Westinghouse Electric Corporation
Energy Systems

Box 355
Pittsburgh Pennsylvania 15230-0355

AW-97-1098

September 22, 1997

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: MR. T. R. QUAY

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT: PRESENTATION MATERIAL FROM MARCH 13, 1997 NOTRUMP MEETING

Dear Mr. Quay:

The application for withholding is submitted by Westinghouse Electric Corporation ("Westinghouse") pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10CFR Section 2.790, Affidavit AW-97-1098 accompanies this application for withholding setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-97-1098 and should be addressed to the undersigned.

Very truly yours,

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

jml

cc: Kevin Bohrer NRC OWFN MS 12E20

AW-97-1098

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Brian A. McIntyre, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Corporation ("Westinghouse") and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Brian A. McIntyre

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

Sworn to and subscribed
before me this 22nd day
of September, 1997

Janet A. Schwab
Notary Public

Notarial Seal
Janet A. Schwab, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires May 22, 2000
Member, Pennsylvania Association of Notaries

(1) I am Manager, Advanced Plant Safety And Licensing, in the Nuclear Projects Division, of the Westinghouse Electric Corporation and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Energy Systems Business Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Energy Systems Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) Enclosed is Letter DCP/NRC0824 (NSD-NRC-97-5080), September 22, 1997, being transmitted by Westinghouse Electric Corporation (W) letter and Application for Withholding Proprietary Information from Public Disclosure, Brian A. McIntyre (W), to

Mr. T. R. Quay, Office of NRR. The proprietary information as submitted for use by Westinghouse Electric Corporation is in response to questions concerning the AP600 plant and the associated design certification application and is expected to be applicable in other licensee submittals in response to certain NRC requirements for justification of licensing advanced nuclear power plant designs.

This information is part of that which will enable Westinghouse to:

(a) Demonstrate the design and safety of the AP600 Passive Safety Systems.

(b) Establish applicable verification testing methods.

(c) Design Advanced Nuclear Power Plants that meet NRC requirements.

(d) Establish technical and licensing approaches for the AP600 that will ultimately result in a certified design.

(e) Assist customers in obtaining NRC approval for future plants.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for advanced plant licenses.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar advanced nuclear power designs and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing analytical methods and receiving NRC approval for those methods.

Further the deponent sayeth not.

ENCLOSURE 2 TO DCP/NRC0824

Analysis Of The SPES Facility With The Westinghouse NOTRUMP Code

Prepared By:

A. F. Gagnon

Advanced & VVER Plant Safety Analysis

Westinghouse Electric Corporation

Presented At:

Westinghouse Office

Rockville, Maryland

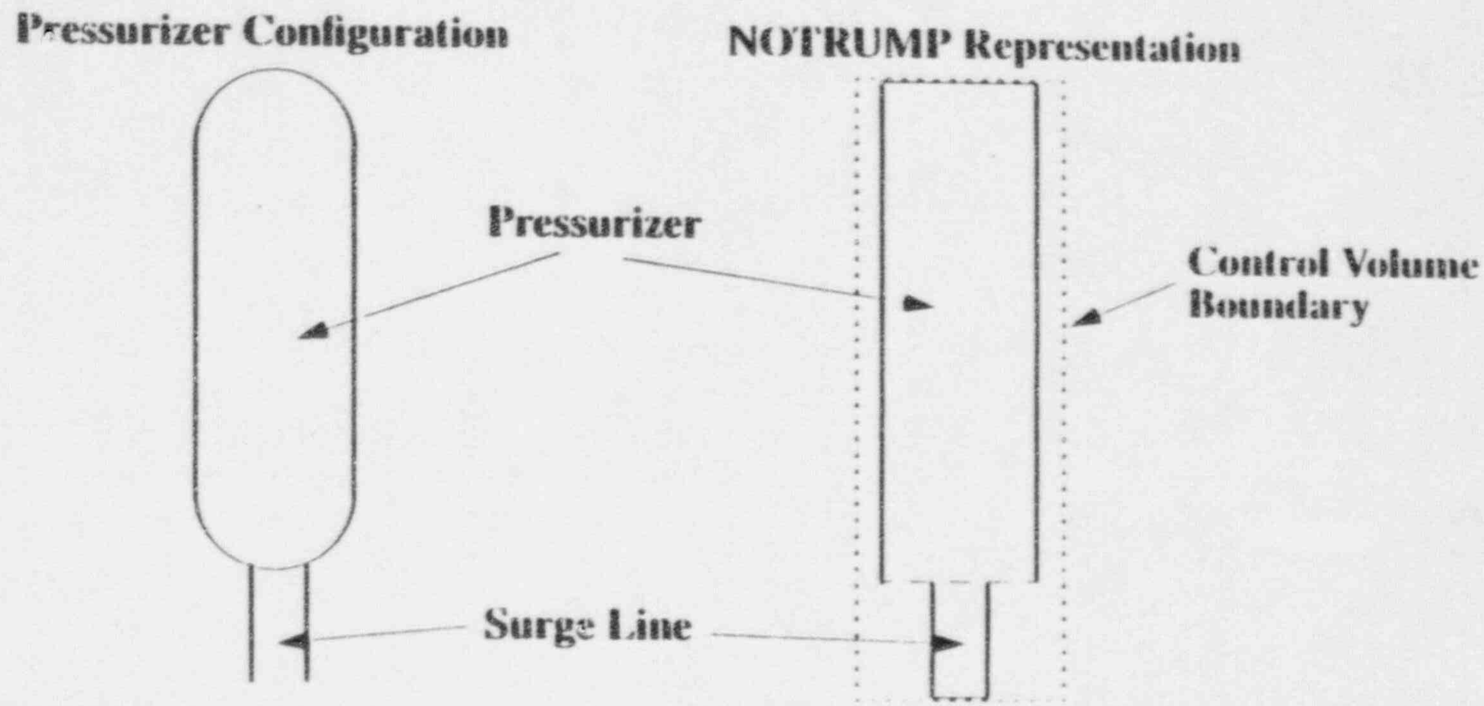
March 13, 1997

Overview

- Review Of Test Matrix
- NOTRUMP Noding Diagram
- Pressurizer Mixture Level Correction
- Review Of 2 Inch Cold Leg Break Results (Test S00303)
- Discussion Of Revised 2 Inch Cold Leg Balance Line Break Results (Test S01007)
  - Results Presented In Report Did Not Model Correct Break Location
- Discussion Of SPES Validation Report Summary Section (Section 7.4)

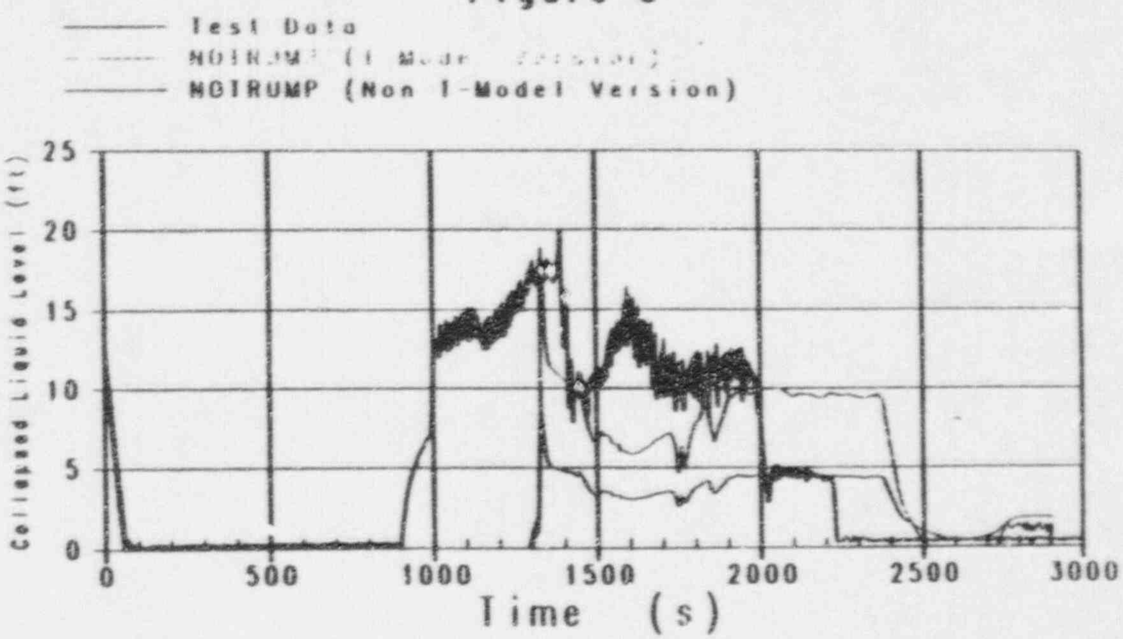
Pressurizer Mixture Level Correction

- Comparison Of Simulation To Test Data Did Not Account For Variable Area Fluid Modeling
  - NOTRUMP Pressurizer Node Consists Of Pressurizer And Surge Line Represented by Variable Area Fluid Node



Pressurizer Mixture Level Correction (Example)

SPES-2 2 Inch Cold Leg Break (S00303)
Pressurizer Level (Relative to Bottom Tap)
Figure-3



2 Inch Cold Leg Break (S00303) Results Summary

- NOTRUMP Predicts Delayed ADS Actuation Relative To Test Data
  - Test ADS Time = 896 Seconds
  - S00303 Simulation = 1223 Seconds
- Delays Related To Delay In SG Downside Tube Drain And Subsequent Level Formation In RCS Cold Legs
  - Results In Delayed Cold Leg Balance Line Vapor Formation And Subsequent CMT Draining
- No Core Coverage Concerns Exhibited By NOTRUMP Or Test
  - NOTRUMP Predicts Lower System Mass At IRWST Injection Time Compared To Test

TABLE 7.3.1-1
S00303 SEQUENCE OF EVENTS

Event	Definition	SPES-2 (seconds)	NOTRUMP (seconds)
Break Opens	0	[a,c]	0
Reactor Trip (R)	P = 1800 psi		59
MSLIV	R + 2 sec.		64
S Signal	P = 1700 psi		68
MFW-IV Close	S + 2 sec.		69
CMT-IV Open	S + 2 sec.		69
RCPs Trip	S + 16.2 sec.		84
CMT-A Starts to Drain	CMT level starts to drop		~840
CMT-B Starts to Drain	CMT level starts to drop		~810
ADS-1	CMT level 67% + 30 sec		1223
Accumulators Start	Flow > 0		1258
ADS-2	CMT level 67% + 125 sec.		1318
ADS-3	CMT level 67% + 245 sec.		1438
Accumulators Empty	Sharp Flow Decrease that follows Level = ~0		~1876
ADS-4	Later of CMT level 20% + 60 sec.		2375
IRWST Injection	–		~ 2510

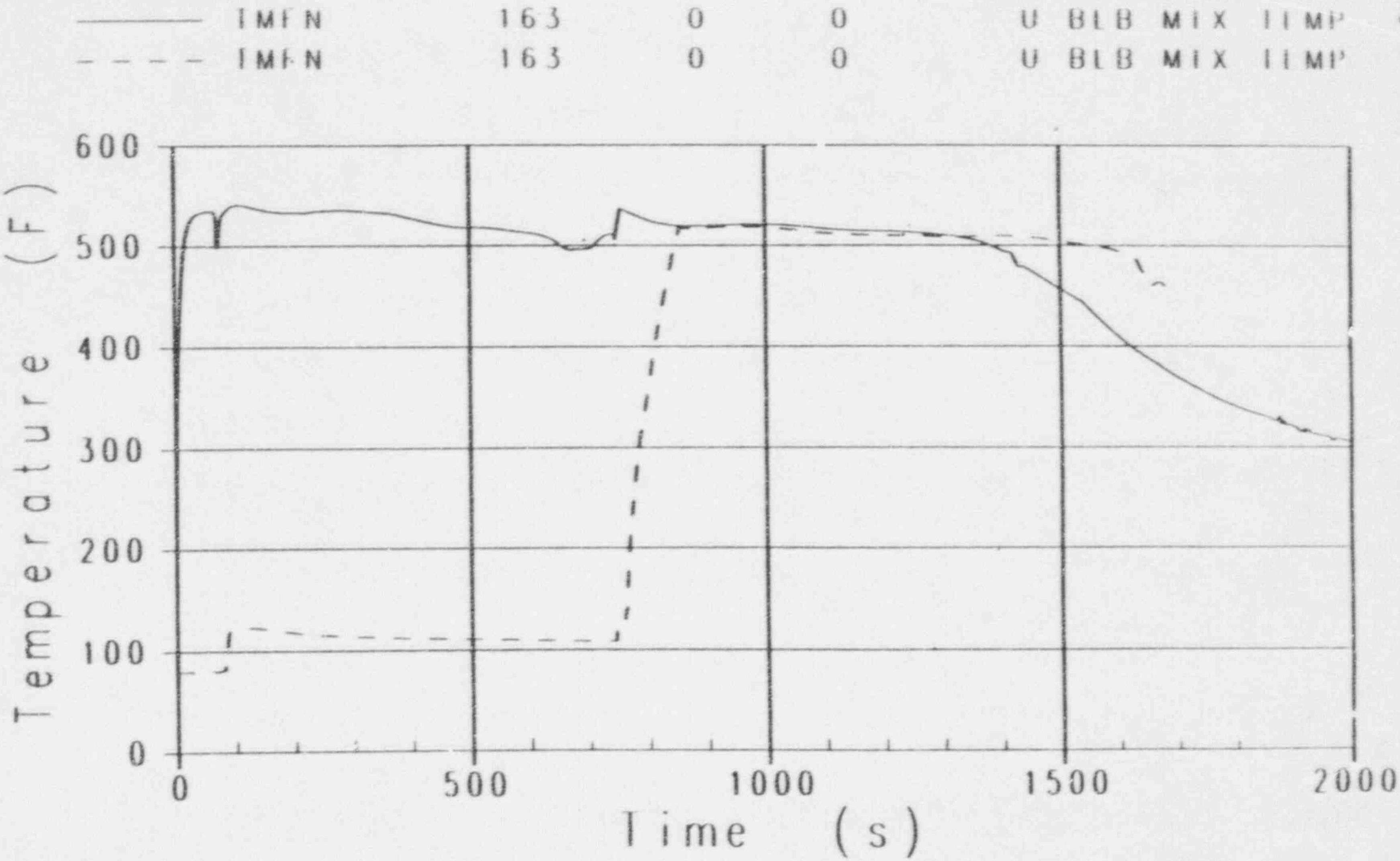
a,c

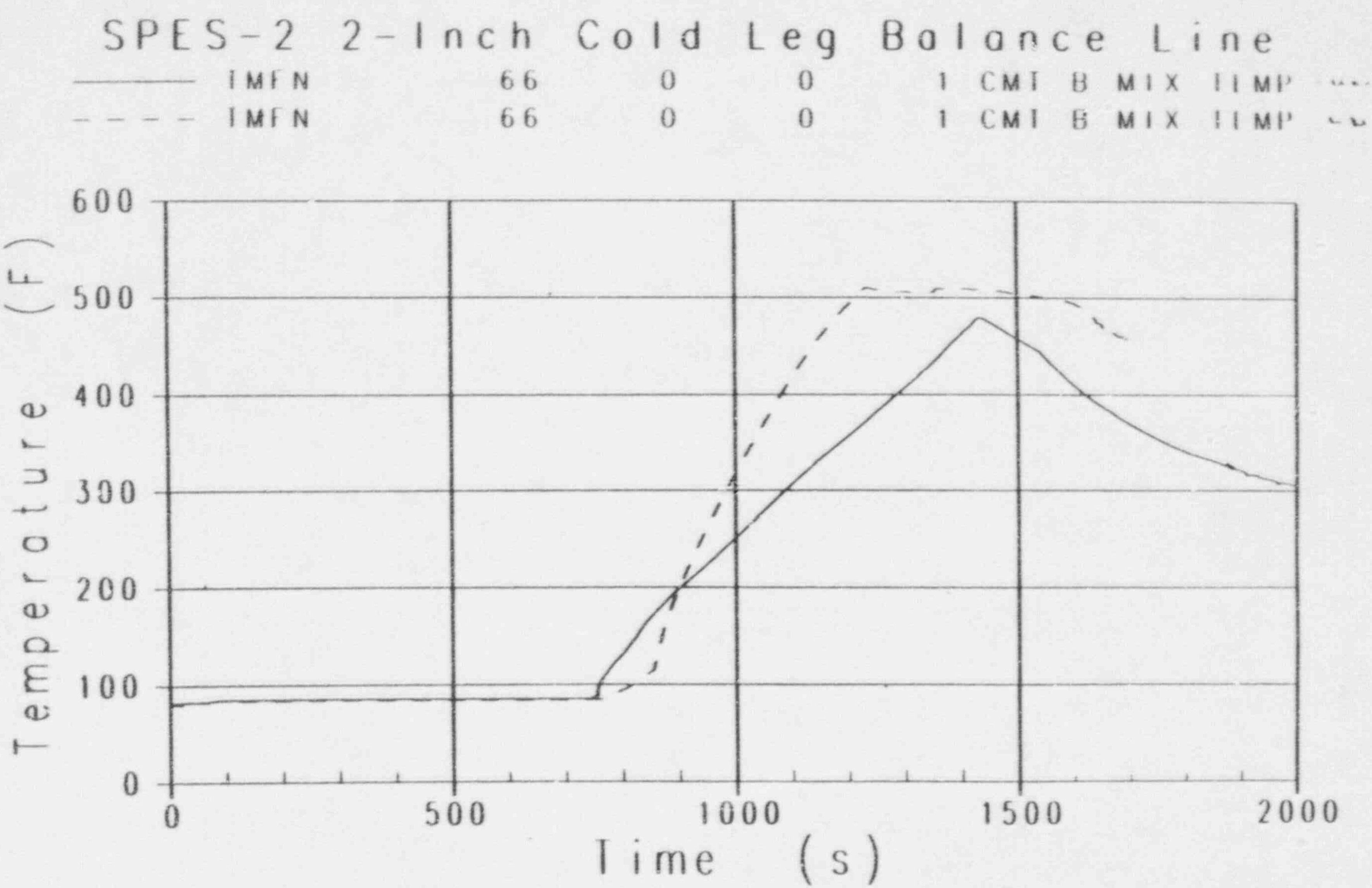
a,c

2 Inch Cold Leg Balance Line (S01007) Results Summary

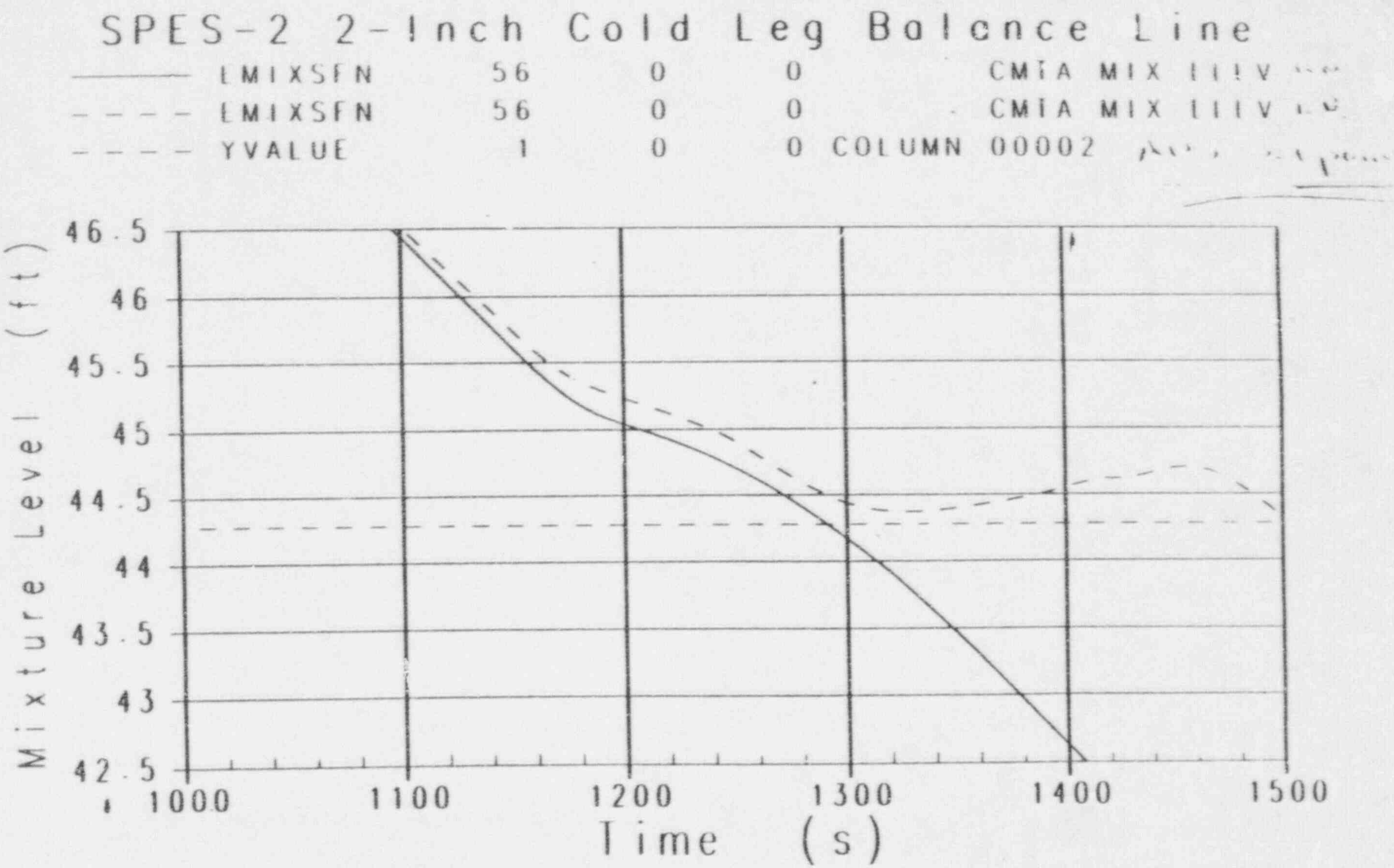
- Results Reported Does Not Accurately Reflect Test Break Location
  - Break Modeled In Upper Fluid Node (FN-163) Instead Of Lower Fluid Node (FN-164)
- Modified Break Location Results In An Additional Delay In Achieving ADS Actuation Compared To Test Facility
  - Test ADS Time = 1072 Seconds
  - Original S01007 Simulation = 1321 Seconds
  - Revised S01007 Simulation = 1533 Seconds
- Results Essentially Identical For First 750 Seconds Of Transient Simulation
  - Differences Observed In Behavior Of CMT-B
  - CMT-A Mixture Level Observed To Hang-up Just Prior To ADS Setpoint
- No Significant Impact On Safety (Core Coverage) Observed
  - NOTRUMP Predicts Lower System Mass Than Observed In Test At IRWST Injection Time

SPES-2 2-Inch Cold Leg Balance Line

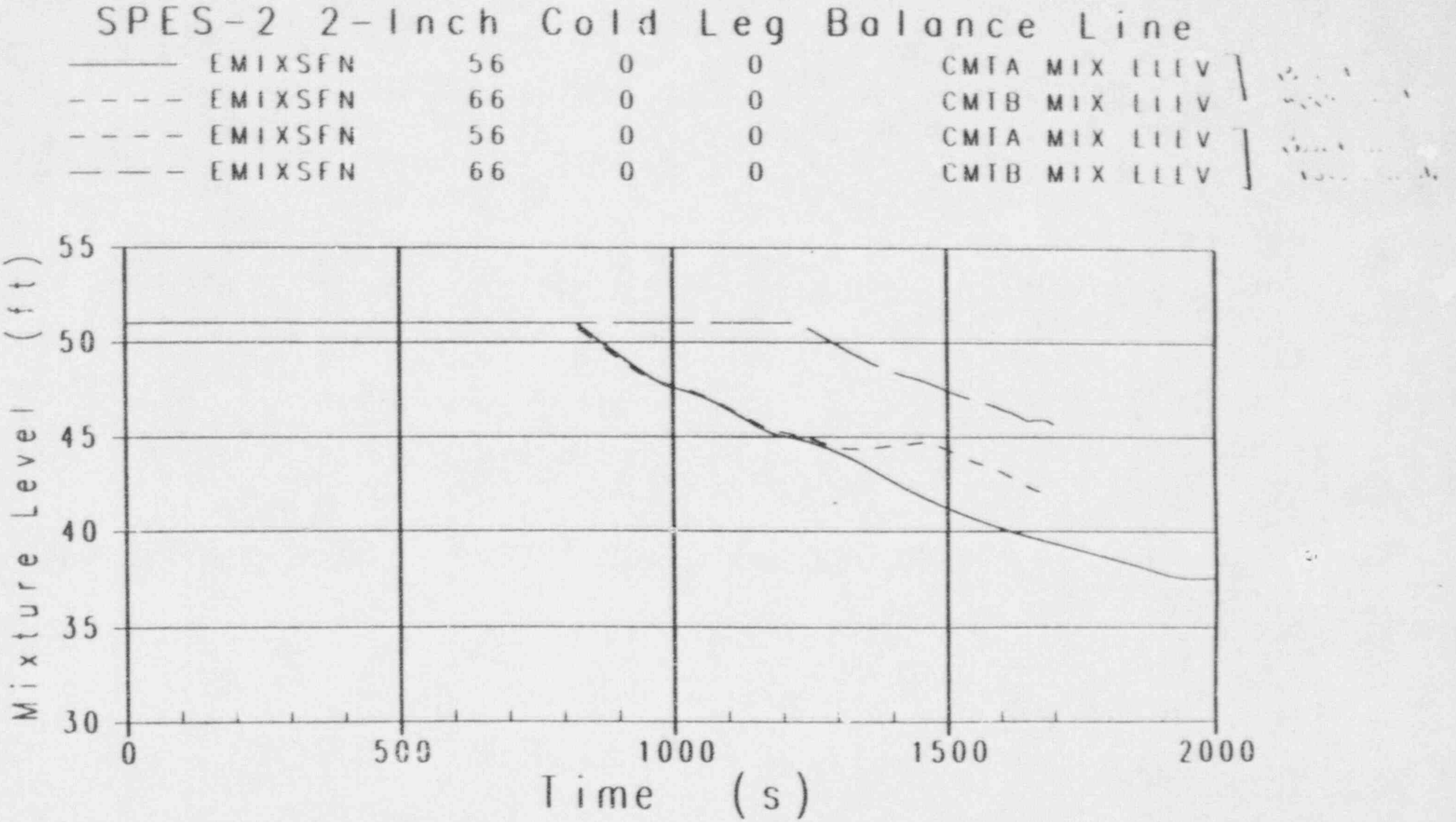




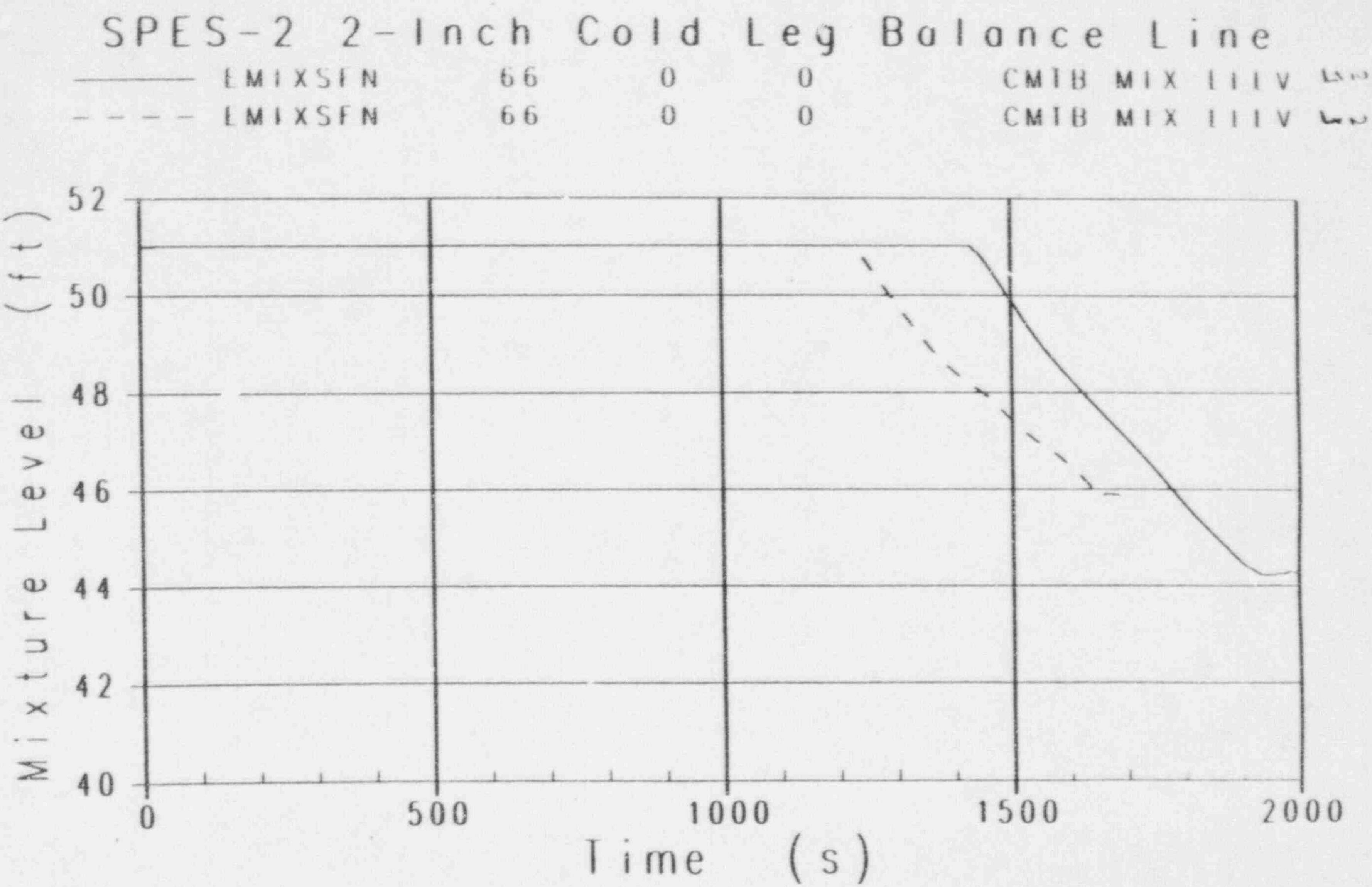
SPES-2 2-Inch Cold Leg Balance Line
IMFN 66 0 0 1 CMT B MIX TEMP
IMFN 66 0 0 1 CMT B MIX TEMP
600
500
400
300
200
100
0
Temperature (F)
0
500
1000
1500
2000
Time (s)

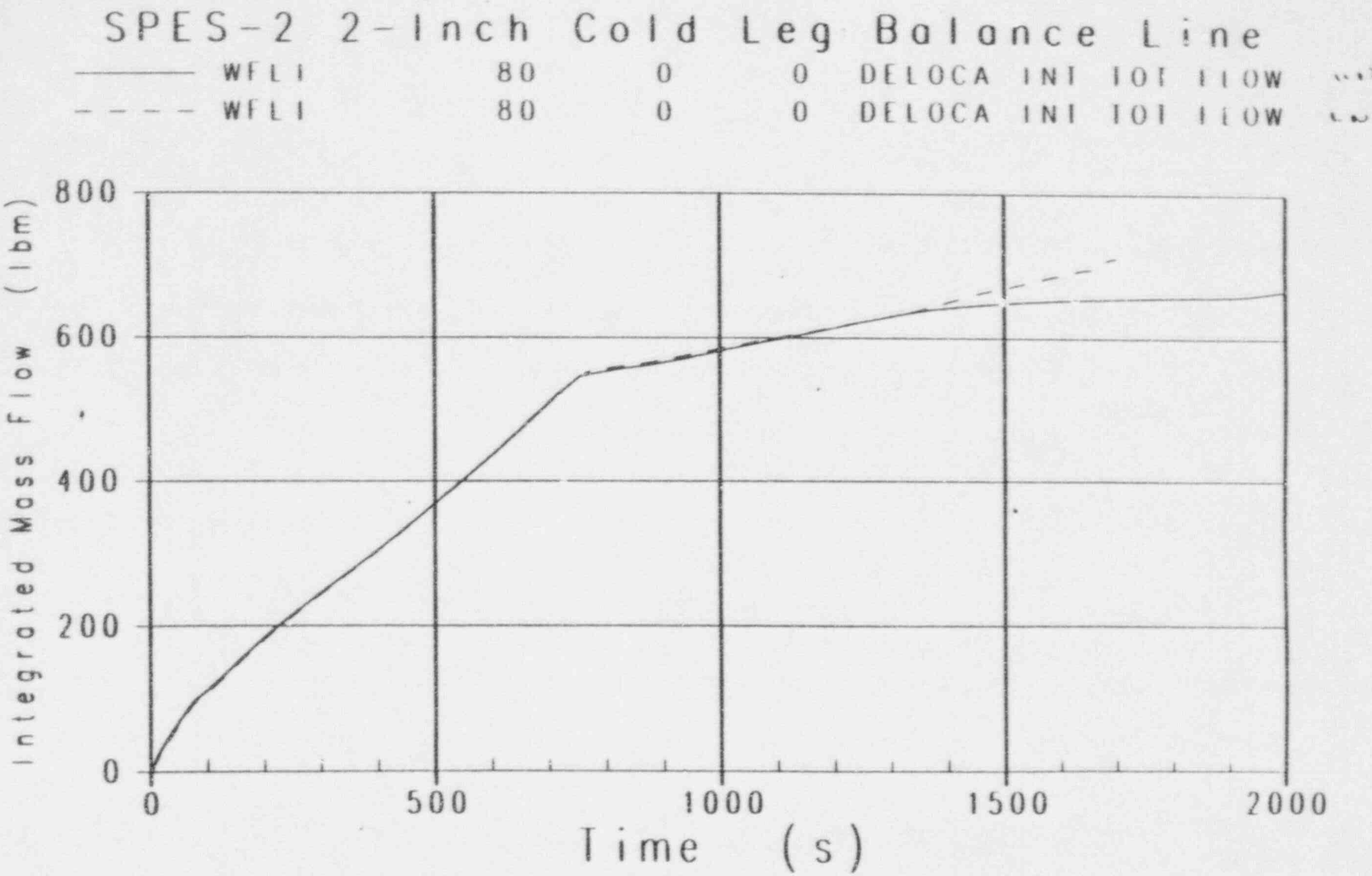


SPES-2 2-Inch Cold Leg Balance Line
LMIXSFN 56 0 0 CMTA MIX LEV
LMIXSFN 56 0 0 CMTA MIX LEV
YVALUE 1 0 0 COLUMN 00002
46.5
46
45.5
45
44.5
44
43.5
43
42.5
Mixture Level (ft)
1000
1100
1200
1300
1400
1500
Time (s)



