TEST PLAN

FOR

RELAP 5/MODIFICATION 1

AND

FORCE

NOVEMBER 1, 1982

Prepared By: D. P. Konichek

Approved By: C. F. Wolfe

TABLE OF CONTENTS

Quality Assurance
Test Plan
for
RELAP5 for Mod 1 and FORCE

1.0 Introduction

1.1 Background

RELAP5/1 and FORCE are to be tested for certification to BCS B-class and nuclear regulated status, per authority from Memo G-7623-029, June 27, 1982, and according to ETA Quality Assurance Procedures 40356.01 and 40356.40.

RELAP5/1 and FORCE are vendor-supplied modifications of public-domain codes. The vendor, with whom BCS has a licensing agreement, is Energy Engineering Computer Code Laboratories (EECCL). These codes are a part of the Nuclear Library (NUCLIB) code collection being implemented by BCS.

1.2 Scope

This test plan describes the methods, means, objectives, test cases and procedures for assuring conformance of computer codes RELAP5/1 and FORCE to BCS quality assurance standards at a demonstrated performance level.

1.3 Test Objectives

The objectives of testing these vendor-supplied codes are to establish (at a reasonable level of confidence) that they perform as advertised in user documentation, they operate accurately on the BCS EKS-Mainstream systems, and they have proper version test controls.

Brief descriptions of the codes given below illustrate their applications.

RELAP5/Mod 1 describes the behavior of light-water nuclear reactors resulting from loss-of-coolant from massive or small pipe breaks, pump failures, control system failures, etc. The program calculates fluid conditions, thermal conditions, nucleonics, status, and pump, trip, and control system status. The output includes variables such as fluid velocity, mass flows, fluid pressures, temperature distributions, heat fluxes, and reactor power and reactivity. In addition to reactor applications, the program may conveniently be used to analyze other water-based thermal-hydraulic systems.

FORCE takes thermal hydraulics parameters from RELAP4, RELAP5 and TRAC and generates forces in the various node positions in the piping network for input into the SAP-IV Dynamic Structural Analysis. The data transfer between RELAP, FORCE and SAP has been automated, and so is the plotting of the transferred data that is relevant to the physics of the problem.

1.4 Test References

RELAP 5/1 Code Manuals	10208-2010-1 & 2
FORCE Reference Manual	10208-2032
BCS Policy-Quality Assurance	1-1301.01
ETA Quality Assurance Procedures	40356.01
ETA Verification Procedure	40356.10
BCS Procedure-Nuclear Industry Defect Reporting	1-1011.09

2.0 Test Requirements

Test procedures will reflect the standards of BCS document ETA Quality Assurance Procedure, 40356.10.

In accordance with those procedures, test cases, as shown in Attachment A have been selected to fulfill the needs for: standard tests, host regression tests, base verification tests, and hand calculation tests. These test cases will be run on the BCS EKS-Mainstream system, evaluated according to the comparison methods given below, and test results and variances reported.

The matrix, Attachment B, shows the major capabilities of the codes which the test cases demonstrate. These tests demonstrate a baseline functional capability. They do not exercise all input options, input checking, individual computing paths, or etc.

3.0 Test Specifications

All test cases mentioned below are found in Attachment A.

RELAP 5/1:

1. Eight cases comprise the standard test set; 5 test cases will compare our version with the results of INEL runs, 1 LOFT case also comparable with INEL and 2 cases representing actual Combustion Engineering (CE) experiments which were mated to runs by EPR1. The two CE test cases reflect current industry interest in safety relief valve analysis.

2. For host regression, assuring that system changes don't adversely affect the code, 2 of the simple test cases are expected to exercise the operating system.

3. Base verification cases are not applicable, since no other computer code with the same procedures is now available for the CRAY.

4. Hand calculations are considered unfeasible for this code, since it involves interactive time steps, large input specifications, and involves the inversion of large matrices. There is no practical way to check or exercise every functional part of the code and ongoing projects at Sandia and Intermountain Technology are aimed at verification to experiment rather than calculated results. These contracts are supported by EG&G, the originators, who have not made hand calculation checks.

FORCE

1. Because this code is a post-processor for RELAP 5/1, performing simple calculations on output, two cases comprise the standard test set to assure its compatibility with real RELAP 5/1 input; the 2 CE cases, both of which are safety valve release problems.

2. A single selected host regression test will exercise and check system changes.

3. Base verification will be conducted with this code since the test case selected has been run on another system and another code, BLAZER, can be exercised through procedures on the CRAY.

4. Hand calculated values obtained from input parameters will be compared to code results to demonstrate calculational accuracy.

4.0 Methods of Comparison

Verification that the codes function as expected will be established as follows:

RELAP 5/1

- Five of the standard test case outputs will be numerically compared with runs of the same cases made by INEL, and all deviations reported in the test results.

- One standard test case output will be compared with plotted output from actual test data by Combustion Engineering and modeled data points provided by EPRI which are superimposed on the actual test data.

FORCE

- One case will be calculated by hand to demonstrate that the code performs arithmetic correctly.

- As in the second method of RELAP 5/1 above the same case will be used for comparison of FORCE results.

The test cases used are given in Attachment A.

5.0 Test Reporting

Whenever updated versions of the BCS code are implemented, the test cases above will be rerun to assure replication. In the event the new version modification presents special capability or extra features, at least one additional test case which shows exploitation of that variation may be run for verification, if the variations are not clearly testable by the original cases or modification of them. The additional cases will be added to the test set and will become a permanent part of the verification plan.

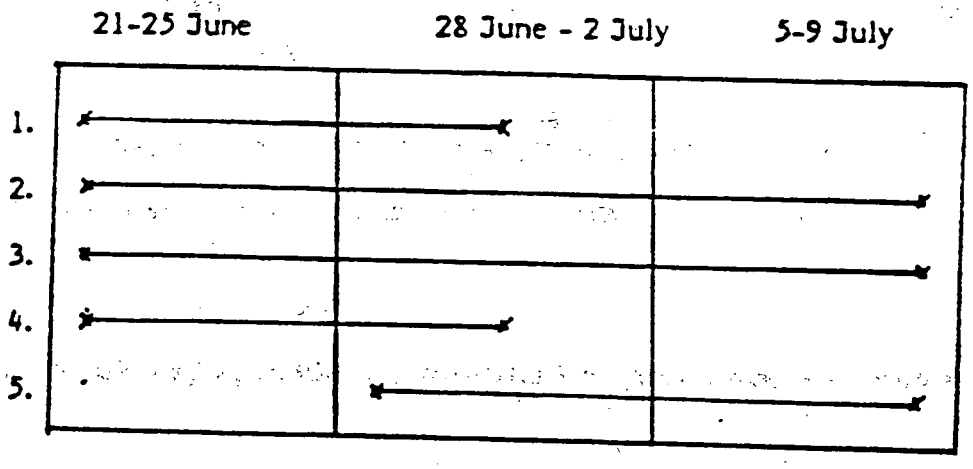
All results will be included in a test report revised as necessary.

Problems reporting will be according to ETA procedure 40356.01, as required by BCS Procedure 1-1011.09 for as nuclear regulated products.

6.0 Test Schedule

This section discusses, to the extent possible, the validation test schedule to be followed. At a minimum, the start date, any intermediate milestone dates, and the end date, shall be given for the following milestones:

1. System Validation Test Activity scheduling
2. Personnel scheduling
3. Hardware scheduling
4. Test Procedure scheduling
5. Test Analysis scheduling



APPENDIX A

TEST SET MATRIX

THE MATRIX CROSS REFERENCES

TEST CASES TO TEST SETS

Appendix A
Test Matrix

Test ID	Test Title	RELAP5/1 Standard Regression		Base Verif.	Hand Calc.	Standard Regression	Base Verif.	Hand Calc.
QA-10	Simple Valve Area Test, 2Vol			(1)	(2)			X(3)
-1	Super heated Vapor Pipe filled with Subcooled Water (Low (Pressure)	X (5)						
-2	Two-Phase Pipe Filled with Same Water	X (5)	X					
-3	Edward's Pipe, 9Vol, 10 vol (Scrambled)	X (5)						
-4	Superheated Vapor Pipe Filled with Subcooled Water (High Pressure)	X (5)						
-5	Liquid Over Vapor - Vertical Pipe		X (5)	X				
-6	LOFT 19-1 Post Test Analysis Initialization Deck	X						
-7	CE Test 1411 (BCS Model) SRV	X			X			
-9	CE Steam Test 1411 SRV	X			X (4)		X	

Notes:
(1) Not Applicable
(2) Not Feasible
(3) Simple Case
(4) Verifiable with CE experiment
(5) Comparable to INEL runs.

APPENDIX B

CAPABILITY MATRIX

THIS MATRIX CROSS REFERENCES

MAJOR PROGRAM TO TEST CASES

Appendix B

Capability Matrix

Code	Modeling Capability	Test ID's
RELAP5/1	Hydrodynamics	QA-1,2,3,4,5,6
	Heat Structures	"
	Trips	"
	Reactor Kinetics	"
	Controls	"
	Special Interest (Safety Relief Valves)	QA-7,9
FORCE	Calculation of Forces	QA-10
	Special Interest (Safety Relief Valves)	QA-7,9

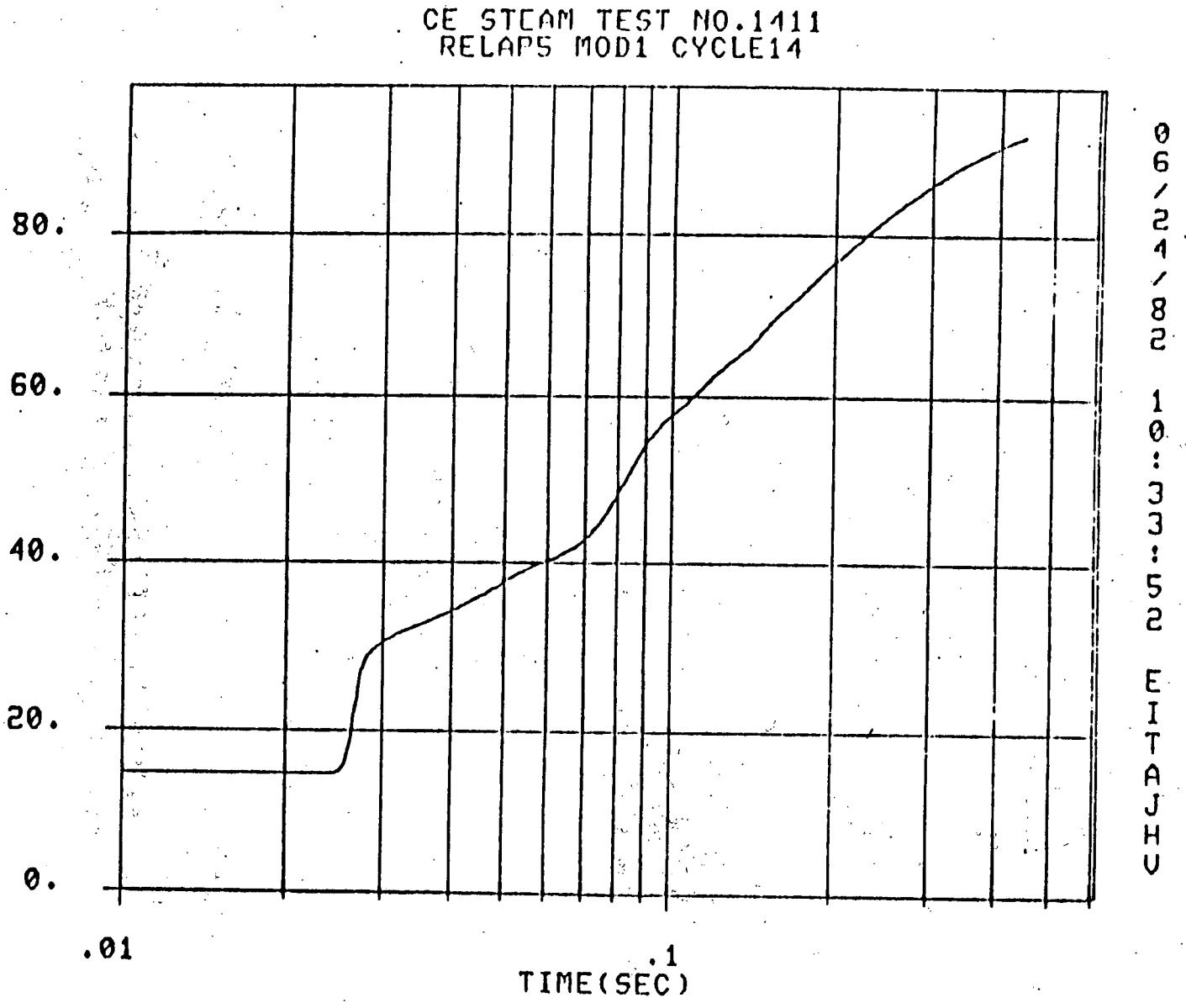


Figure 5 (Semilog)

BOEING COMPUTER SERVICES COMPANY
A Division of The Boeing Company

November 1, 1982 - Revision
G-7623-046R

To: B. Block
F. Hanna
B. Mukherji
S. Pruitt
C. Wolfe

Subject: FORCE Version 2 Quality Assurance, Product Test Report, BCS QA Certification (QA Section 2.3)

Reference: Memo G-7623-028, Test Plan for RELAP 5/1 and FORCE, dated June 28, 1962 (QA Section 2.1.2)

Test Procedure Execution Results (QA Section 2.3.2)

The test cases set forth in the referenced Test Plan were run on the BCS operating system as planned. All files used to create and test this version have been stored on tape (Attachment A). The test case runs, including input and output, are bound in "FORCE Quality Assurance Standard Test Case Set and Hand Calculation Test" and are a part of this certification.

Test Analysis (QA Section 2.3.3)

The results of the three test cases cited in the standard Test Case Set (Section 2.1.2), QA-7, QA-9, and QA-10 are presented as follows:

1. The QA-7 (Combustion Engineering Test 1411 Safety Release Valve, BCS Model) case was run to provide test output from customer initated problems and to demonstrate ability to handle safety release valve tests. Cursory examination of output indicates that the code handles this case successfully.

2. Case QA-9 (Combustion Engineering Steam Test 1411 Safety Release Valve) results matched the Combustion engineering and EPRI results shown in the attached plots, the valves being the same as the "BCS" curve. Attachment B shows an earlier comparison done for verification and Attachment C replicates these results for FORCE certification.

