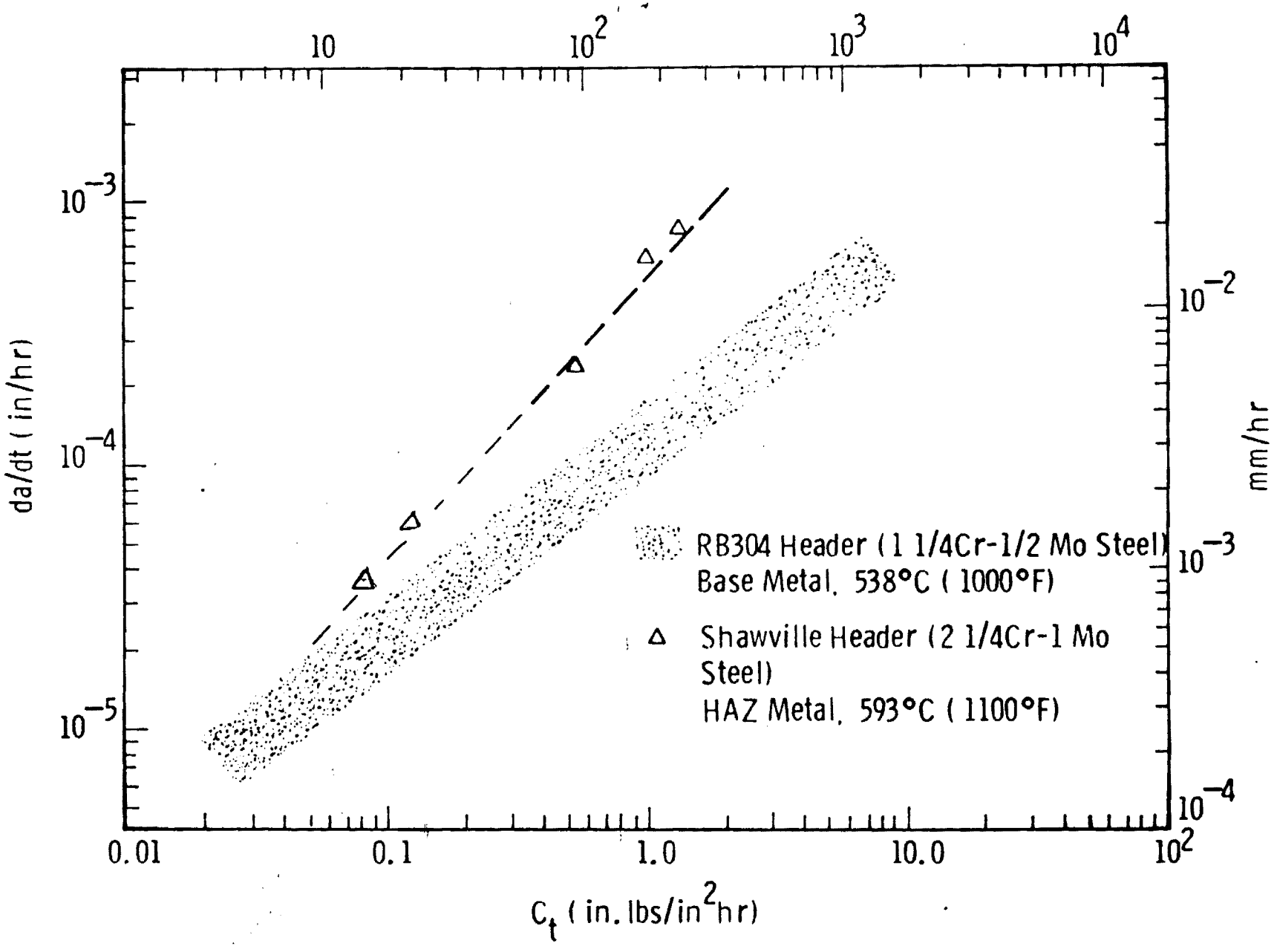


Figure 1 - Comparison of creep crack growth rates of base and HAZ metals

15

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894-

June 8, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 5-31-88. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 5-1-88 to 5-31-88