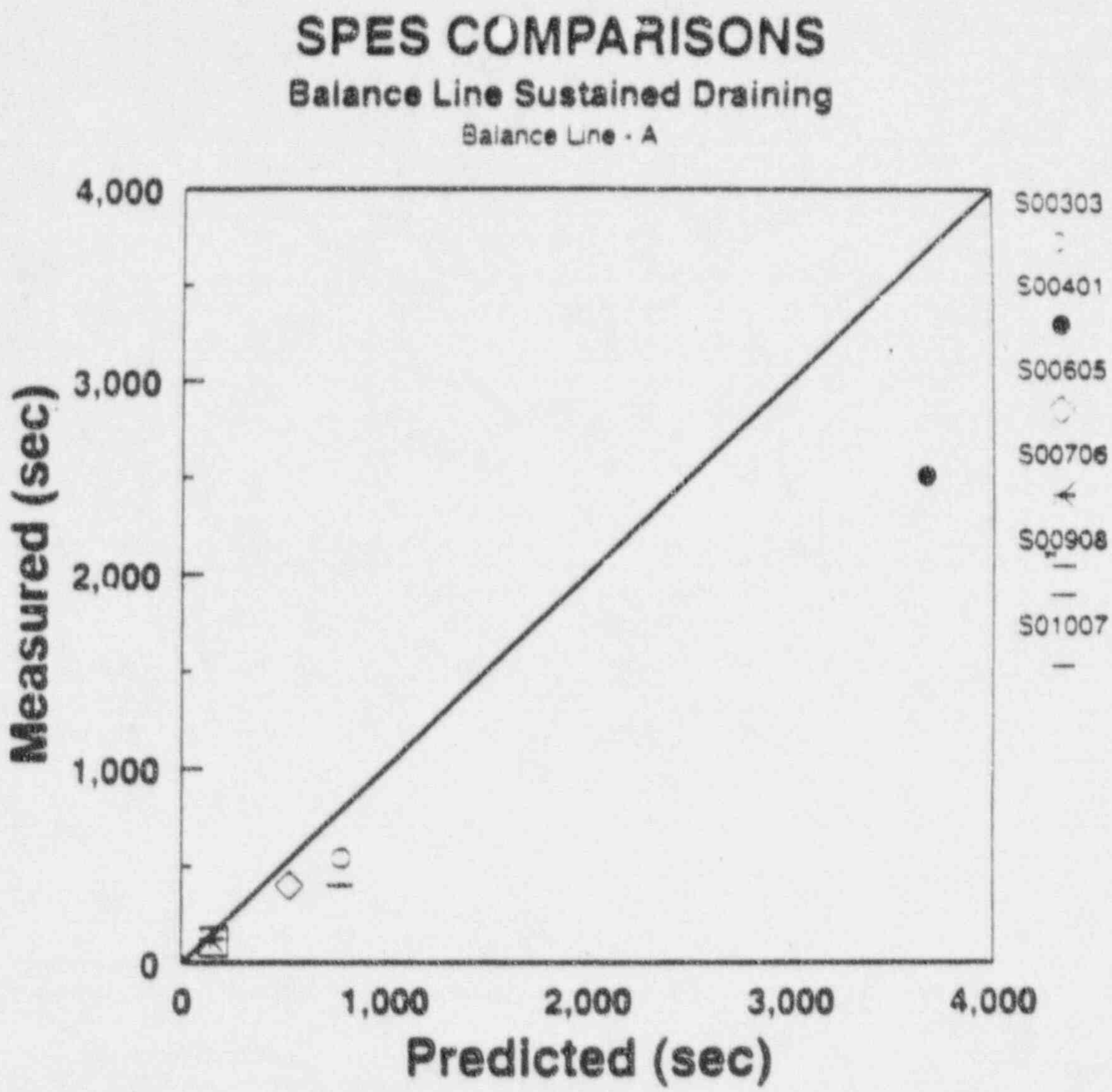
SPES-2 2-Inch Cold Leg Balance Line
EMIXSFN 56 0 0 CMTA MIX LLEV
EMIXSFN 66 0 0 CMTB MIX LLEV
EMIXSFN 56 0 0 CMTA MIX LLEV
EMIXSFN 66 0 0 CMTB MIX LLEV
Mixture Level (ft)
55
50
45
40
35
30
0
500
1000
1500
2000
Time (s)


SPES-2 2-Inch Cold Leg Balance Line
EMIXSFN 66 0 0 CMTB MIX IIIV
EMIXSFN 66 0 0 CMTB MIX IIIV
Mixture Level (ft)
52
50
48
46
44
42
40
0
500
1000
1500
2000
Time (s)

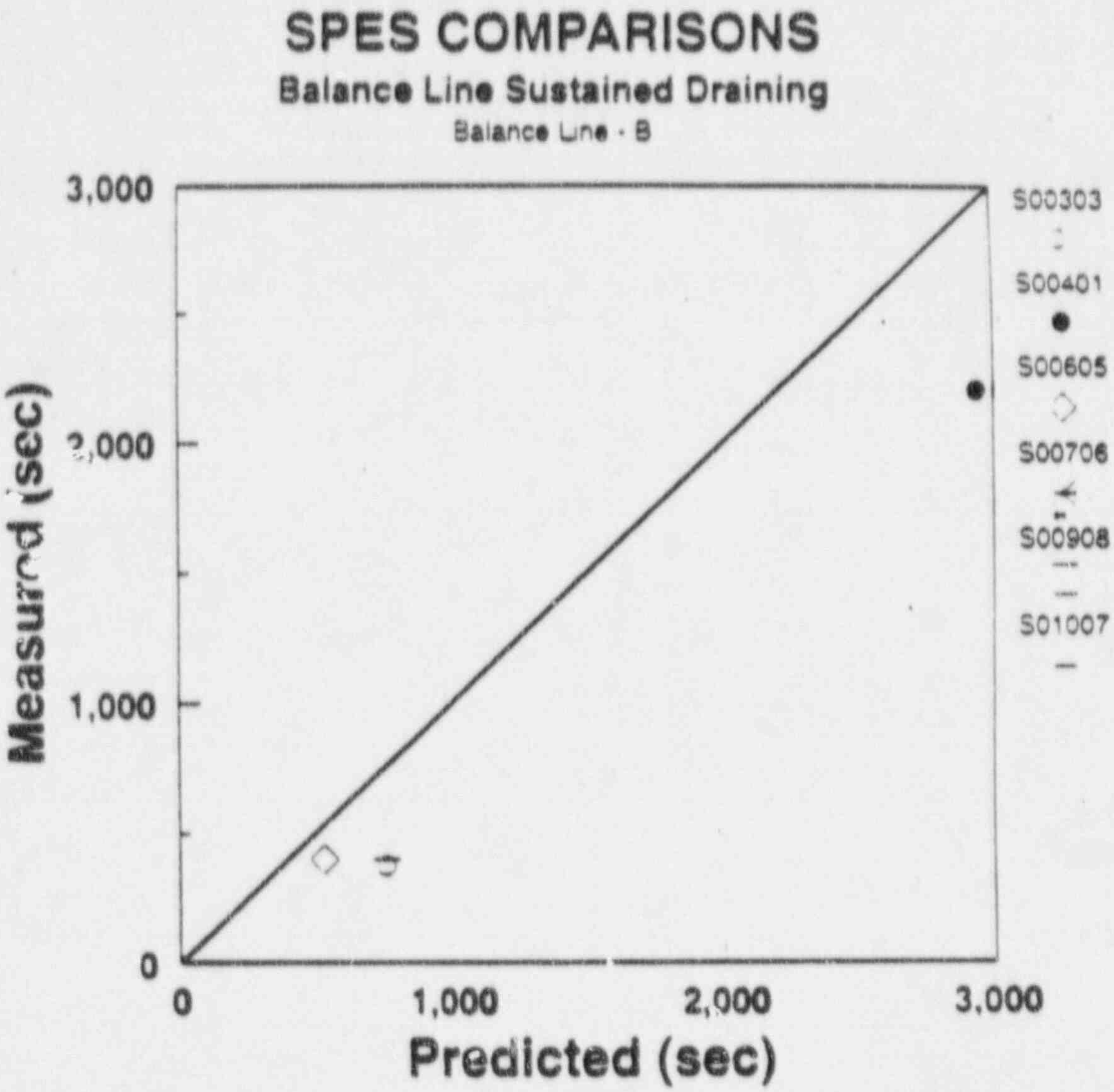

SPES-2 2-Inch Cold Leg Balance Line
WFLI 80 0 0 DELOCA INT TOT FLOW
WFLI 80 0 0 DELOCA INT TOT FLOW
800
600
400
200
0
Integrated Mass Flow (lbm)
0
500
1000
1500
2000
Time (s)

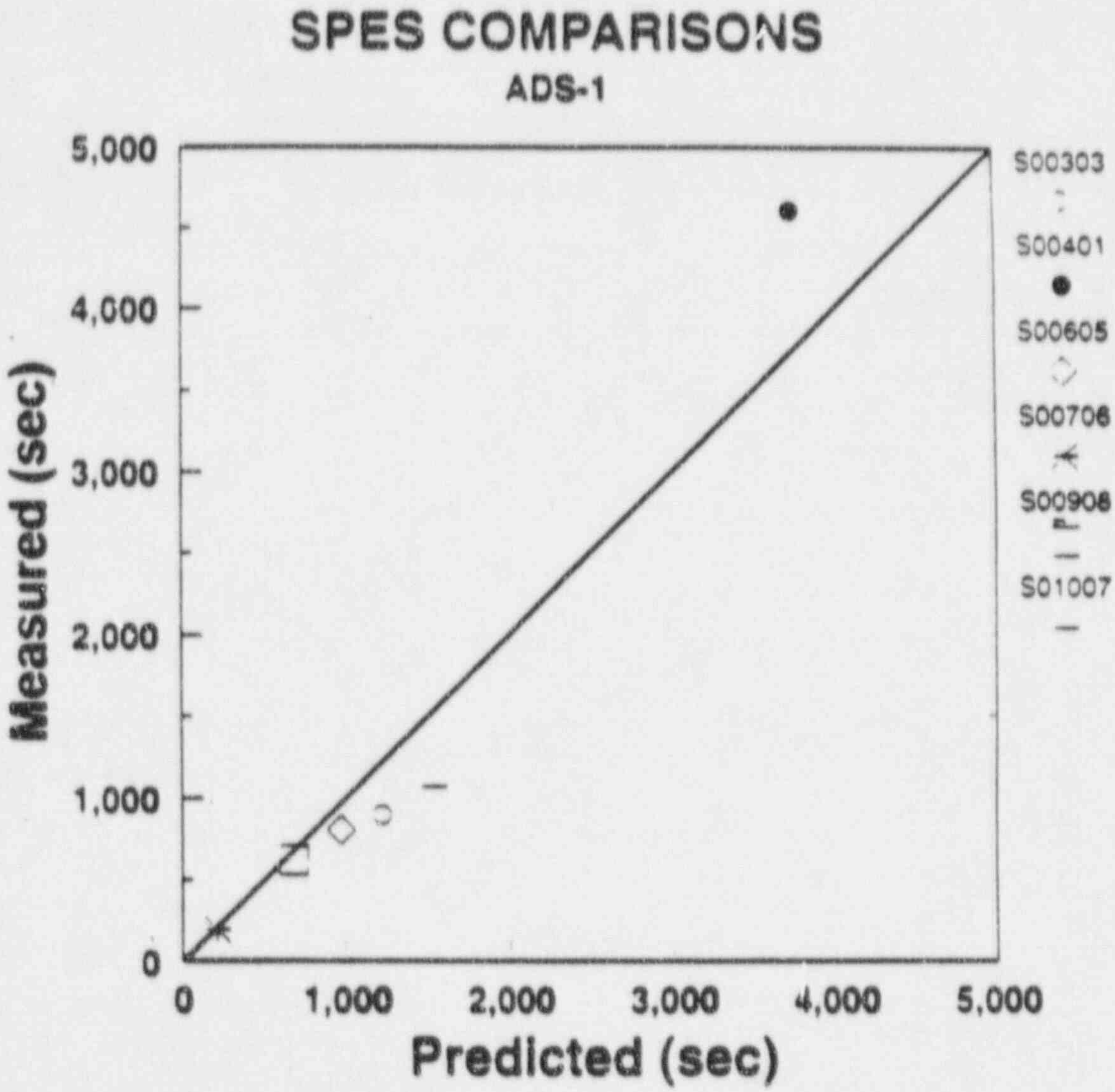
Validation Report Summary Section

- **Timing Related Issues**
  - **NOTRUMP Consistently Predicts Delayed ADS Actuation And IRWST Injection Relative To Test**
    - 1 Inch Cold Leg Break Is An Exception
- **Flow Related Issues**
  - **NOTRUMP Reasonably Represents Break, ADS 1-3, ADS 4, CMT Recirculation, Accumulator, and IRWST Injection Flows**
- **NOTRUMP Consistently Under-predicts PRHR Heat Transfer**
  - **Only Impacts Small Break Simulations (Less Than 2 Inches In Diameter)**
- **NOTRUMP Consistently Predicts Conservative System Inventory Relative To Test At IRWST Injection Time**



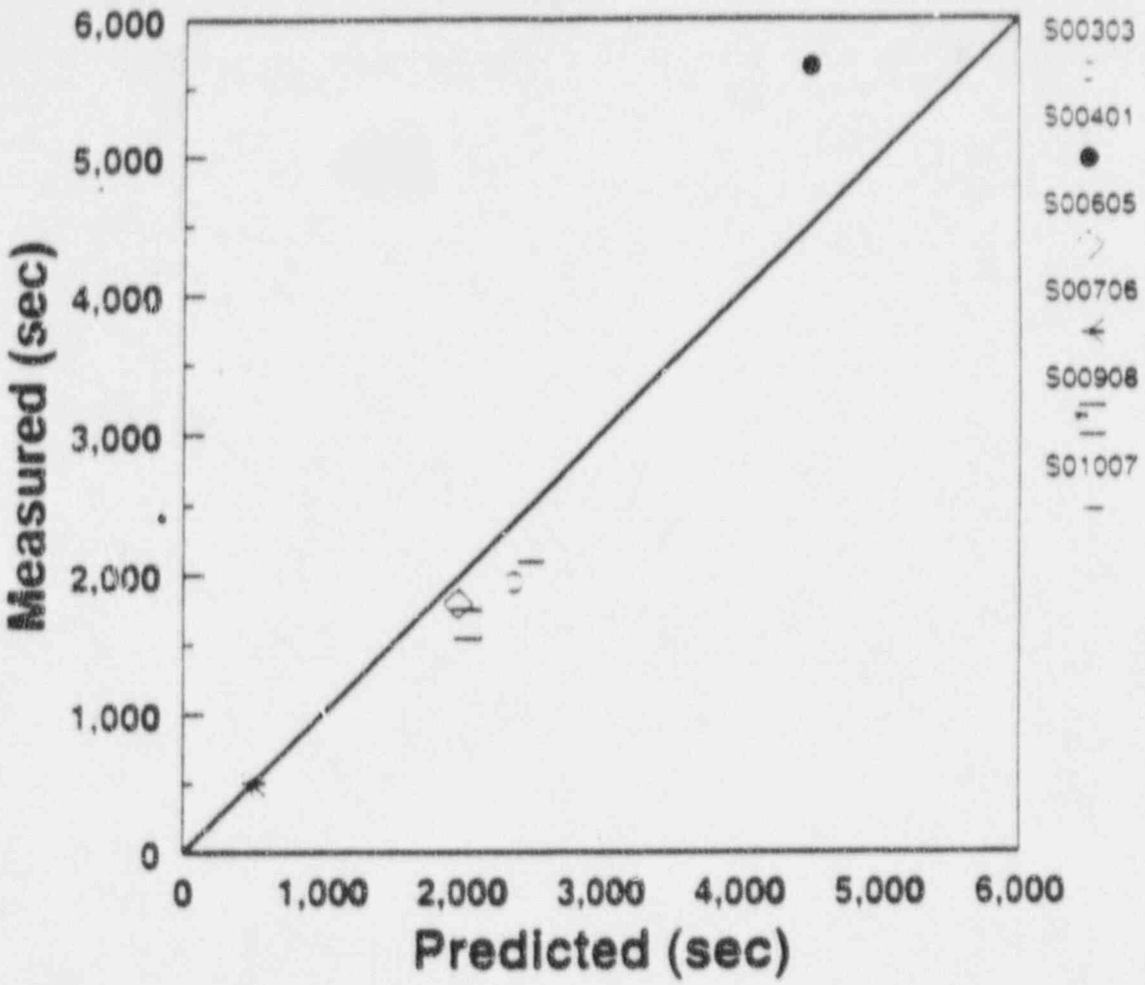
SPES COMPARISONS
Balance Line Sustained Draining
Balance Line - A
Measured (sec)
Predicted (sec)
4,000
3,000
2,000
1,000
0
0
1,000
2,000
3,000
4,000
S00303
S00401
S00605
S00706
S00908
S01007


SPES COMPARISONS
Balance Line Sustained Draining
Balance Line - B
Measured (sec)
Predicted (sec)
0
1,000
2,000
3,000
S00303
S00401
S00605
S00706
S00908
S01007

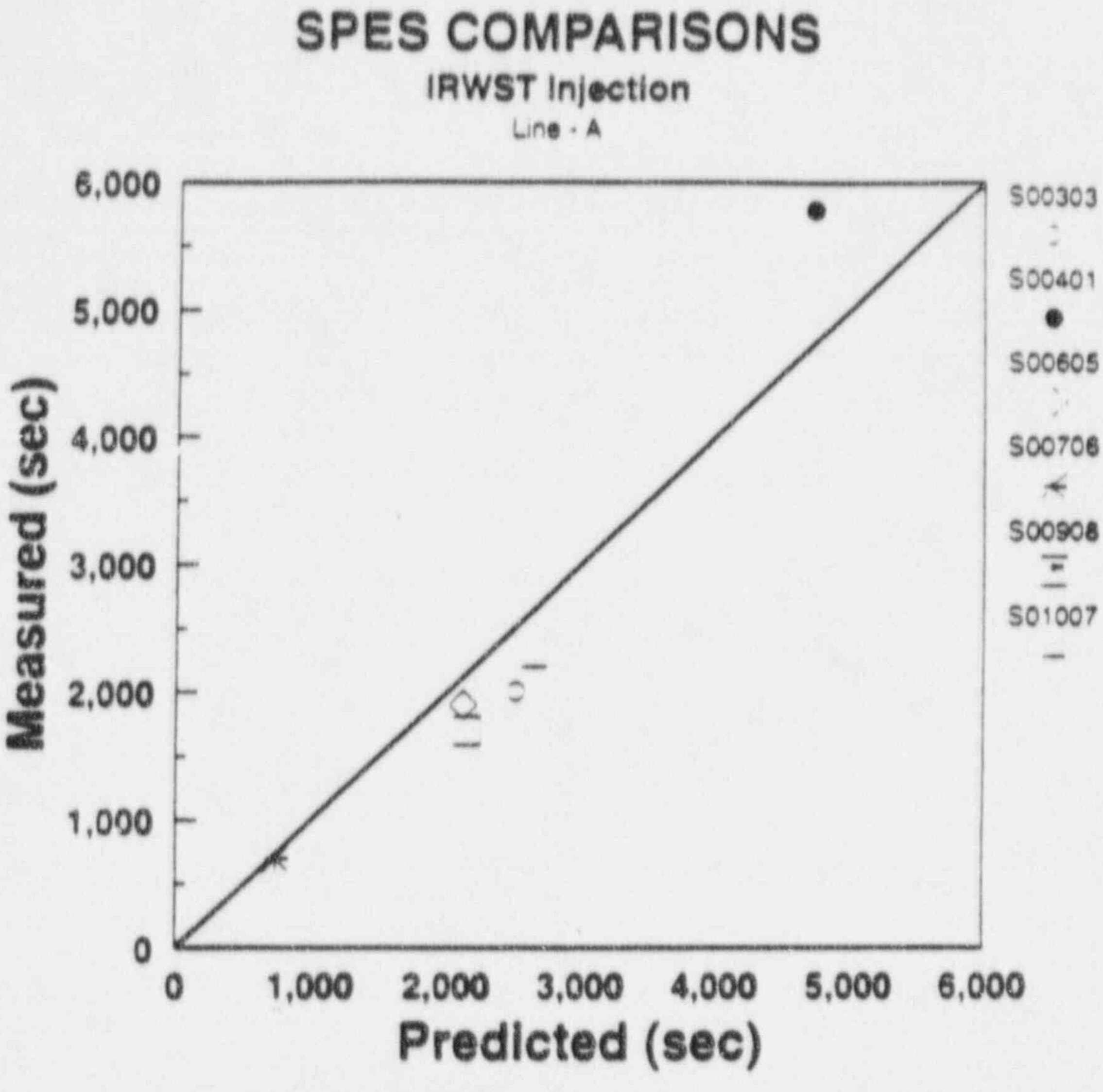

SPES COMPARISONS
ADS-1
Measured (sec)
Predicted (sec)
0
1,000
2,000
3,000
4,000
5,000
S00303
S00401
S00605
S00706
S00908
S01007

SPES COMPARISONS

ADS-4



Note: Test S00401 - ADS Valve was lifted approximately 300 sec. late.

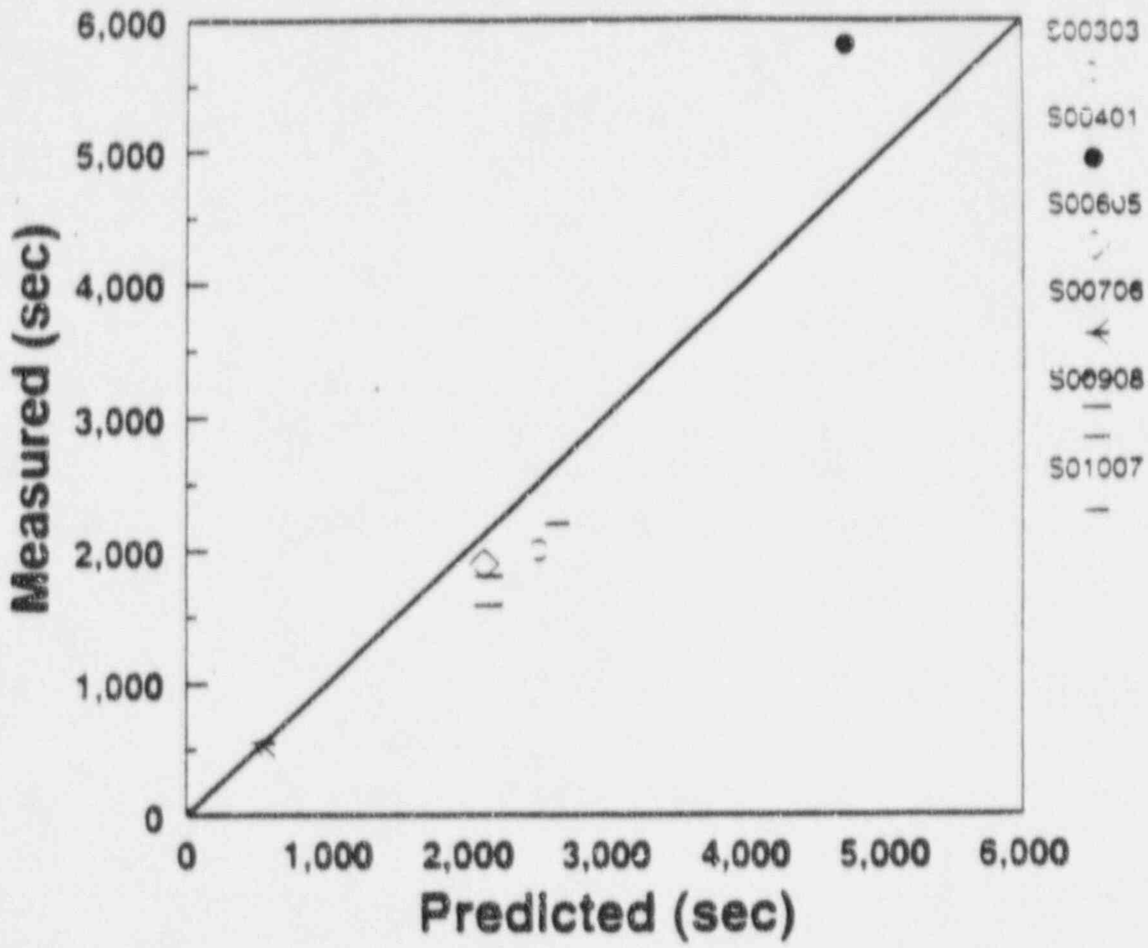


Note: Test S00401 - ADS Valve was lifted approximately 300 sec. late.

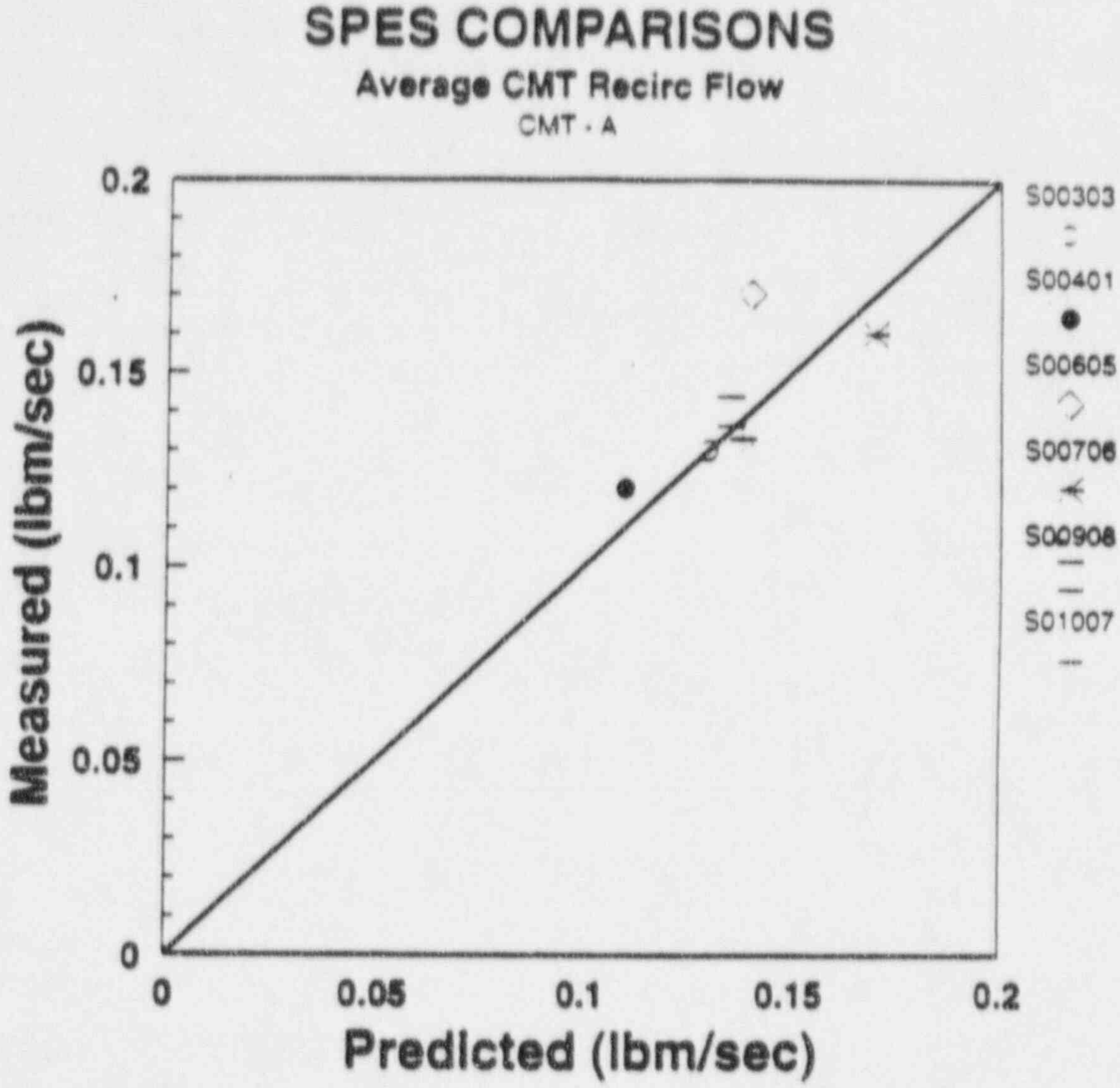
SPES COMPARISONS

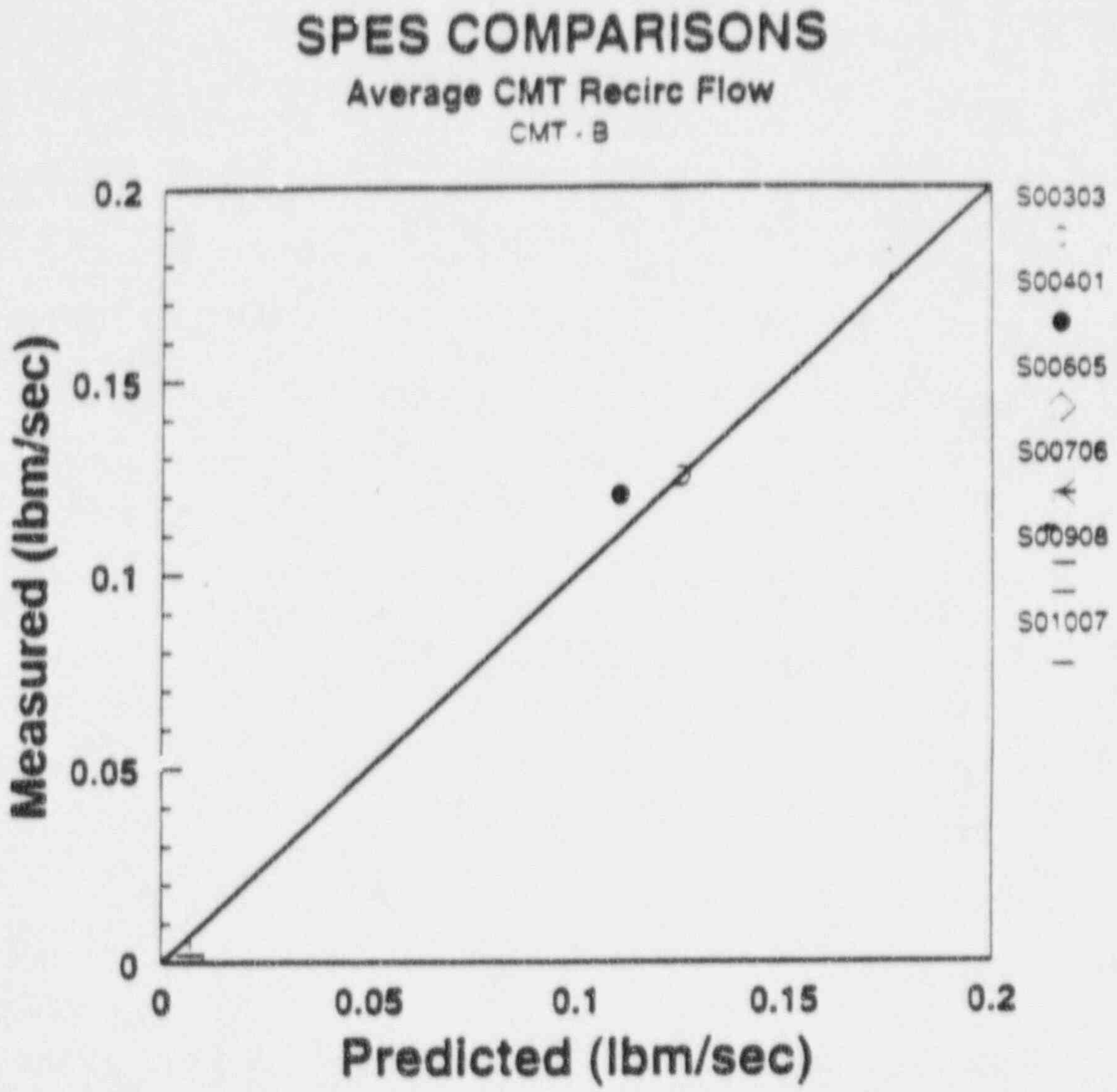
IRWST Injection

Line - B



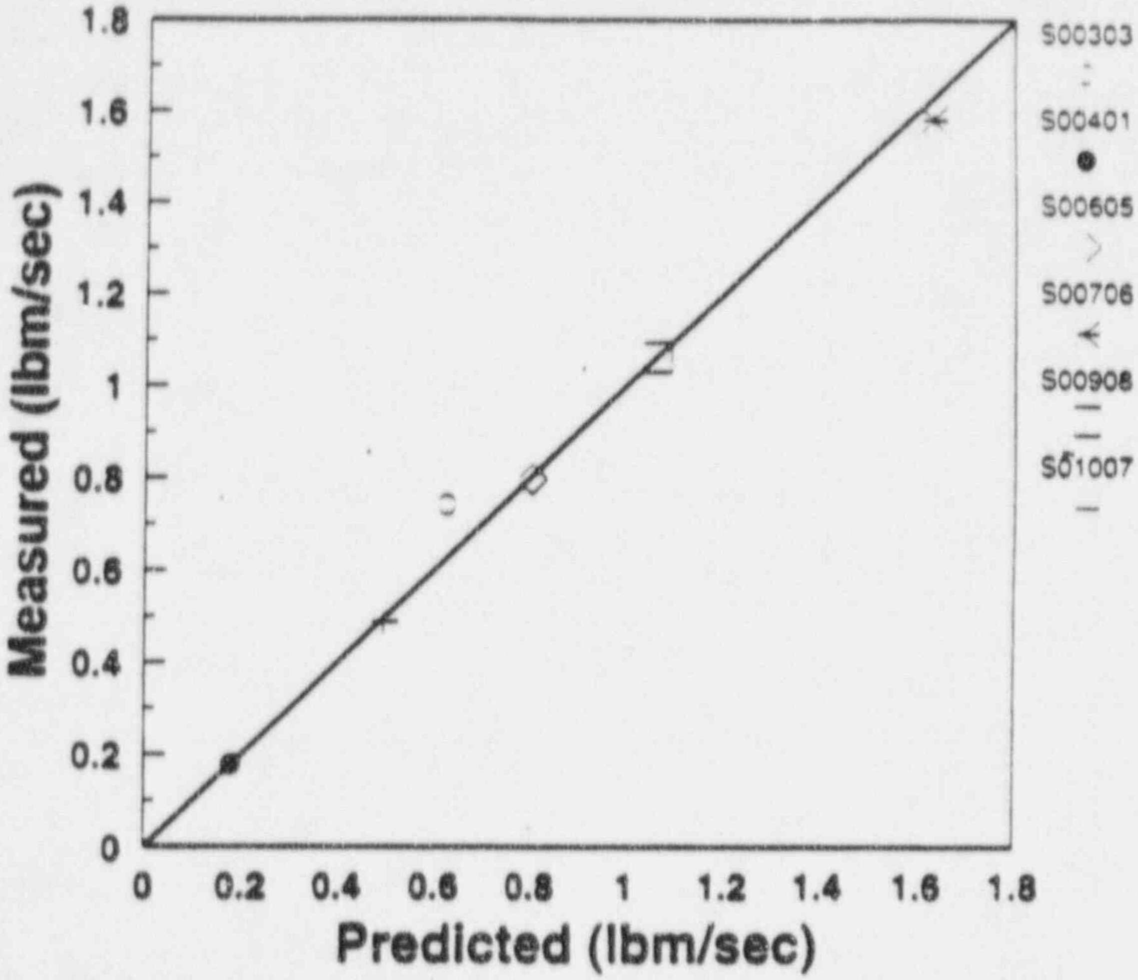
Note: Test S00401 - ADS Valve was lifted approximately 300 sec. late.