3. Case QA-10 is a simplified model of a pipe and it was run to provide a manageable hand calculational case intended to reinforce that FORCE performs its calculations properly. FORCE calculates forces in a hydraulic pipe based on fluid and gas conditions. The calculations are made from density, velocity, pressure, and time parameters and the geometry of the pipe segments under consideration. A run of this case on the RELAP 5/1 code was made and the output used as input to FORCE. The calculations and comparison with the run are shown in Attachment D

The actual BCS computer runs of cases QA-7 through QA-10, as above, showing both input and output, are bound as part of the certification package.

Test Deficiencies (QA Section 2.3.4)

No deficiencies were found in the testing of FORCE.

Any deficiencies discovered in future will be given in the On-Line News/Error file (see QA Section 3.8).

D P Konichek
D. P. Konichek
11/10/82

Attachments:

ATTACHMENT A

The following is a list of files used for the FORCE installation and testing. Files can be retrieved via the "D' command in NUCLIB interactive, or by standard JCL commands.

FORCE INPUT

File	Revision	Length	Tape	UN
FORIOA6	82/06/28. 13.28.50.	2	534858	PFUITT
FORIOA7	82/06/22. 14.51.52.	2	534858	PFUITT
FORIOA8	82/06/22. 14.51.52.	3	534858	PFUITT
FORIOA9	82/06/29. 16.11.00.	3	534858	PFUITT

FORCE OUTPUT

File	Revision	Length	Tape	UN		
FOROOA9	82/06/29. 16.24.16.	2672	534858	PFUITT	C	FF
FOROOA6	82/06/28. 13.37.23.	21	534858	PFUITT	C	FF
FOROOA7	82/06/28. 13.39.23.	351	534858	PFUITT	C	FF
FOROOA8	82/06/28. 13.42.19.	789	534858	PFUITT	C	FF

FORCE PLOT FILES

File	Revision	Length	Tape	UN		
FORI001	82/06/28. 10.36.51.	3	534858	PFUITT	C	FF
FORI002	82/06/28. 13.37.02.	3	534858	PFUITT	C	FF
FORI092	82/06/29. 16.23.49.	917	534858	PFUITT	C	FF
FORI071	82/06/28. 13.38.52.	166	534858	PFUITT	C	FF
FORI072	82/06/28. 13.39.12.	105	534858	PFUITT	C	FF
FORI081	82/06/28. 13.41.51.	401	534858	PFUITT	C	FF
FORI082	82/06/28. 13.42.02.	230	534858	PFUITT	C	FF
FORI091	82/06/29. 16.23.15.	1527	534858	PFUITT	C	FF

FORCE SOURCE

File	Revision	Length	Tape	UN
FOROLD	82/06/08. 09.27.29.	64	692433	PFUITT
FORUPD	82/06/11. 11.34.24.	4	535368	PFUITT
FORUPF	82/06/11. 12.41.07.	13	535368	PFUITT

BCS BOEING COMPUTER SERVICES COMPANY

A Division of The Boeing Company

ATTACHMENT B

VERIFICATION OF BCS FORCE FOR SAFETY AND RELIEF VALVE DISCHARGE

(Standard Test Case QA-9)

Reference 1: "Application of RELAP5/MOD1 for Calculation of Safety and Relief Valve Discharge Piping Hydrodynamic Loads," March 1982, Intermountain Technology, Inc. and Electric Power Research Institute, R. K. House (ITI) and A. J. Wheeler (EPRI)

The BCS CRAY Version (2) of FORCE is benchmarked against the CE test 1411 (steam discharge). Figures 1 and 2 show the schematics and nodalization of the CE Test Facility. The calculated forces are compared with the measured forces and the computed forces reported by Intermountain Technologies, Inc. (ITI), and the Electric Power Research Institute (EPRI) (Reference 1) in Figures 6, 7, and 8. Since the same RELAP5 input decks are used as in Reference 1, as input to FORCE, the calculated force values are the same.

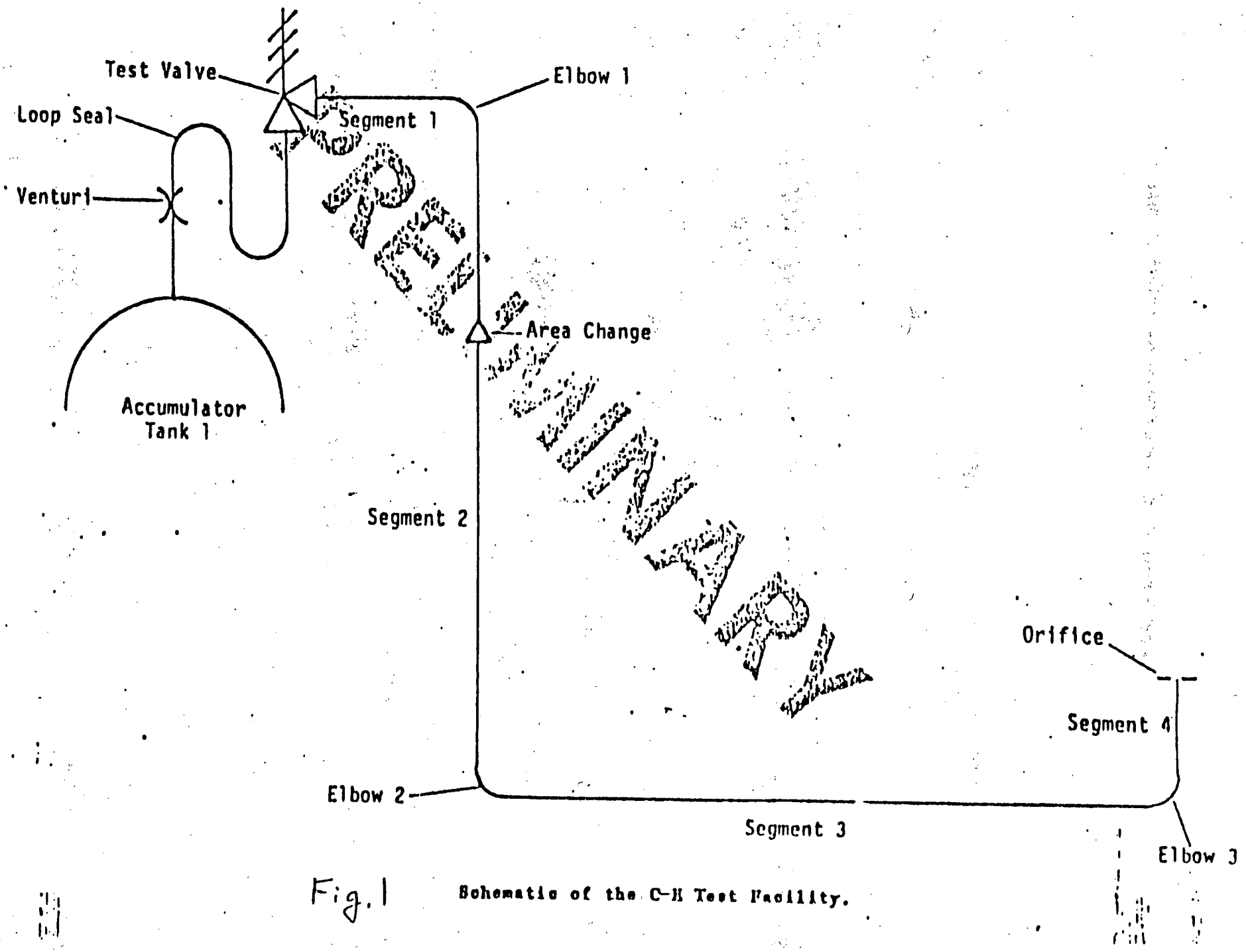


Fig. 1 Schematic of the C-E Test Facility.

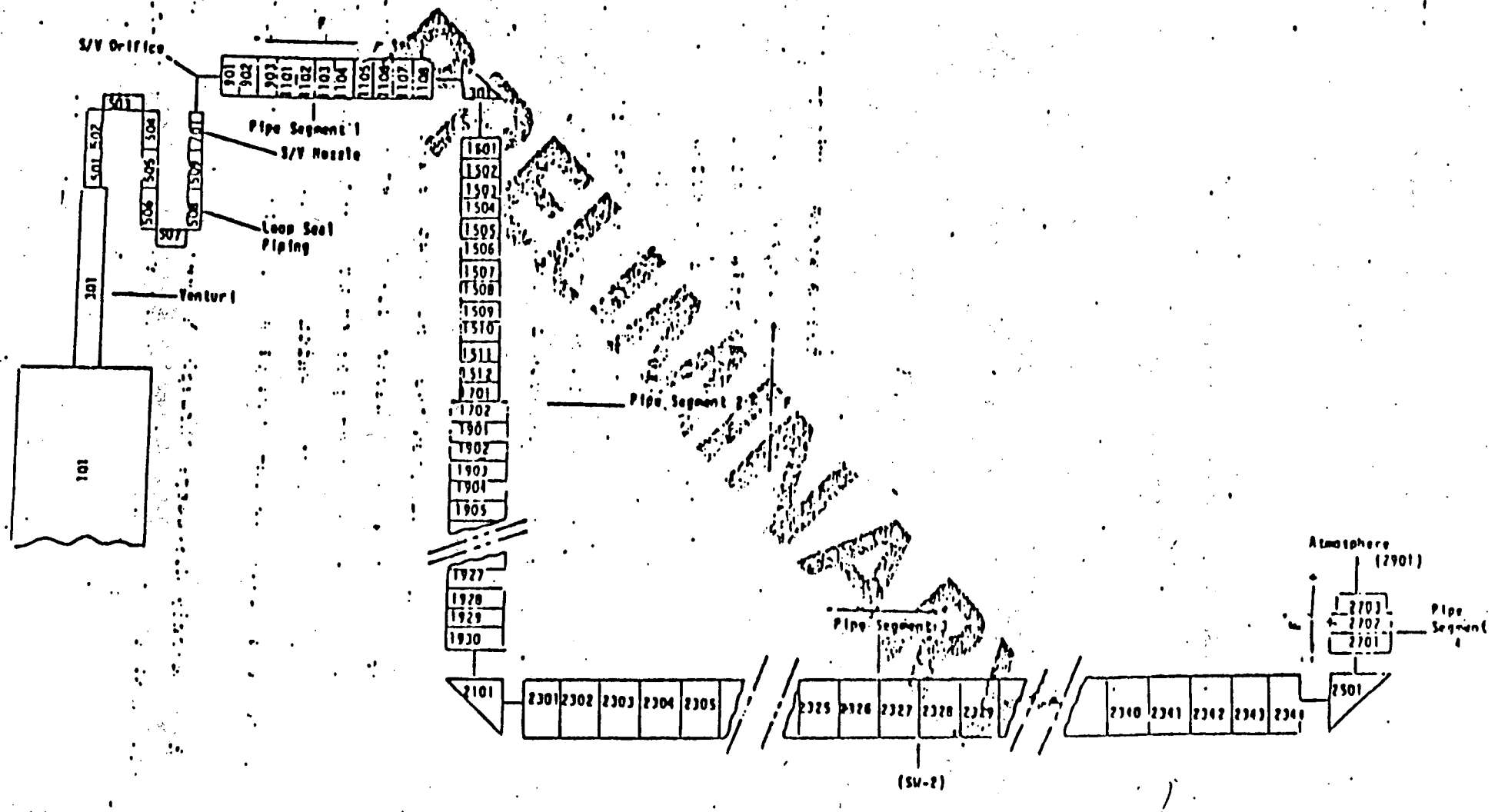


Fig. 2 Nodalization Diagram of the RELAP5/MOD1 Input Model.