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

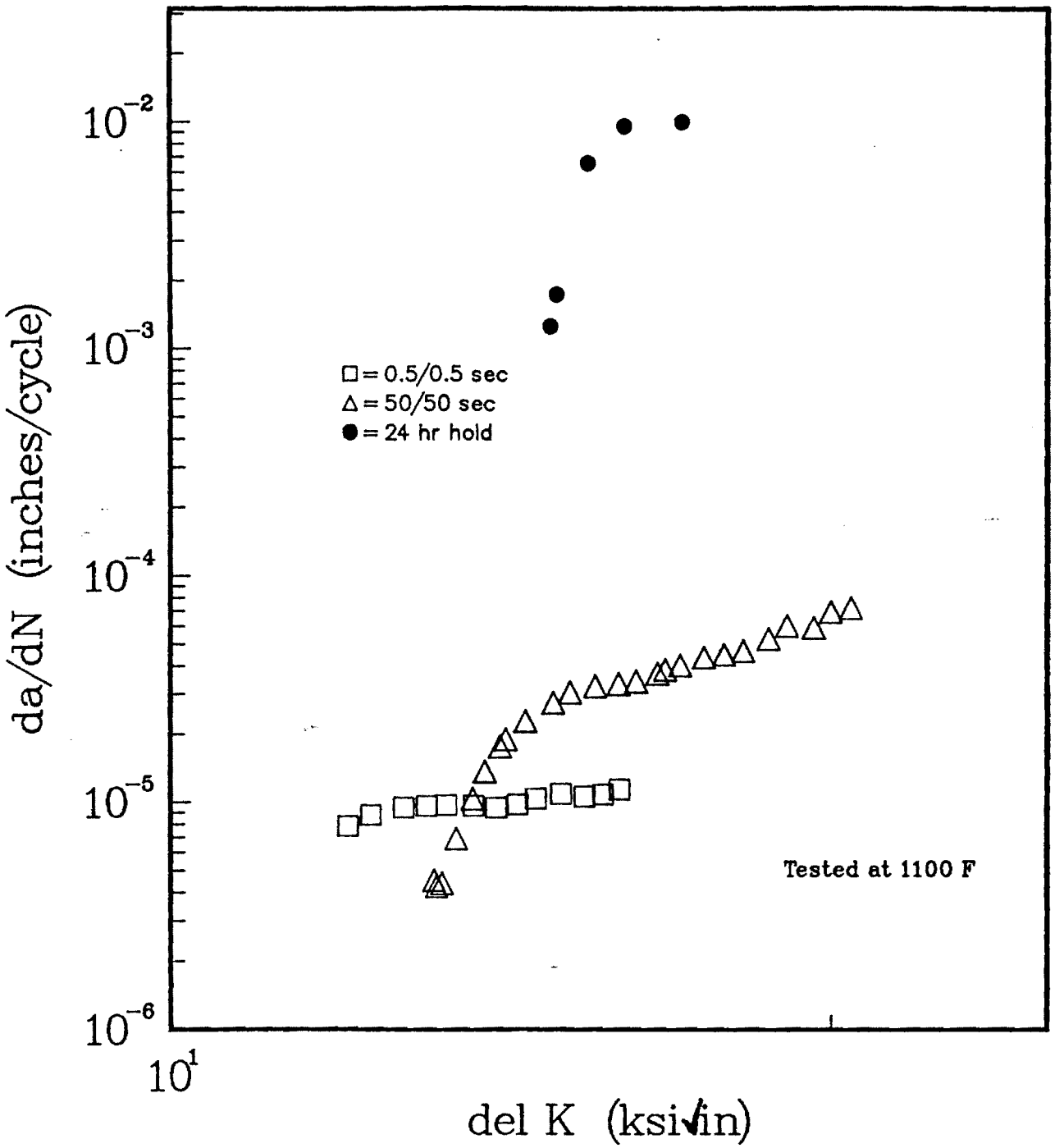
The creep-fatigue crack growth tests on the Shawville header materials were nearly completed. The results from tests conducted with a triangular waveform at 1 and .01 hz and the 24 hour hold time tests are plotted in the attached figure. The twenty-four hour hold time test is still continuing and additional test data will be available in the future.

Some additional creep-fatigue test were also conducted on the RB 304 header material to fill gaps in our previously reported data. The report on fracture toughness test results is in typing. The report on results summarizing the finite element analysis involving primary creep is also nearly completed.

PLANS FOR THE NEXT REPORTING PERIOD

In the next reporting period creep and creep-fatigue crack growth testing will continue. The fracture toughness and finite element analysis reports will be completed and crack growth modeling will continue.

C–FCGR BEHAVIOR OF SHAWVILLE MATERIAL



GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894-

July 15, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 6-30-88. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Fracture and Fatigue Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 6-1-88 to 6-30-88

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

The work on inclusion of primary creep in the estimation of C_t parameter is now complete. A thesis based on this work has been sent to Mr. R. H. Ryder for information. This work will be summarized in a topical report to be published by EPRI at a future date.

The report summarizing the fracture toughness results on the header materials has also been completed and is currently under review. This will be forwarded to GA for review shortly and will ultimately be published as an EPRI project report.