SPES COMPARISONS
Average CMT Recirc Flow
CMT - A
Measured (lbm/sec)
Predicted (lbm/sec)
0
0.05
0.1
0.15
0.2
S00303
S00401
S00605
S00706
S00908
S01007


SPES COMPARISONS
Average CMT Recirc Flow
CMT - B
Measured (lbm/sec)
Predicted (lbm/sec)
0
0.05
0.1
0.15
0.2
S00303
S00401
S00605
S00706
S00908
S01007

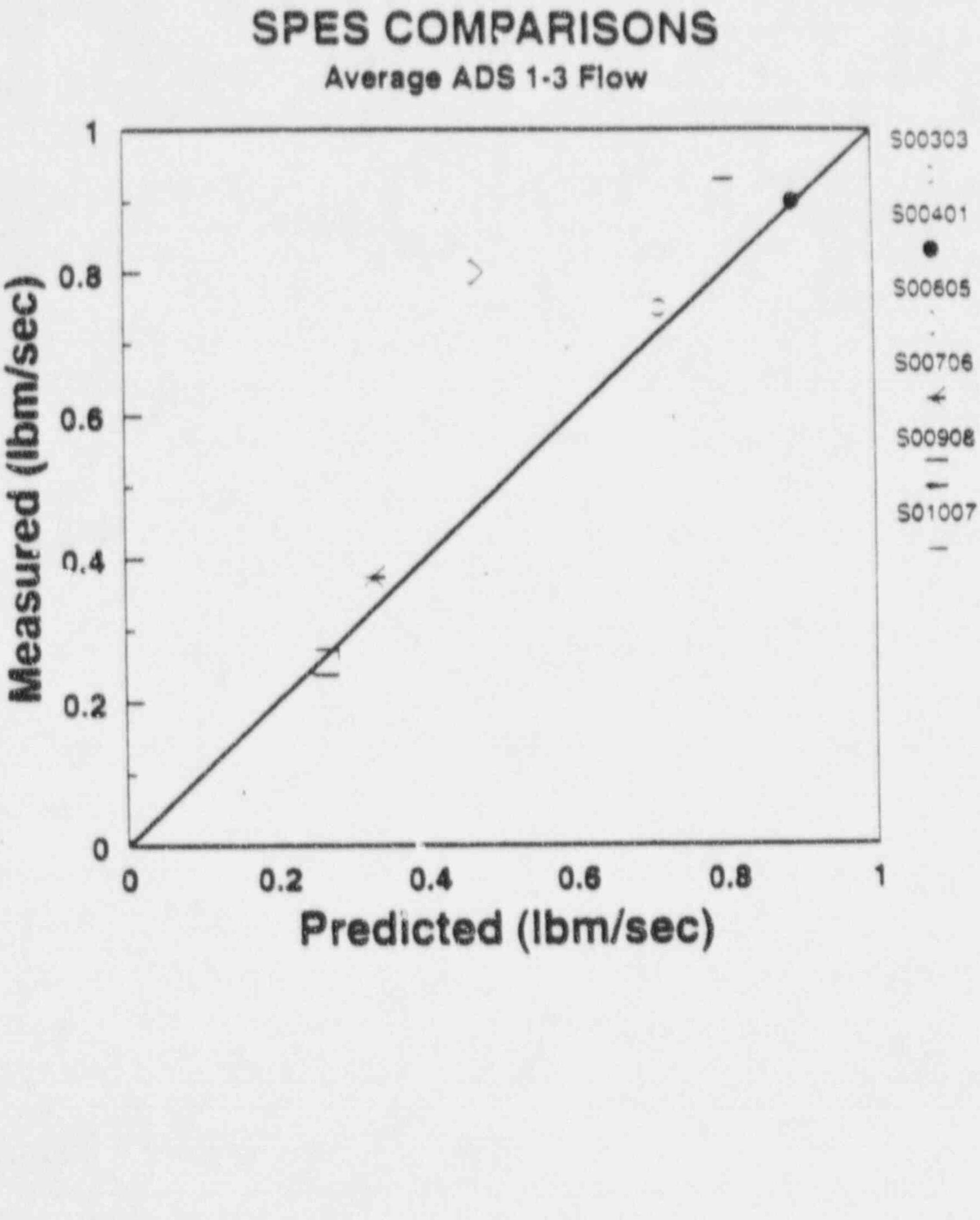
SPES COMPARISONS

Average Break Flow



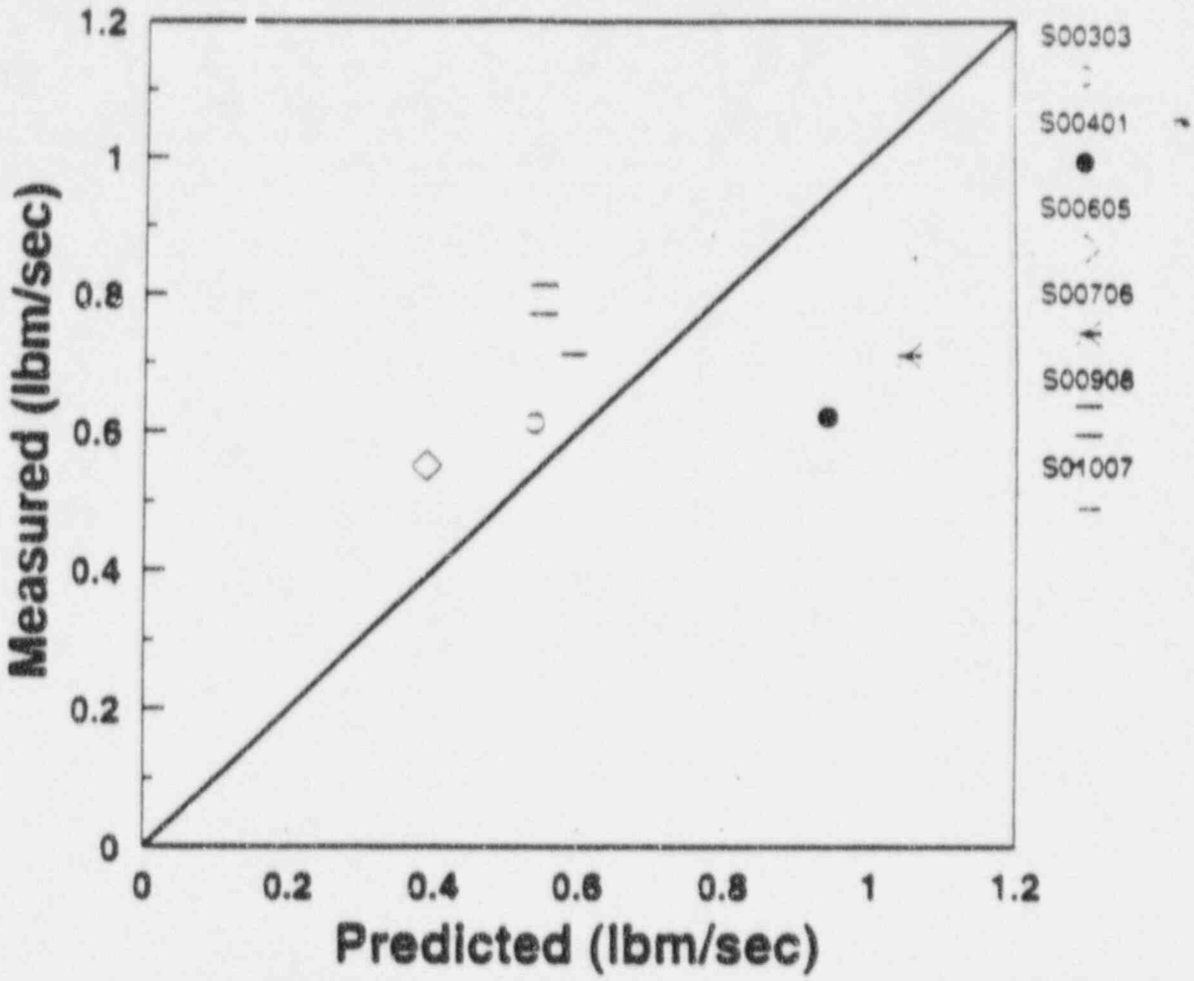
Note: Test S00908 - Data represents only the Lower Balance Line region

Note: Test S00706 - Data represents only the Vessel Side of the break


SPES COMPARISONS
Average ADS 1-3 Flow
Measured (lbm/sec)
Predicted (lbm/sec)
0
0.2
0.4
0.6
0.8
1
S00303
S00401
S00605
S00706
S00908
S01007

SPES COMPARISONS

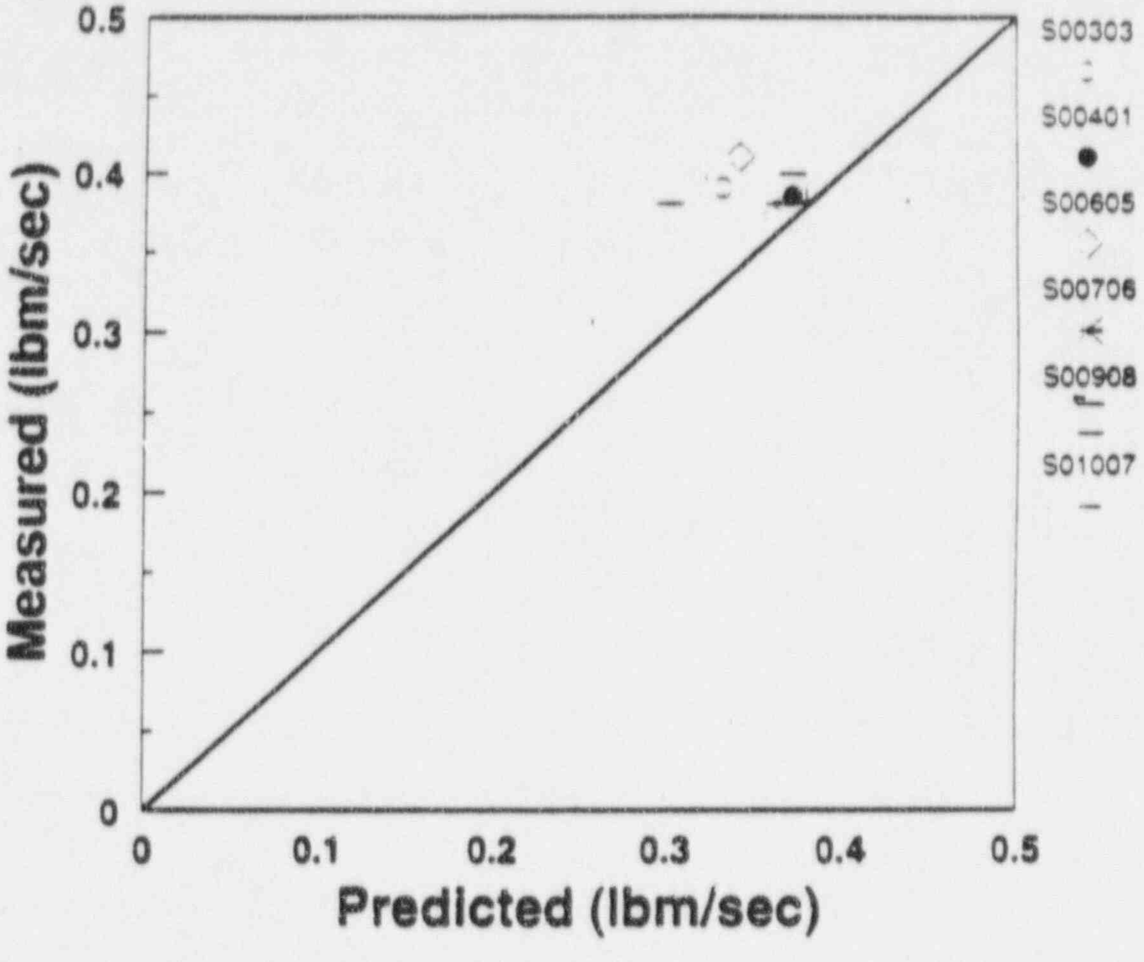
Average ADS 4 Flow



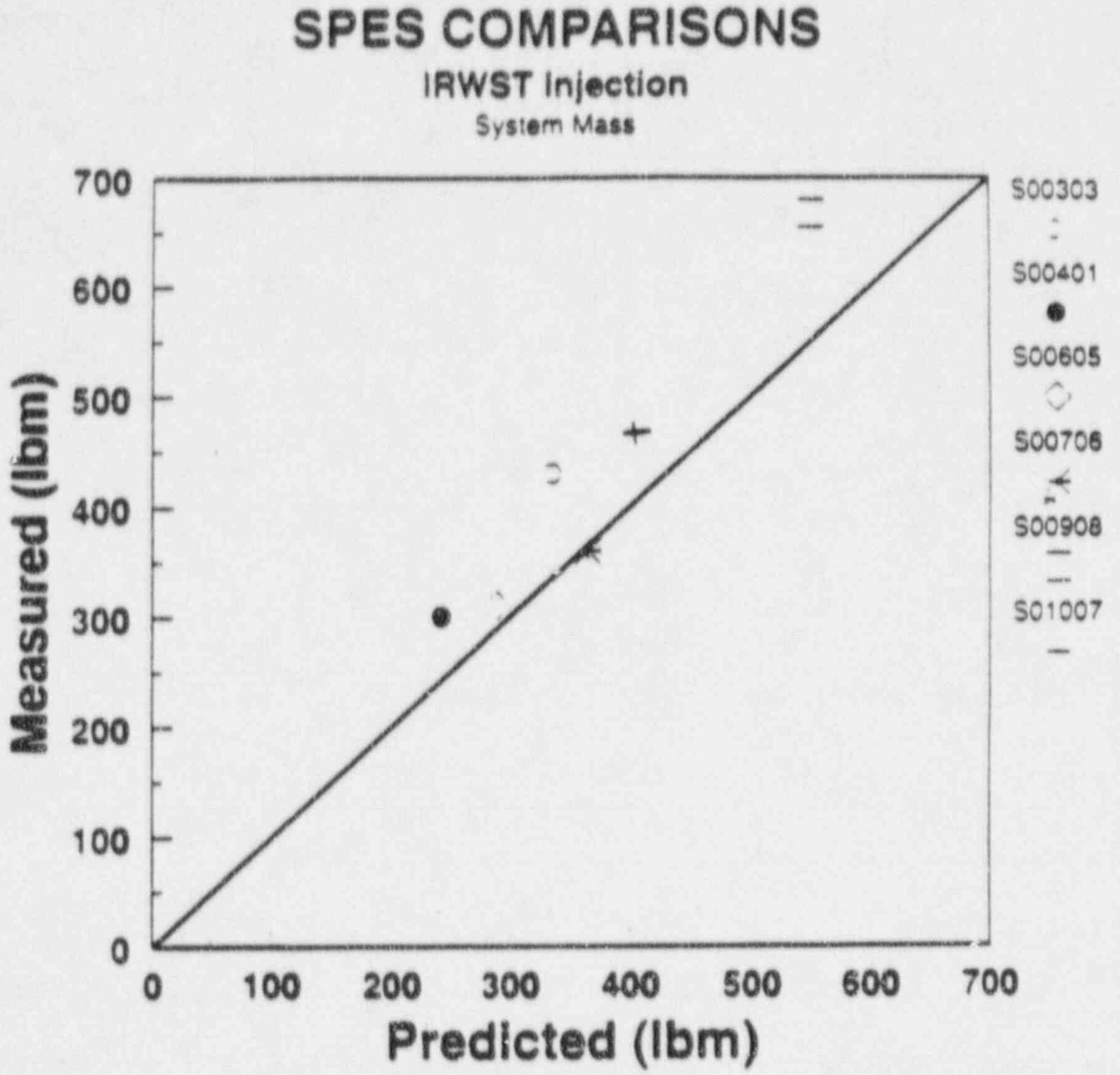
SPES COMPARISONS

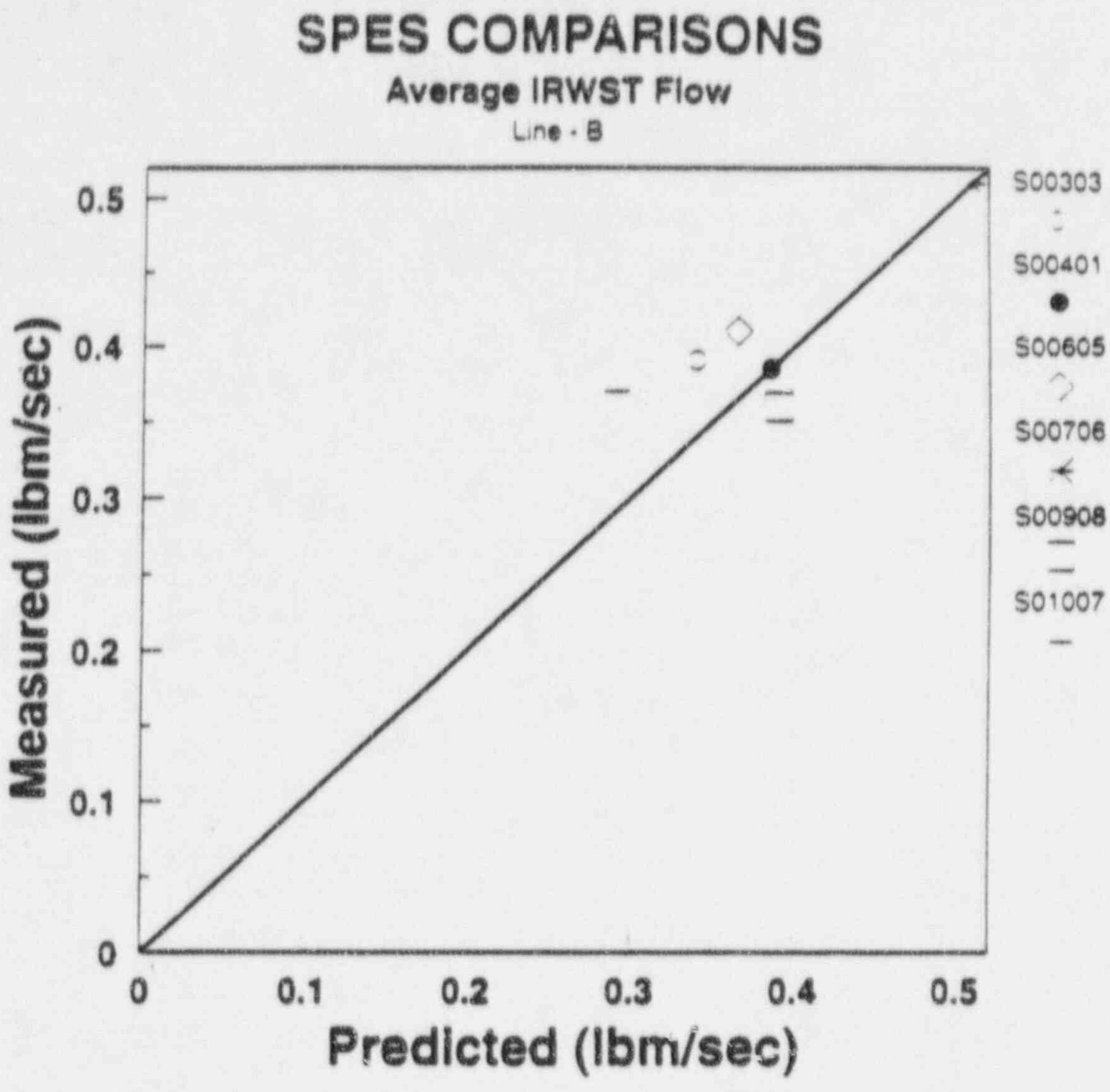
Average IRWST Flow

Line - A



Note: S00706 - IRWST flow not fully developed yet.


SPES COMPARISONS
IRWST Injection
System Mass
Measured (lbm)
Predicted (lbm)
0
100
200
300
400
500
600
700
S00303
S00401
S00605
S00706
S00908
S01007



Note: S00706 - IRWST flow not fully developed yet.

TABLE 7.2-1
SPES-2 TEST MATRIX

Test No.	Test Type	Test Description (AP600 Transient Simulated)	Status Nonsafety-related systems	AP600 Single Failure Simulated	Comment
(S00401)	Small-Break LOCA	1-in. cold leg break (Note 2), bottom of loop B (Note 1)	CVCS, NRHR, and SFWS off. No operator actions (OAs).	One of two fourth-stage valves on loop B	Maximize CMT heatup prior to ADS actuation
2	Small-Break LOCA	1-in. cold leg break, bottom of loop B	CVCS, NRHR Off; SFWS on (Note 3). No OAs.	One of two fourth-stage valves on loop B	This test deleted due to AP600 design changes.
3 (S00303) (Note 4)	Small-Break LOCA	2-in. cold leg break, bottom of loop B	CVCS, NRHR, and SFWS off. No OAs.	One of two fourth-stage valves on loop B	Reference cold leg break
4	Small-Break LOCA	2-in. cold leg break, bottom of loop B	CVCS, NRHR, and SFWS on (Note 3).	One of two fourth-stage valves on loop B	Nonsafety-related/passive system interactions
5 (S00605)	Small-Break LOCA	2-in. DVI break	CVCS, NRHR and SFWS off. No OAs.	One of two fourth-stage valves on loop B	Asymmetric CMT performance.
6 (S00706)	Small-Break LOCA	DEG break of DVI	CVCS, NRHR, and SFWS off. No OAs.	One of two stage 1 and stage 3 valves	Complete loss of one of two injection flow paths
7 (S01007)	Small-Break LOCA	2-in. break in cold leg/CMT-B balance line	CVCS, NRHR, and SFWS off	One of two fourth-stage valves on loop B	Examine effect on CMT drain down
8 (S00908)	Small-Break LOCA	DEG break of a cold leg/CMT-B balance line	CVCS, NRHR, and SFWS off. No OAs.	One of two stage 1 and stage 3 ADS valves	No delivery from faulted CMT

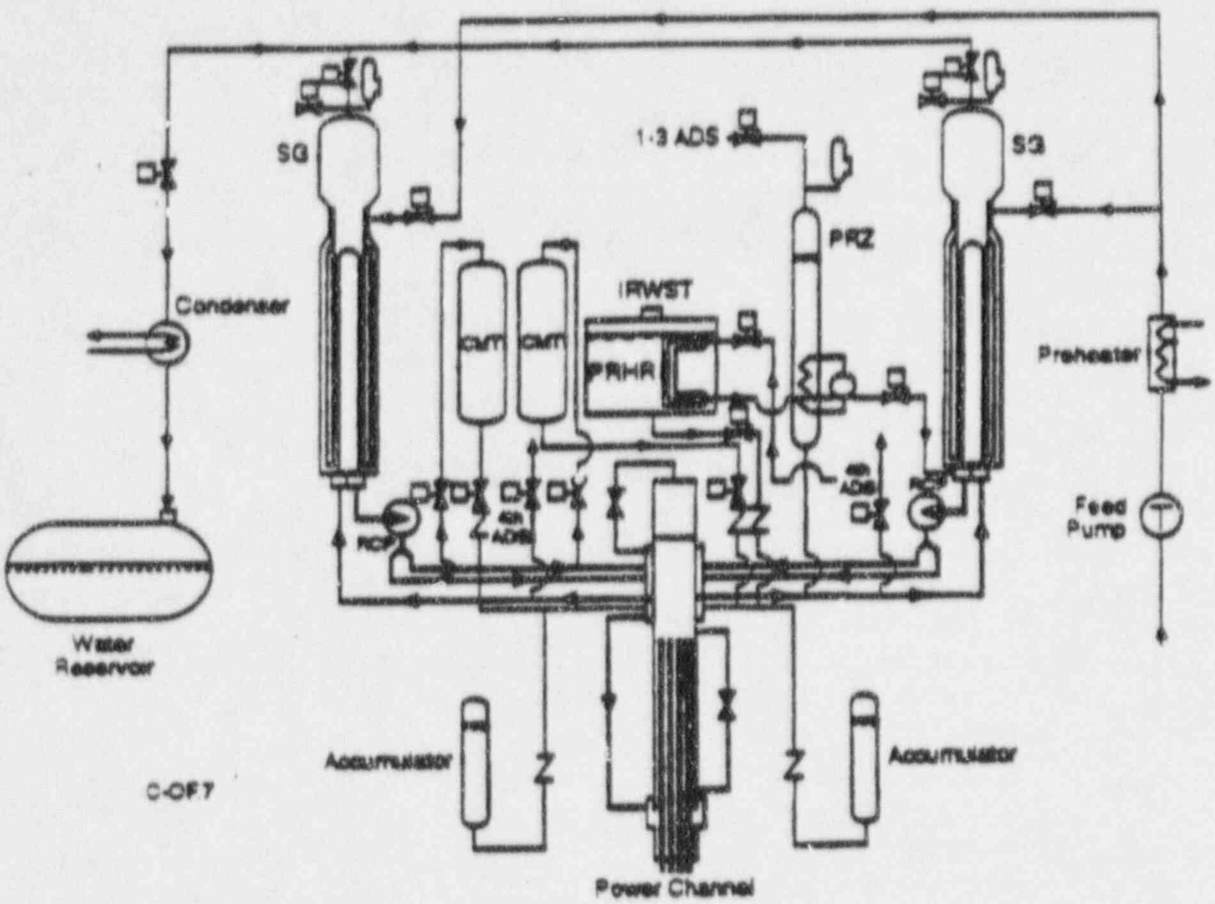


Figure 7.2-1 SPES-2 Test Facility

a

Figure 7.2-2 NOTRUMP Noding Diagram (Fluid Nodes) for SPES-2 Facility

Analysis of the OSU Facility With the Westinghouse NOTRUMP Code

Bob Osterrieder

Westinghouse Electric

March 13, 1997

Overview

- o Review of Test Matrix
- o NOTRUMP Noding Diagram
- o Review of 2 Inch Cold Leg Break Results (Test SB18)
- o Discussion of OSU Validation Report Summary Section (Section 8.4)

8.2.3 Selected Oregon State University Tests for Analysis

A total of seven OSU tests (six small-break LOCA tests and an inadvertent ADS actuation test) were selected for analysis with the NOTRUMP code. The selected tests cover the range of break locations and sizes that were tested in the OSU facility. All tests analyzed use only the passive emergency core cooling systems to mitigate the transient and to maintain core cooling. The tests include:

- SB18: 2-in. cold leg break in the bottom of cold leg 3. This is a repeat of the reference test for the OSU test matrix and simulates a typical small-break LOCA case.
- SB23: 0.5-in. cold leg break in the bottom of cold leg 3. This test is the smallest break performed for the facility and provides a break size comparison to the reference case.
- SB13: 2-in. break in DVI line 1. This test provides a different break location for the same size break as the reference case.
- SB12: double-ended DVI line break of DVI line 1. One half of the safety injection is lost to the containment. This break, along with test SB13, gives a break size sensitivity for the same break location.
- SB09: 2-in. cold leg balance line break is also a different break location for the same size break as the reference test.
- SB10: double-ended balance line break. This test, along with test SB09, gives another break size sensitivity at a different break location.
- SB14: inadvertent ADS actuation. This test provides the system response to the no-break LOCA event.

The combinations of the selected OSU tests exercise the NOTRUMP code over a wide range of break sizes and locations, which allows examination of different performance aspects of the AP600 passive emergency core cooling systems so that the code is adequately validated.

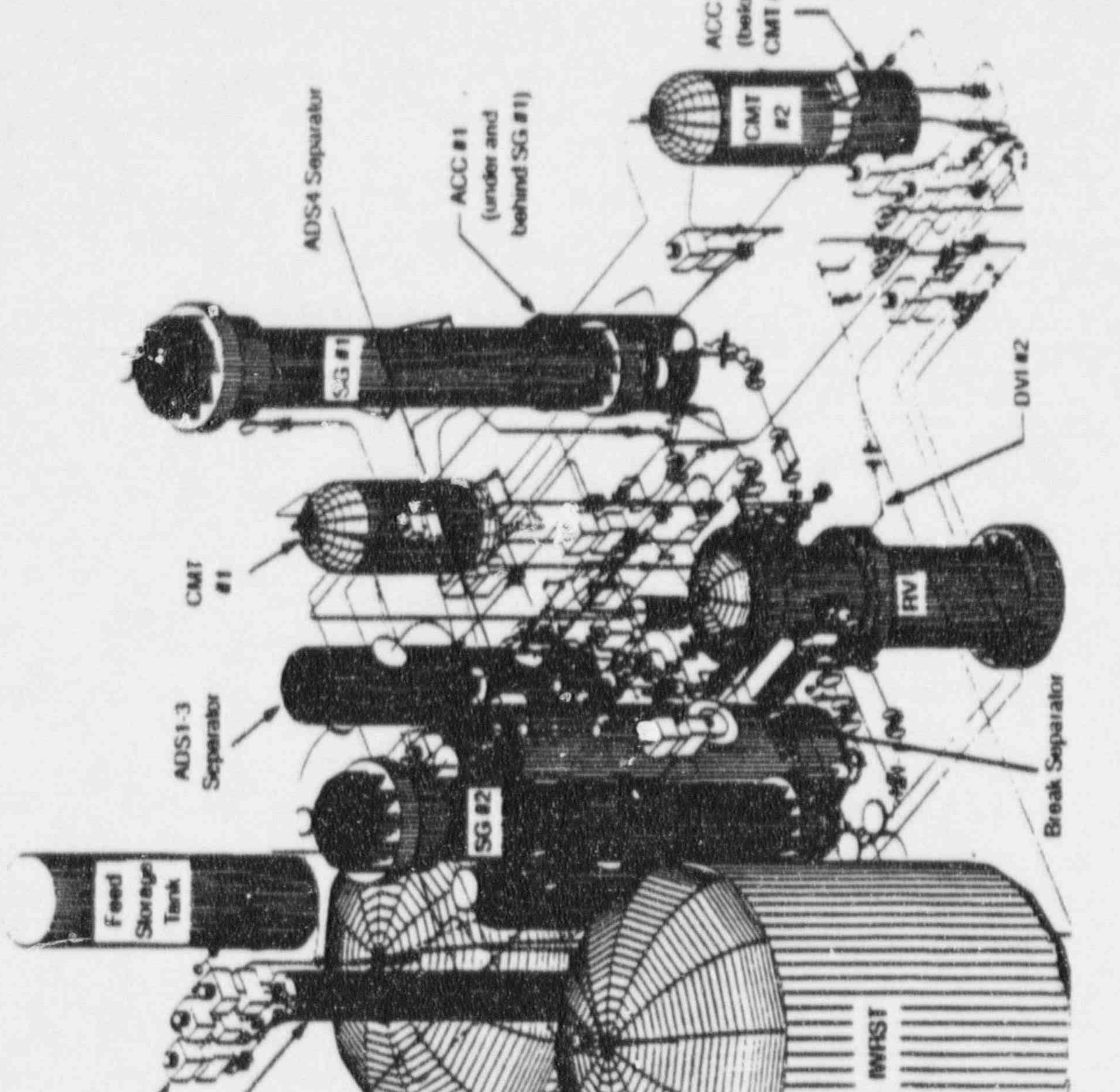


Figure 8.2-1 Isometric Drawing of the Oregon State University Test Facility

Figure 8.2-2 NOTRUMP Noding Diagram (Fluid Nodes) for Oregon State University Facility

OSU 2 Inch Cold Leg Break (SB18) Results Summary

- NOTRUMP Predicts Delayed ADS Actuation Relative to Test Data
  - Test ADS Time = 390 seconds
  - SB18 Simulation = 548 seconds
- Delays Related to Delay in Fluid in Top of CMTs Reaching Saturation
  - Results in Delay in Start of CMT Draindown Phase
- No Core Coverage Concerns Exhibited by NOTRUMP or Test
  - NOTRUMP Predicts Lower System Mass During Most of Transients

TABLE 8.3.1-1
SB18 SEQUENCE OF EVENTS

Event	Definition	OSU (seconds)	NOTRUMP (seconds)
Break Opens		0	0
R Signal		0	0
S Signal		0.5	0
MFW Isolation Valve Closes		3.6	3.1
CMT Isolation Valves Open		6.1	5.6
RCPs Trip		9	6
CMT-1 Starts Draindown Phase	CMT level dropping and top of tank saturated	160	385
CMT-2 Starts Draindown Phase	CMT level dropping and top of tank saturated	355	420
ADS-1	CMT level 41in. + 15 sec	390	548
Accumulators Start		400	535
ADS-2	ADS-1 + 47 sec.	438	595
ADS-3	ADS-1 + 107 sec	498	655
Accumulators Empty		665	770
ADS-4		950	1114
IRWST Injection		1226	1310

(a,b,c)

SB18

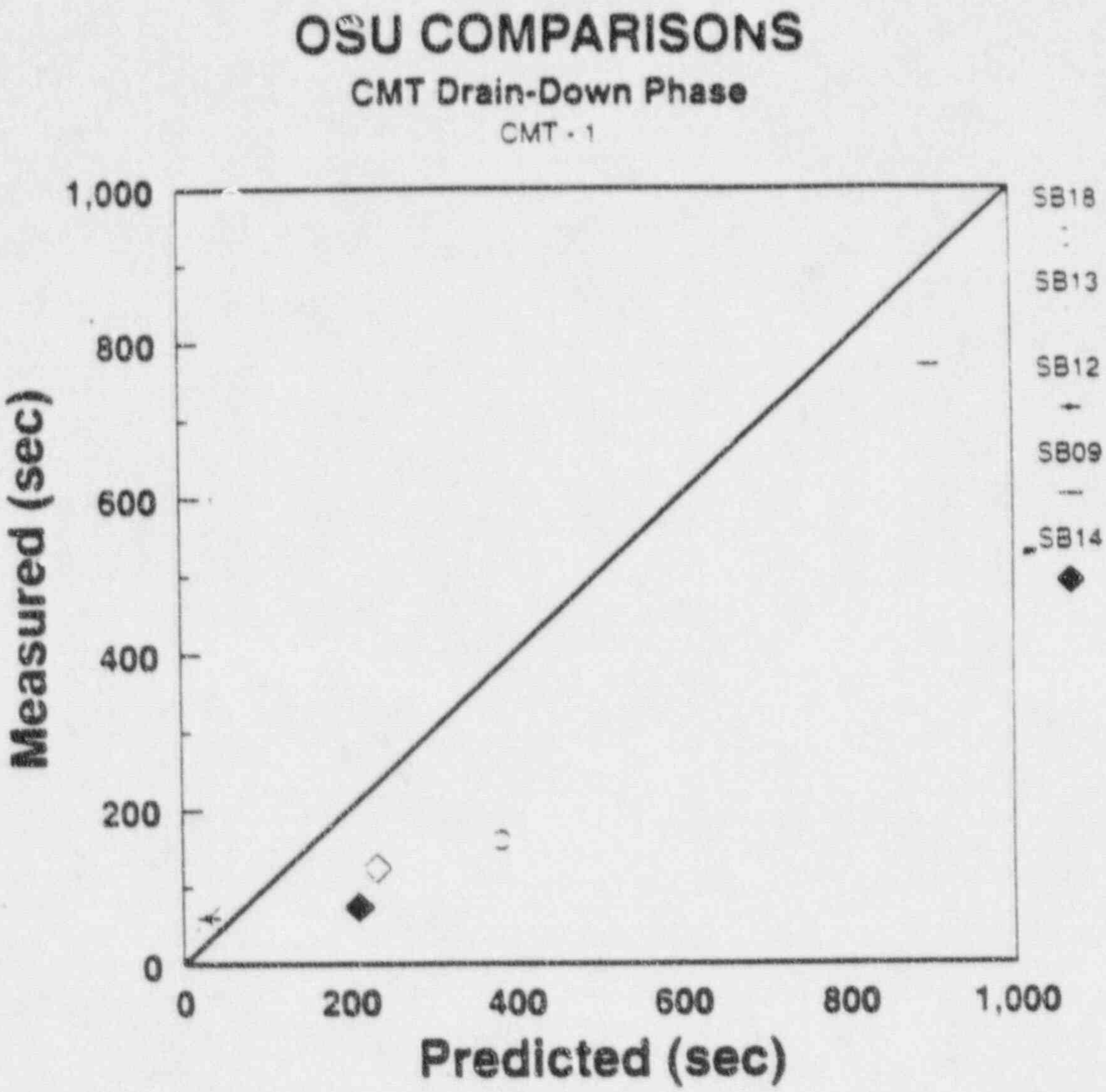
(a,b,c)