Fig. 6

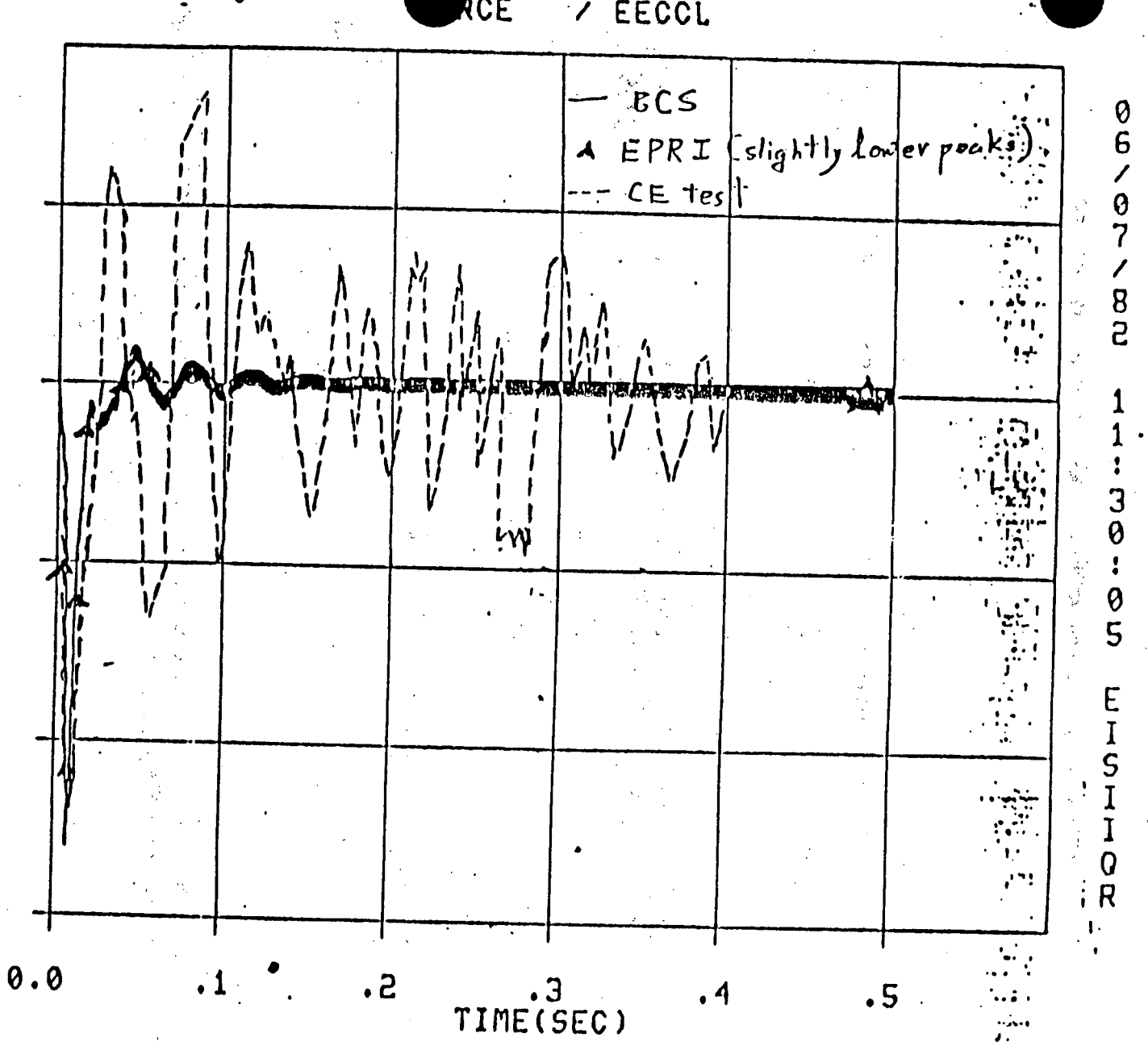
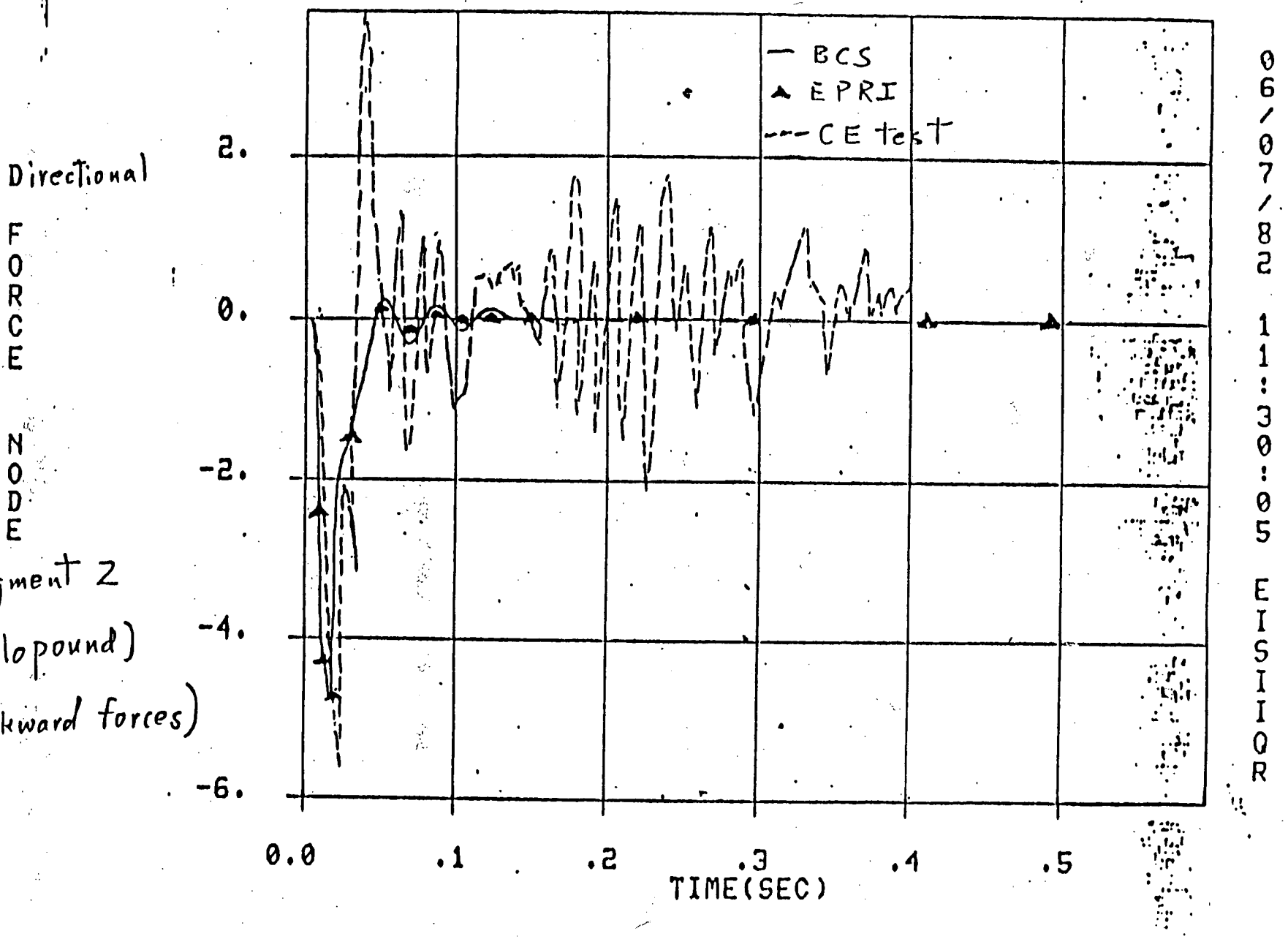
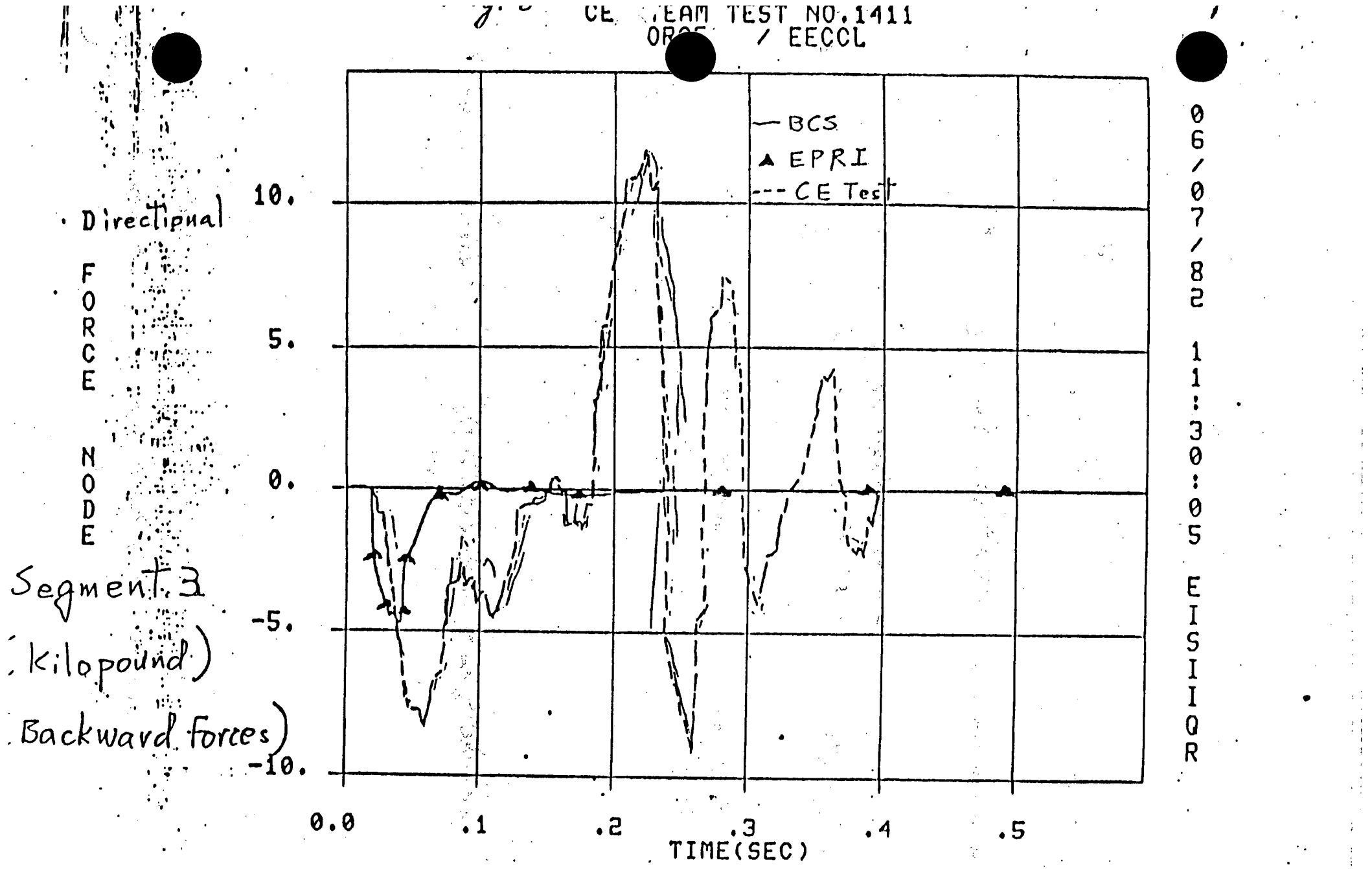

EAM TEST NO.1411
RCE / EECCL
— BCS
▲ EPRI (slightly lower peaks)
--- CE test
Directional
FORCE
NODE
Segment 1
(Kilopound)
(Backward forces)
1.
0.
-1.
-2.
-3.
0.0
.1
.2
.3
.4
.5
TIME(SEC)
06/07/82 11:30:05 EISIQR

Fig.7 CE [redacted]AM TEST NO.1411
[redacted]CE / EECCL




CE TEAM TEST NO.1411
ORE / EECCL
— BCS
▲ EPRI
--- CE Test
Directional
FORCE
NODE
Segment 3
(kilopound)
(Backward forces)
10.
5.
0.
-5.
-10.
0.0
.1
.2
.3
.4
.5
TIME(SEC)
06/07/82 11:30:05 EISIQR