The creep and creep-fatigue testing and modeling of the data is continued during this reporting period.

FUTURE WORK:

Work on the fracture toughness report and finite element reports will continue. Creep and creep-fatigue crack growth modeling will also continue.

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

Georgia Institute of Technology
School of Materials Engineering
Atlanta, Georgia 30332-0245
(404) 894-

August 10, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 7-31-88. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Mechanical Properties Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 7-1-88 to 7-31-88

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

The topical report on the work related to inclusion of primary creep is under preparation. This report will be completed during the next reporting period. Comments on the fracture toughness report prepared by Westinghouse were communicated to Dr. P. K. Liaw. This report should also be completed during the next reporting period for transmittal to GA.

Creep-fatigue crack growth date with 24 hours and 0.25 hours hold time is continuing. Preliminary results from these tests are now available and are being further analyzed.

An experimental set-up for conducting creep-fatigue crack growth tests under compressive loading is being built. These tests will be conducted on cylindrical specimens loaded in tension and containing a circumferential crack. The expressions for estimating K, J, C_t and C^* were derived for the specimen geometry.

PLANS FOR NEXT MONTH

Work will proceed on the two topical reports as mentioned in the previous section. Creep crack growth specimens will be machined from laboratory damaged 2 1/4 Cr - 1 Mo material recently received from GA. Creep and creep-fatigue crack growth testing will continue.

Georgia Tech

School of Materials Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0245
(404) 894-

E-18-621

October 14, 1988

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 9/30/88. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Mechanical Properties Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 8-1-88 to 9-30-88

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

The revised report on fracture toughness results was received and has been sent back to Westinghouse for further revision. The creep and creep-fatigue tests already initiated are continuing. Test specimens from the service damaged material were machined. However, due to budgetary changes, tests will not be initiated until next year. A topical report on primary creep effects on C_t was mailed to GA for review.

PLANS FOR NEXT MONTH

The topical report on fracture toughness results will be completed and mailed to GA during the next reporting period. Creep and creep-fatigue crack growth testing will continue.

E-18-621

Georgia Tech

School of Materials Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0245
(404) 894-

April 3, 1989

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 3/31/89. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Mechanical Properties Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 10/1/88 to 3/31/89

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

The topical reports summarizing the work on finite element analysis was completed and also the report on fracture toughness results was completed. These reports were sent to GA Technologies for review and transmitted to EPRI.

The creep-fatigue crack growth testing was continued. The crack growth rates for various hold times were correlated with C_t. The tests with 15 minutes and 24 hour hold times have now been completed and the data were included in the above correlation. It was observed that the creep-fatigue crack growth rates during hold time accelerate significantly if the hold times are followed by a fatigue cycle with a maximum K greater than the K at hold. These results were reported during the industry advisory group meeting in Cincinnati in early March.

PLANS FOR NEXT MONTH

An interpolation scheme is being developed to predict the crack growth rates as a function of applied C_t and the hold time for 1.25 Cr-1Mo steel. The constants in the above scheme are being determined from test results developed at various hold times. Similar equations will also be developed for 2.25 Cr-1Mo steel.

E-18-

Georgia Tech

School of Materials Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0245
(404) 894-

June 9, 1989

Mr. Jim Elliott
GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports - GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 5/31/89. If you have any questions, please call me at (404) 894-2888.

Sincerely,

Ashok Saxena
Professor of Materials Engineering

AS/ptl

cc: OCA Reports Coordinator
GTRC

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P.O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Mechanical Properties Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, GA 30332

Period of Performance: 4/1/89 to 5/31/89

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

The attached table provides a summary of tests completed and ongoing at Westinghouse. The GTRC portion of the creep-fatigue testing has also been completed. The attention is now focussed at modeling of the creep-fatigue crack growth data.

In order to aid the development of an appropriate crack growth model, some mechanistic work was carried out in the last reporting period. It was found that when the hold period was 10 or 98 seconds, environment (in the form of oxides spikes) was the dominant mechanism of crack growth. The da/dt versus $(C_t)_{ave}$ data agree very well for these conditions. When the hold time is increased to 10 minutes, considerable cavitation is observed ahead of the crack tip and the da/dt vs. C_t behavior moves toward the creep crack growth behavior. At 24 hour hold time, the data agree with creep crack growth data.

The above observations have been modeled in the form of equations suitable for integration in BLESS Code. Drs. Saxena, Harris and Bloom discussed the form of the model in May in a meeting at Kansas City.

PLANS FOR NEXT MONTH

An interpolation scheme is being developed to predict the crack growth rates as a function of applied C_t and the hold time for 1.25 Cr-1Mo steel. The constants in the above scheme are being determined from test results developed at various hold times. Similar equations will also be developed for 2.25 Cr-1Mo steel.