(a,b,c)

(a,b,c)

Validation Report Summary Section for OSU

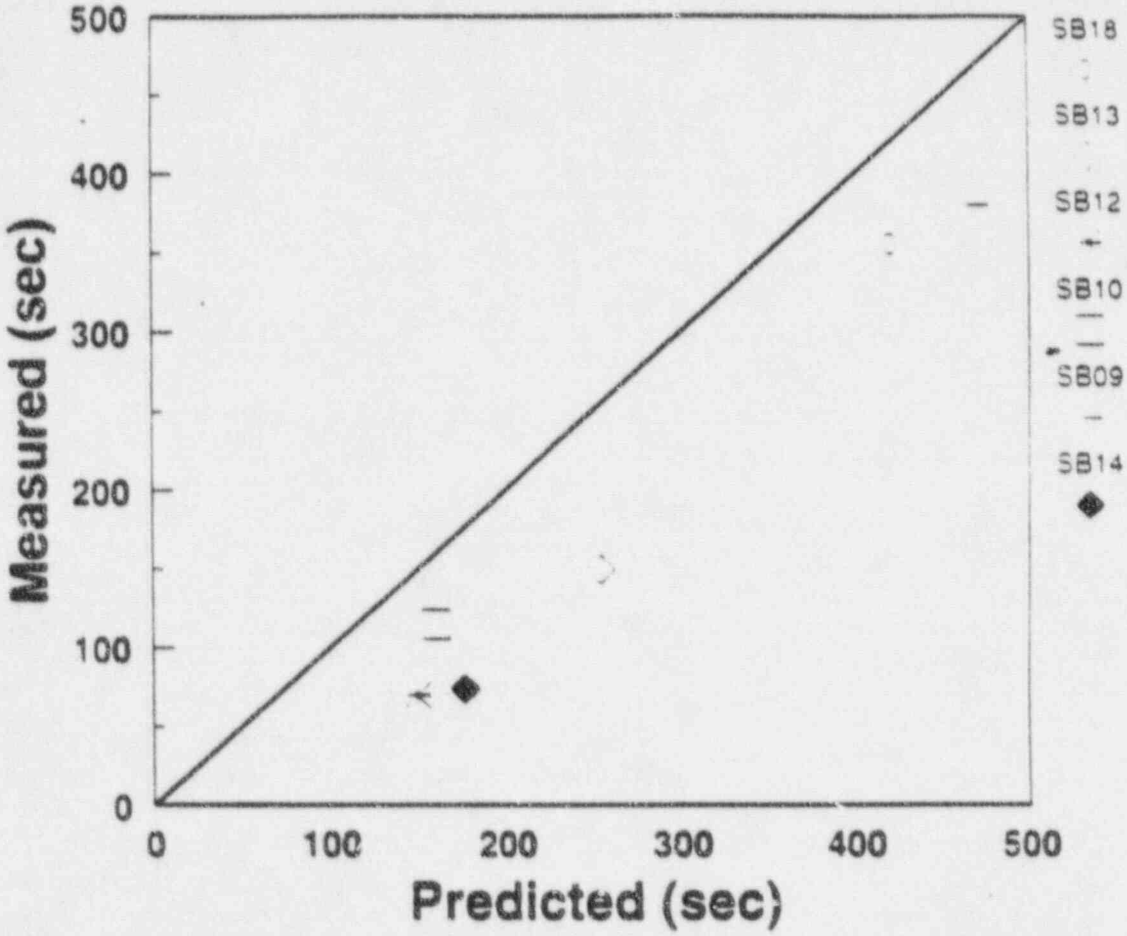
- o Timing Related Issues
  - NOTRUMP Consistently Predicts Delayed ADS Actuation Relative to Test
- o Flow Related Issues
  - NOTRUMP Consistently Underpredicts the Mass Through ADS 1-3 Valves
  - NOTRUMP Consistently Overpredicts Break Flow by the Same or Greater Amounts than the Underprediction of ADS 1-3 Flows
- o NOTRUMP Consistently Under-predicts PRHR Heat Transfer
  - Only Impacts Small Break Sizes (Less than 2 Inches in Diameter)
- o NOTRUMP Consistently Predicts Conservative System Inventory Relative to Test

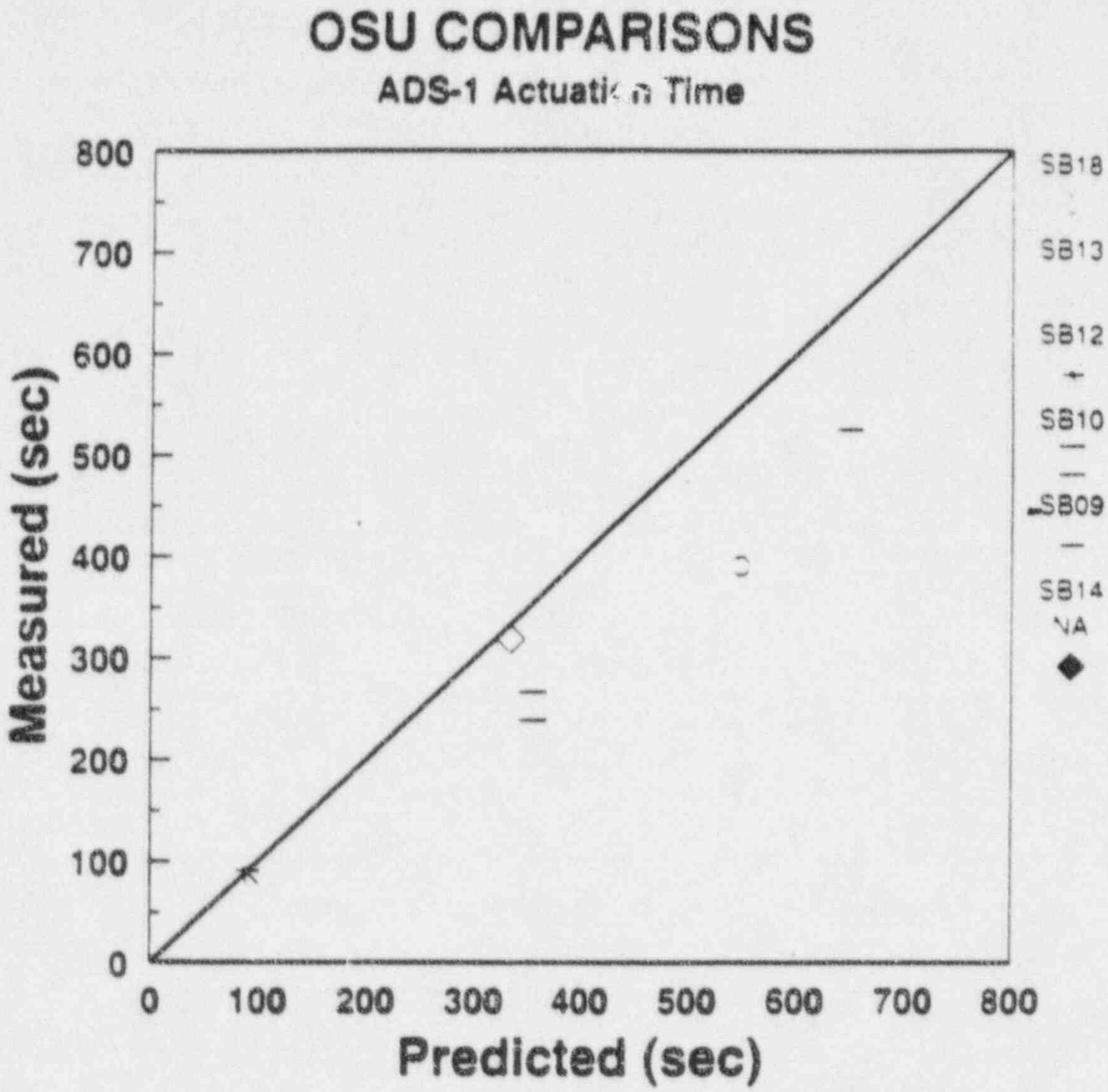

OSU COMPARISONS
CMT Drain-Down Phase
CMT - 1
Measured (sec)
Predicted (sec)
0
200
400
600
800
1,000
SB18
SB13
SB12
SB09
SB14

OSU COMPARISONS

CMT Drain-Down Phase

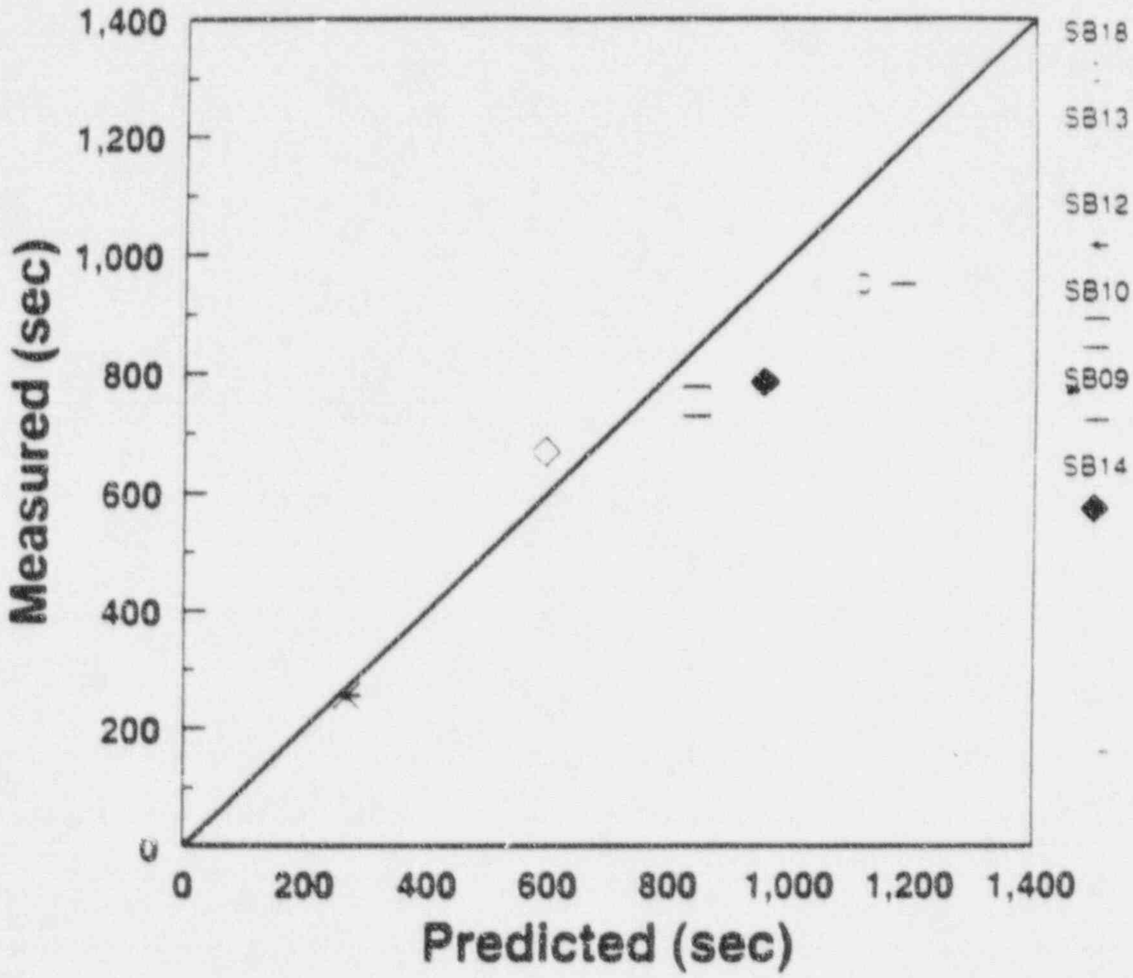
CMT - 2

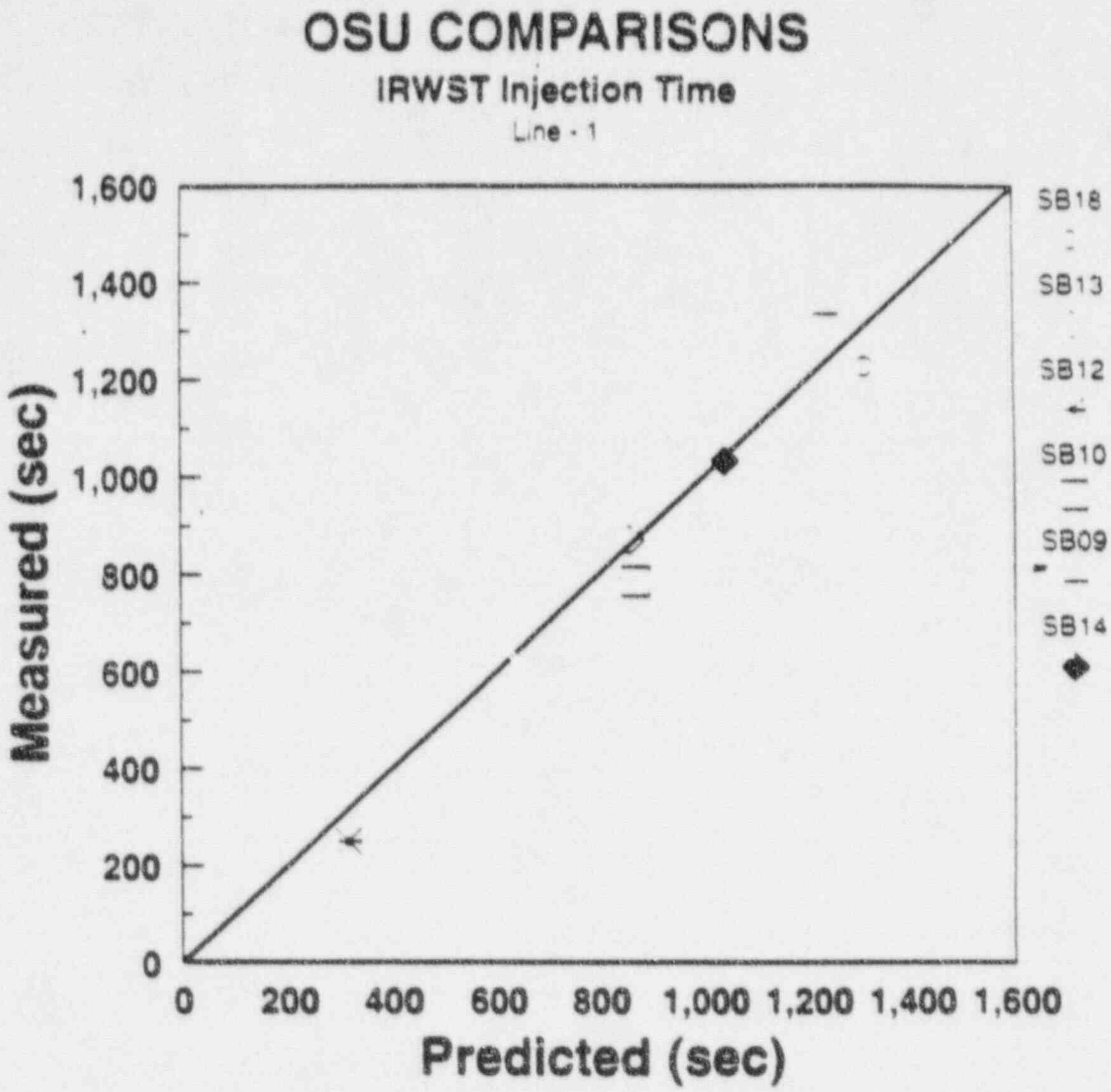


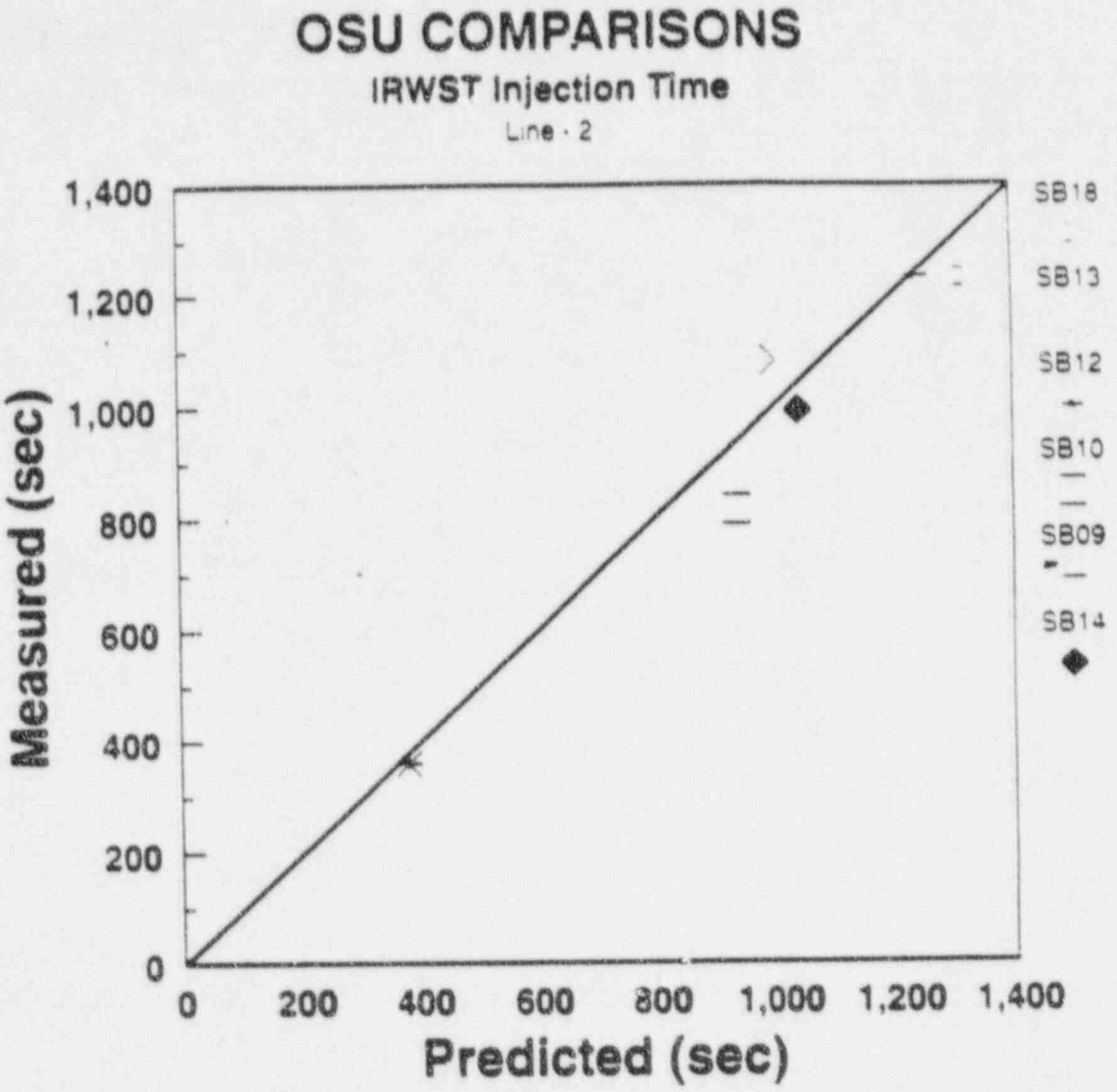

OSU COMPARISONS
ADS-1 Actuati‹ n Time
Measured (sec)
Predicted (sec)
0
100
200
300
400
500
600
700
800
SB18
SB13
SB12
SB10
SB09
SB14
NA

OSU COMPARISONS

ADS-4 Actuation Time




OSU COMPARISONS
IRWST Injection Time
Line - 1
Measured (sec)
Predicted (sec)
0
200
400
600
800
1,000
1,200
1,400
1,600
SB18
SB13
SB12
SB10
SB09
SB14

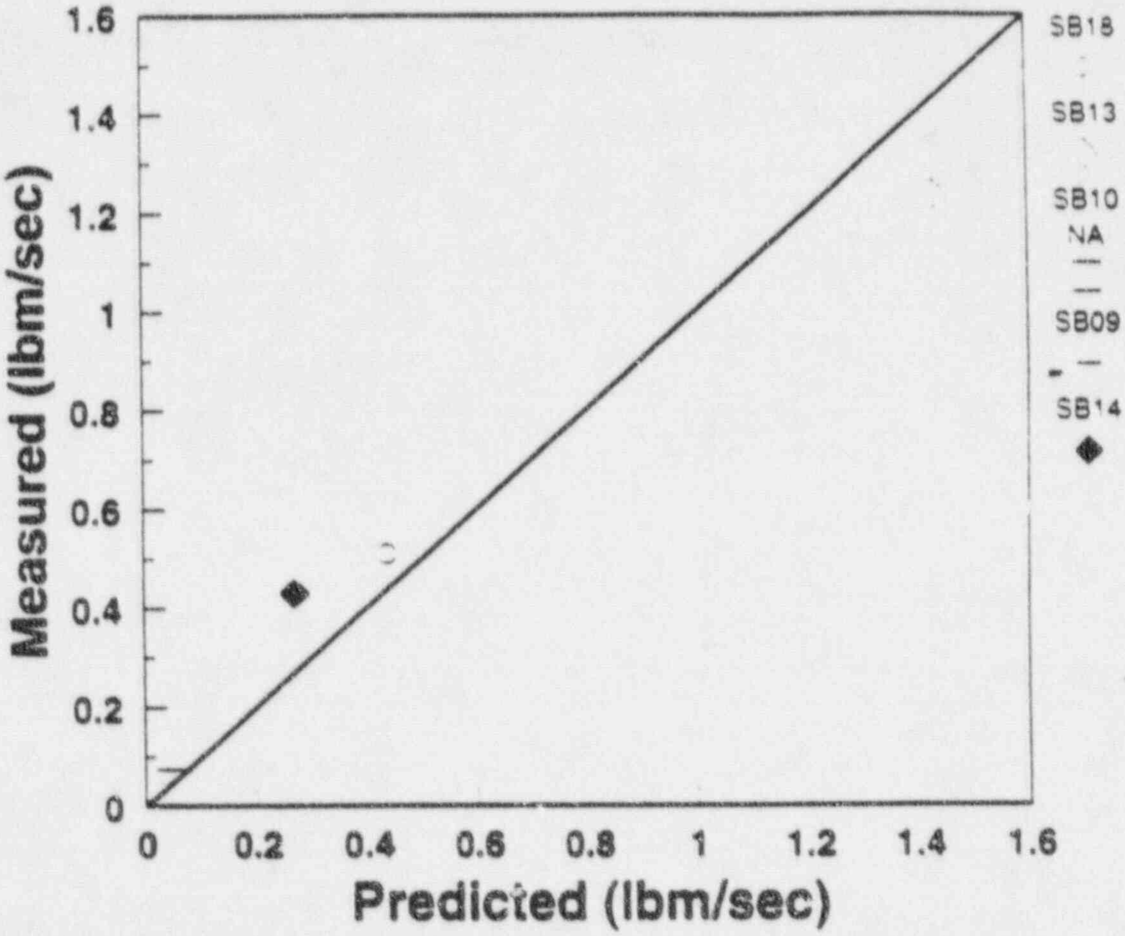


OSU COMPARISONS
IRWST Injection Time
Line - 2
Measured (sec)
Predicted (sec)
0
200
400
600
800
1,000
1,200
1,400
SB18
SB13
SB12
SB10
SB09
SB14

OSU COMPARISONS

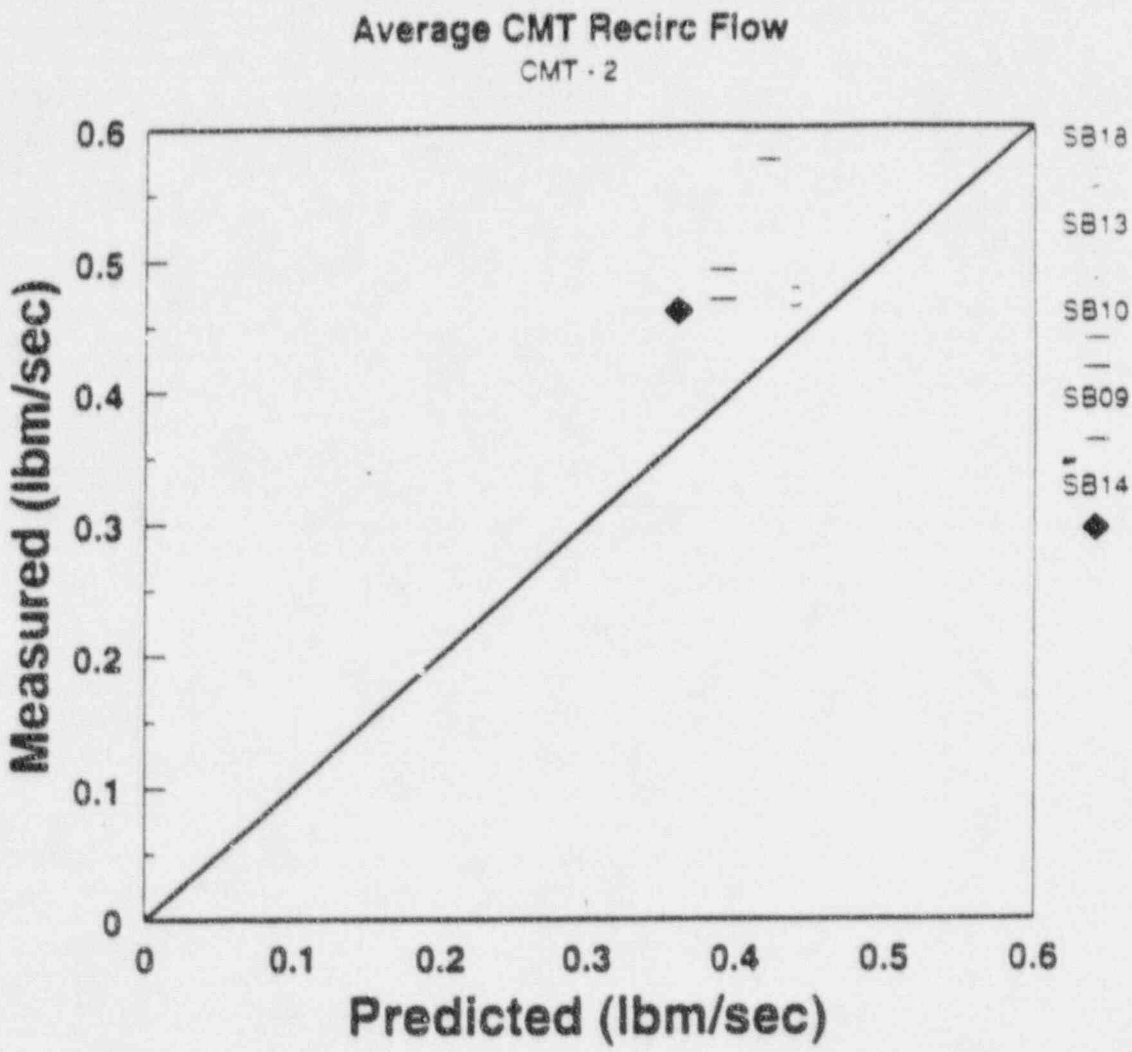
Average CMT Recirc Flow

CMT - 1

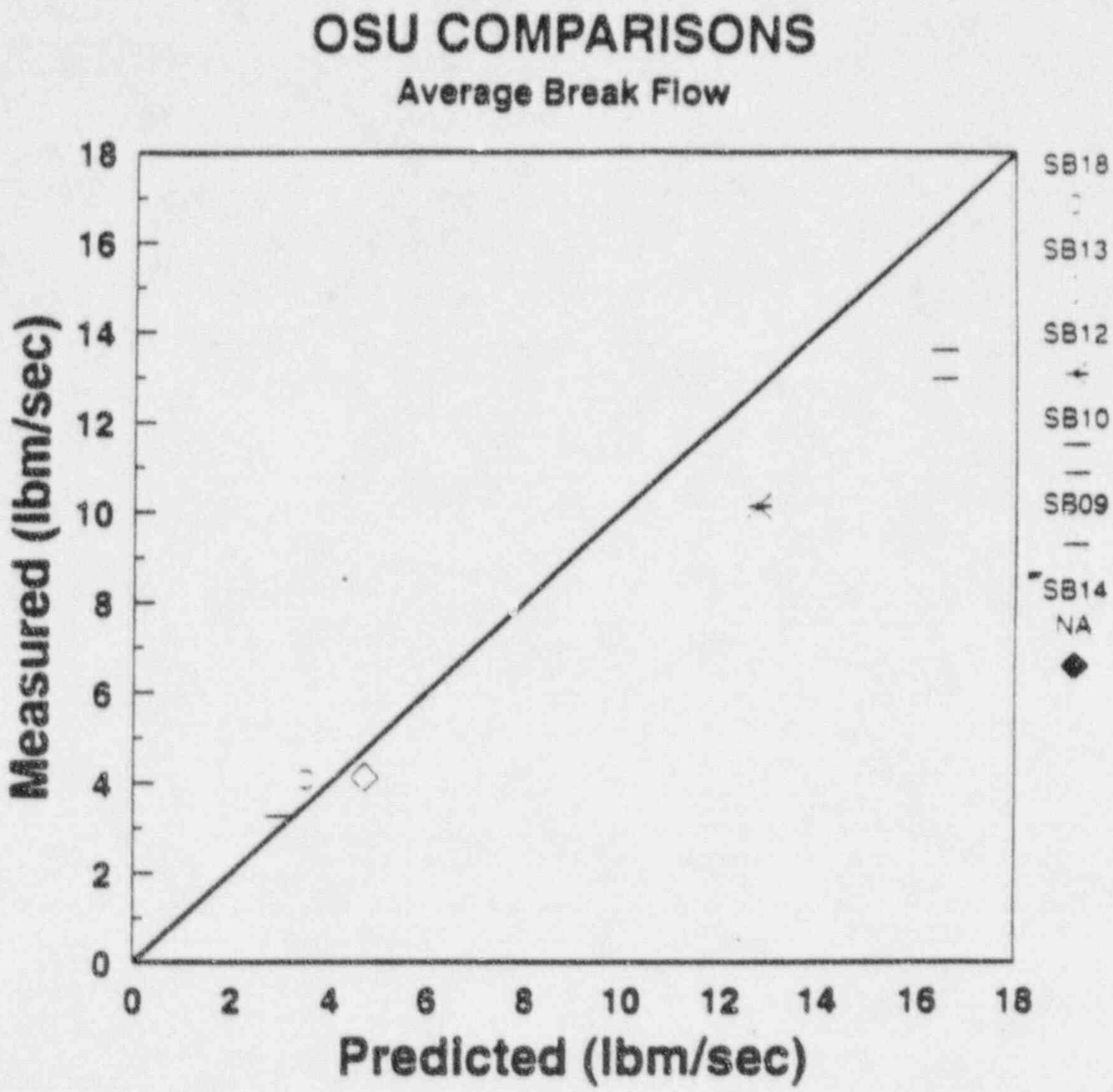


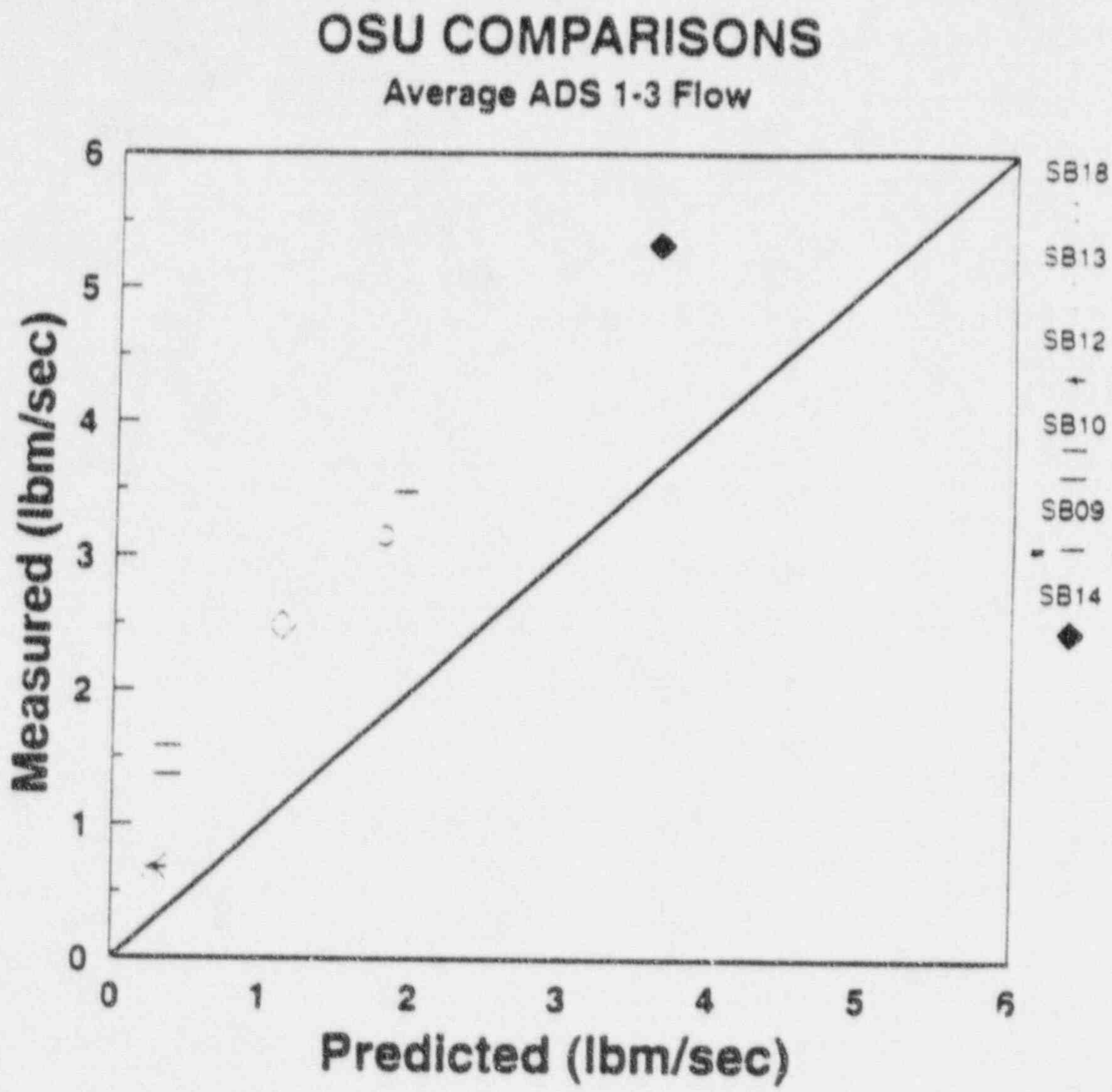
SB12 - Not included (flows exceeded test measurement range)