BCS BOEING COMPUTER SERVICES COMPANY

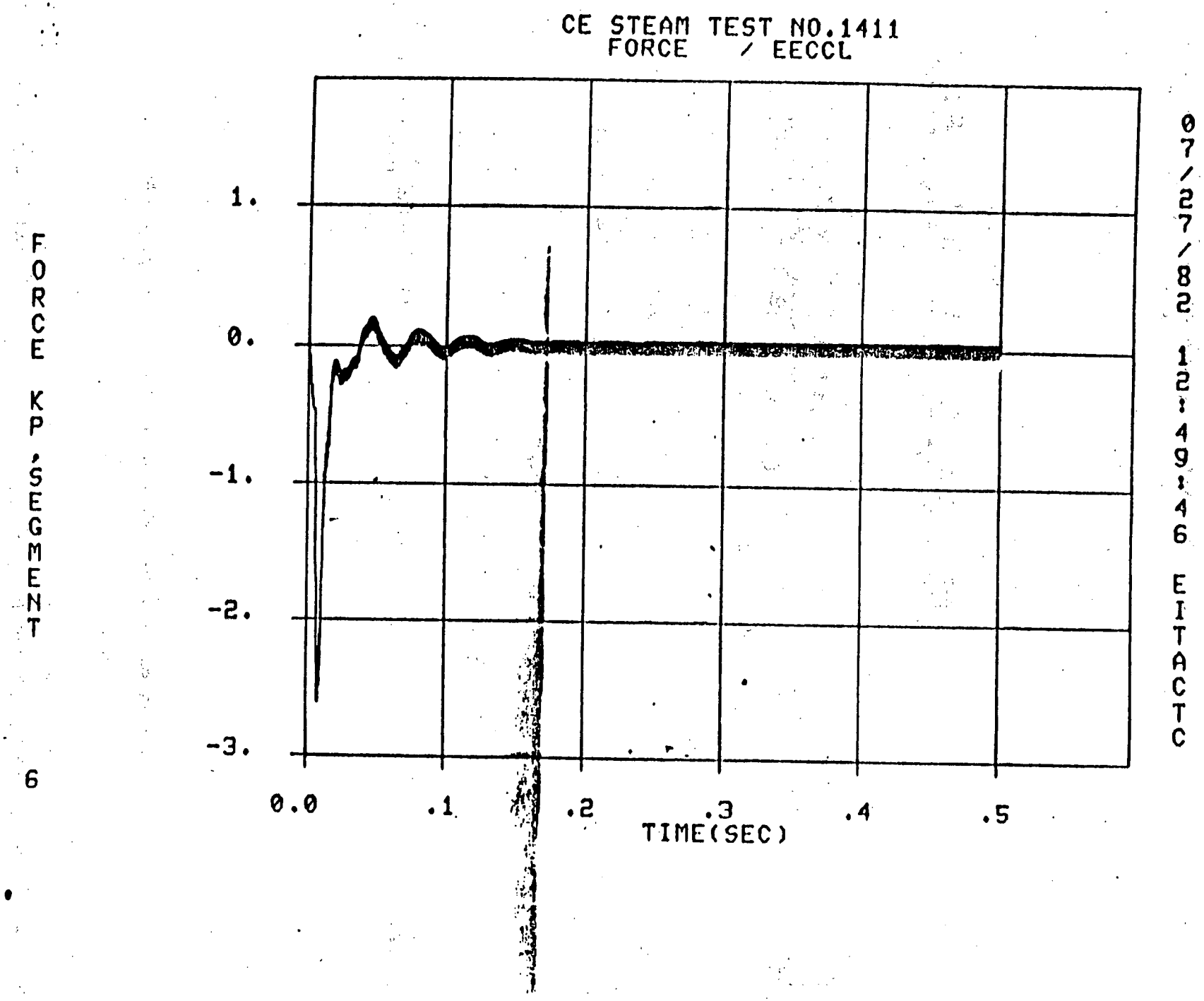
A Division of The Boeing Company

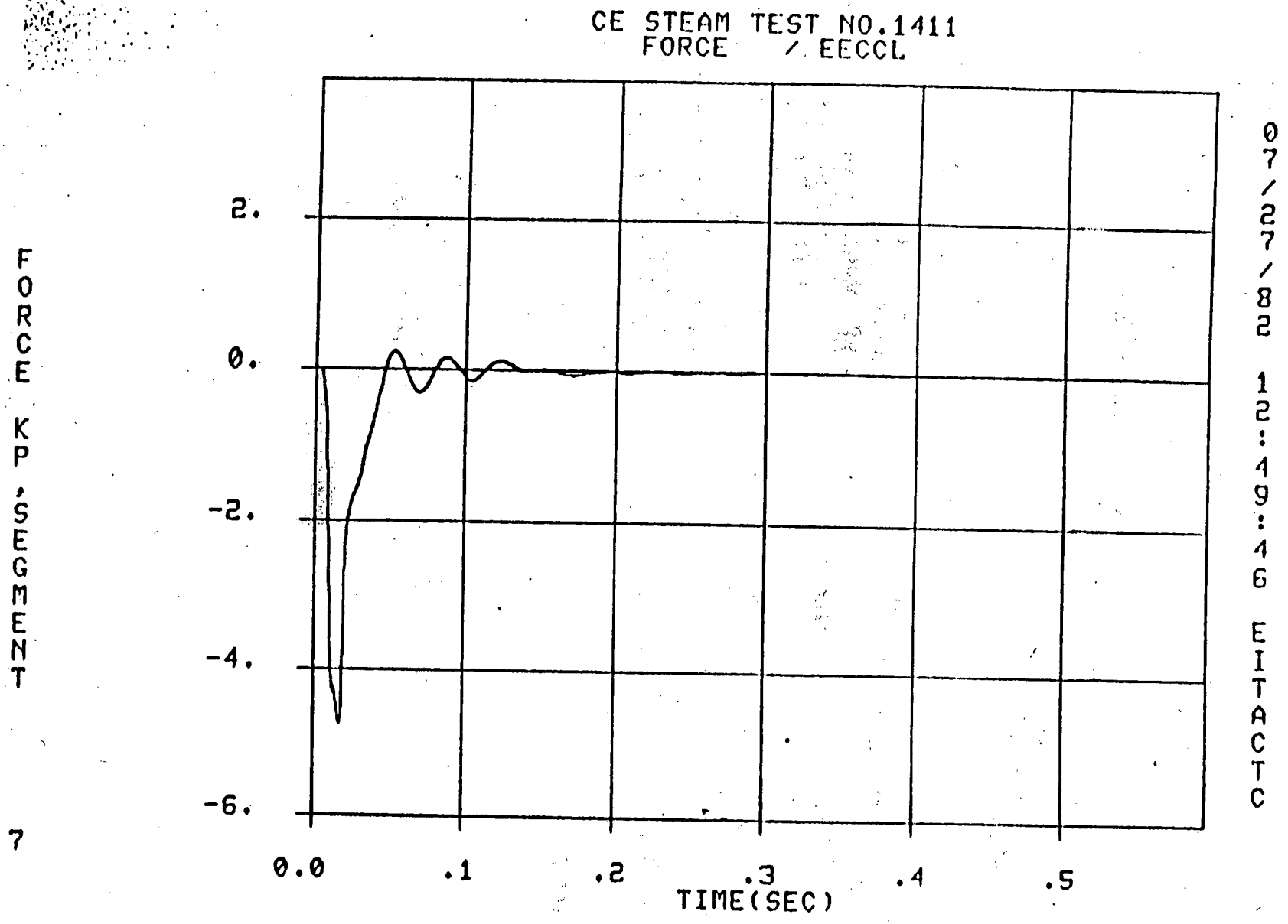
ATTACHMENT C

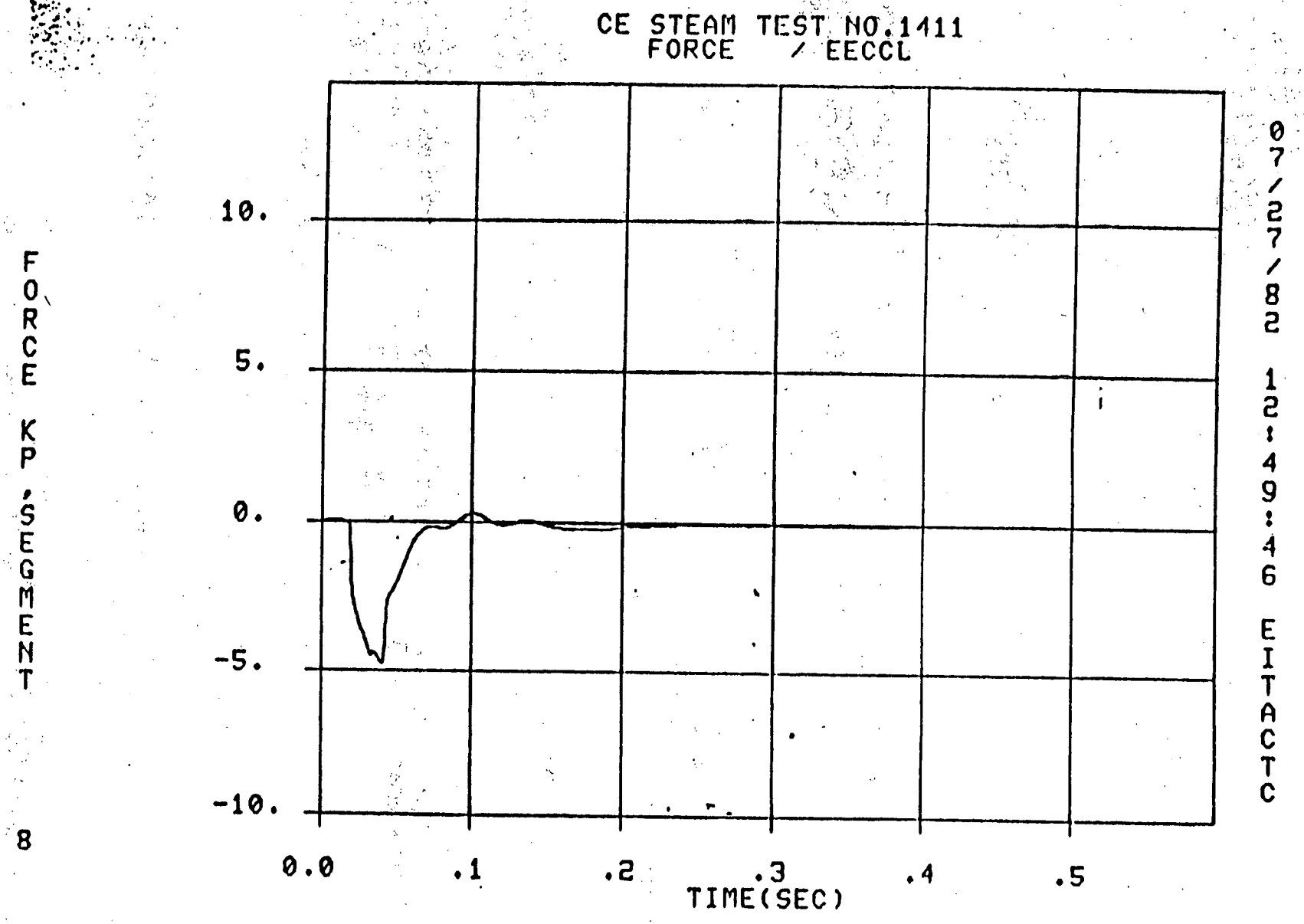
BCS FORCE CERTIFICATION TEST RESULTS FOR SAFETY AND RELIEF VALVE DISCHARGE

(Standard Test Case QA-9)

These figures are identified with their corresponding figures of Attachment B.


CE STEAM TEST NO.1411
FORCE / EECCL
FORCE KP, SEGMENT 6
1.
0.
-1.
-2.
-3.
0.0
.1
.2
.3
.4
.5
TIME(SEC)
07/27/82 12:49:46 EITACTC


CE STEAM TEST NO.1411
FORCE / EECCL
FORCE KP, SEGMENT 7
2.
0.
-2.
-4.
-6.
0.0
.1
.2
.3
.4
.5
TIME(SEC)
07/27/82 12:49:46 EITACTC


CE STEAM TEST NO.1411
FORCE / EECCL
FORCE KP, SEGMENT 8
10.
5.
0.
-5.
-10.
0.0
.1
.2
.3
.4
.5
TIME(SEC)
07/27/82 12:49:46 EITACTC

BOEING COMPUTER SERVICES COMPANY
A Division of The Boeing Company

ATTACHMENT D

BCS FORCE CERTIFICATION HAND CALCULATIONS

(Standard Test Case QA-10)

The calculations made are referenced in the FORCE Users Manual and Access Guide, 10208-2032 and in the printout of the FORCE code bound with the test cases.

Test Results reviewed by

P. Konichek

G. vonFuchs

FORCE Hand Calculations

The calculation being checked to obtain the results that FORCE computes takes flow and time values and employs them as follows:

$$Force_{vol} = (Vol\ length)(Flow\ Rate)\frac{1.5}{4}(Units\ Conversion)$$

where, in RELAP5/1, for each volume,

$$Vol\ length = ALENGT$$

$$Flow\ Rate = \frac{\Delta FLOWEW}{\Delta TIME}$$

and,

$$Units\ Conversion = 2.27E-4$$

FORCE reports the sum of forces in the whole pipe segment for the volumes at each time step. In this test case, the forces for volume 101-301 dominate and the contributions of other volumes are swamped due to insufficient digit significance in the hand calculations.

For volume 101-301, Vol length is .305E4 and Flow Rate is on the order of E5, therefore

$$Force \approx (.305E4)(E5)\frac{1.5}{4}(2.27E-4) \approx .26E5$$

All other volumes have Vol length of .305E1 and Flow Rates less than E-3, so

$$Force \leq (.305E1)(E-3)\frac{1.5}{4}(2.27E-4) \leq .26E-6$$

Therefore volume 101-301 is the only significant contributor.

The calculations are tabulated, and comparison made with the GA-10 test run, on the following pages.

Data input to FORCE from RELAP5/11

Flow (FLONEW)

Time (sec)	Volume ID			
	101→301	401→402	402→403	etc →
.0001	.000	.000	.000	
2	.101 E2	.284 E-12		
3	.182			
4	.258			
5	.335		all of	all of
6	.412		order	this order
7	.364	all of	< E-24	< E-10.
8	.395	order		
9	.375	between		
10	.388	E-8 & E-12		
11	.380		.226 E-24	
12	.385			
13	.382		Order	
14	.384		between	
15	.382		E-10 & E-24	
16	.383			
17	↓			
18				
19				
20		.711 E-8	.122 E-10	

Comparison of FORCE Calculated & Computed Forces

Start Time (sec)	dFlow[1] 101−201	Calcd Force[2] 101−301	Computed Force[3] 101−301	% Diff[4] 101−301
.0001	-.101 E3	.26222 E5	.26021 E5	0.8
2	.081	.21630		
3	.076	.19722		
4	.077	.19992	.19899	0.5
5	.077	.19992		
6	-.045	-.12462		
7	.031	.08049	.08128	-1.1
8	-.020	-.05193		
9	.013	.03375	.03345	0.9
10	-.008	-.02077		
11	.005	.01295	.01325	-2.0
12	-.003	-.00779		
13	.002	.00519	.00526	-1.3
14	-.002	-.00519		
15	.001	.00260	.00208	24.4
16	.000	.00000		
17			.00053	n.a.
18				
19			.00033	n.a
20				

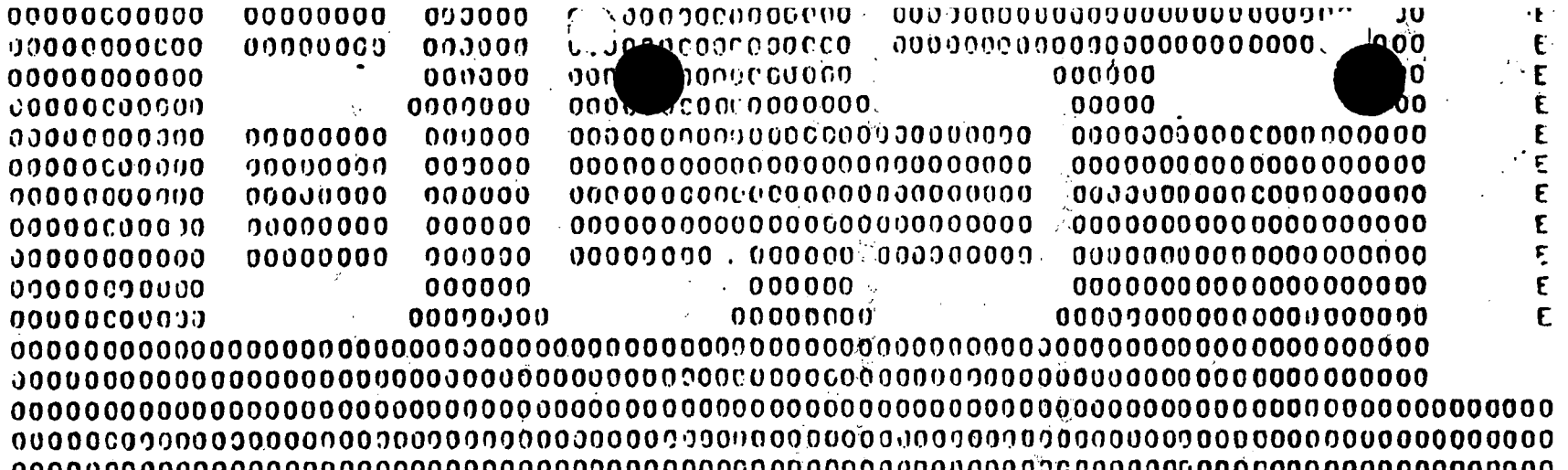
Notes:

1. dFlow = (Flow$_{t+\Delta t}$ − Flow$_t$)/Δt
2. By method shown earlier.
3. From FORCE output following.
4. All of these are well within the propagation of lack of significant digits in the calculations.

Results from FORCE QA-10 Test Run

RESULTANT DIRECTIONAL FORCING FUNCTION(IN KILOPOUND)

TIME	SEGMENT 1
1.[illegible]E-04	-2.5[illegible]E-[illegible]
2.[illegible]E-04	-2.[illegible]E+04
5.[illegible]E-04	-1.9899E+04
8.[illegible]E-04	-8.1376E+03
1.[illegible]E-03	-3.3448E+03
1.2[illegible]E-03	-1.3252E+03
1.4[illegible]E-03	-5.263[illegible]E+02
1.6[illegible]E-03	-2.[illegible]918E+02
1.8[illegible]E-03	-8.3164E+01
2.[illegible]E-03	-3.3[illegible]6E+01



21.53.44. 82/06/29.EKS1 760E.N0551.58 C R2/06/27.DS-1

ROUTING JOB NAME: EITA771, USER PRUITT PRIORITY P15.
21.53.44. ROUTED FILE NAME- OUT PRIORITY P11.

LENGTH IN PRUS IS 27.

MAILING INFORMATION:
==========

STEVE PRUITT
9C-02
575-5125

SC1183

ROUTE,OUT,DC=PR,UN=SC1183 ,P=11,MB=TO,NO.

Record of FORCE QA-10 Test Run

Conclusions

There are no substantial differences between the hand calculations and the computer run valves for this case. Although all options of FORCE were not checked, this agreement demonstrates a satisfactory level of confidence that the code performs as it should.