TABLE 1

TEST MATRIX AND TEST STATUS OF CREEP AND CREEP-FATIGUE CRACK GROWTH TESTS

Specimen Number	Material Identification	Material Type	Location	Temperature °C	Test Type	K ksi$\sqrt{in}$	Hold Time hr.	Test Status
N2A1-CFG1B	1-1/4Cr-1/2Mo	Base	Hot Region	1000	Creep-Fatigue	14	24	In progress
N2A1-CFG2B	1-1/4Cr-1/2Mo	Base	Hot Region	1000	Creep-Fatigue	12	0.25	Completed
N2A1-CFG3B	1-1/4Cr-1/2Mo	Base	Hot Region	1000	Creep-Fatigue	17	24	In progress
S3A-CFG1B	1-1/4Cr-1/2Mo	Base	Cold Region	1000	Creep-Fatigue	12	0.25	In progress
N2A1-CCG1H	1-1/4Cr-1/2Mo	HAZ	Hot Region	1000	Creep	13	--	Completed
N2A1-CCG2H	1-1/4Cr-1/2Mo	HAZ	Hot Region	1000	Creep	18	--	Completed
N2A1-CFG1H	1-1/4Cr-1/2Mo	HAZ	Hot Region	1000	Creep-Fatigue	12	0.25	Completed
WCB1B-CFG1	2-1/4Cr-1Mo	Base	Cold Region	1100	Creep-Fatigue	16	24	Completed
WCB1A-CFG2	2-1/4Cr-1Mo	Base	Cold Region	1100	Creep-Fatigue	13	0.25	Completed
WCB1C-CFG3	2-1/4Cr-1Mo	Base	Cold Region	1100	Creep-Fatigue	13	0.25	Completed
WCB1B-CCG1	2-1/4Cr-1Mo	Base	Cold Region	1100	Creep	12	--	Completed
WCB1B-CCG2	2-1/4Cr-1Mo	Base	Cold Region	1100	Creep	16	--	Completed
WHB1B-CCG1	2-1/4Cr-1Mo	Base	Hot Region	1100	Creep	18	--	Completed
WCW1B-CCG1H	2-1/4Cr-1Mo	HAZ	Cold Region	1100	Creep	10	--	Completed
WCW1C-CCG2H	2-1/4Cr-1Mo	HAZ	Cold Region	1100	Creep	14	--	Completed
WCW1C-CFG1H	2-1/4Cr-1Mo	HAZ	Cold Region	1100	Creep-Fatigue	10	0.25	Completed

Georgia Tech

School of Materials Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0245
(404) 894-

August 15, 1989

Mr. Jim Elliott
GA Technologies, Inc.
P. O. Box 85608
San Diego, CA 92138

Re: Subcontract 071341 - Monthly Technical Progress Reports
GTRC Project E-18-621

Dear Mr. Elliott:

We are pleased to submit two copies of the progress report for the period ending 7-31-89. If you have any questions, please call me at (404) 894-2888.

Sincerely yours,

Ashok Saxena
Professor of Materials Engineering

AS/gef

Monthly Technical Progress Report

Submitted to:

GA Technologies, Inc.
P. O. Box 85608
San Diego, CA 92138

Attn.: Jim Elliott

AN INTEGRATED APPROACH TO LIFE ASSESSMENT OF BOILER PRESSURE PARTS

(RP-2253-10) - Task 2.3

GA Subcontract: SC 071341

Contractor: Mechanical Properties Research Laboratory
Georgia Tech Research Corporation
Atlanta, GA 30332

Principal Investigator: Dr. A. Saxena
Professor of Materials Engineering
Bunger Henry Building
Georgia Institute of Technology
Atlanta, Georgia 30332

Period of Performance: 06-1-89 to 07-31-89

OBJECTIVE OF TASK 2.3

The objective of this task is to develop the appropriate crack growth data and mathematical models so that the crack growth portion of life can be determined for heavy wall boiler pressure components. The sub-tasks include:

2.3.1 - Fracture Toughness Testing
2.3.2 - Creep Crack Growth Characterization
2.3.3 - Cracked Body Finite Element Analysis
2.3.4 - Creep-Fatigue Crack Growth Characterization
2.3.5 - Crack-Growth Model Development

TECHNICAL PROGRESS

We have completed all but two crack growth tests. The two ongoing tests are due for completion at the end of September.

Creep-fatigue crack growth data with hold time have been modelled and the results are summarized in a topical report which will be sent to General Atomics for review and distribution.

PLANS FOR NEXT MONTH

In the next reporting period we intend to continue testing, model results of the creep-fatigue tests with overloads and start work on the final report.