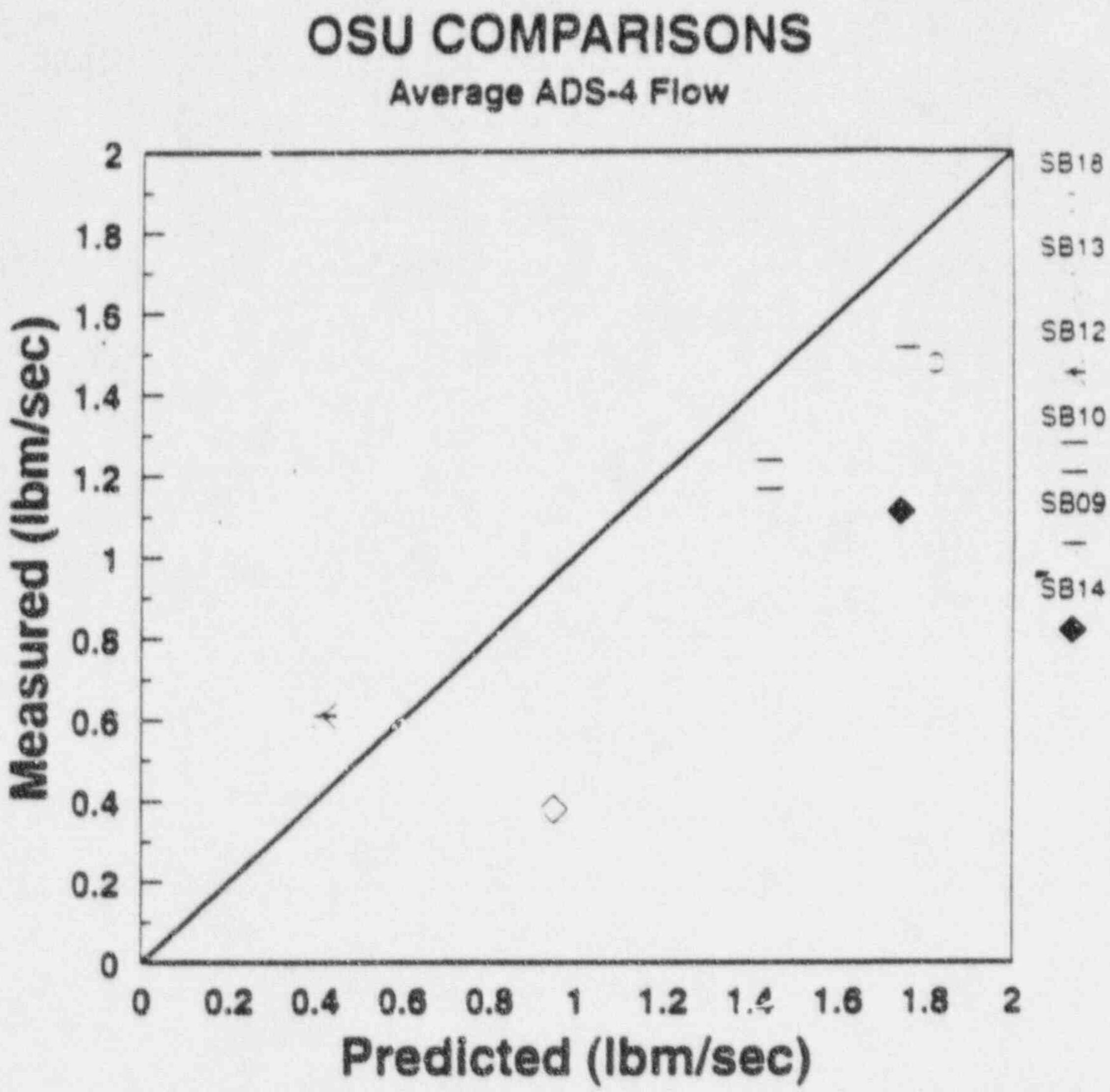
OSU COMPARISONS



SB12 - Not included (flows exceeded test measurement range)


OSU COMPARISONS
Average Break Flow
Measured (lbm/sec)
Predicted (lbm/sec)
0
2
4
6
8
10
12
14
16
18
SB18
SB13
SB12
SB10
SB09
SB14
NA


OSU COMPARISONS
Average ADS 1-3 Flow
Measured (lbm/sec)
Predicted (lbm/sec)
0
1
2
3
4
5
6
SB18
SB13
SB12
SB10
SB09
SB14

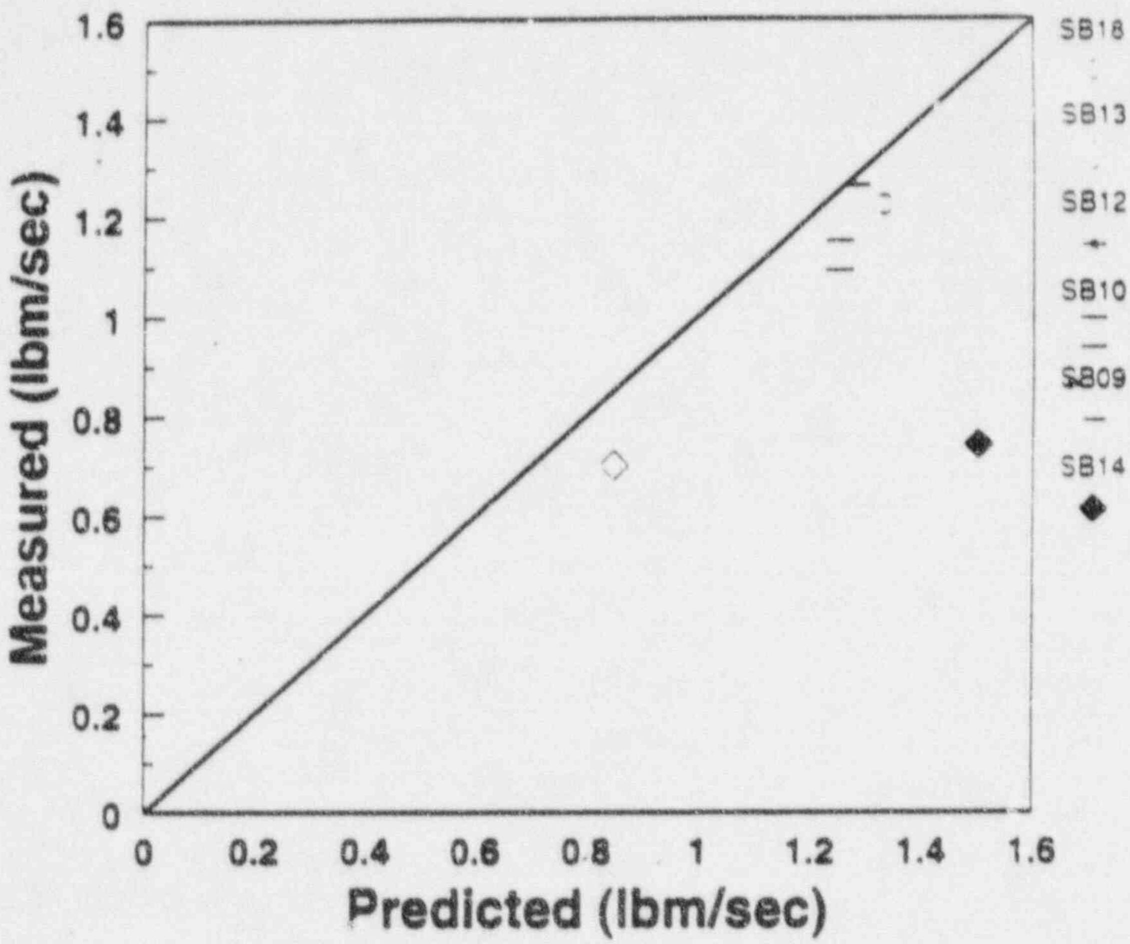


OSU COMPARISONS
Average ADS-4 Flow
Measured (lbm/sec)
Predicted (lbm/sec)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
SB18
SB13
SB12
SB10
SB09
SB14

OSU COMPARISONS

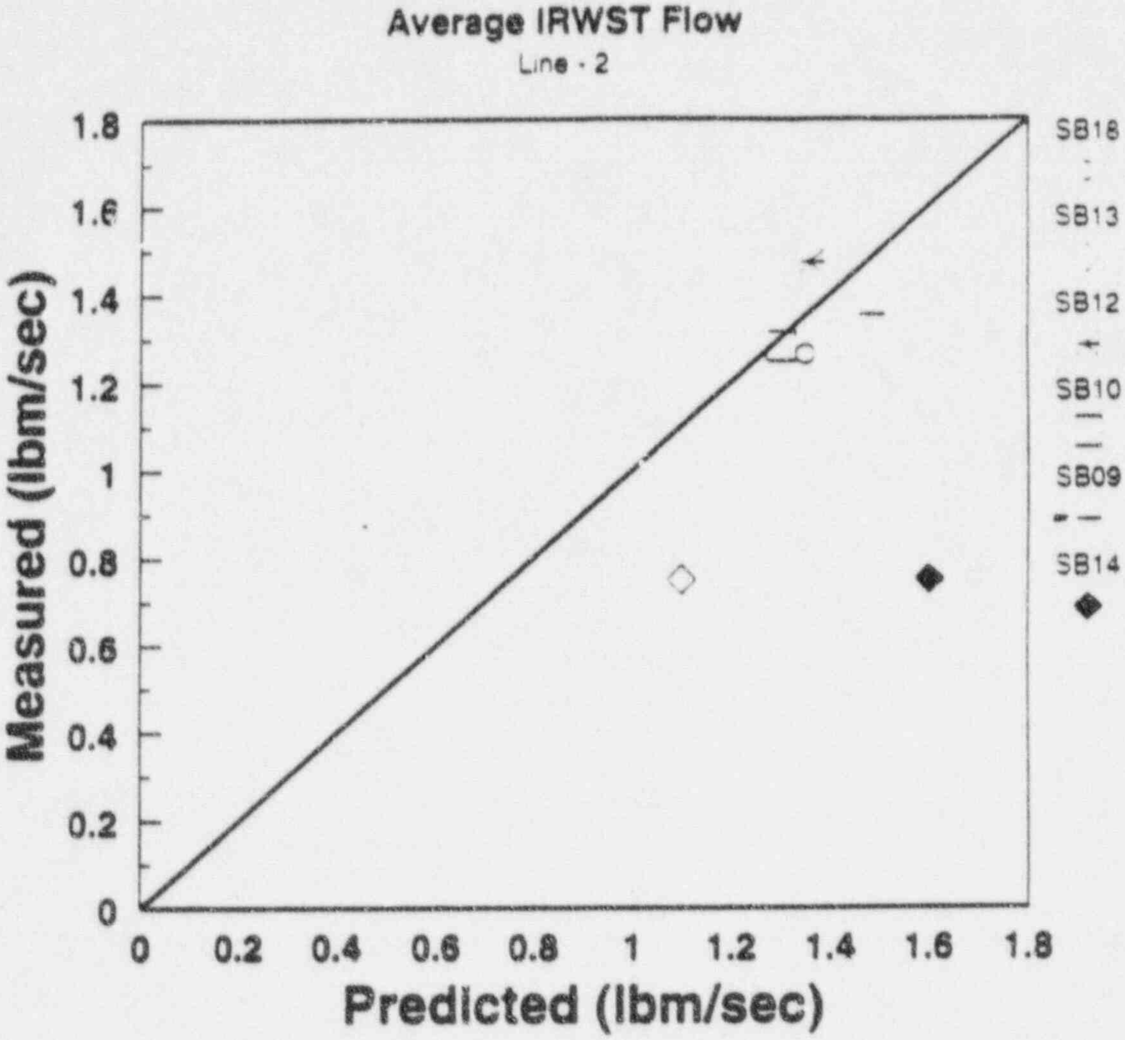
Average IRWST Flow

Line - 1



SB13, SB09, SB14 - Flows not fully developed yet

OSU COMPARISONS



SB13, SB09, SB14 - Flows not fully developed yet

(a,b,c)

NRC/WESTINGHOUSE MEETING
NOTRUMP VALIDATION
MARCH 13, 1997

M. Y. YOUNG

NOTRUMP SUMMARY REPORT

PURPOSE:

To bring together the PIRT, descriptions of important NOTRUMP models, and results from the FVR (Final Validation Report) in a form suitable for discussion with the ACRS subcommittee

REPORT WILL EMPHASIZE AREAS OF PARTICULAR INTEREST TO ACRS:

- relationship of PIRT to key models
- assumptions and range of application
- deficiencies and assessment of impact

REPORT WILL ALSO ADDRESS ISSUES RAISED IN NRC REVIEW OF FVR

REPORT OUTLINE:

I. KEY MODELS IDENTIFIED BY THE PIRT

II. KEY MODEL SUMMARY DESCRIPTIONS

III. MODEL VALIDATION SUMMARY (SINGLE EFFECTS TESTS) / CONCLUSIONS

IV. INTEGRAL TEST VALIDATION SUMMARY / CONCLUSIONS

V. AP600 APPENDIX K APPLICATION

REPORT CONTENT

REPORT WILL FOCUS ON (AND ALL RECENT CODE CHANGES WILL BE RELATED TO) THE FOLLOWING KEY MODELS IDENTIFIED BY THE PIRT:

- drift flux model (vertical and horizontal)
- mixture level tracking model
- hydraulic resistance model
- condensation heat transfer models for RCS
- heat transfer model for PRHR
- critical flow model
- thermal stratification model

FOR EACH MODEL:

- describe in summary form (reference NOTRUMP sections for numerical or coding details)

- identify assumptions used in the model

- identify range of applicability, and demonstrate that calculations of AP600 and integral tests are within range most of the time

- discuss separate effects validation results, what they indicate about potential compensating effects in integral tests

- discuss identified deficiencies, expected impact on results, and why code is still applicable

REPORT CONTENT

INTEGRAL EFFECTS TESTS:

- evaluate code mis-predictions in terms of identified model deficiencies

- conclude that system mass prediction is conservative, and compensating effects are known and understood

AP600 APPENDIX K CALCULATION:

- discuss additional conservative assumptions

EXAMPLE MODEL SUMMARY

MIXTURE LEVEL TRACKING MODEL:

DESCRIPTION:

- includes bubble rise, fluid node stacking, mixture level overshoot, reflux flowlinks, contact coefficients code mods.

- focus on calculation of vapor flow from two phase mixture to vapor bubble, not coding logic to make model work

ASSUMPTIONS:

- stratified conditions are assumed to always exist

- no entrainment of liquid from lower mixture to vapor phase

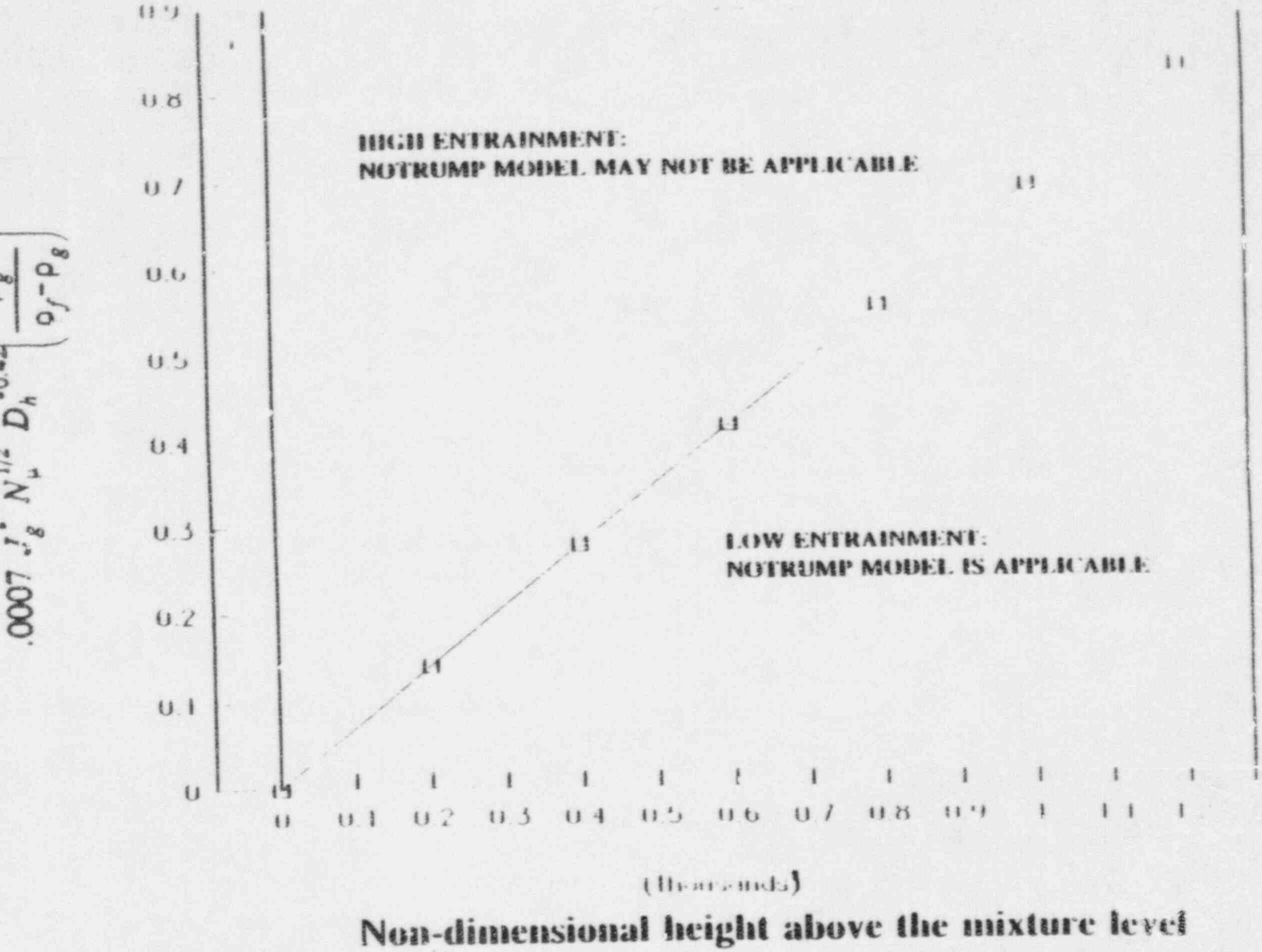
RANGE OF APPLICABILITY:

- pool entrainment data will quantify importance of entrainment above the mixture level

- stratified break flow tests will quantify importance of entrainment to tees

- confirm that calculated conditions are within range most of the time

LOW TO HIGH ENTRAINMENT TRANSITION



PROPOSED ACRS AGENDA

FIRST DAY:

I. INTRODUCTION

brief overview of AP600 design and small break LOCA scenario

II. NOTRUMP CODE OVERVIEW

development and licensing history
overall code structure

III. KEY MODELS IDENTIFIED BY THE PIRT

relationship of PIRT to phenomena, models used to simulate phenomena

IV. KEY MODEL DESCRIPTION / SEPARATE EFFECTS ASSESSMENT

model summary
assumptions
range of applicability
validation

PROPOSED ACRS AGENDA

SECOND DAY:

V. INTEGRAL TEST ASSESSMENT

present SPES, OSU comparisons

VI. CONCLUSIONS

NOTRUMP is applicable for use in AP600 small break LOCA

VII. AP600 APPENDIX K APPLICATION

list Appendix K requirements which will be applied
identify additional conservative assumptions to be made
identify conservative features identified by code assessment

DOCUMENTATION CLOSURE

Bob Osterrieder

Westinghouse Electric

a,c

Figure 1.2-1 NOTRUMP Noding Scheme for the AP600 Plant

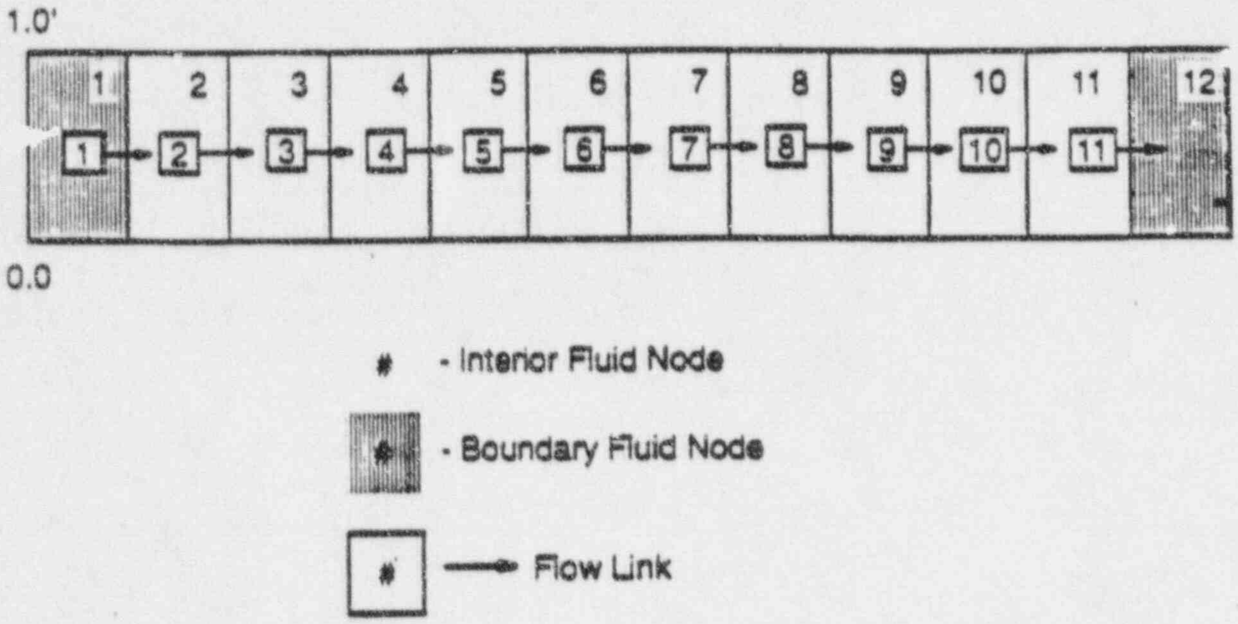


Figure 3.5-14 NOTRUMP Model for Demonstration Problem

DISCUSSION OF USE OF QUENCH MODEL

Bob Osterrieder

Westinghouse Electric

USE OF QUENCH MODEL

- o Quench model developed for cases with core nodes that uncover then have some recovery
- o Quench model originally used for all reported G2 runs
- o Quench model originally used for all reported ACHILLES runs
- o Code changes during project along with test cases indicated no need for use of quench model in final calculations therefore, quench model description not included in report
- o In closing out documentation, repeated calculations with final code version, final options (quench model off, birthing off)
- o Repeat of base ACHILLES calculations with quench model off showed no difference in results
- o Repeat of ACHILLES noding study Section 4.3.4 (4, 12, 24 & 48 nodes) showed no difference in results except for 4 node case only (mixture level spikes - 4 node case uses quench model to eliminate spikes)

  Section 4.3.4 concludes that we will use approximately 1 foot axial noding for NOTRUMP simulations of heated bundles or cores. Therefore, 4 node case not used to justify bigger nodes and not important to support final model.
- o Quench model NOT USED for any reported OSU or SPES-2 runs
- o Repeat of all G2 calculations indicated need for quench model for a few cases

TABLE 4.4-3 G2 LOOP CORE UNCOVERY TEST PARAMETERS				
Run Number	Pressure (psia)	Bundle Power (MW)	Initial Bundle Water Level (in.)	Tests Analyzed with NOTRUMP
715	779	0.603	114	✓
716	775	0.252	138	✓
717	796	0.905	102	
718	799	1.258	90	
719	394	0.267	138	✓
720	395	0.615	114	✓
721	394	0.914	102	
722	395	1.264	84	
723	395	0.614	114	
724	96	0.252	126	✓
725	96	0.599	96	✓
726	96	0.857	84	
727	97	1.247	78	
728	50	0.596	84	✓
729	50	0.250	114	✓
730	50	0.894	66	
731	50	1.244	54	
732	15.1	0.254	102	✓
733	15.8	0.600	72	✓
734	16.1	0.900	60	
735	16.7	1.249	54	
736	15.3	0.253	102	

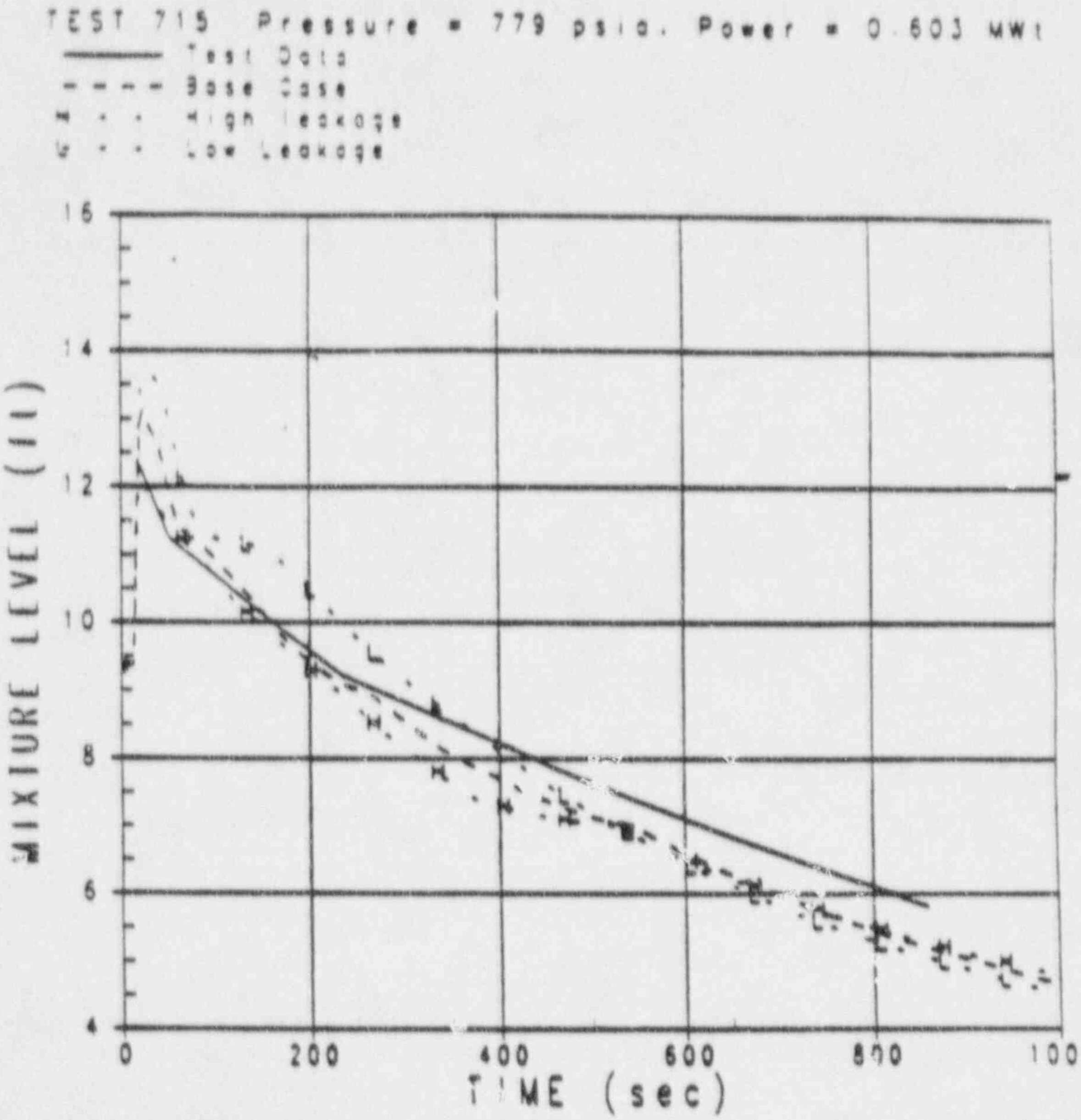


Figure 4.4-24 NOTRUMP Comparisons to G2 Test 715 Mixture Height with Uncertainties

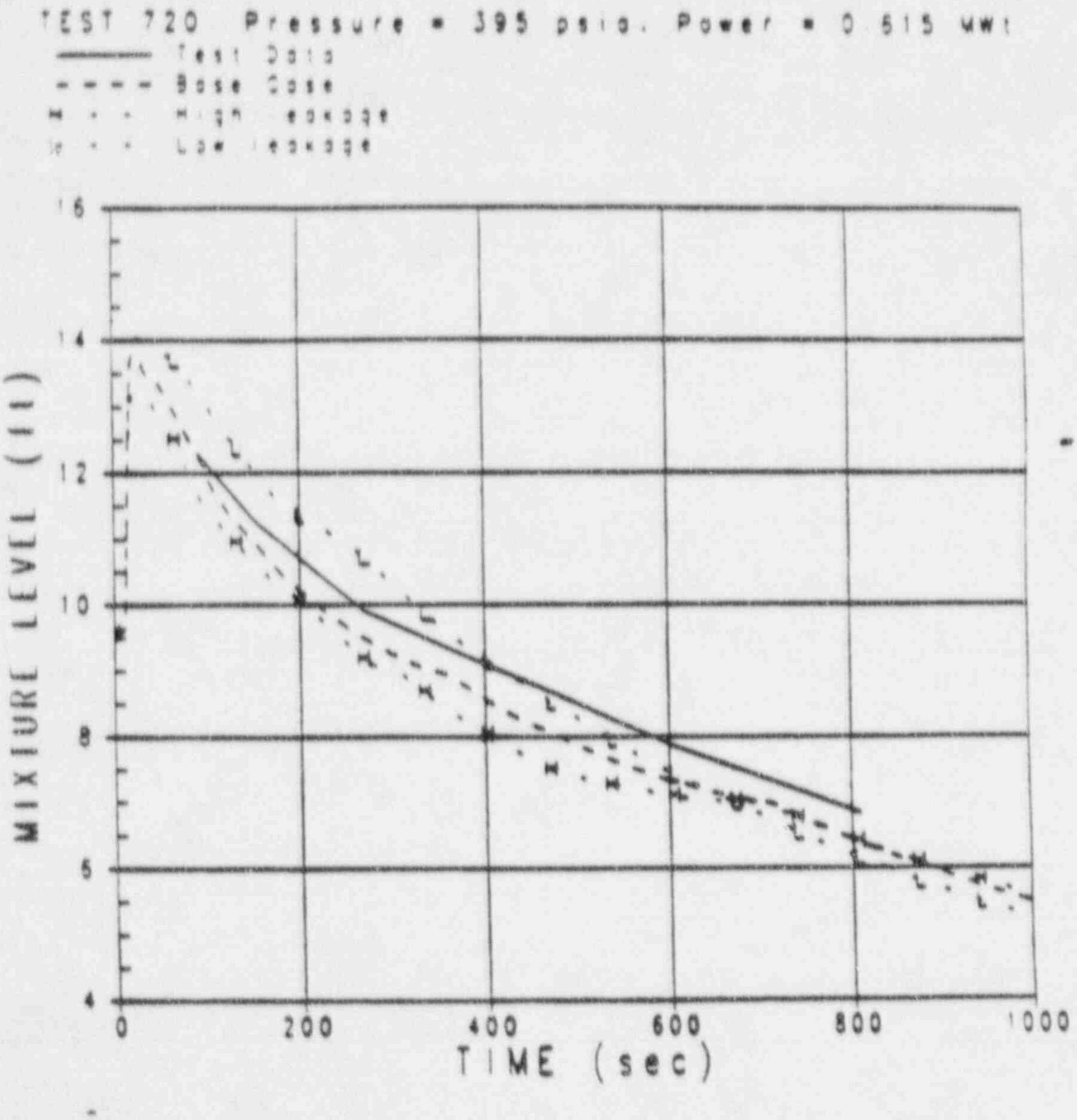


Figure 4.4-26 NOTRUMP Comparisons to G2 Test 720 Mixture Height with Uncertainties

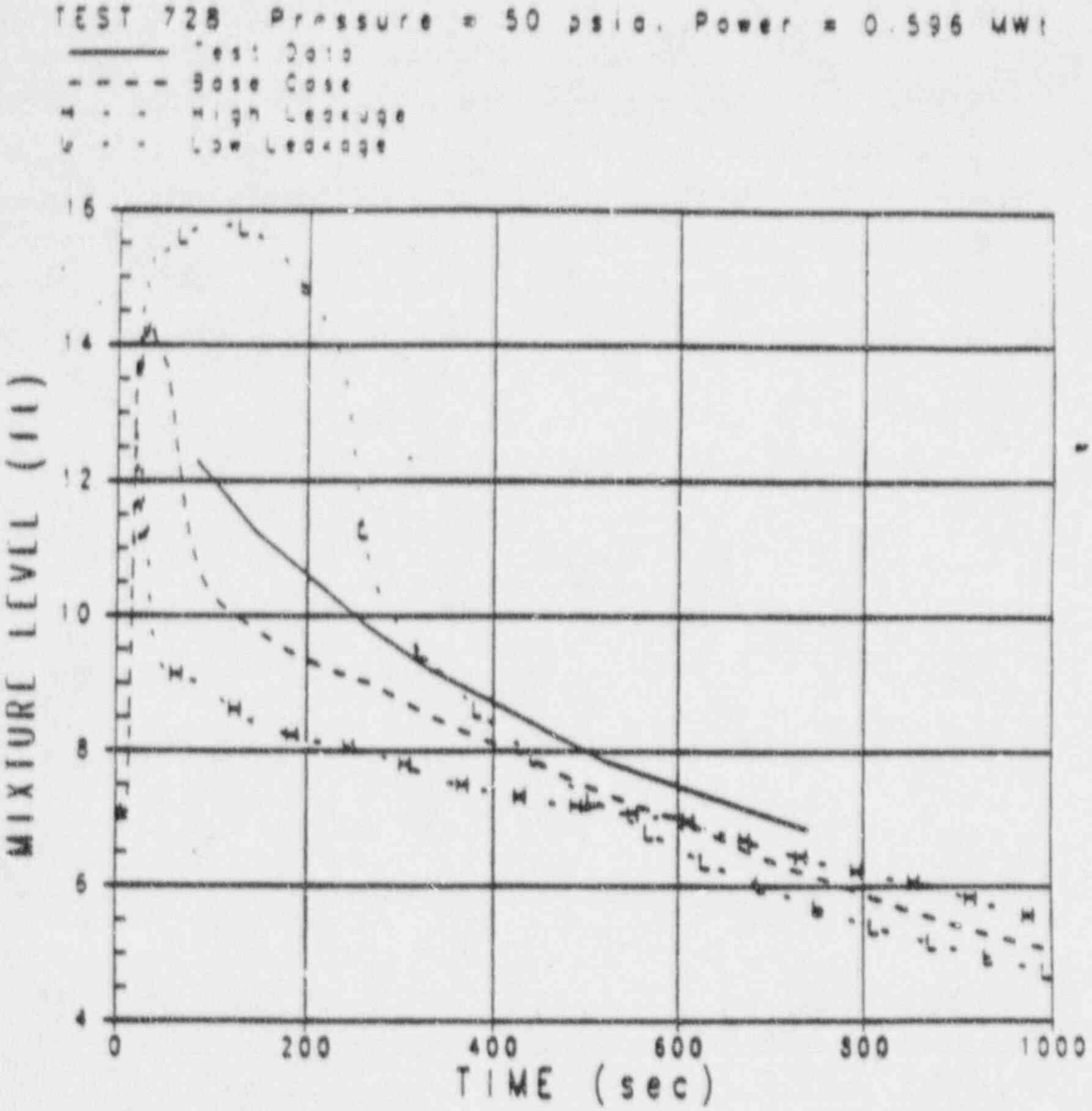


Figure 4.4-29 NOTRUMP Comparisons to G2 Test 728 Mixture Height with Uncertainties