BCS BOEING COMPUTER SERVICES COMPANY
A Division of The Boeing Company

November 1, 1982 - Revision
G-7623-031R

To: B. Block
F. Hanna
B. Mukherji
S. Pruitt
C. Wolfe

Subject: RELAP5/MOD 1 Quality Assurance, Product Test Report, BCS QA Certification (QA Section 2.3)

Reference: Memo G-7623-028, Test Plan for RELAP5/1 and FORCE, dated June 28, 1982 (QA Section 2.1.2)

Test Procedure Execution Results (QA Section 2.3.2)

The test cases set forth in the referenced Test Plan were run on the BCS operating system as planned. All files used to create and test this version have been stored on tape (Attachment A). The test case runs, including input and output, are bound in "RELAP5/1 QA Standard Test Set and Comparative INEL Runs" are are a part of this certification.

Test Analysis (QA Section 2.3.3)

The undersigned numerically compared five test case outputs from both INEL and BCS versions. Those cases are cited in the Standard Case Set (Section 2.1.2), QA-1 through QA-5. Results were as follows:

1. No significant differences were found.

2. Slight absolute numerical differences of the order of 10^{-4} to 10^{-6} were due to roundoff in the system and output format.

3. Large relative errors were observed only on extremely small absolute values of the order of 10^{-10}.

4. In one case, (QA-1, Superheated Vapor Pipe Filled with Subcooled Water -Low Pressure), both absolute and relative errors occurred in the RIJ parameter. This, however, correlates with the rapid change of void fraction of parameter VOIDJG from 0 to 1. That is, this discrepancy is caused by attempting to read an almost vertical step function. There is no practical problem with this discrepancy.

5. All discrepancies are satisfactorily explainable and the versions produce essentially identical results.

The remaining three standard test cases, QA-6, QA-7, and QA-9, were not compared to INEL runs, but produced other results, as follow:

1. The QA-6 case (LOFT 19-1 Post Test Analysis Intialization Deck) would not run on the current Version 2 because there is not sufficient storage space for the mass of input. This constraint should be eliminated in Version 3. Meanwhile, cases with large amount of inputs may not run, although there is no suspicion of calculational inability.

2. Case QA-7 was run to provide test output from customer-initiated problems and to demonstrate ability to handle safety release valve tests. Cursory examination of output indicate that the code operates successfully on this case.

3. Case QA-9 results matched the Combustion Engineering and EPRI results shown in the attached plots, the values being the same as the "BCS" curve. Attachment B shows an earlier comparison done for verification and Attachment C replicates these results for RELAP5/1 QA certification.

The actual BCS computer runs, showing both input and output, are bound as part of the QA certification package. The INEL runs to which comparison was made are also included.

Test Deficiencies (QA Section 2.3.4)

During testing of RELAP5, minor problems arose:

1. Ten-character names had to be shortened to eight characters in the input decks due to the word size differences between the CRAY and CDC equipment. This is a minor annoyance to most customers but once they make the initial conversion to our system, it presents no problem to them since they are arbitrary names and eight characters is descriptive enough for most segments.

2. Plot input cards - these cards, although they appear in the manual, are currently ignored by RELAP5. Certain combinations of cards may cause the program to abort. It is best to omit the cards from the input deck. An alternate plotting capability is available (R51PLO).

3. Large problems (QA #6 for example) will NOT run on Version 2. The memory needs to be expanded in the FTB storage array. The dimension will be increased in Version 3. A preliminary test was made using several large problems (including QA #6) on Version 3 and all problems ran successfully.

These problems are not entered in the Trouble Report, but are given in the on-line News/Error file (see QA Section 3.8).

D. P. Konichek
@ 11/10/82

Attachments:

ATTACHMENT A

The following is a list of files used for the RELAP5 installation and testing. Files can be retrieved via the "D" command in NUCLIB interactive, or by standard JCL commands.

RELAP5 INPUT

File	Revision	Length	Tape	UN
R5110A6	82/06/24. 08.31.56.	299	692433	PPUITT
R5110A7	82/06/24. 08.32.41.	8	692433	PPUITT
R5110A8	82/06/24. 08.33.03.	25	692433	PPUITT
R5110A1	82/06/24. 08.29.17.	4	692433	PPUITT
R5110A2	82/06/24. 08.30.29.	4	692433	PPUITT
R5110A3	82/06/24. 08.30.53.	8	692433	PPUITT
R5110A4	82/06/24. 08.30.53.	4	692433	PPUITT
R5110A5	82/06/24. 08.30.54.	8	692433	PPUITT
R5110A8	82/06/24. 11.43.55.	25	692763	PPUITT
R5110A9	82/06/24. 09.57.57.	19	692763	PPUITT
R5110A7	82/06/24. 11.41.13.	8	692763	PPUITT
R5110A0	82/06/29. 21.30.18.	4	534858	PPUITT

RELAP5 OUTPUT

File	Revision	Length	Tape	UN		
R510UT	82/06/08. 09.27.10.	4958	692754	PPUITT		
R5100A4	82/06/24. 08.42.25.	186	692433	PPUITT	C	FF
R5100A5	82/06/24. 08.43.59.	395	692433	PPUITT	C	FF
R5100A6	82/06/24. 08.43.54.	914	692433	PPUITT	C	FF
R5100A7	82/06/22. 17.22.06.	365	692433	PPUITT	C	FF
R5100A8	82/06/22. 17.58.12.	2172	692433	PPUITT	C	FF
R5100A1	82/06/24. 08.39.07.	186	692433	PPUITT	C	FF
R5100A2	82/06/24. 08.39.53.	186	692433	PPUITT	C	FF
R5100A3	82/06/24. 08.41.57.	334	692433	PPUITT	C	FF
R5100A7	82/06/24. 11.51.31.	364	692763	PPUITT	C	FF
R5100A8	82/06/24. 12.03.59.	2171	692763	PPUITT	C	FF
R5100A9	82/06/24. 11.40.48.	1022	692763	PPUITT	C	FF
R5100A0	82/06/29. 21.33.05.	145	535068	PPUITT	C	FF

RELAP5 PLOT FILES

File	Revision	Length	Tape	UN	
R51D0A1	82/06/24. 08.38.07.	992	692433	PPUITT	01
R51D0A2	82/06/24. 08.39.28.	987	692433	PPUITT	01
R51D0A3	82/06/24. 08.40.47.	2887	692433	PPUITT	01
R51D0A4	82/06/24. 08.41.52.	418	692433	PPUITT	01
R51D0A5	82/06/24. 08.43.15.	1375	692433	PPUITT	01
R51D0A7	82/06/24. 11.50.43.	4525	692763	PPUITT	01
R51D0A8	82/06/24. 12.00.16.	48071	692763	PPUITT	01
R51D0A9	82/06/24. 11.33.31.	78705	692763	PPUITT	01
R51D0A7	82/06/28. 13.23.42.	4525	534858	PPUITT	01
R51D0A8	82/06/28. 13.25.07.	48071	534858	PPUITT	01
R51D0A9	82/06/28. 13.15.44.	78705	534858	PPUITT	01

RELAP5 SOURCE

File	Revision	Length	Tape	UN
R510LD	82/06/08. 09.27.10.	4958	692754	PRUITT
R51UPD	82/06/11. 11.15.38.	4	692754	PRUITT
R51UPP	82/06/22. 08.41.12.	6	692763	PRUITT

ENVIRONMENTAL SOURCE

File	Revision	Length	Tape	UN
ENVOLD	82/06/08. 11.04.06.	831	692754	PRUITT
ENVOUT	82/06/08. 15.43.31.	2989	692754	PRUITT
ENVUPD	82/06/08. 13.02.08.	26	692754	PRUITT

STEAM TABLES

File	Revision	Length	Tape	UN
STEUPD	82/06/08. 10.57.43.	6	692754	PRUITT
STEINP5	82/06/08. 10.49.38.	560	692754	PRUITT

GRAPHICS SOURCE

File	Revision	Length	Tape	UN
GRAUPD	82/06/22. 08.58.40.	21	692763	PRUITT
GRAUPP	82/06/24. 11.26.46.	8	692763	PRUITT
GRADAT	82/06/24. 11.21.55.	18	534858	PRUITT

All tapes are 9-track, 6250-BPI, Internal Format

BOEING COMPUTER SERVICES COMPANY
A Division of The Boeing Company

ATTACHMENT B

VERIFICATION OF BCS RELAP5/1 FOR SAFETY AND RELIEF VALVE DISCHARGE

(Standard Test Case QA-9)

Reference 1: "Application of RELAP5/MOD1 for Calculation of Safety and Relief Valve Discharge Piping Hydrodynamic Loads," March 1982, Intermoutain Technology, Inc. and Electric Power Research Institute, R. K. House (ITI) and A. J. Wheeler (EPRI)

The BCS CRAY Version (2) of RELAP5/MOD1 is benchmarked against the CE test 1411 (steam discharge). Figures 1 and 2 show the schematics and nodalization of the CE Test Facility. The calculated pressures are compared with the measured pressures and the computed pressures reported by Intermountain Technologies, Inc. (ITI), and the Electric Power Research Institute (EPRI) (Reference 1) in Figures 3, 4, and 5. Since the same RELAP5 input decks are used as in Reference 1, the calculated pressure values are the same.

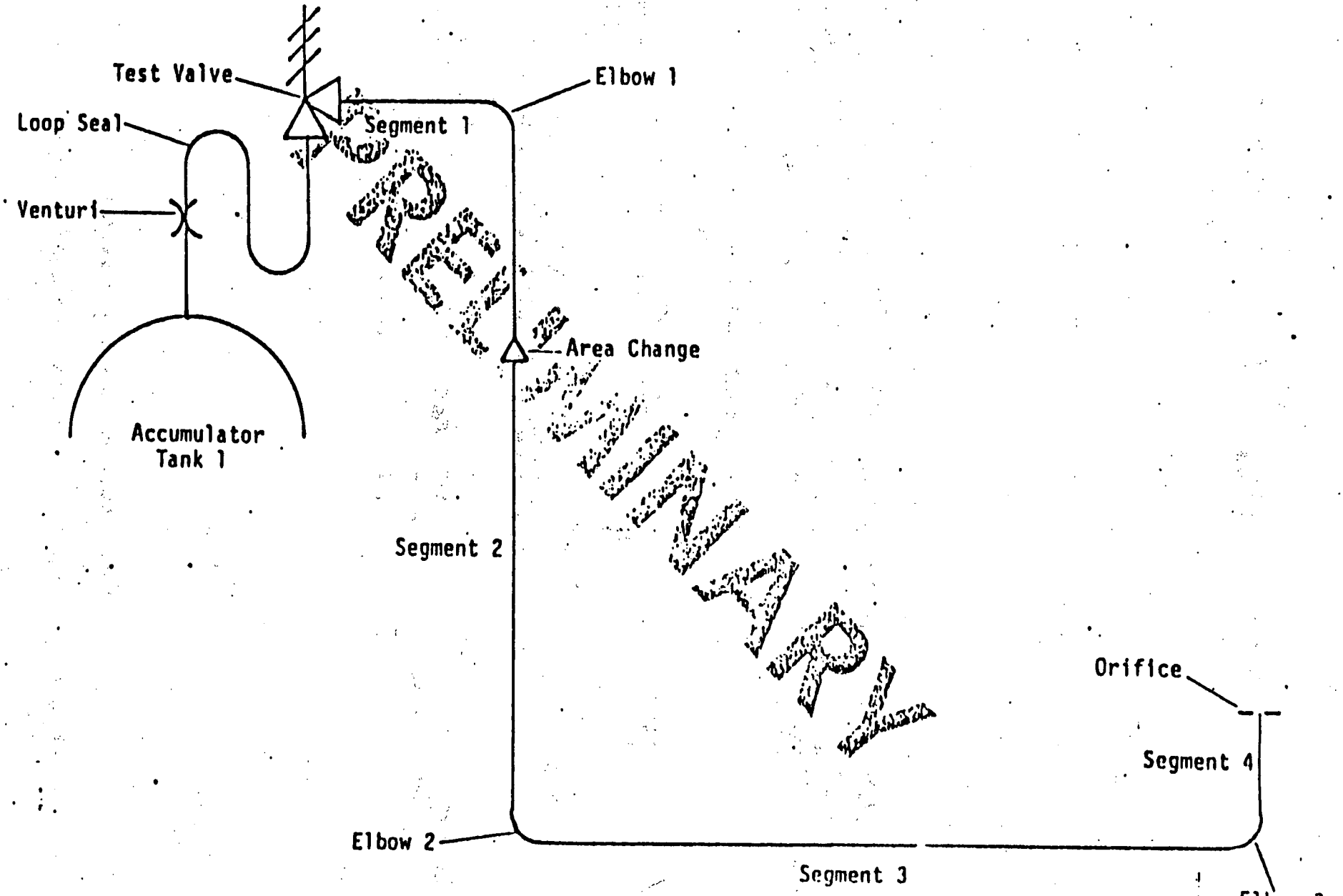


Fig. 1 Schematic of the C-E Test Facility.