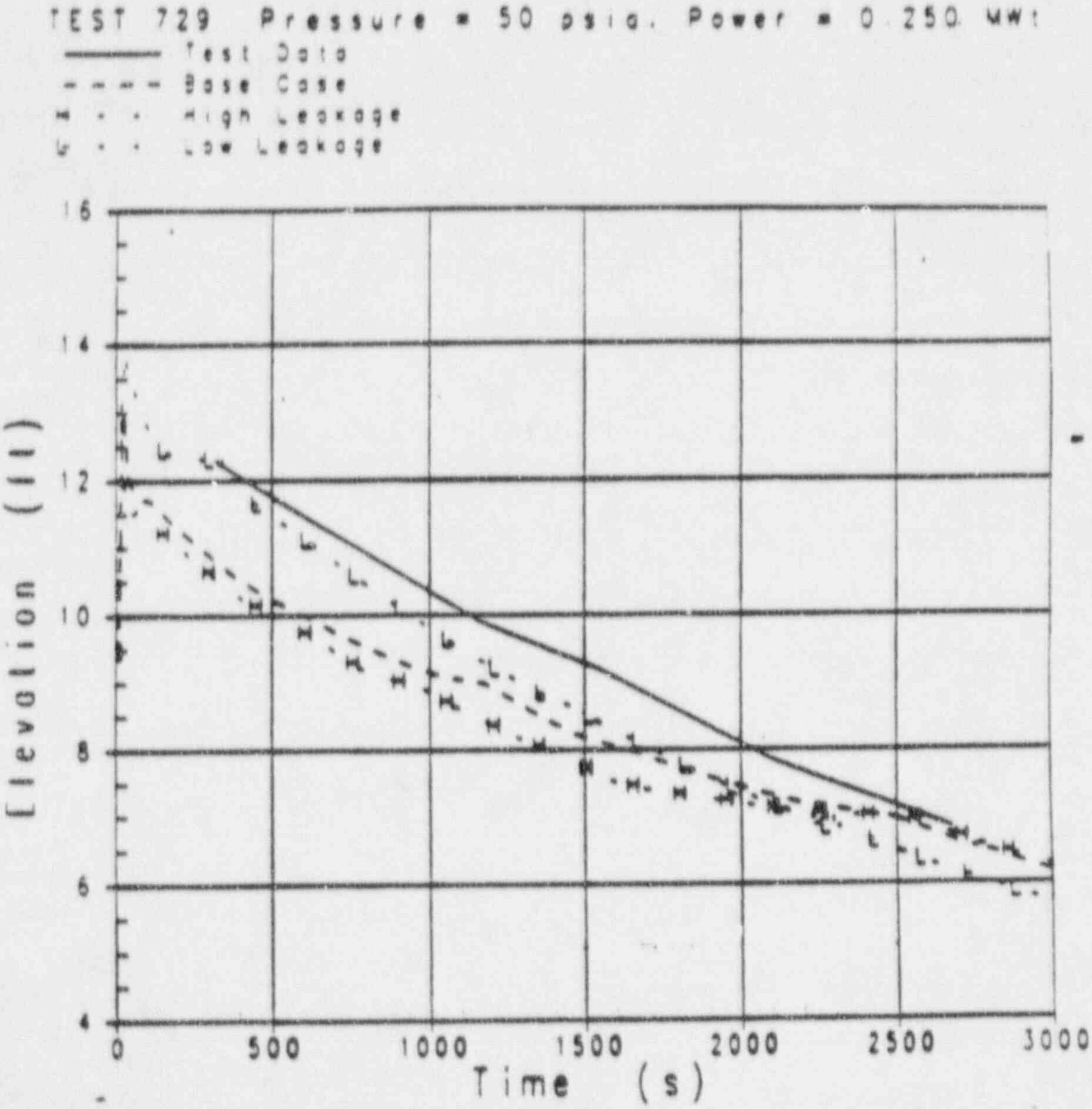


Figure 4.4-30 NOTRUMP Comparisons to G2 Test 729 Mixture Height with Uncertainties

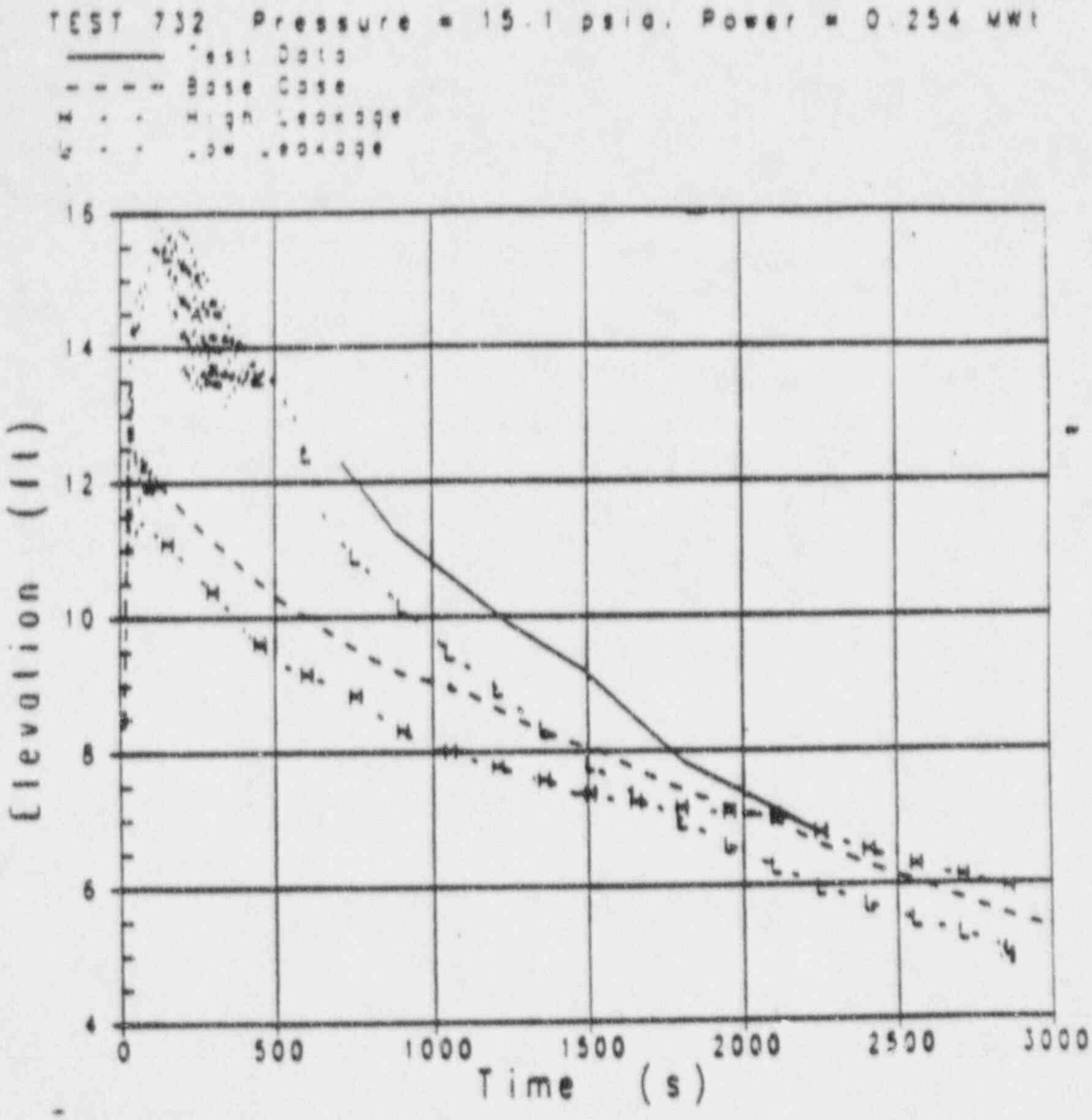


Figure 4.4-31 NOTRUMP Comparisons to G2 Test 732 Mixture Height with Uncertainties

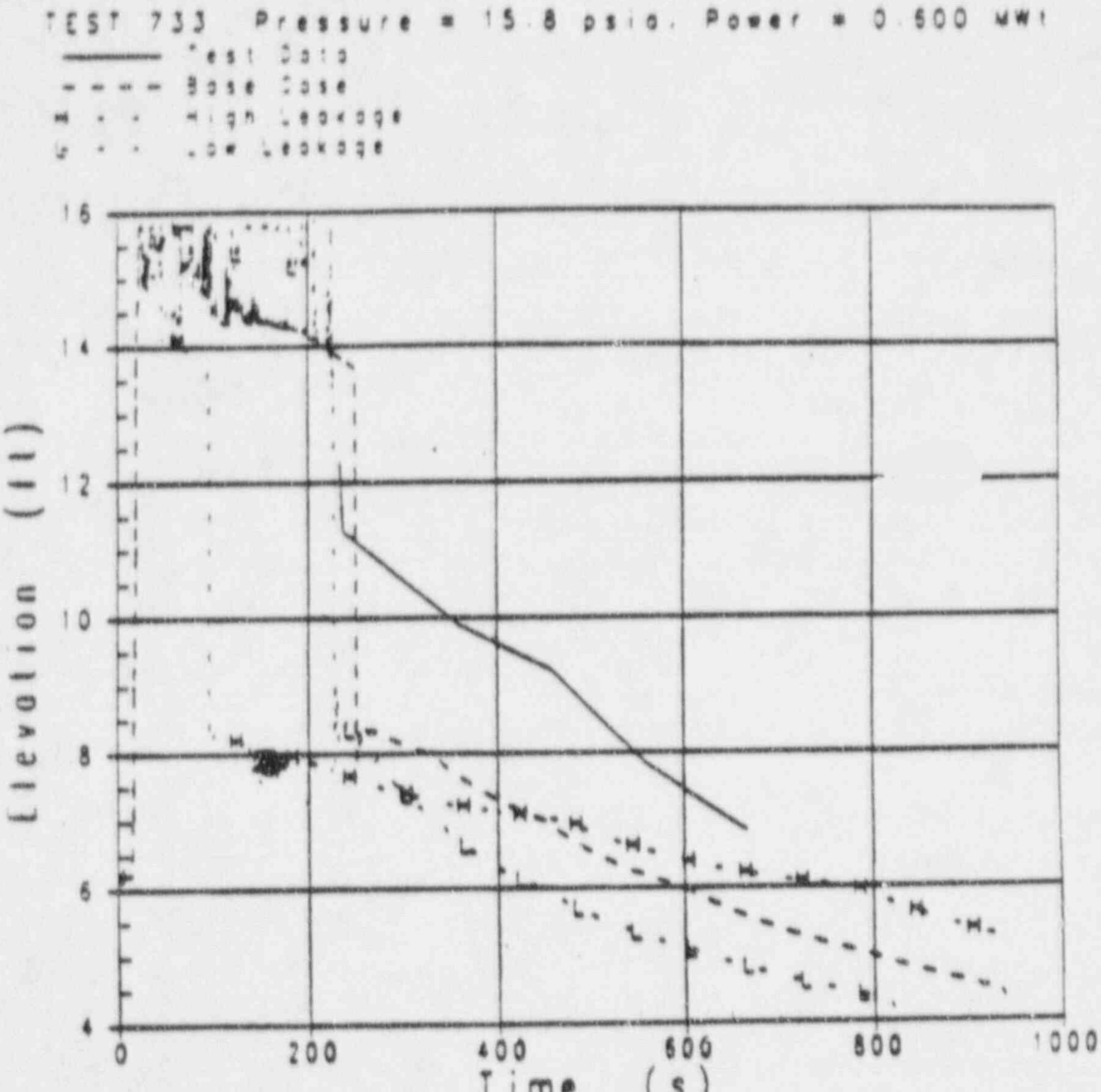
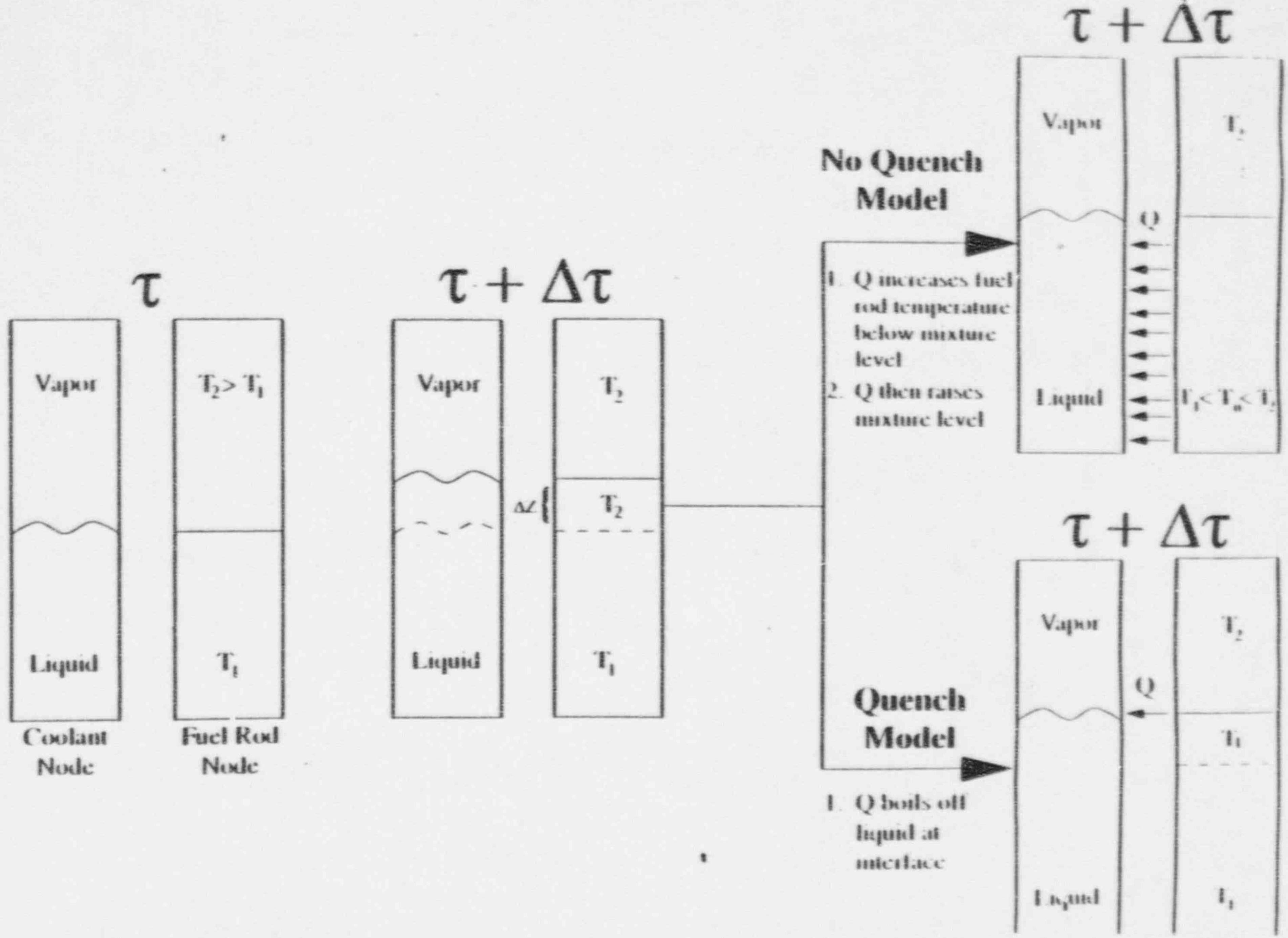


Figure 4.4-32 NOTRUMP Comparisons to G2 Test 733 Mixture Height with Uncertainties

Quench Model

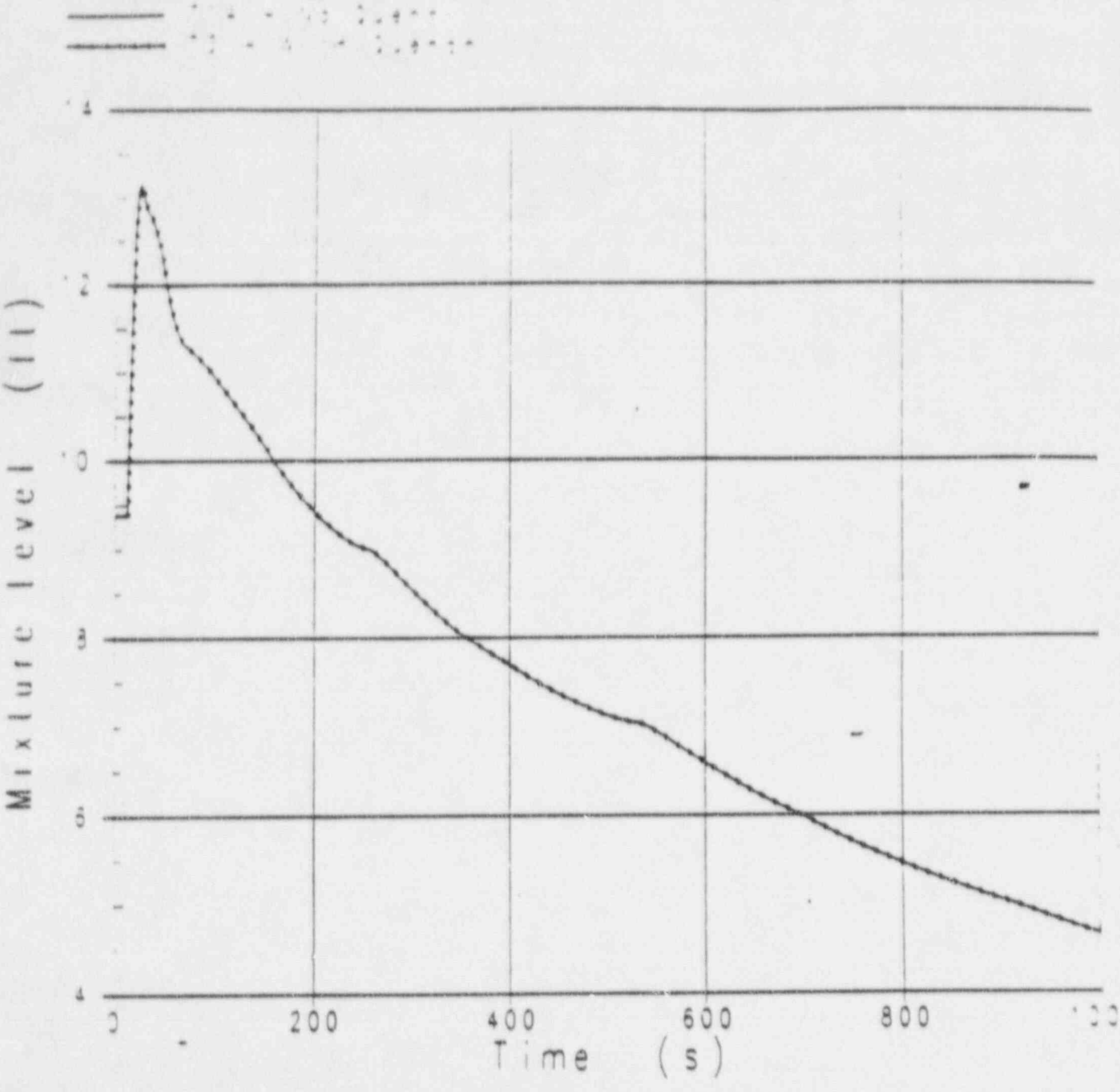


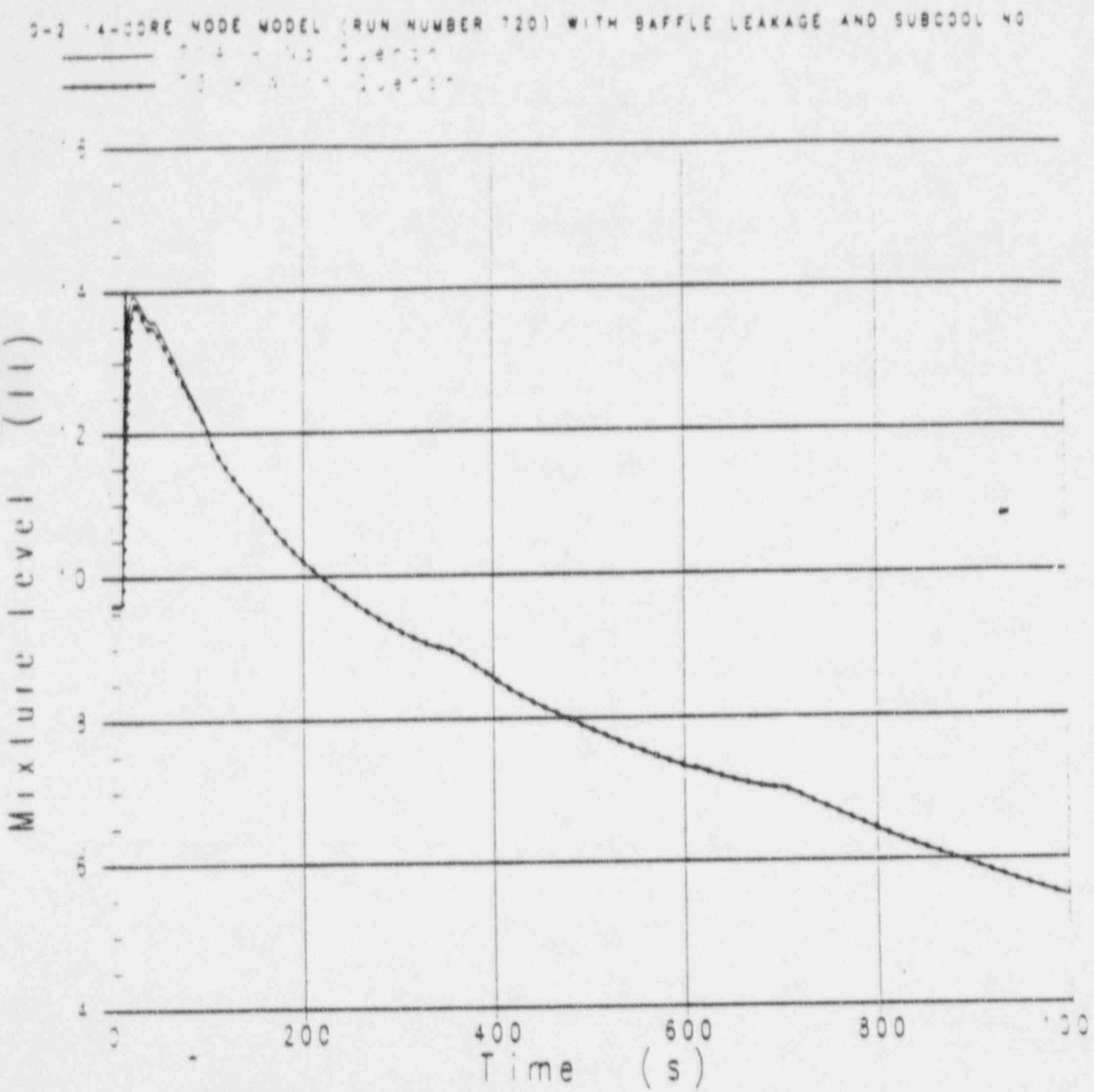
SUMMARY OF G2 CASES WITH FINAL CODE VERSION AND OPTIONS
(Quench Model Off)

NSD = No significant difference

Case	Base	High Leakage	Low Leakage
715	NSD	NSD	NSD
716	NSD	NSD	NSD
719	NSD	NSD	NSD
720	NSD	NSD	NSD
724	NSD	NSD	NSD
725	NSD	NSD	NSD
728	NSD	NSD	mixture level spike
729	mixture level spikes	NSD	NSD
732	mixture level spike	mixture level spikes	mixture level spike
733	run aborted ~ 200 sec	run aborted ~ 220 sec	some early differences, level spikes

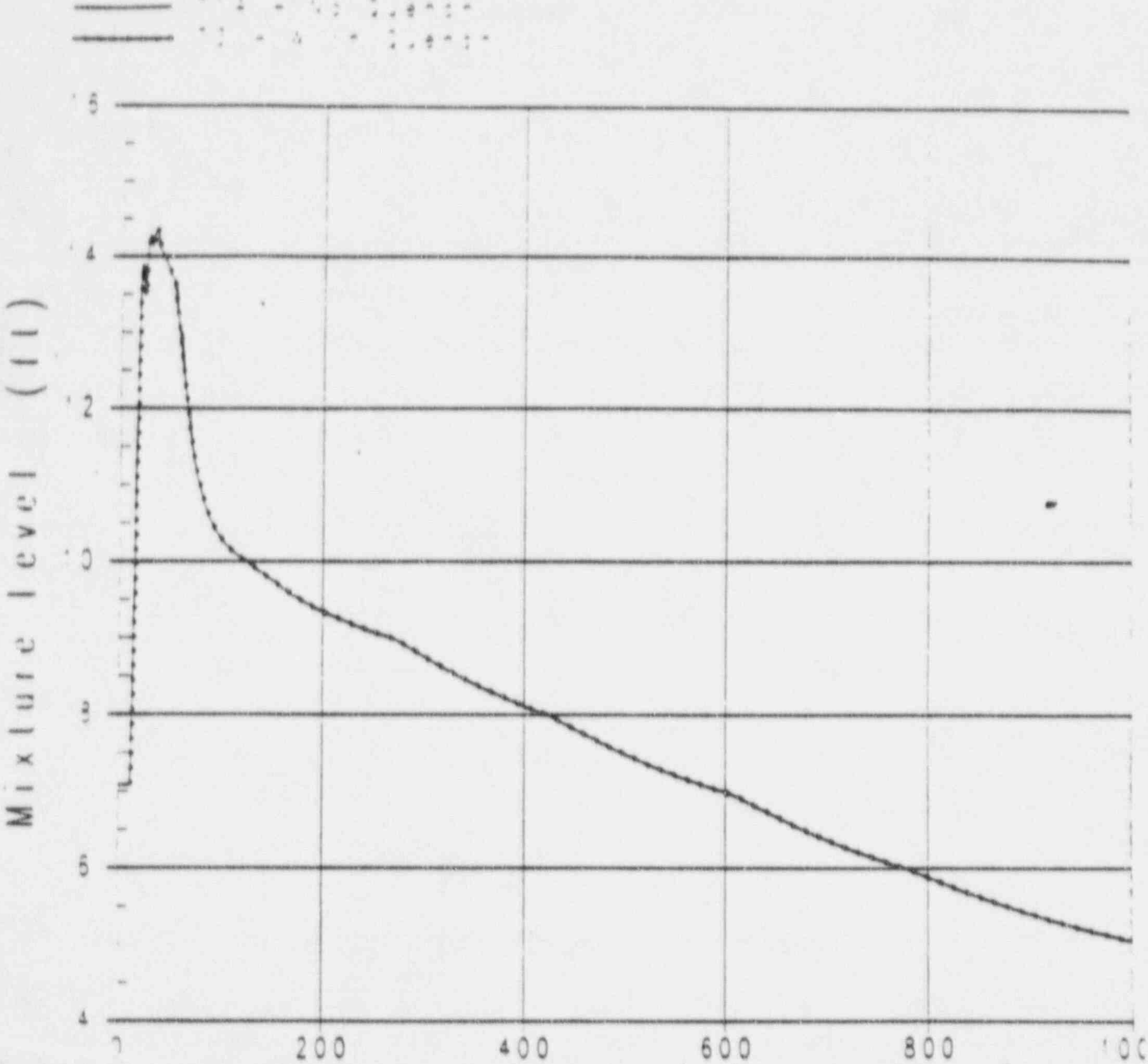
D-2 14-CORE NODE MODEL (RUN NUMBER 715) WITH BAFFLE LEAKAGE AND SUBCOOLING

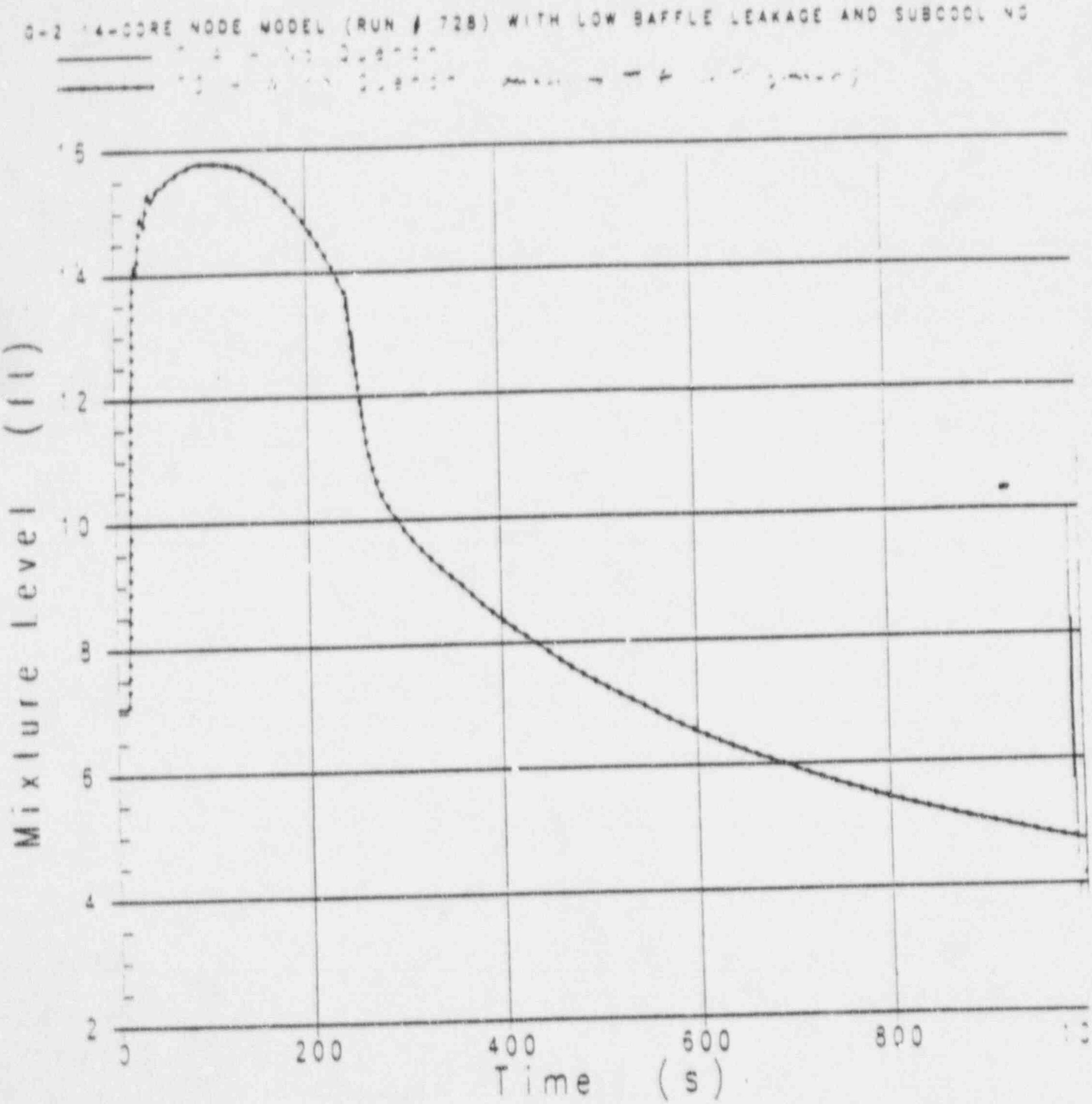




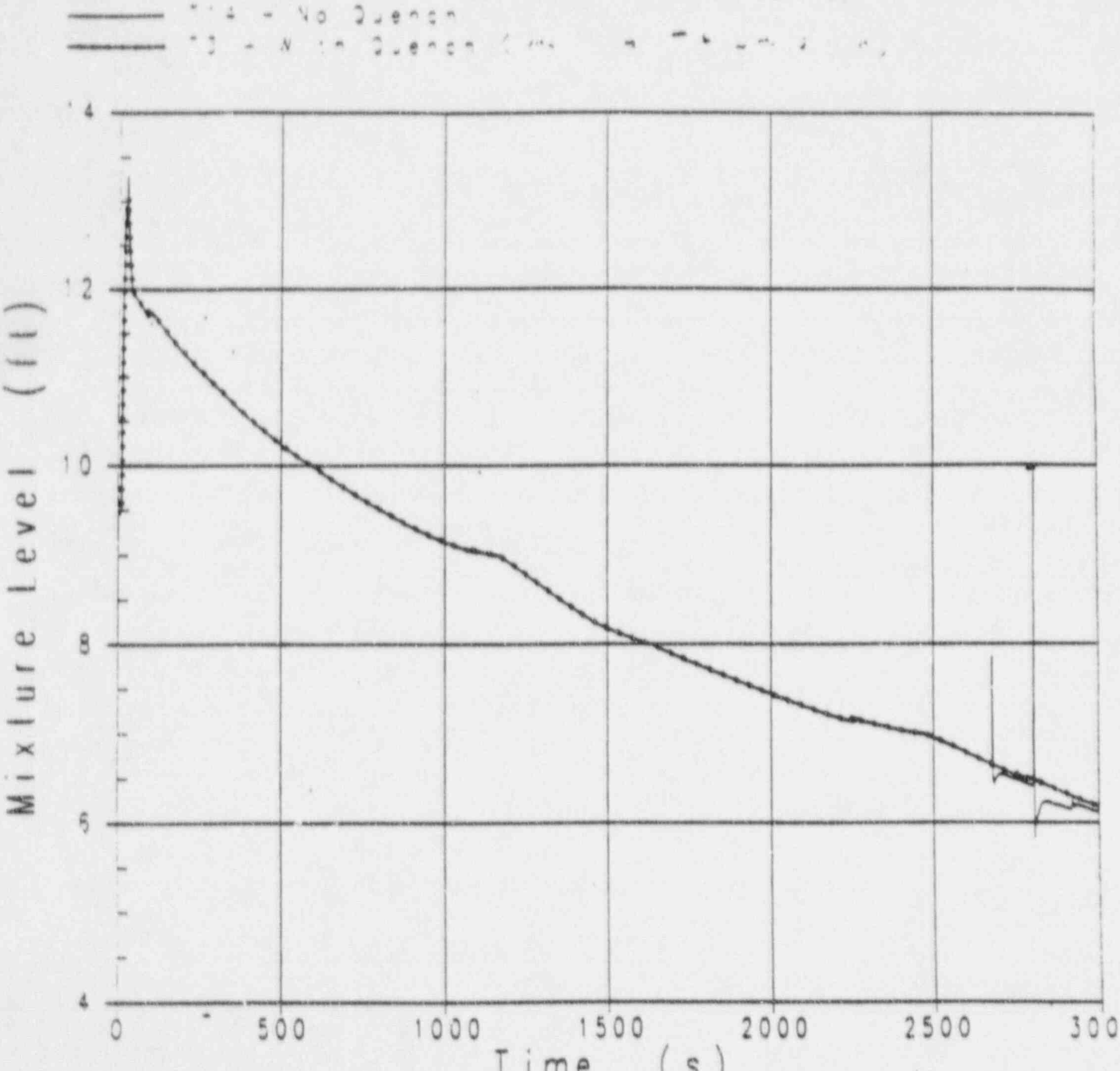
14-CORE NODE MODEL (RUN NUMBER 720) WITH BAFFLE LEAKAGE AND SUBCOOL NG
Mixture level (ft)
Time (s)
4
6
8
10
12
14
16
0
200
400
600
800

D-2 14-CORE NODE MODEL (RUN NUMBER 728) WITH BAFFLE LEAKAGE AND SUBCOOLING

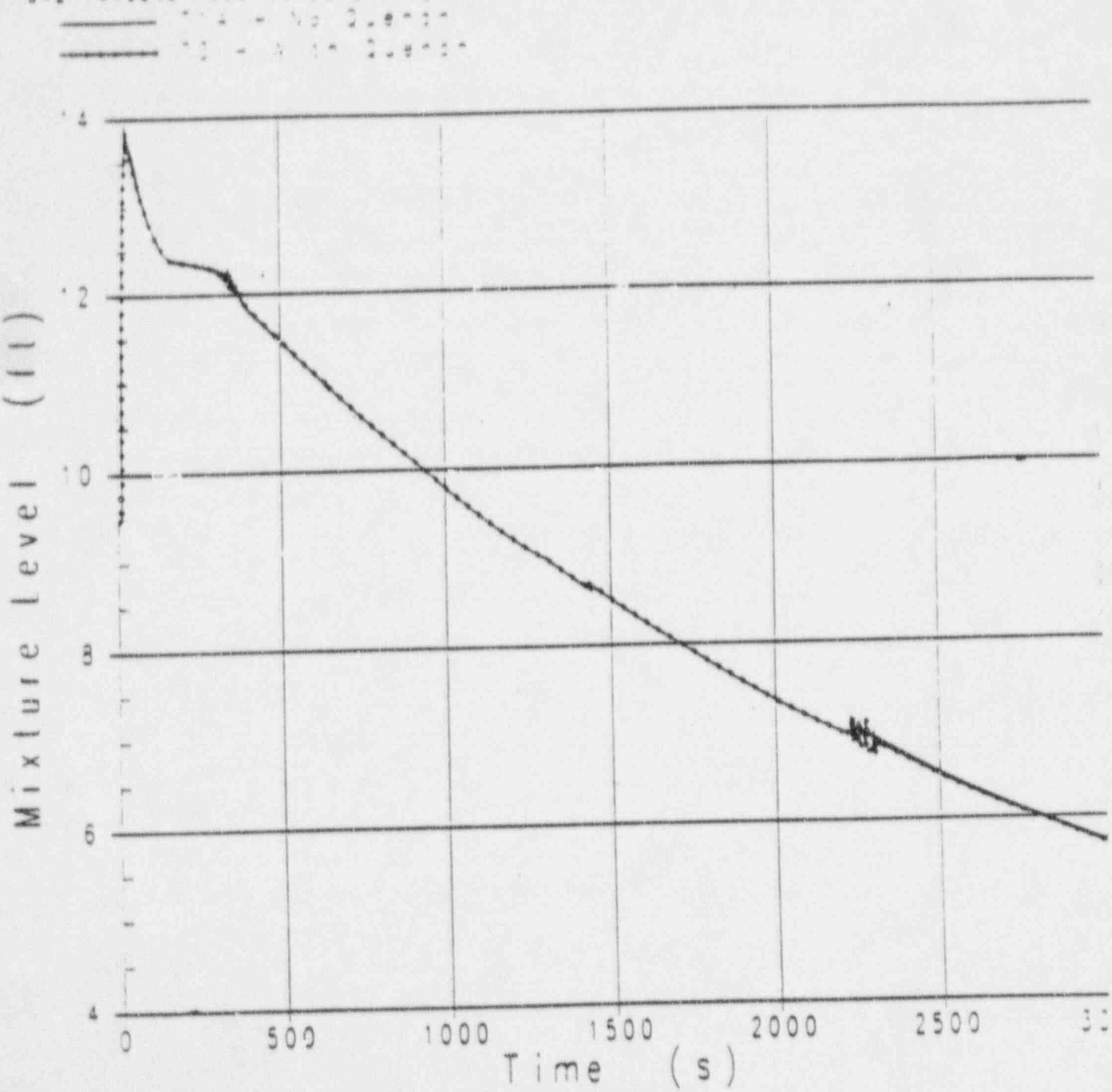


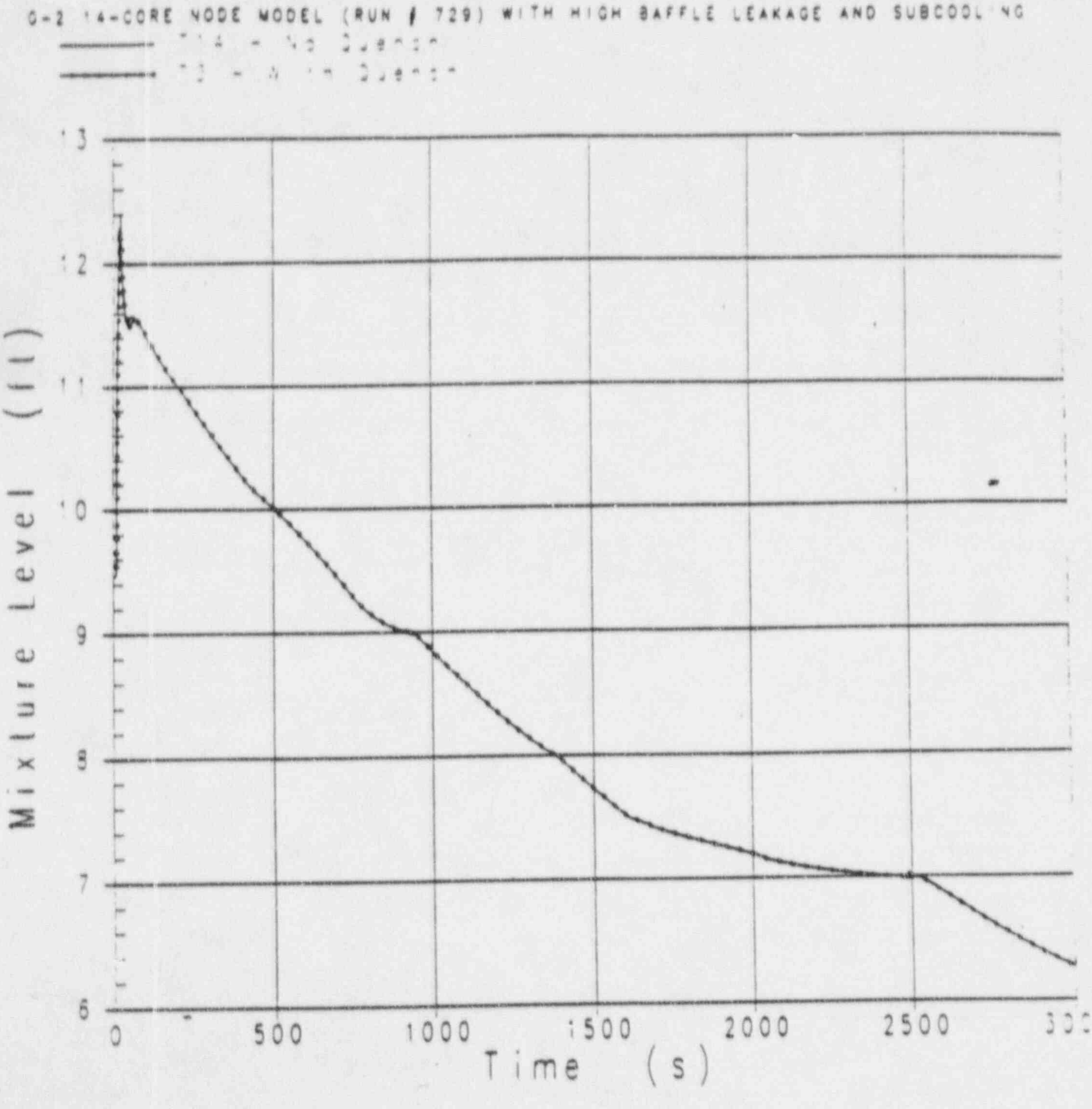

0-2 14-CORE NODE MODEL (RUN # 728) WITH LOW BAFFLE LEAKAGE AND SUBCOOL NO
Mixture Level (ft)
Time (s)
0
200
400
600
800
2
4
6
8
10
12
14
15

G-2 14-CORE NODE MODEL (RUN NUMBER 729) WITH BAFFLE LEAKAGE AND SUBCOOLING

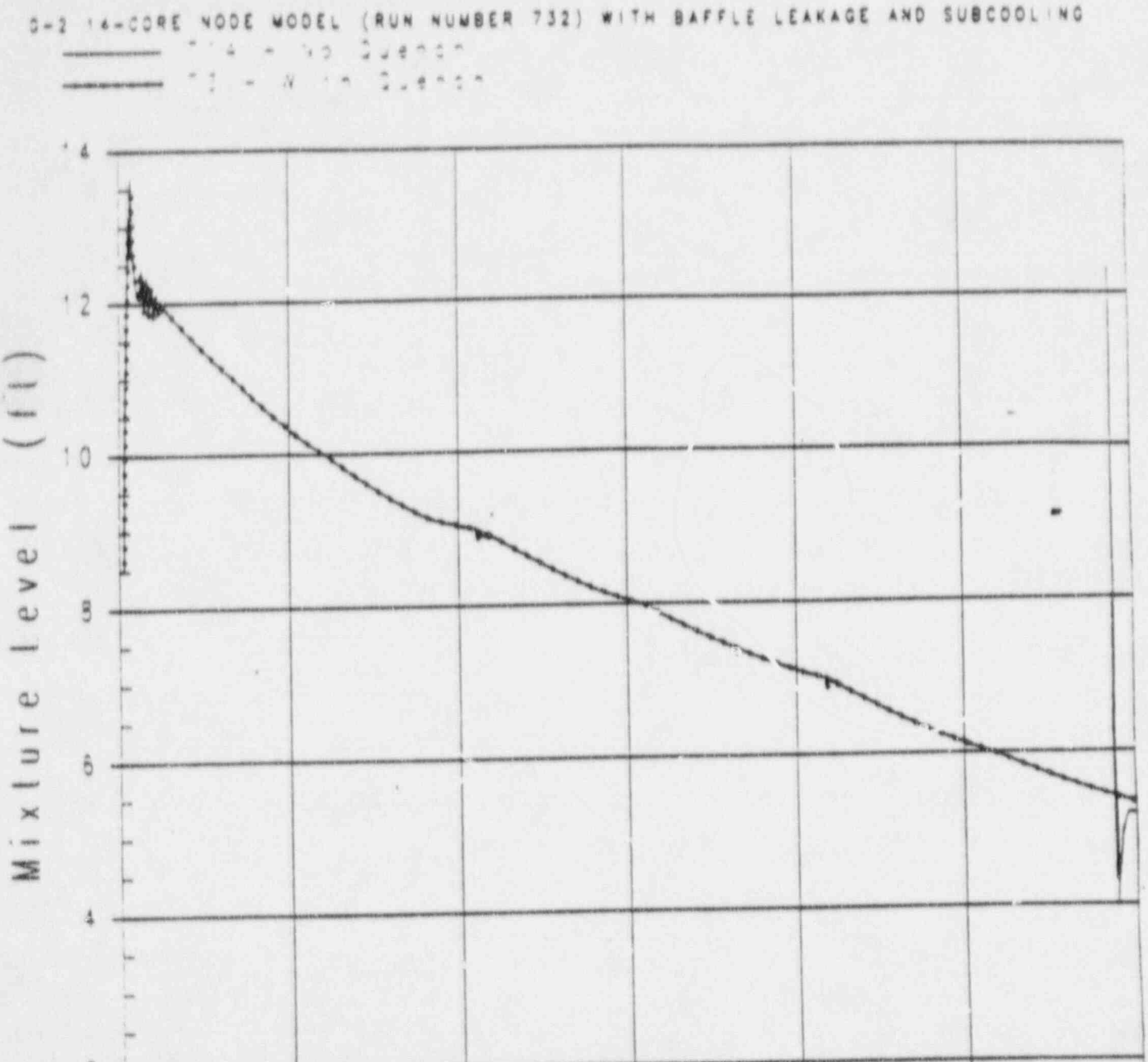


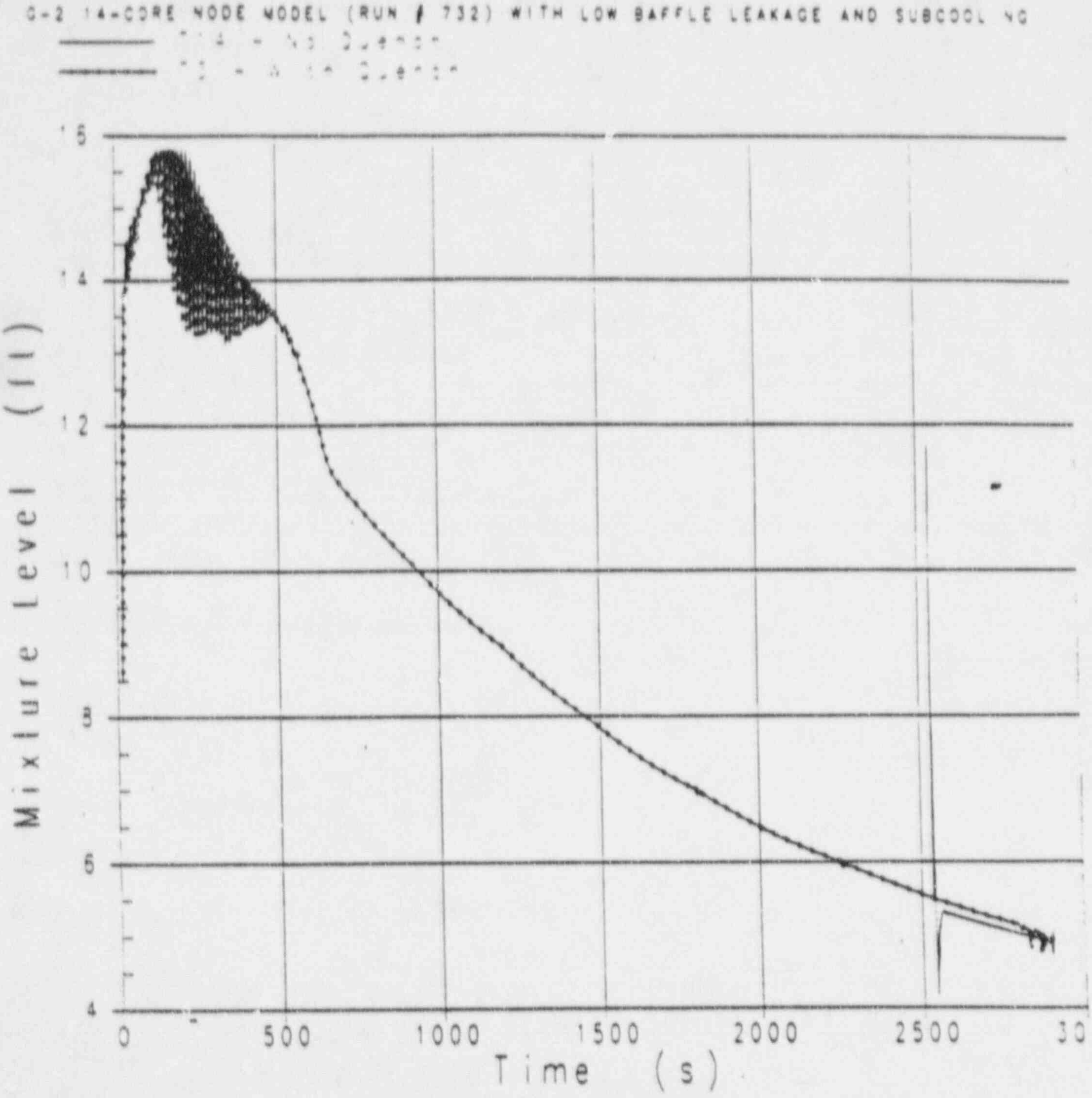
D-2 14-CORE NODE MODEL (RUN # 729) WITH LOW BAFFLE LEAKAGE AND SUBCOOL NG



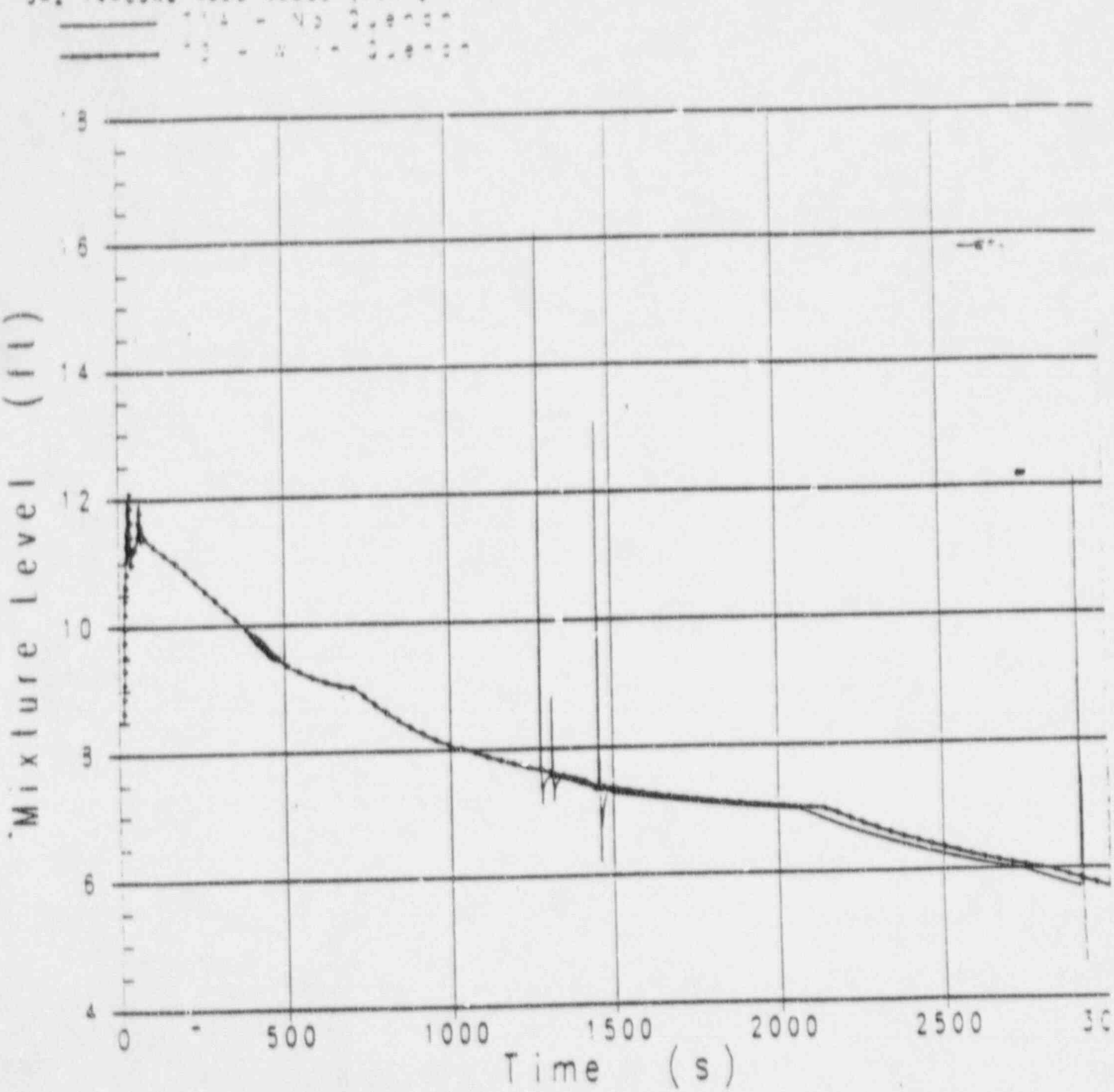


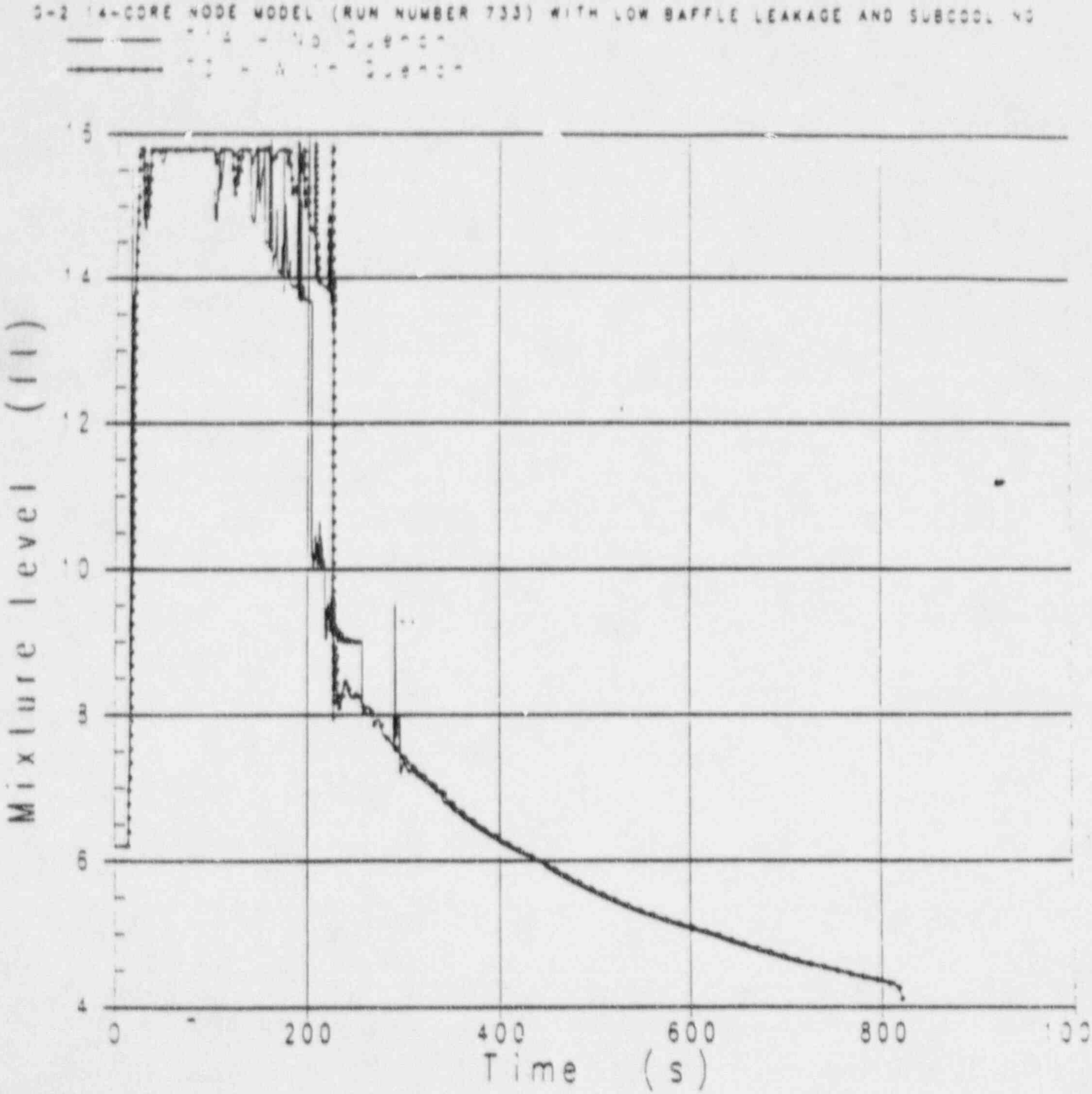
D-2 14-CORE NODE MODEL (RUN # 729) WITH HIGH BAFFLE LEAKAGE AND SUBCOOLING
Mixture Level (ft)
13
12
11
10
9
8
7
6
0
500
1000
1500
2000
2500
Time (s)

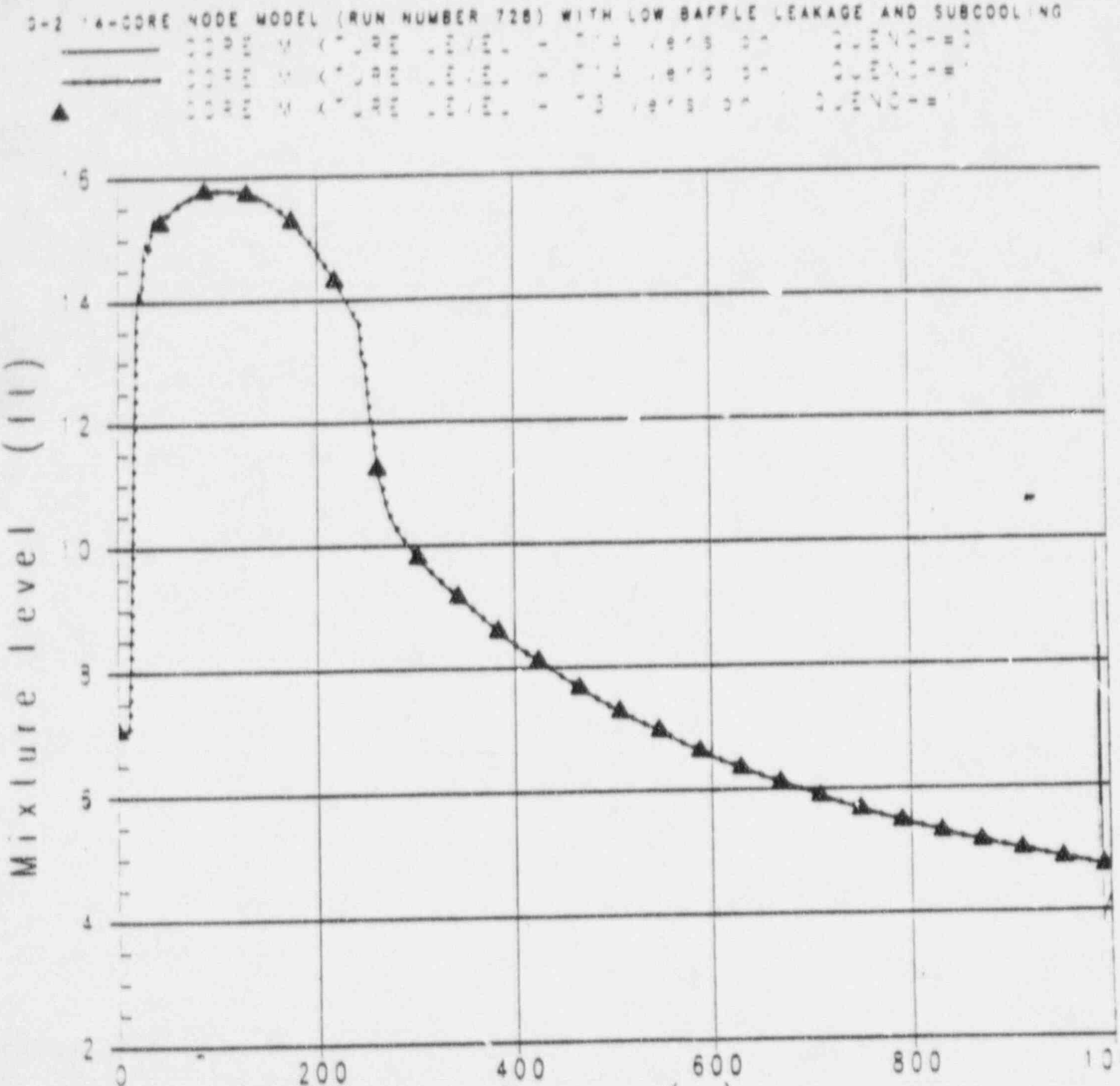

D-2 16-CORE NODE MODEL (RUN NUMBER 732) WITH BAFFLE LEAKAGE AND SUBCOOLING
No Quench
With Quench
Mixture level (ft)
Time (s)
0
500
1000
1500
2000
2500
2
4
6
8
10
12

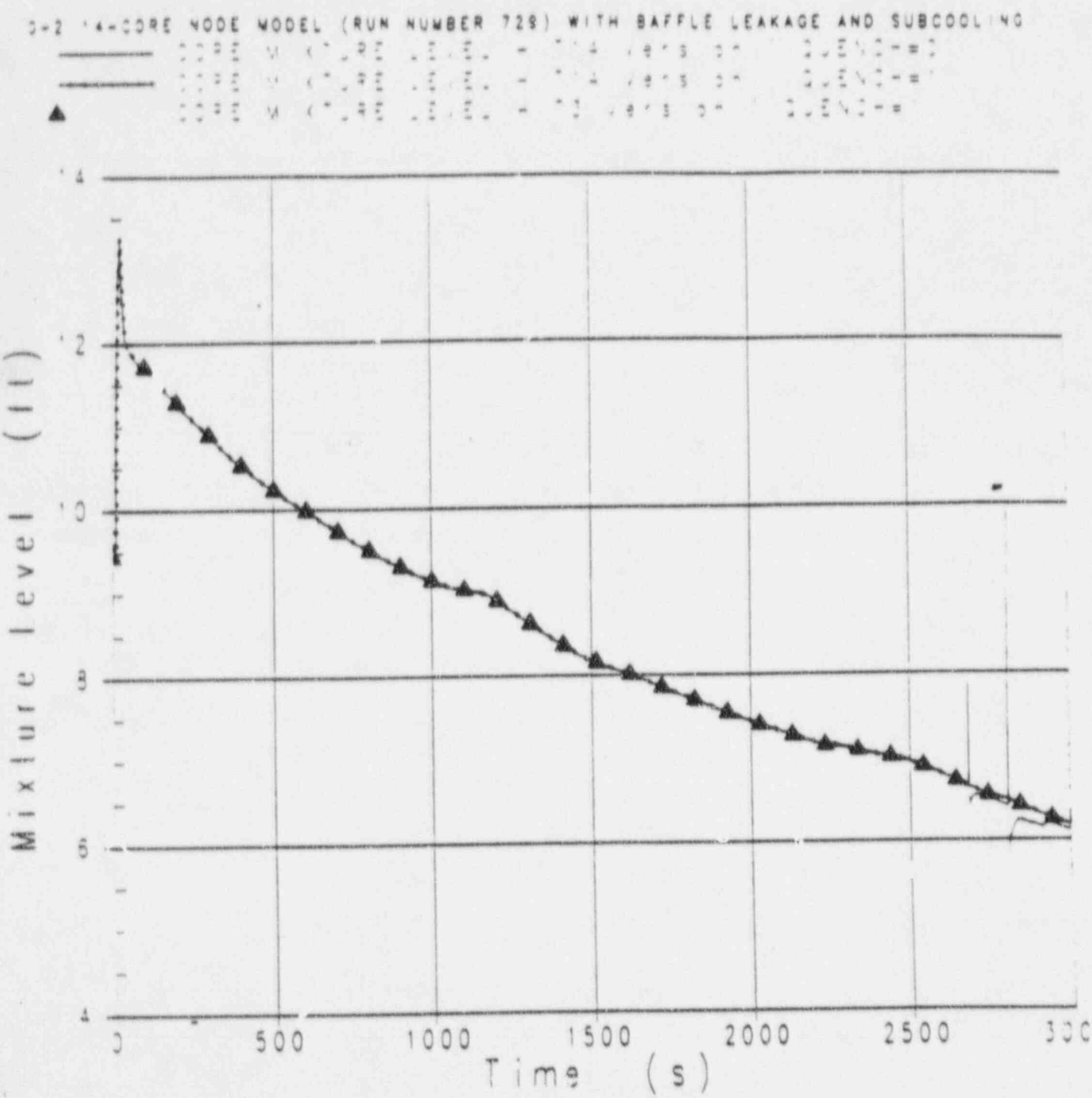

G-2 14-CORE NODE MODEL (RUN # 732) WITH LOW BAFFLE LEAKAGE AND SUBCOOL NG
Mixture Level (ft)
15
14
12
10
8
6
4
0
500
1000
1500
2000
2500
30
Time (s)