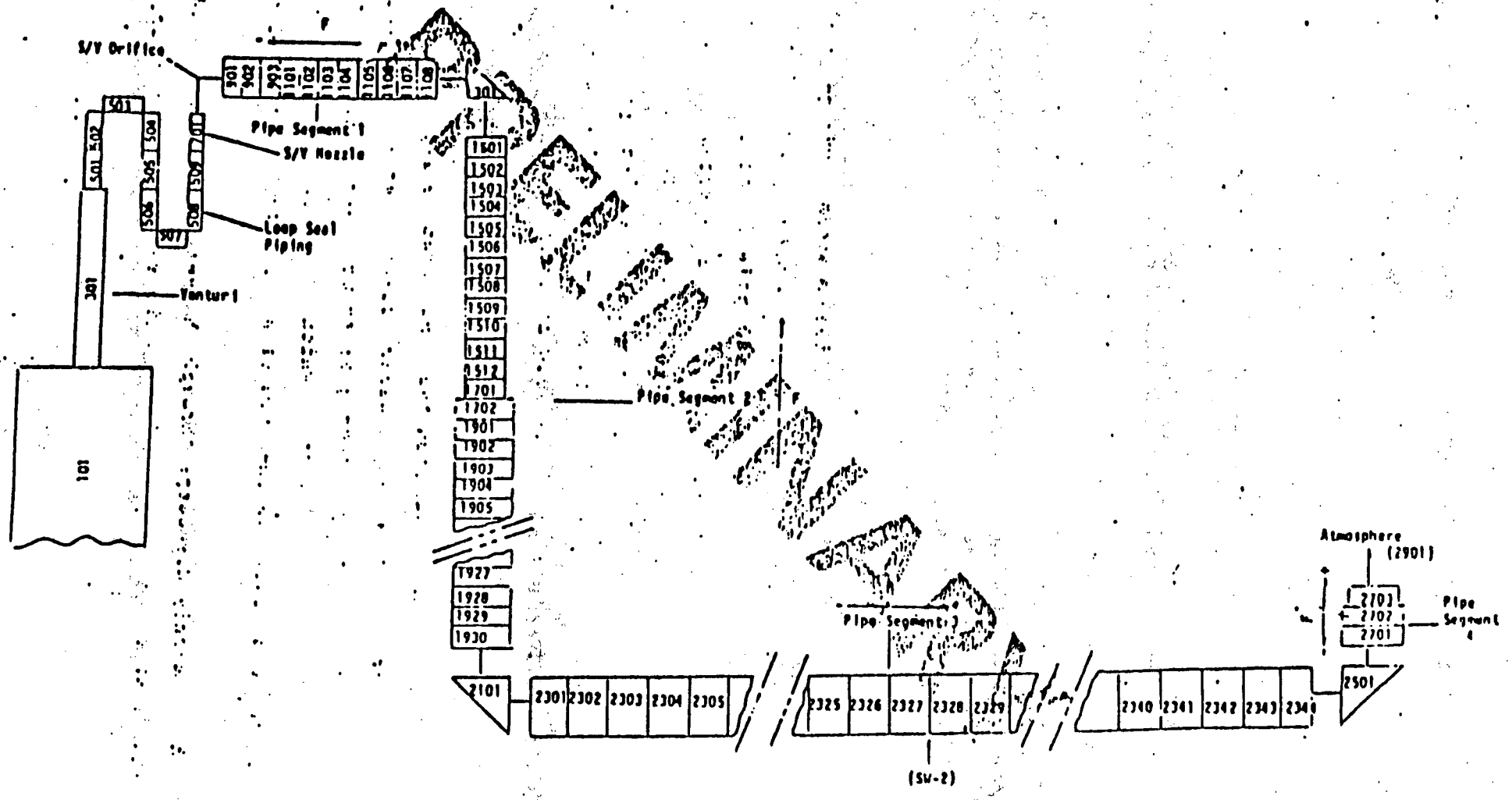


Fig. 2 Nodalization Diagram of the RELAP5/MOD1 Input Model.

Fig. 3 CE STEAM TEST NO.1411
RELAP5 MOD1 CYCLE14

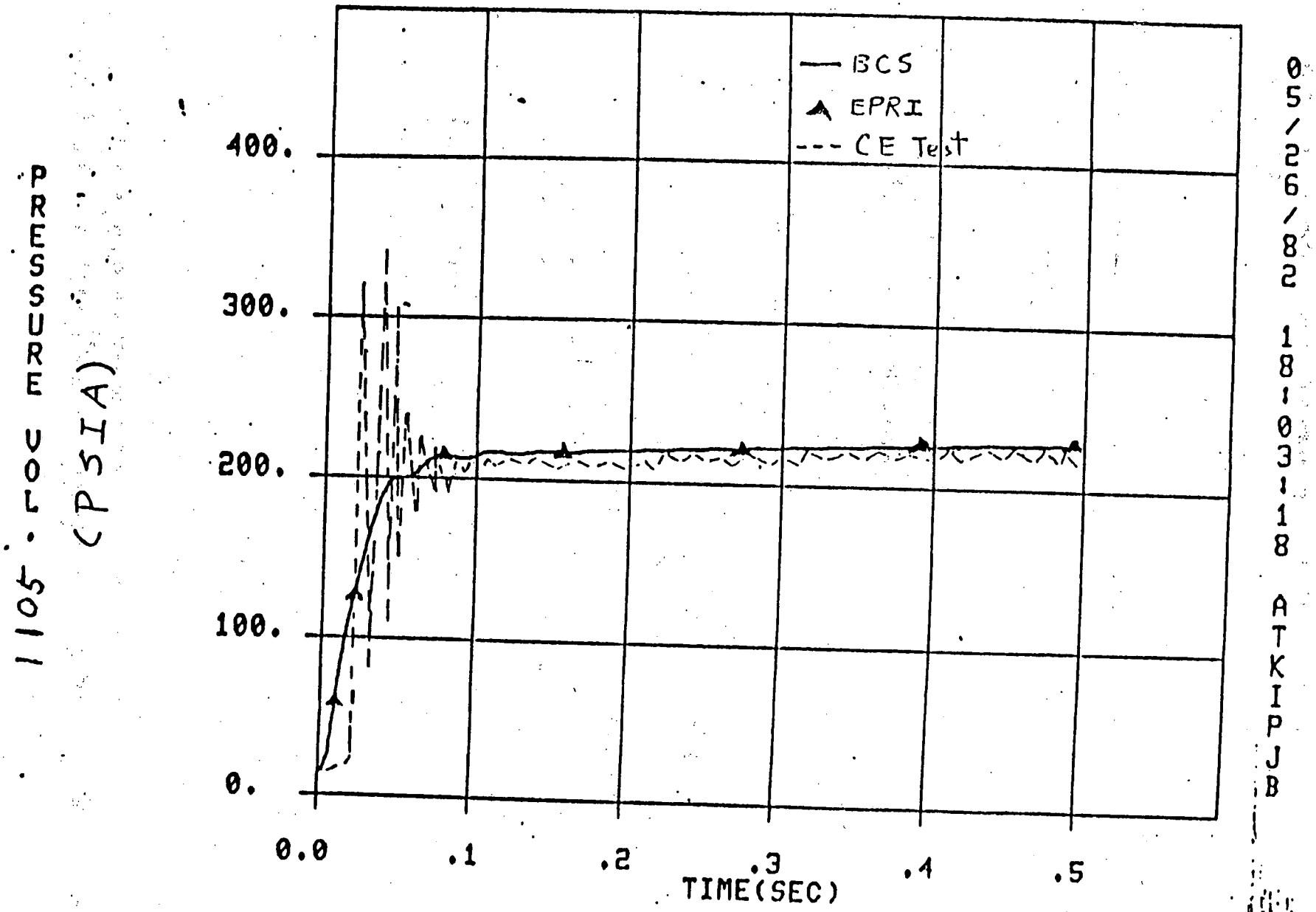


Fig. 4 CE STEAM TEST NO.1411
RELAP5 MOD1 CYCLE14

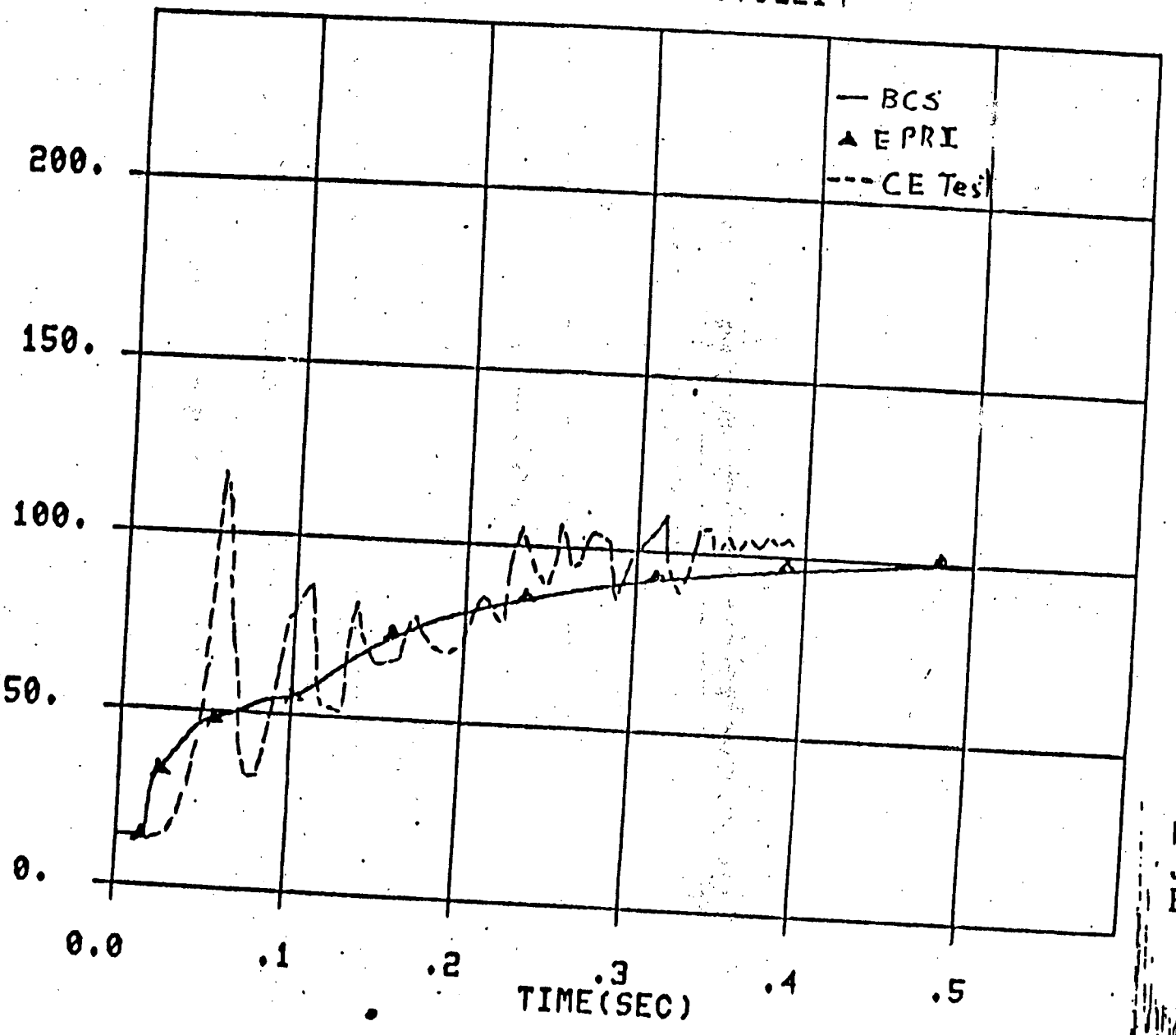
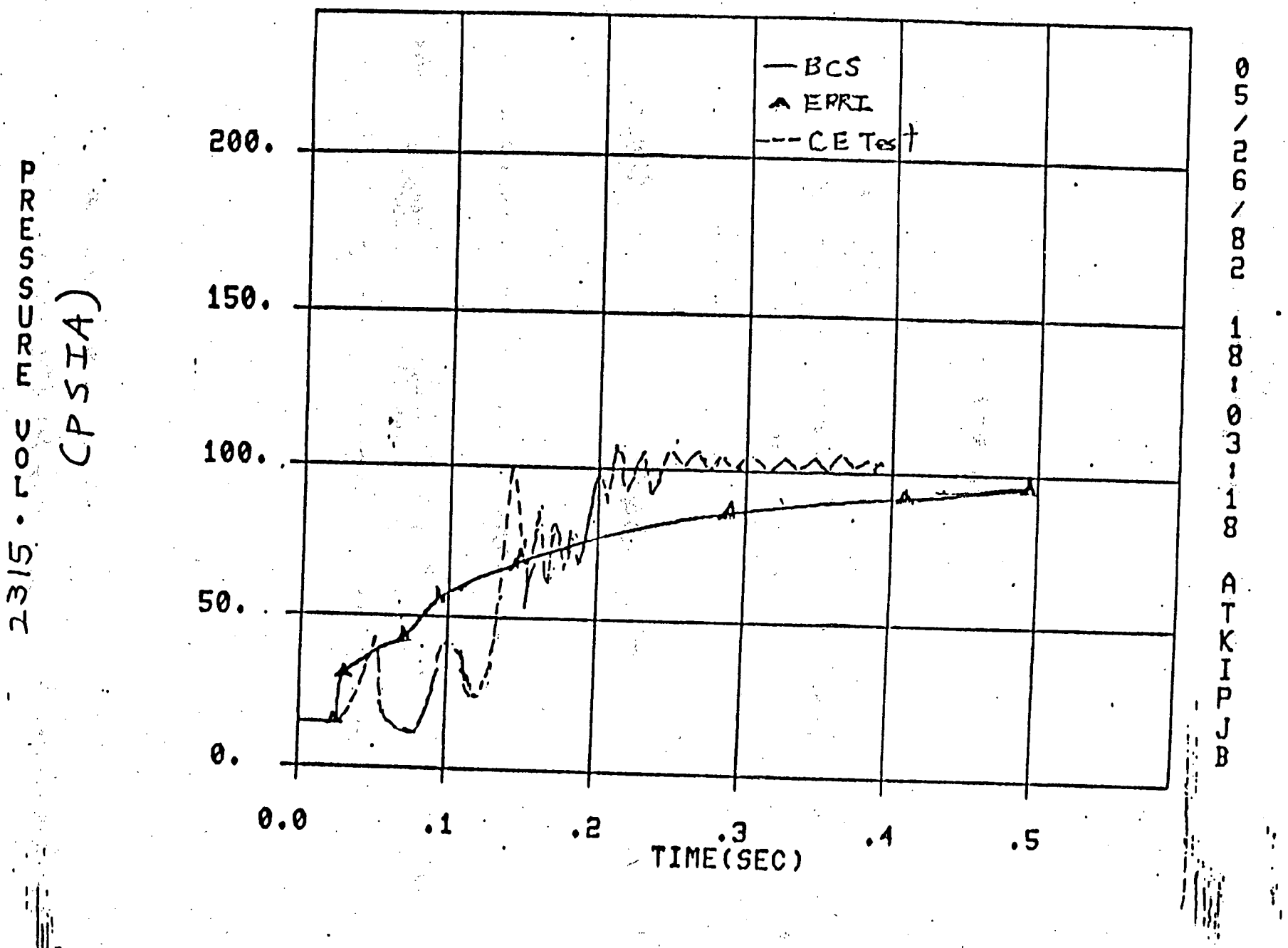


Fig. 5 CE STEAM TEST NO.1411
RELAP5 MOD1 CYCLE14



BCS BOEING COMPUTER SERVICES COMPANY

A Division of The Boeing Company

ATTACHMENT C

BCS RELAP5/1 CERTIFICATION TEST RESULTS FOR SAFETY AND RELIEF VALVE DISCHARGE

(Standard Test Case QA-9)

These figures are identified with their corresponding figures of Attachment B.

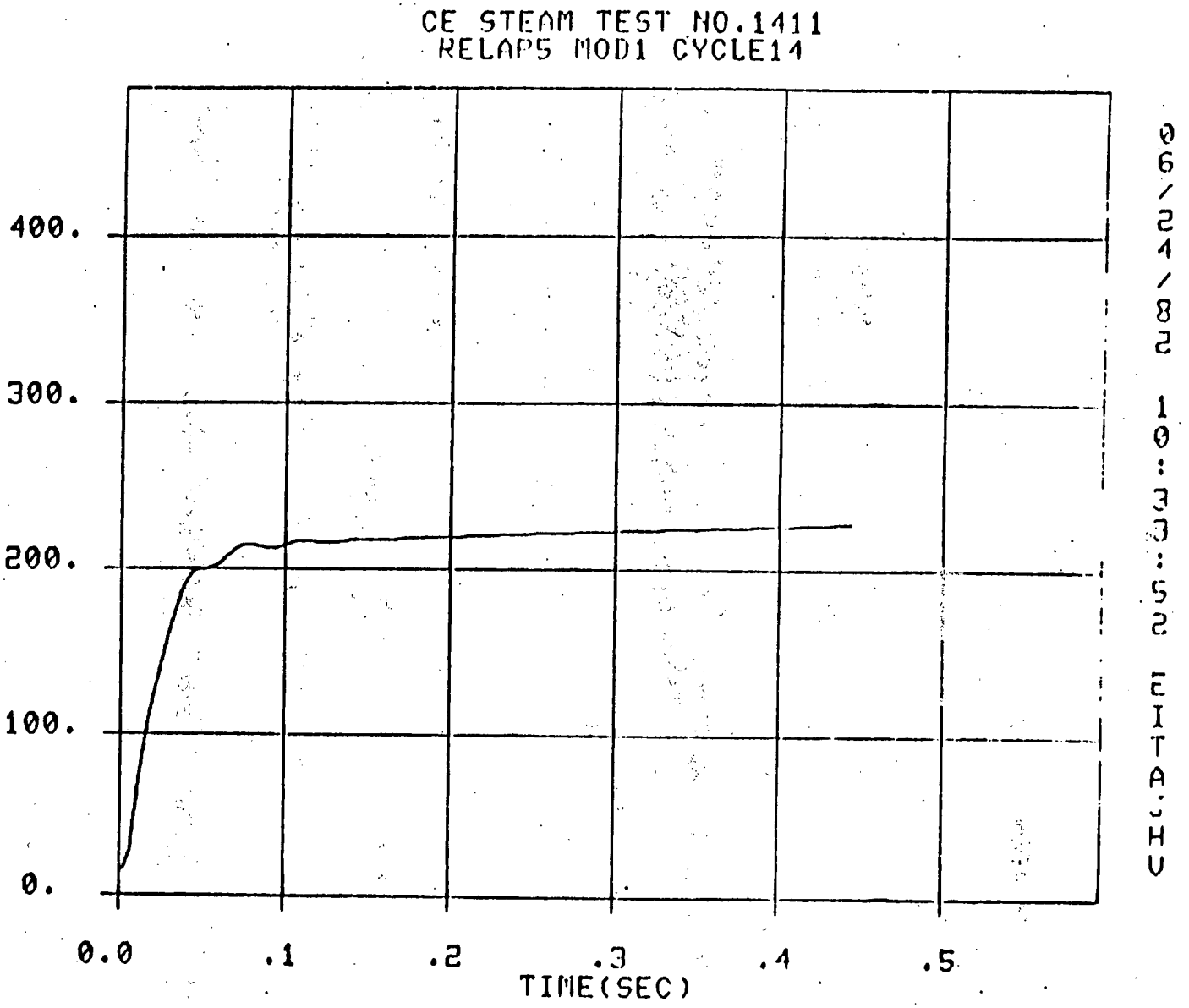

CE STEAM TEST NO.1411
RELAP5 MOD1 CYCLE14
PRESSURE VOL. 20
400.
300.
200.
100.
0.
0.0
.1
.2
.3
.4
.5
TIME(SEC)
06/24/82 10:33:52 EITA.HU

Figure 3

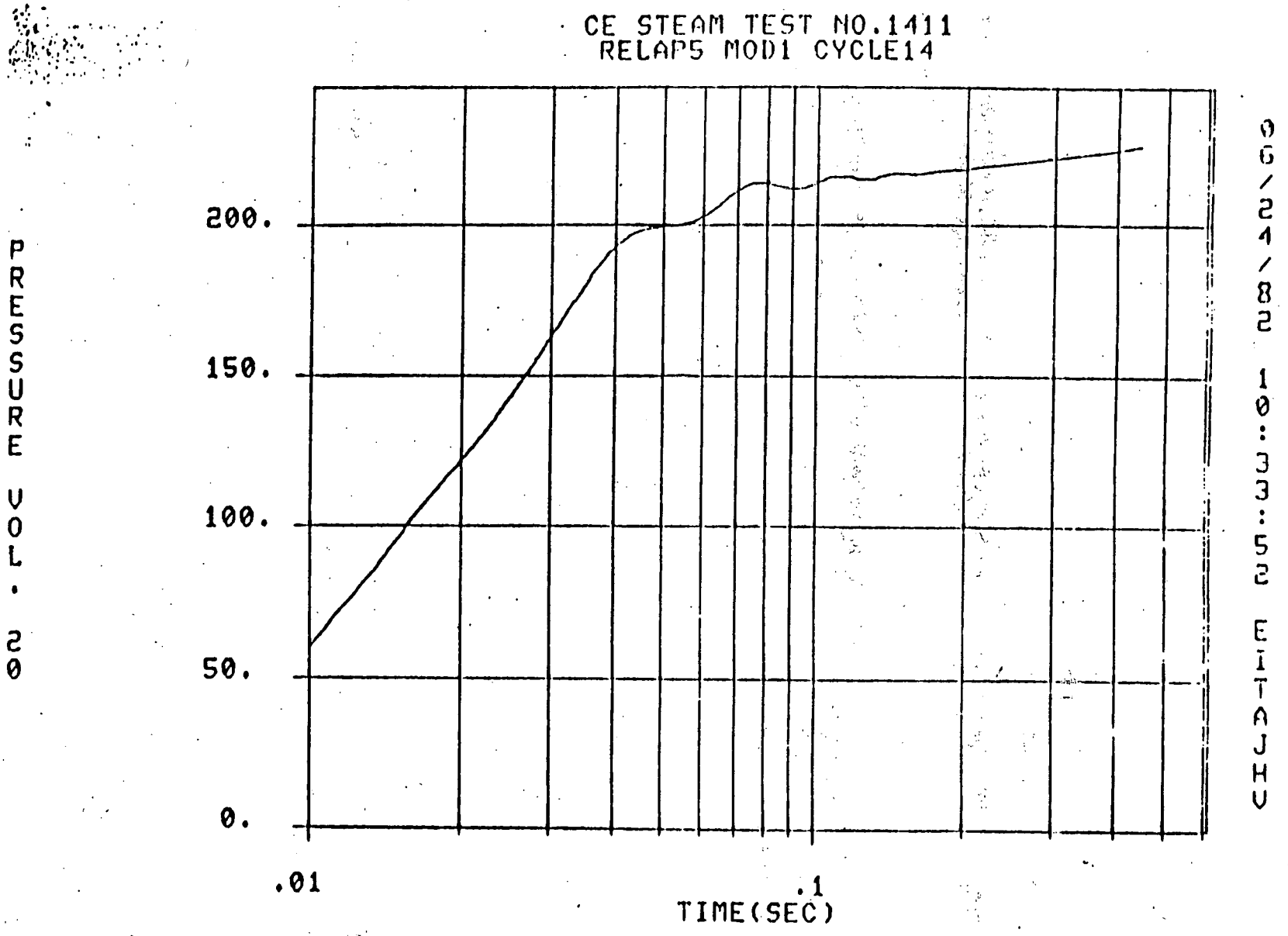


Figure 3 (Semilog)

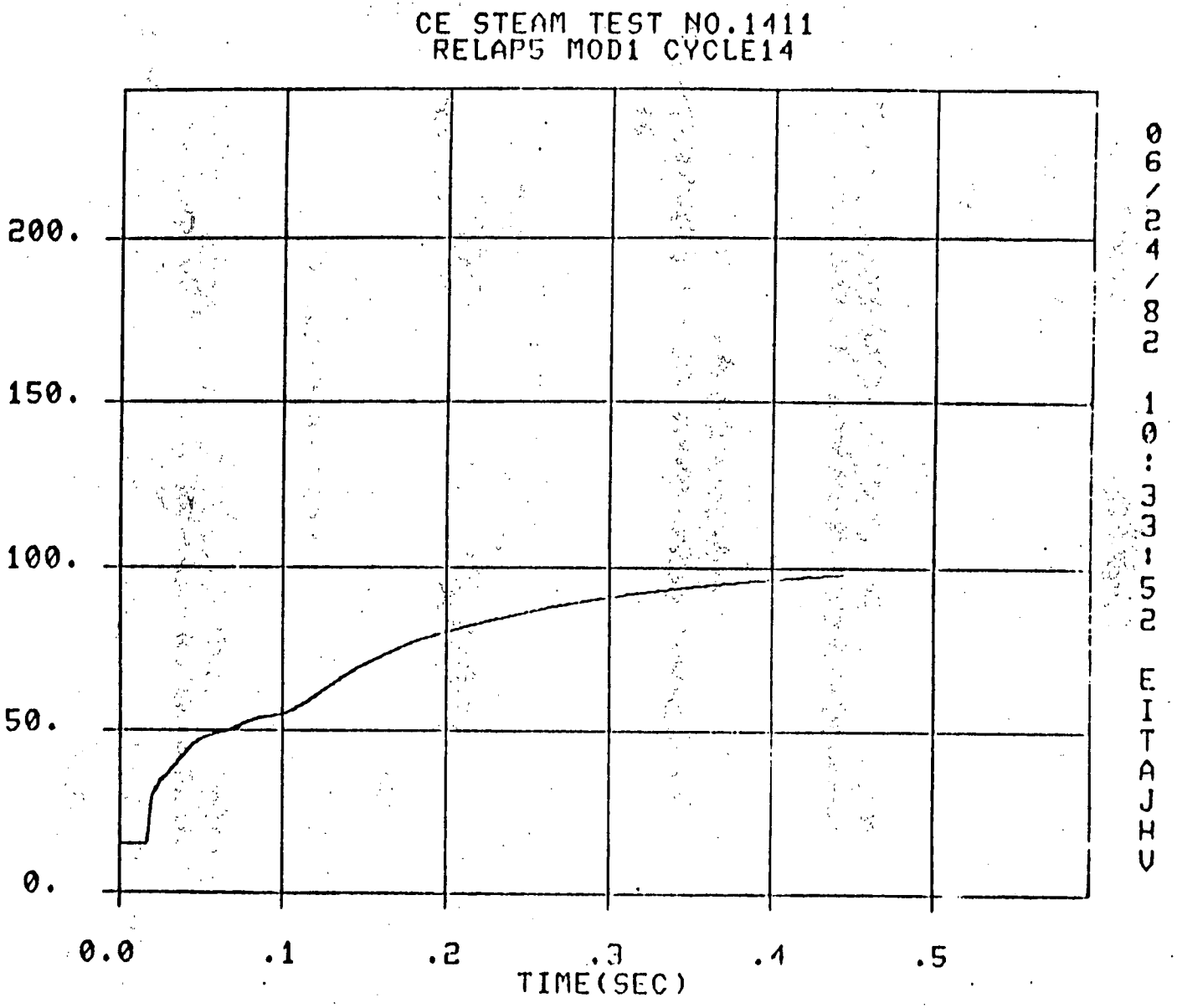

CE STEAM TEST NO.1411
RELAP5 MOD1 CYCLE14
PRESSURE VOL. 65
200.
150.
100.
50.
0.
0.0
.1
.2
.3
.4
.5
TIME(SEC)
06/24/82 10:33:52 EITAJHV

Figure 4

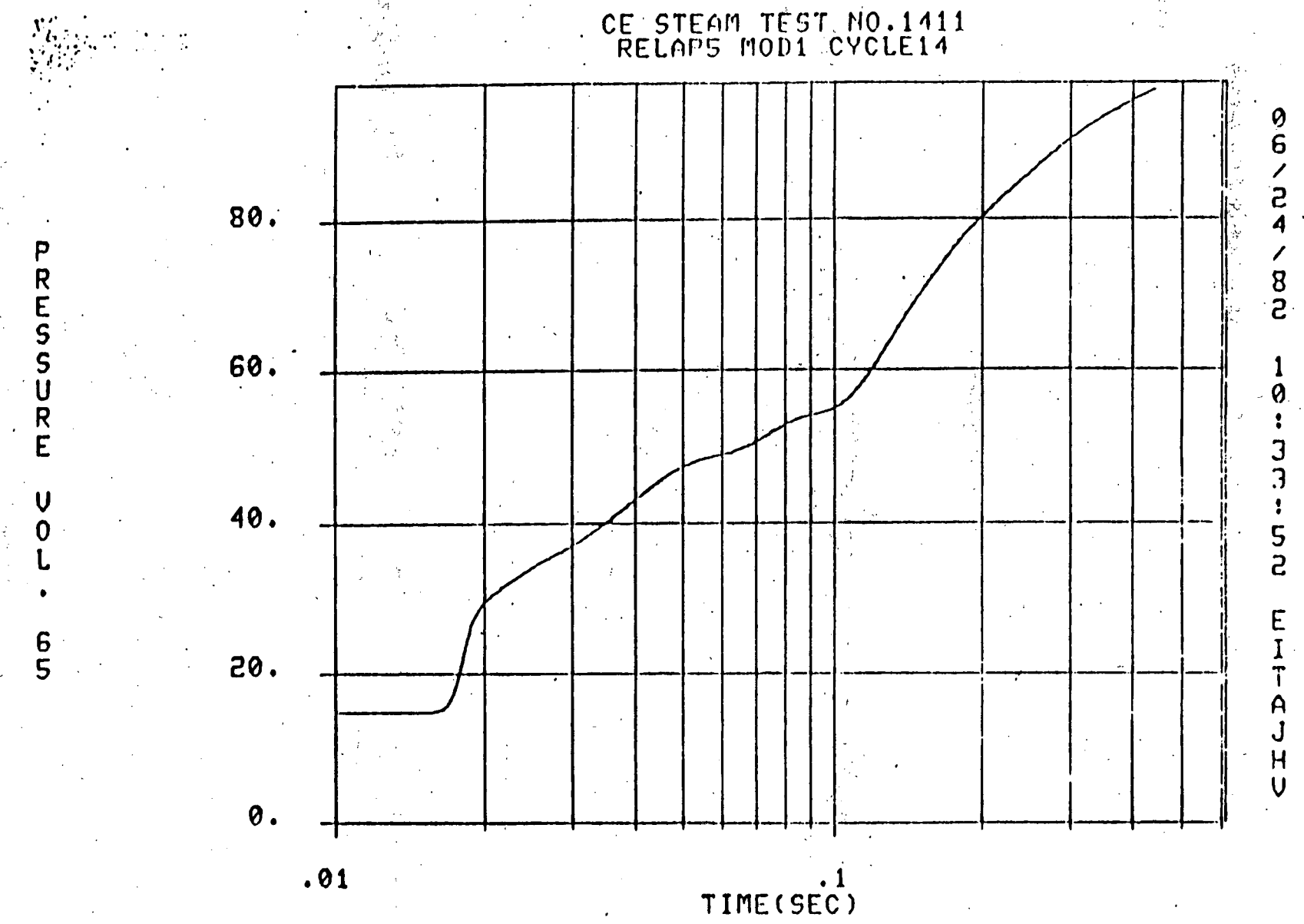


Figure 4 (Semilog)

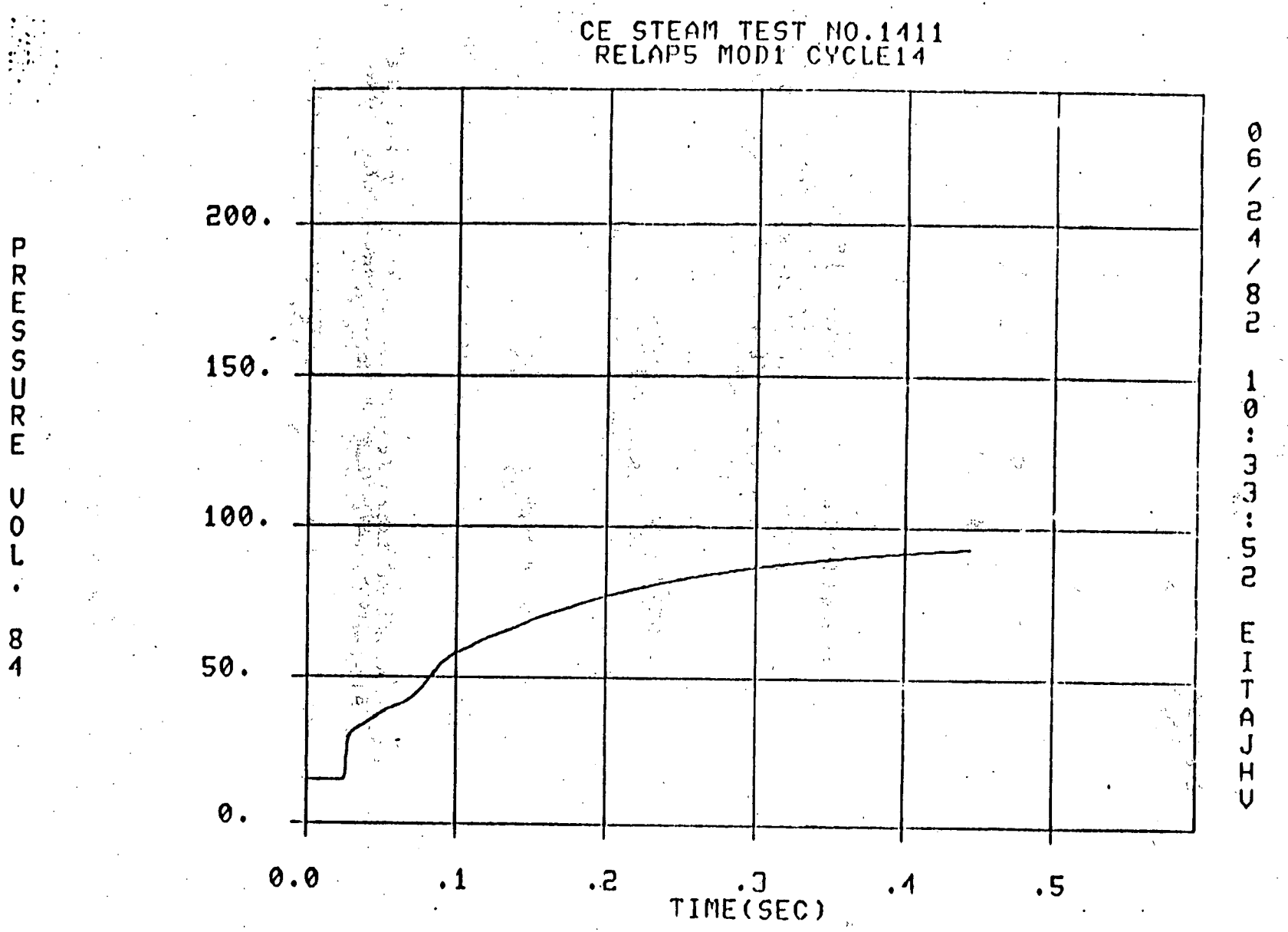

CE STEAM TEST NO.1411
RELAP5 MOD1 CYCLE14
PRESSURE VOL. 84
200.
150.
100.
50.
0.
0.0
.1
.2
.3
.4
.5
TIME(SEC)
06/21/82 10:33:52 EITAJHV

Figure 5

September 20, 1982
G-1020-20-DAJ-071

To:
T. L. Bennett
B. T. Block
R. W. Blohm
R. D. Broad
E. J. Corrie
E. J. Ferri
J. E. Haines
C. R. Harvey
D. P. Konichek
R. C. Lundquist
J. T. Madden
E. C. Maher
J. F. Presti
M. J. Synge
J. L. Tocher
J. C. Turley
R. von Tobel

cc:
F. A Hanna
J. C. Jervert

Subject: National Certification: Force Version 2.0

Reference: Memo G-7610-190, Dated September 14, 1982, J. C. Jervert and F. A. Hanna to C. R. Harvey and D. Johnson, Subject: Certification: Force V2

As evidenced by the referenced memo, Force Version 2.0 is granted conditional certification as a Class B National Product that has also met the requirements of the Regulated Nuclear Industry.

Full Certification will be granted upon completion of an audit of EECCL, Nuclibe Vendor, for development and maintenance practices.

Force Version 2.0 is installed on the EKS Mainstream and VSP services.

D. A. Johnson

DAJ/svv

BOEING COMPUTER SERVICES COMPANY

A Division of The Boeing Company

September 14, 1982
G-7610-190

To:	C. R. Harvey	CV-45
	D. Johnson	7A-44
cc:	R. W. Blohm	7A-21
	R. D. Broad	6K-39
	E. J. Corrie	7A-20
	D. P. Konichek	9A-02
	R. C. Lundquist	7A-36
	J. F. Presti	7A-21
	M. J. Synge	7A-21
	J. L. Tocher	9C-02
	J. C. Turley	7A-23
	R. Vontoble	6K-39

Subject: Certification: Force V2

The FORCE program is certified to perform as described in attachment 1.

Technical Requirements for Class B, Regulated, described in document G-40356.01, have been med as evidenced in attachment 2.

Conditional Certification, Class B and Category Regulated is granted. Unconditional Certification will be granted upon completion of an audit of EECCL, Nuclibe Vendor, for development and maintenance practice.

FORCE will be installed on the EKS Mainstream and VSP Services.

J. C. Jervert
ETA Quality Assurance

F. A. Hanna
Engineering and Scientific Services

Attachments

Attachment 1

1. MAINSTREAM-EKS, FORCE, Reference Manual and Access Guide, 10208-2032, July 1982

2. Test Report, FORCE, G-7623-046, August 27, 1982

QA CERTIFICATION REPORT

SOFTWARE END PRODUCT: FORCE - VERSION 2 ____
NAME WBS #

QA CLASS: B QA CATEGORY Reg
A,B,C,or D NORMAL or REGULATED

PRODUCED BY: P. KONICHEK
NAME

BRIEF DESCRIPTION Actions required for certification, signatures, and notification of product certification.

REVIEW MATERIALS:

IDENTIFICATION (TITLE, DOC #, REV. DATE) DESCRIPTION

ITEM FOR REVIEW:

QA RECORD BOOK :

:

SUPPORTING DOCUMENTATION:

REFERENCE MANUAL & ACCESS GUIDE 10208-2032

TEST CASES : (NOTEBOOK)

LOG NOTEBOOK : (HOTLINE & TROUBLE REPORT

CERTIFICATION MEMO:

REVIEW PARTICIPANTS:

REVIEW LEADER: J. SERVERT (NAME)

NAME	DATE	ACCEPT (NO FURTHER REVIEW)	REJECT (ATTACH REASONS)	SIGNATURE
B. MUKHERJI		✓		9/9/82
R. LUNDQUIST	9-8-82	X		
C. WOLFE		X		C. Wolfe 9/7/82
G. VONFUCHS		X		George von Fuchs 9/7/82

STATEMENT OF CERTIFICATION:

THIS SOFTWARE END PRODUCT IS CERTIFIED TO CLASS B AND CATEGORY REG TECHNICAL QUALITY ASSURANCE LEVELS ACCORDING TO PROCEDURE 40356.01.

ETA QA INTERFACE: 14 Sept 82

ENGINEERING AND SCIENTIFIC SUPPORT MANAGER :

CONCURRENCE: 9/14/82

QA CERTIFICATION REPORT

SOFTWARE END PRODUCT: FORCE VERSION 2 ____
NAME WBS #

WORK UNIT: — ____ 1ST ____
TITLE WBS# REVIEW # DATE

FUNCTIONAL MANAGER: C. WOLFE
NAME

ACTION ITEMS:

ASSIGNED TO:	DUE BY:	DESCRIPTION

January 27, 1984
G-1020-DAJ-009

To: W. C. Aikens, T. W. Cook, A. C. Gilmore, G. E. Grant, F. A. Hanna, J. C. Jervert, D. M. Schoenbrot

cc: B. T. Block, J. W. Crosby, E. J. Ferri, C. R. Harvey, B. Mukherjui, G. L. Olson, S. Pruitt, J. W. Spencer

Subject: RELAP5, Vendor Version 3.00 and BCS Version 1.0.1--National Certification, Class C and Category Regulated

Reference: Memo G-7611-006, dated January 9, 1984, J. C. Jervert and F. A. Hanna to D. A. Johnson, Subject: Certification: RELAP5/MOD1, Vendor Version 3.00 and BCS Version 1.0.1

RELAP5/MOD1 V3.00/1.0.1 is an intermediate version of V4.01/1.1.1 and is being certified to satisfy a special request of a BCS customer.

As evidenced by the referenced memo, RELAP5/MOD1 has completed all requirements of the certification process with no qualifications. As such, this product is certified as a Class C National Product and has also met the requirements of the Regulated Nuclear Industry. This product will be offered on the Mainstream-VSP service.

It is requested that the Functional Industry Manager provide the formal Marketing announcement to the BCS Sales organization for approval of J. W. Spencer.

D. A. Johnson, Manager
Headquarters Quality Assurance
7C-36, 763-5122

DAJ:sw

BOEING COMPUTER SERVICES COMPANY
A Division of The Boeing Company
P.O. BOX 24346
SEATTLE, WASHINGTON 98124

January 9, 1984
G-7611-006

To: C. R. Harvey CV-45
D. A. Johnson 7C-36

cc: B. T. Block (Software Records) 7A-36
J. W. Crosby CV-01
B. Mukherji 7A-36
S. J. Pruitt 7A-36

Subject: Certification: RELAP5/MOD1, Vendor Version 3.00 and BCS Version 1.0.1

The thermal-hydraulic response program RELAP5/MOD1, vendor version 3.00 and BCS version 1.0.1, is certified to perform according to the documentation listed in Attachment 1. Technical quality assurance requirements for Class C and Category Regulated service offerings described in document 40356.01 have been met as evidenced by Attachment 2.

RELAP5/MOD1 V3.00/1.0.1 is an intermediate version of V4.01/1.1.1 and is being certified to satisfy a special request of a BCS customer.

Unconditional Certification, Class C and Category Regulated is granted. RELAP5/MOD1 is installed on the Mainstream VSP service.

Please issue the National Certification Letter.

J. C. Jervert
ESS Project Operations
and Quality Assurance

F. A. Hanna
Engineering and Scientific
Services Manager

Attachments: Documentation List
Certification Summary Report

0213c

RELAP5/MOD1 3.00/1.0.1

Documentation List

User Manual:

RELAP5/MOD1 Code Manual
Volume 1: System Model and Numerical Methods 10208-2010-1
Volume 2: User Guide and Numerical Methods 10208-2010-2

Test Plan: BELAP 5/1 V3.00 Dated, January 4, 1984

Test Report: RELAP5/MOD1 Version 3 Product Test Report,
Dated January 4, 1984

QA CERTIFICATION REPORT

SOFTWARE END PRODUCT: RELAP5/MOD1 Version 3.00 BCS 1.0.1
NAME WBS #

QA CLASS: ~~A~~ B C (per 1/9/84) QA CATEGORY Reg
A,B,C,or D NORMAL or REGULATED

PRODUCED BY: S. Pruitt
NAME

BRIEF DESCRIPTION: Certification Q.A. Record book Contents dated 1/4/84 -

REVIEW MATERIALS:

IDENTIFICATION (TITLE, DOC #, REV. DATE) DESCRIPTION

ITEM FOR REVIEW:

QA RECORD BOOK : Contents through 9 Jan 84

:

SUPPORTING DOCUMENTATION:

Test Report Q.A Summary : Q.A. Record Book (Section 2.3) 4th review dated 1/4/84

Test Plan. :

:

:

REVIEW PARTICIPANTS:

REVIEW LEADER: (NAME)

NAME	DATE	ACCEPT	REJECT (NO FURTHER REVIEW)	SIGNATURE (ATTACH REASONS)
B. Mukherji	1-5-84	✓		
R. Lundquist	1-9-84	✓		
A. Kenneaff	1/9/84	✓		

STATEMENT OF CERTIFICATION:

THIS SOFTWARE END PRODUCT IS CERTIFIED TO CLASS C AND CATEGORY R TECHNICAL QUALITY ASSURANCE LEVELS ACCORDING TO PROCEDURE 40356.01.

ETA QA INTERFACE: Jon C Sorrest 1/9/84

ENGINEERING AND SCIENTIFIC SUPPORT MANAGER : CONCURRENCE: Fred Haas 1/9/84

QA CERTIFICATION REPORT

SOFTWARE END PRODUCT: RELAP5/MOD1 Version 3.00 BCS 1.0.1
NAME WBS #

WORK UNIT: _____ ____ ____ ____
TITLE WBS# REVIEW # DATE

FUNCTIONAL MANAGER: B. Mukherji
NAME

ACTION ITEMS:

ASSIGNED TO:	DUE BY:	DESCRIPTION