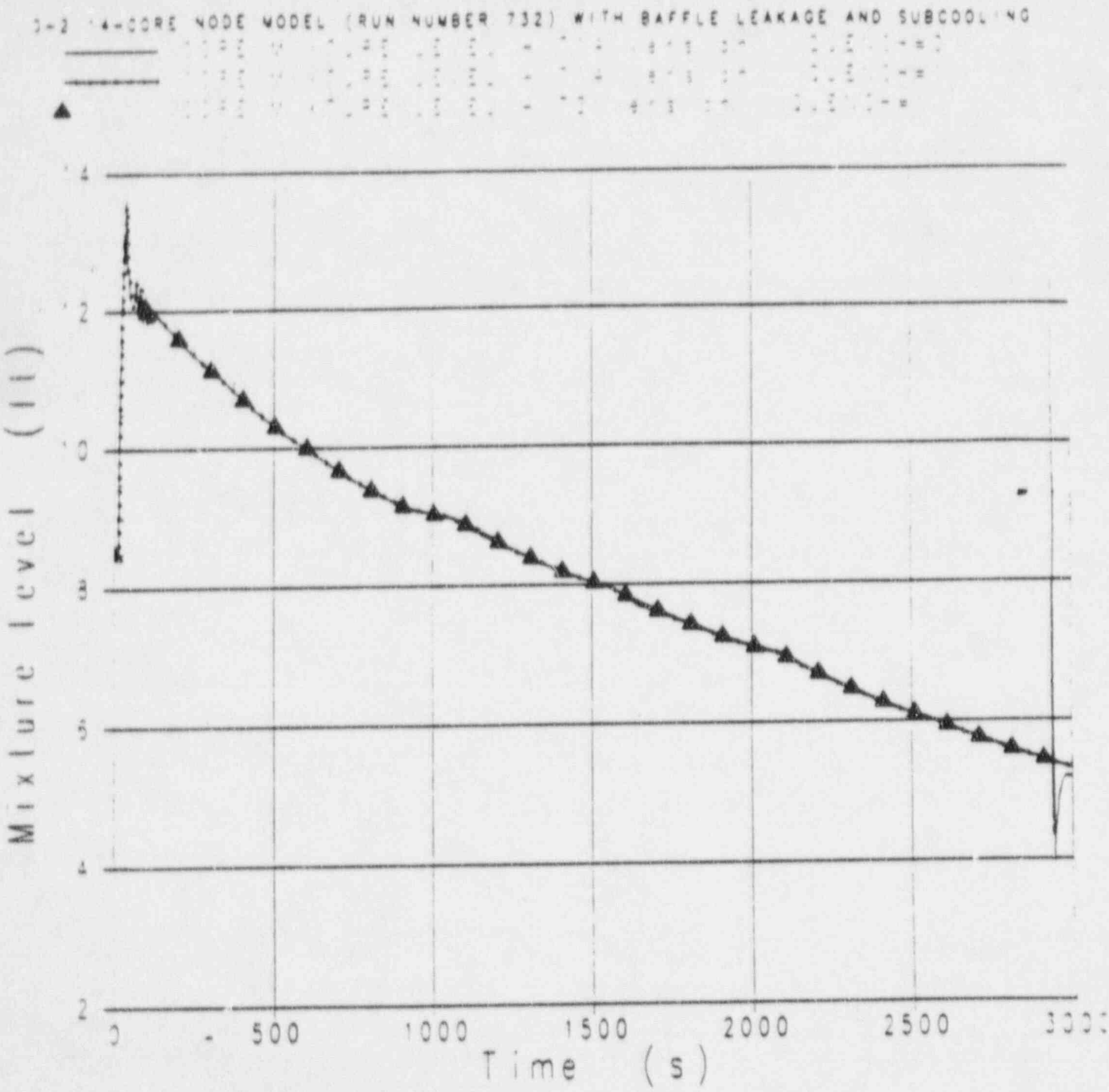
D-2 14-CORE NODE MODEL (RUN # 732) WITH HIGH BAFFLE LEAKAGE AND SUBCOOLING

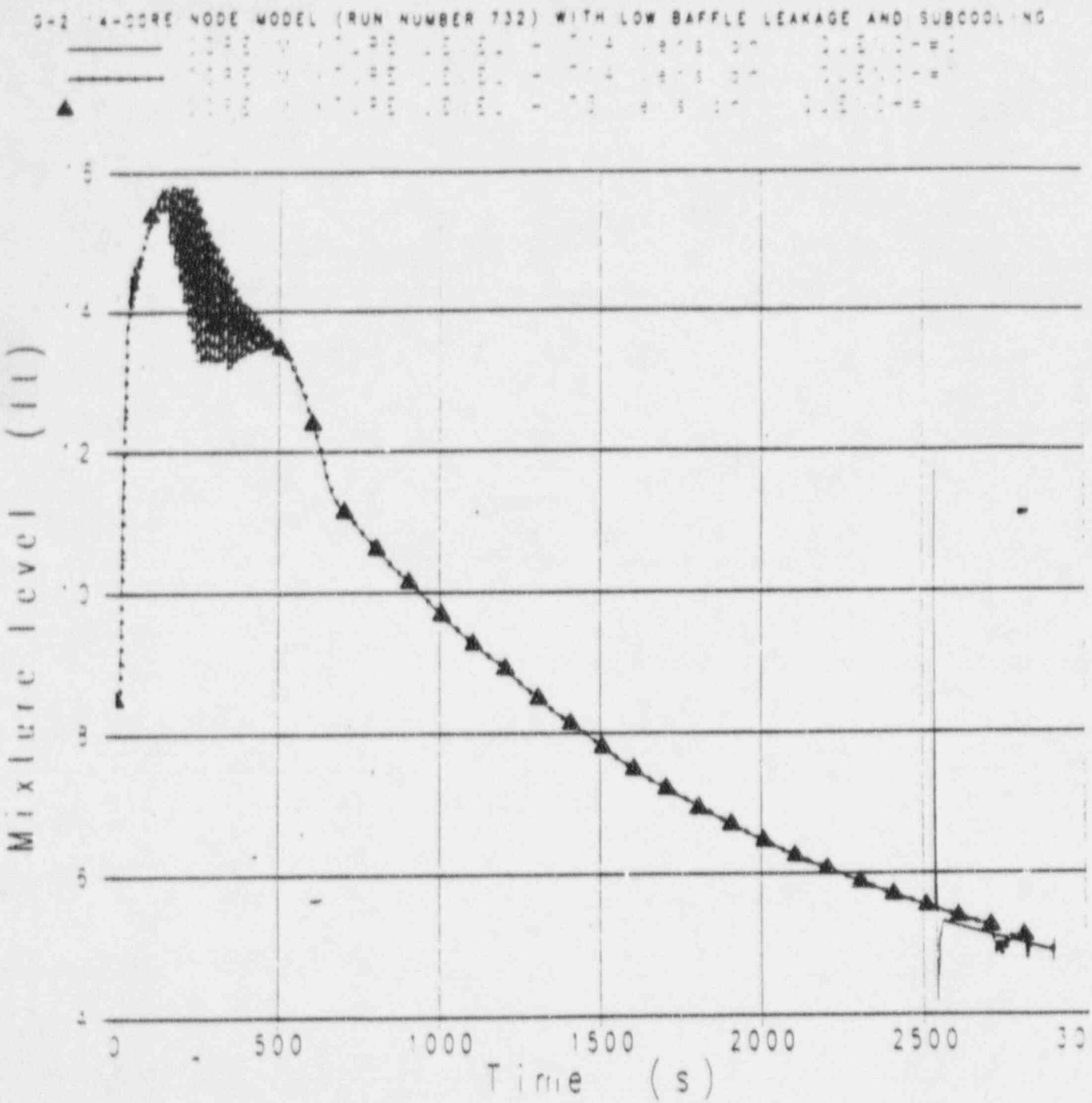


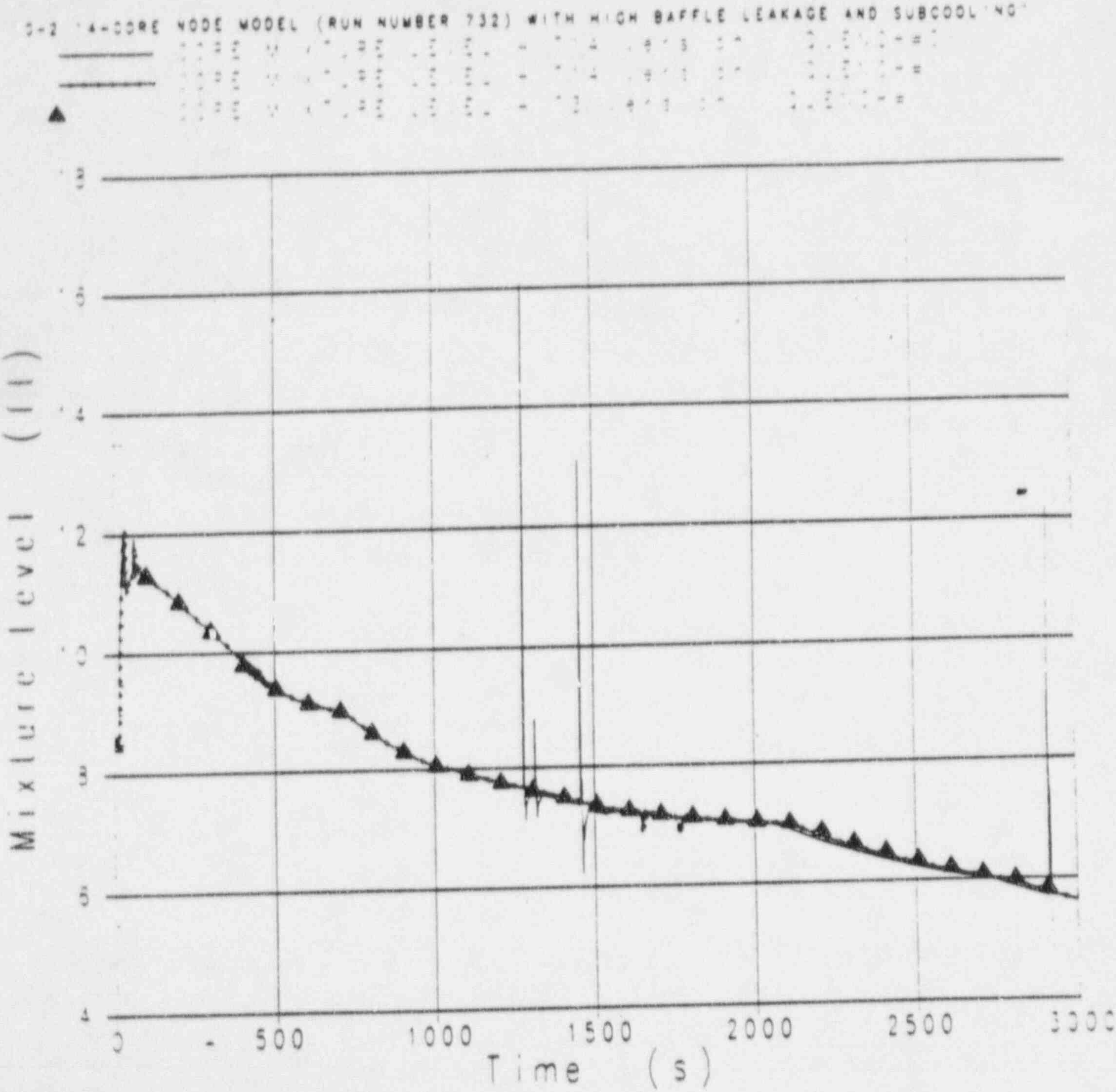

14-CORE NODE MODEL (RUN NUMBER 733) WITH LOW BAFFLE LEAKAGE AND SUBCOOL
Mixture level (ft)
Time (s)
4
6
8
10
12
14
0
200
400
600
800


NODE MODEL (RUN NUMBER 728) WITH LOW BAFFLE LEAKAGE AND SUBCOOLING
Mixture level (ft)
Time (s)
0
200
400
600
800
2
4
6
8
10
12
14

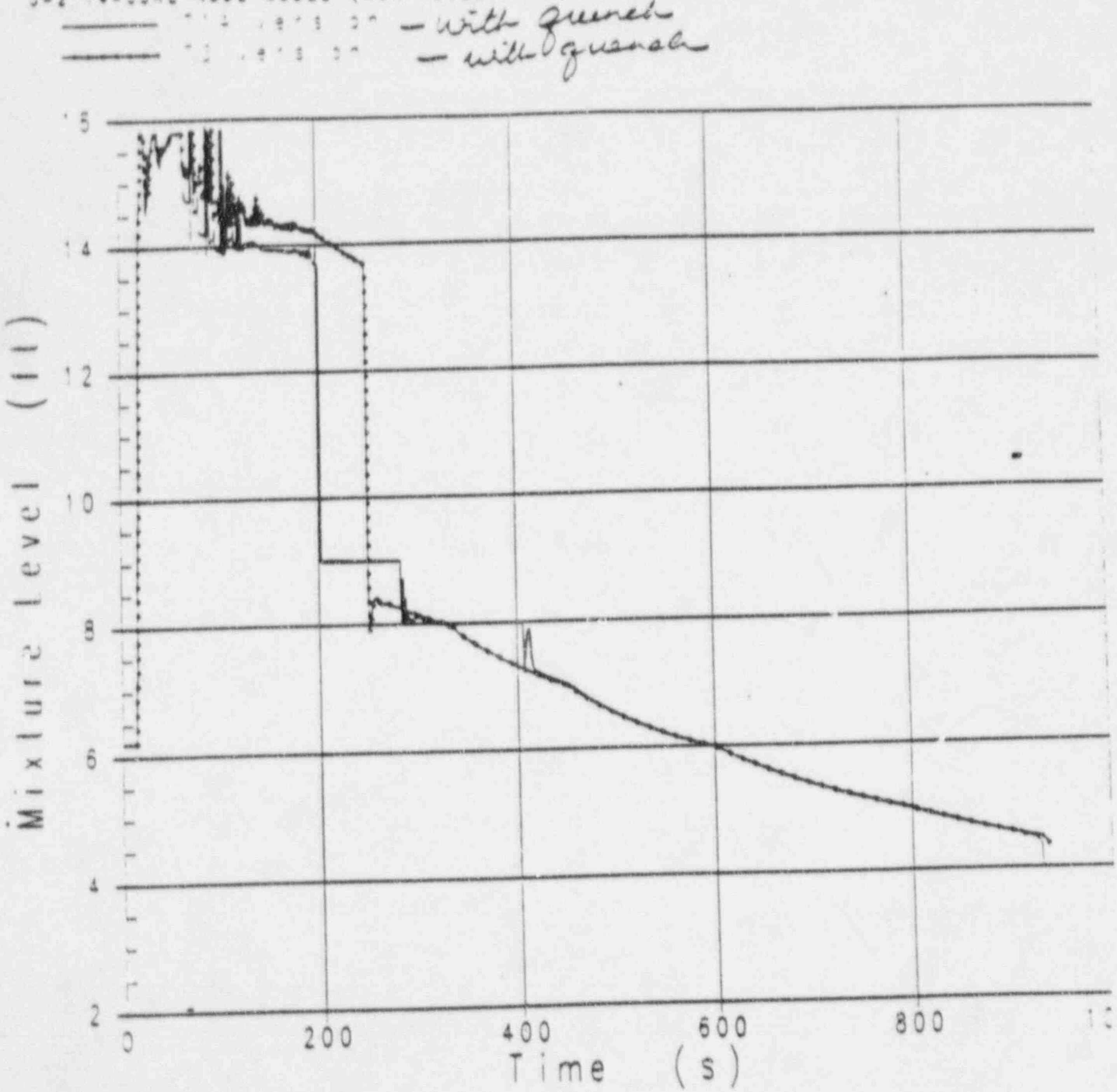

CORE NODE MODEL (RUN NUMBER 729) WITH BAFFLE LEAKAGE AND SUBCOOLING
Mixture Level (ft)
Time (s)
12
10
8
6
4
500
1000
1500
2000
2500


CORE NODE MODEL (RUN NUMBER 732) WITH BAFFLE LEAKAGE AND SUBCOOLING
Mixture level (ft)
12
10
8
6
4
2
Time (s)
0
500
1000
1500
2000
2500

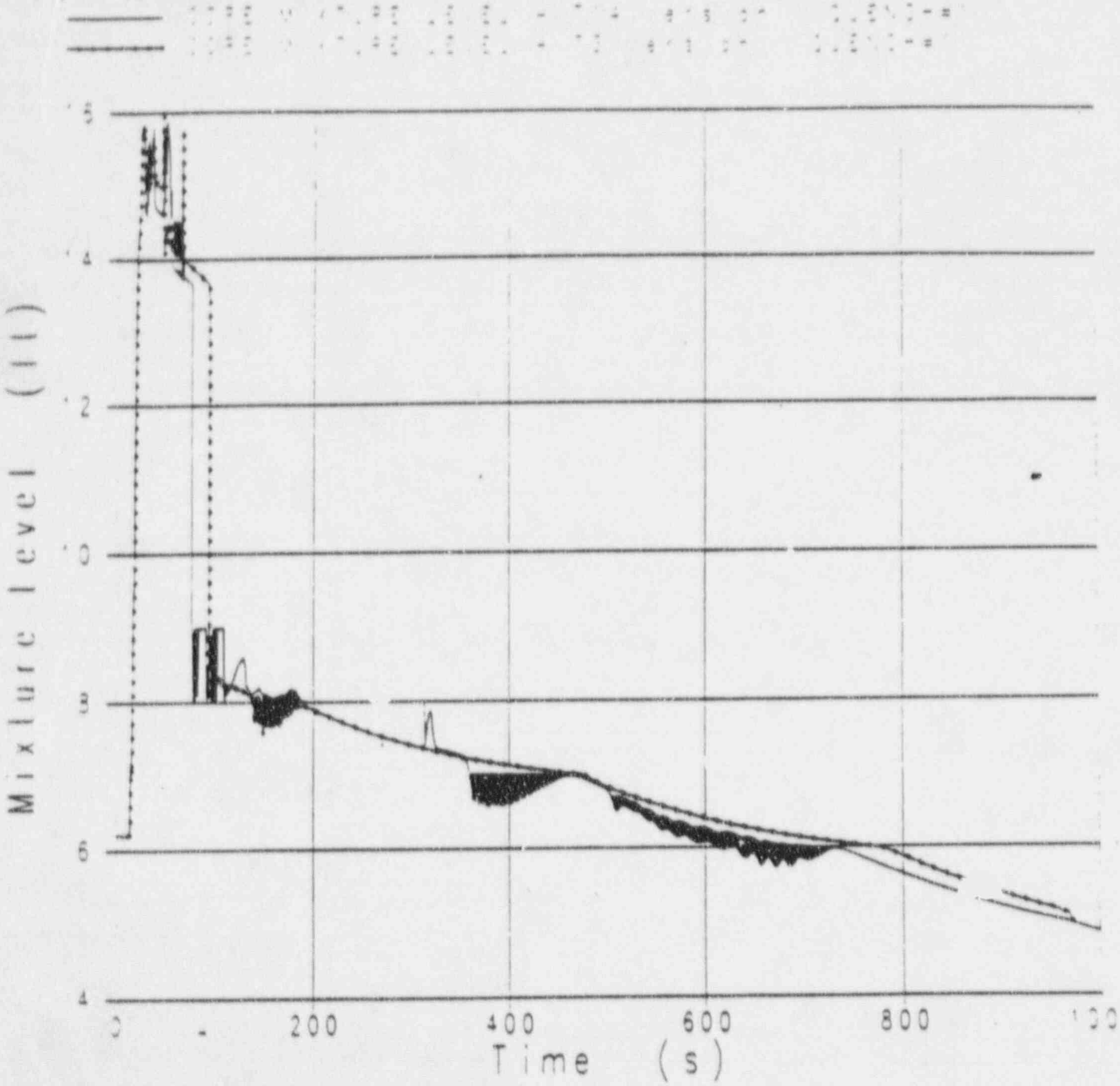

D-2 14-CORE NODE MODEL (RUN NUMBER 732) WITH LOW BAFFLE LEAKAGE AND SUBCOOLING
Mixture level (ft)
Time (s)
0
500
1000
1500
2000
2500
4
6
8
10
12
14
16

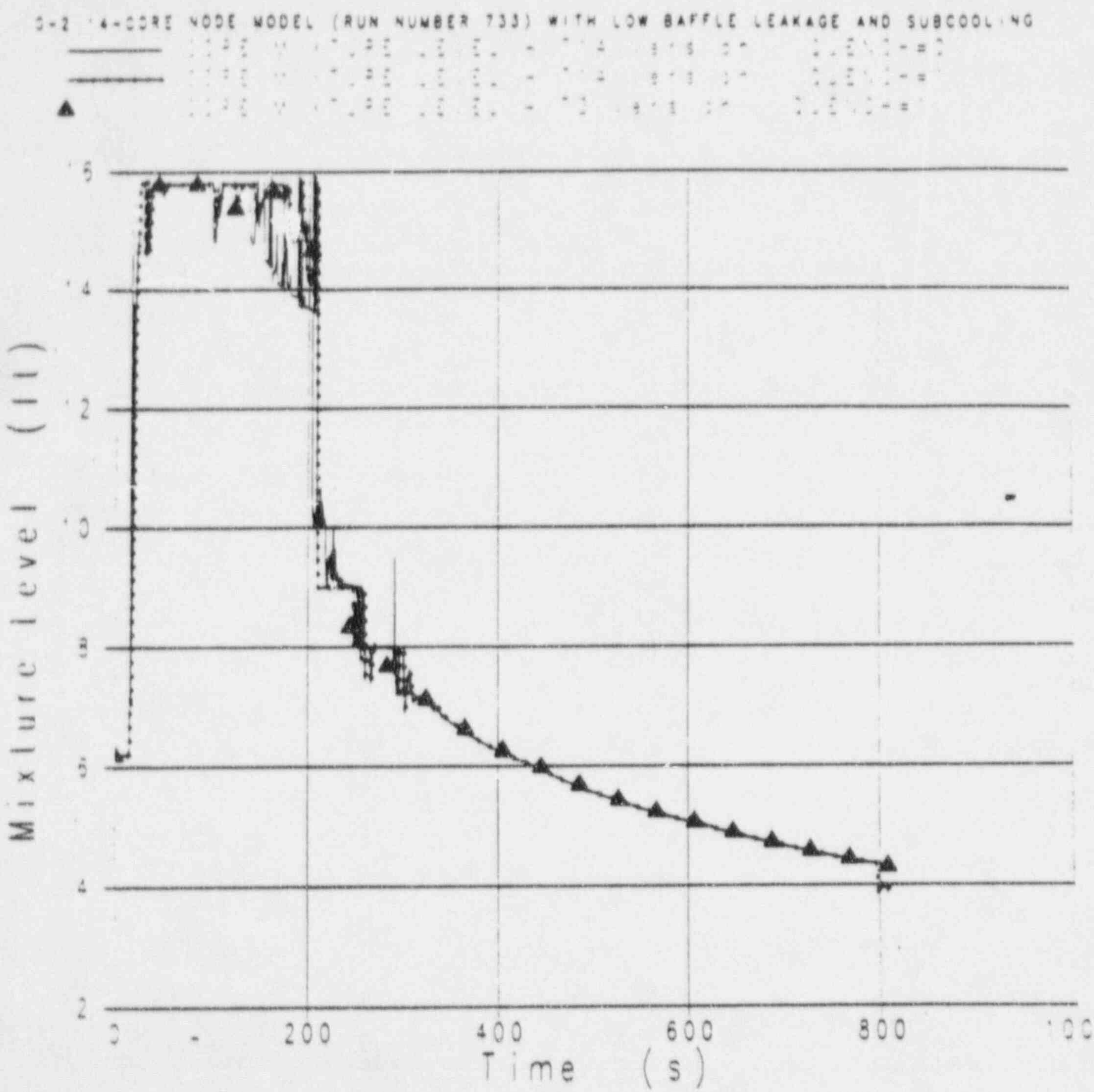

D-2 14-CORE NODE MODEL (RUN NUMBER 732) WITH HIGH BAFFLE LEAKAGE AND SUBCOOLING
Mixture level (ft)
Time (s)
4
6
8
10
12
14
16
18
0
500
1000
1500
2000
2500
3000

D-2 14-CORE NODE MODEL (RUN NUMBER 733) WITH BAFFLE LEAKAGE AND SUBCOOLING



D-2 14-CORE NODE MODEL (RUN NUMBER 733) WITH HIGH BAFFLE LEAKAGE AND SUBCOOLING




D-2 14-CORE NODE MODEL (RUN NUMBER 733) WITH LOW BAFFLE LEAKAGE AND SUBCOOLING
Mixture level (ft)
12
10
8
6
4
2
0
200
400
600
800
Time (s)

RESULTS OF USE OF QUENCH MODEL FOR G2 CALCULATIONS

- Most cases don't need quench model
- Quench model eliminates mixture level sp[illegible]
- Mixture levels trends similar with or without spikes

CONCLUSIONS

- o Demonstration of code prediction of level swell based on GE, ACHILLES, and G2
- o Report already indicates that G2 calculations have much uncertainty
- o Not planning to use quench model for plant design basic calculations since no uncovery in analyzed cases
- o Plan to
  1) Indicate in G2 section of report that quench model exists and which cases use it
  2) Include new plots for cases with quench model included in G2 section of report
  3) Include reference to T/H Uncertainty report for description of quench model

DISCUSSION OF ROADMAP

SDSER Confirmatory Item #	Description of Item	Reference Where Answered
DSER-CN 21.6.2.4-1	The application of SIMARC drift-flux is acceptable pending confirmation of the model through benchmark and assessment of code to be provided in NOTRUMP Final Validation Report (FVR).	The NOTRUMP FVR (WCAP-14807, Revision 1) has been submitted.
DSER-CN 21.6.2.4-2	The modifications made to the NOTRUMP drift-flux correlations are acceptable pending confirmation of the model through benchmark and assessment of code to be provided in NOTRUMP FVR.	The NOTRUMP FVR (WCAP-14807, Revision 1) has been submitted.
DSER-CN 21.6.2.4-3	Westinghouse needs to verify that the NOTRUMP code does not use the Bjornard and Griffith modification.	
DSER-CN 21.6.2.4-4	Westinghouse needs to verify that heat link methodology for transition boiling is not used in AP600 NOTRUMP calculations.	
DSER-CN 21.6.2.5-1	The acceptability of the PRHR model used in NOTRUMP is contingent on a finding that the PRHR data are applicable.	
DSER-CN 21.6.2.7-1	Comparisons of the NOTRUMP code simulations to the OSU and SPES-2 test data in the NOTRUMP FVR should confirm the applicability or insensitivity of the NOTRUMP flow regime models to the key system response parameters.	The NOTRUMP FVR (WCAP-14807, Revision 1) has been submitted.

SDSER Open Item #	Description of Item	Reference Where Answered
DSER-OI 21.6.2.2-1	Westinghouse needs to identify which information from the NOTRUMP-related RAI responses will be incorporated into NOTRUMP-related documentation.	This table identifies where RAI information is captured and closes the OI. Note that the NOTRUMP FVR is intended to be the only NOTRUMP related documentation summarizing the NOTRUMP code for use on AP600 plant calculations.
DSER-OI 21.6.2.2-2	Westinghouse needs to submit the NOTRUMP FVR.	The NOTRUMP FVR (WCAP-14807, Revision 1) has been submitted.
DSER-OI 21.6.2.4-1	Westinghouse needs to explain provisions to ensure that volumetric-based momentum equations will be used for all AP600 calculations.	
DSER-OI 21.6.2.4-2	Westinghouse needs to submit the assessment cases demonstrating acceptability of casting equations in net volumetric form.	The NOTRUMP FVR (WCAP-14807, Revision 1) has been submitted. Section 3.5 contains the assessment cases.
DSER-OI 21.6.2.4-3	Westinghouse needs to submit the assessment cases for the Horizontal Stratified Flow Model.	After the preliminary calculations, this model was no longer used. The preliminary calculations were redone without this model, and therefore the model description is not included in WCAP-14807. As a result, the assesments are not needed and not performed.
DSER-OI 21.6.2.4-4	Westinghouse needs to explain provisions to ensure that options to override the default flow partitioning will be used for all AP600 calculations.	
DSER-OI 21.6.2.4-5	Final acceptance of Mixture Overshoot Logic must await completion of benchmark and assessment calculations to be included in NOTRUMP FVR	The NOTRUMP FVR (WCAP-14807, Revision 1) has been submitted.
DSER-OI 21.6.2.4-6	Determination of additional (to G-2 tests) separate effects level swell tests necessary for code qualification.	Section 4 of WCAP-14807, Revision 1 contains GE and ACHILLES separate effect level swell test simulations in addition to G-2.
DSER-OI 21.6.2.4-7	Acceptance of modified pump model must await submittal of benchmark calculations.	Benchmark submitted in Section 3.7 of WCAP-14807, Revision 1
DSER-OI 21.6.2.4-8	Acceptance of implicit treatment of gravitational head await staff review of the benchmark calculations.	Benchmark submitted in Section 3.4 of WCAP-14807, Revision 1

DSER-OI 21.6.2.4-9	Acceptance of the horizontal flow levelizing model must await submittal and staff review of benchmark calculations.	Benchmark submitted in Section 3.3 of WCAP-14807, Revision 1
DSER-OI 21.6.2.4-10	The staff cannot determine the adequacy of the birthing logic until benchmark is submitted and reviewed.	After the preliminary calculations, this model was no longer used. The preliminary calculations were redone without this model for inclusion in WCAP-14807, Revision 1. As a result, no benchmark was performed and the staff does not need to review the birthing logic.
DSER-OI 21.6.2.4-11	Acceptance of the Zuber critical heat flux correlation for AP600 SBLOCA analysis will be determined after review of the NOTRUMP FVR.	The NOTRUMP FVR (WCAP-14807, Revision 1) has been submitted. Section 2.15 to be updated with [illegible]
DSER-OI 21.6.2.4-12	Acceptance of the smoothing logic between choked and unchoked flow must await submittal and review of the Final NOTRUMP Validation Report.	The NOTRUMP FVR (WCAP-14807, Revision 1) has been submitted.
DSER-OI 21.6.2.4-13	Acceptance of the logic schemes for application of fluid node stacking, mixture level overshoot, and bubble rise changes must await the submittal of the assessment cases in the NOTRUMP FVR.	The NOTRUMP FVR (WCAP-14807, Revision 1) has been submitted.
DSER-OI 21.6.2.5-1	The NOTRUMP code tended to overpredict the ADS flow rates in the preliminary OSU and SPES-2 comparisons. The models affecting the fluid entering the ADS piping, particularly for the hot legs and pressurizer, need to be reviewed in the NOTRUMP FVR.	The NOTRUMP FVR includes the OSU and SPES-2 simulations which were redone after the preliminary calculations. Included in the report are comparisons (test data to simulation) of ADS flows.
DSER-OI 21.6.2.5-2	CMT thermal stratification was not captured in the CMT tests. Westinghouse will further investigate inability to properly characterize CMT thermal stratification and these assessments will be provided in the NOTRUMP FVR.	Section 6 of the NOTRUMP FVR contains the CMT test simulations which were redone after the preliminary calculations.
DSER-OI 21.6.2.5-3	The staff must receive and evaluate the CMT and ADS test simulations that were identified in Table 21.7 of the SDSER.	Sections 5 and 6 of the NOTRUMP FVR contain these test simulations.

DSER-OI 21.6.2.6-1	The staff must receive and evaluate the benchmark calculations that were identified in Table 21.8 of the SDSER.	Section 3 of the NOTRUMP FVR contains these benchmarks with the exception of the Birthing Logic and Horizontal Stratified Flow ones which were not performed because the coding was not used in the NOTRUMP FVR calculations and will not be used in AP600 plant calculations.
DSER-OI 21.6.2.6-2	The staff must receive, review, and evaluate the adequacy of the separate-effects testing relative to level swell and void fraction distribution.	Section 4 of the NOTRUMP FVR contains the level swell related test simulations.
DSER-OI 21.6.2.6-3	The staff must receive and evaluate the integral test simulations that were identified in Table 21.10 of the SDSER.	Sections 7 and 8 of the NOTRUMP FVR contain the integral test simulations.
DSER-OI 21.6.2.7-1	Westinghouse needs to address PRHR primary-side heat transfer comparisons between NOTRUMP and OSU/SPES-2 data in the NOTRUMP FVR.	The comparisons for SPES-2 are contained in Section 7 of the NOTRUMP FVR. OSU comparisons were not included because comparable test data was not available.
DSER-OI 21.6.2.7-2	Effects of non-condensible gases on PRHR heat transfer should be addressed in NOTRUMP FVR.	
DSER-OI 21.6.2.7-3	Clarify the use of the COSI condensation model in the AP600 code.	

RAI #	Description of item	Reference Where Answered
RAI 440.325	Questions on NOTRUMP CAD (WCAP-14206) related to PIRT, NOTRUMP modeling of noncondensible gases, and NOTRUMP 1-D model.	Westinghouse Letter NTD-NRC-95-4594; WCAP-14807, Revision 1 Section 1.3 contains final SBLOCA PIRT.
RAI 440.326	Should include an AP600 plant nodalization and reference to SAR calculations.	Westinghouse Letter NTD-NRC-95-4587; WCAP-14807, Revision 1 Section 1.2 contains AP600 plant noding diagram.
RAI 440.327	Provide a matrix of tests that will be used for assessing each of the PIRT items. Also, identify the models that are to be validated for each test.	Westinghouse Letter NTD-NRC-95-4610; WCAP-14807, Revision 1 Section 1.4 contains table of tests and parameters selected for validation of NOTRUMP for highly ranked PIRT items.
RAI 440.328	Explain what analyses were performed to determine the limiting failure.	Westinghouse Letter NTD-NRC-95-4587
RAI 440.329	Describe the low flow correlations applicable to the prediction of the single and two-phase friction factors in NOTRUMP for AP600 and identify the test data that will be used for the assessment.	Westinghouse Letter NTD-NRC-95-4610
RAI 440.330	Describe the enhancements made to the NOTRUMP code for AP600.	Westinghouse Letter NTD-NRC-95-4587; WCAP-14807, Revision 1, Section 2 contains the NOTRUMP code changes for AP600 calculations.
RAI 440.331	Provide the specific inputs for the code externals used to perform the analyses in the SSAR calculations done in January 1994.	Westinghouse Letter NTD-NRC-96-4630
RAI 440.332	Provide a document describing the methods and models comprising the long term cooling code and describe how the code is initialized from the NOTRUMP code.	Westinghouse Letter NSD-NRC-96-4780
RAI 440.333	Justify the use of a fixed containment pressure boundary condition since the response of the safety systems depend on containment pressure.	Westinghouse Letter NSD-NRC-96-4780

RAI 440.334	Provide a test matrix showing the separate effects and integral tests to be used in the validation of NOTRUMP for AP600.	Westinghouse Letter NTD-NRC-95-4610: WCAP-14807, Revision 1, Section 1.4 contains table of tests and parameters selected for validation of NOTRUMP.
RAI 440.335	Justification for using constant friction factors, particularly at low flow, flow pressure conditions are needed.	
RAI 440.336	Describe if momentum flux is included in AP600 analyses and justify its omission if it is not used.	
RAI 440.337	Demonstrate that the Macbeth correlation is adequate for the low flow and pressure conditions expected for AP600.	
RAI 440.338	Demonstrate that the NOTRUMP pump model can predict the AP600 pump coastdown. Describe and justify the use of the two-phase pump degradation curves for AP600 analyses.	
RAI 440.339	Provide time step and nodalization studies to justify the AP600 nodalization.	
RAI 440.340	Discuss the potential for boric acid build-up and precipitation during long transients for AP600.	Westinghouse Letter NSD-NRC-96-4780
RAI 440.341	Describe in detail the IRWST model including how the sparger and plumes are handled as well as their influence on IRWST injection and PRHR heat removal.	Westinghouse Letter NTD-NRC-95-4587
RAI 440.342	Provide documentation for a) NOTRUMP coding changes along with model benchmarks, b) a description of the containment modeling approach with calculations justifying model, c) a description of the "Long Term Cooling Code", d) a section presenting calculative methods including sensitivity studies and the full break spectrum analysis, and e) a test matrix listing the pertinent separate and integral tests used to benchmark the AP600 small break LOCA code package.	
RAI 440.432	Identify where choking occurs in the ADS tests and discuss why the asymetric effects can be ignored in modeling the three ADS valves as a single flow path.	Westinghouse Letter NTD-NRC-95-4610

RAI 440.433	Explain the effect of not modeling air in the ADS lines on the ADS system pressure, flow, and quality responses.	Westinghouse Letter NTD-NRC-95-4610
RAI 440.434	Demonstrate the ability of the NOTRUMP code to accomodate single phase steam critical flow since the ADS system is expected to transition to high quality steam flow discharge.	
RAI 440.435	Questions related to ADS modeling including explain how NOTRUMP treats the void distribution and release of steam from the two-phase regions in the ADS lines.	Westinghouse Letter NTD-NRC-95-4594
RAI 440.436	Explain how NOTRUMP uses equation 4-1 of RCS-GSR-003 in computations of fluid quality.	Westinghouse Letter NTD-NRC-95-4598
RAI 440.437	Questions on ADS test simulation depressurization rates and length of test simulations.	Westinghouse Letter NTD-NRC-95-4594
RAI 440.438	Explain the inconsistency in the discussion of the effect of tank pressure on quality in the ADS Preliminary Validation Report.	Westinghouse Letter NTD-NRC-95-4587
RAI 440.439	Has the NOTRUMP code been assessed against single-phase and two-phase pressure drop test data in piping systems with expansions and contractions present?	Westinghouse Letter NTD-NRC-95-4610
RAI 440.440	Provide the results of a noding study used to justify the CMT noding in the CMT Preliminary Validation Report. Also, provide the plots of the fluid driving heads calculated by NOTRUMP for each side of the loop.	Westinghouse Letter NTD-NRC-96-4622
RAI 440.441	Were wall temperatures measured in the facility in the CMT and piping? If so, provide comparisons with the NOTRUMP code and discuss the results.	
RAI 440.442	Were wall heat structures modeled in the piping and reservoir? If not, justify the omission; if so describe the model.	
RAI 440.443	Justify the reservoir nodalization and explain the effects of thermal stratification and mixing, or lack thereof, in the S/W reservoir on the NOTRUMP results.	

RAI 440.444	Was a time step study performed for the CMT tests? Discuss and show that the time steps used do not contribute to the error in the NOTRUMP predictions. Are the time steps consistent with those used in the plant model?	
RAI 440.445	The early CMT flow rates appear to be overpredicted even though the time averaged flows show good comparisons. Discuss the NOTRUMP behavior given that the early overprediction of flow may affect the RCS loop temperatures and system behavior later in the event.	Westinghouse Letter NTD-NRC-96-4626
RAI 440.446	Explain why the CMT inlet flow uncertainty is higher than the outlet flow uncertainty measurement for the test. Explain this uncertainty in light of the NOTRUMP inlet flow rate predictions.	
RAI 440.463	Justify use of single node for SG secondary side.	Westinghouse Letter NTD-NRC-95-4587
RAI 440.464	Perform two-phase level swell simulations to justify core noding.	WCAP-14807, Revision 1 Section 4 for level swell, Sections 4.2.5 and 4.3.4 for noding
RAI 440.465	Justify omission of wall heat transfer from loop piping and secondary components.	Westinghouse Letter NTD-NRC-95-4594
RAI 440.466	For SIMARC drift flux model ... Please describe how the void fraction is computed for countercurrent flow conditions.	WCAP-14807, Revision 1 Section 2.2
RAI 440.467	Two drift flux models were added to NOTRUMP. Which model is to be used for AP600 calcs? Explain models.	Westinghouse Letter NTD-NRC-95-4587; WCAP-14807, Revision 1 Section 2.3
RAI 440.468	Provide benchmark calcs for level swell and counter current flow data to evaluate flooding.	WCAP-14807, Revision 1 Section 4 for level swell, Sections 3.2 & 3.3 for flooding
RAI 440.469	Provide volumetric flow based momentum equations and code benchmarks for this model change.	WCAP-14807, Revision 1 Section 2.4 for equations, Section 3.5 for benchmark
RAI 440.470	Questions on Horizontal Stratified Flow Model in preliminary NOTRUMP report LTCT-GSR-001	After the preliminary calculations, this model was no longer used. The preliminary calculations were redone without this model, and therefore the model description is not included in WCAP-14807. As a result, the RAI no longer applies.

RAI 440.471	Discuss the use of partitioning models for AP600 calculations and show that there use would not adversely affect the level swell results.	Westinghouse Letter NTD-NRC-95-4598
RAI 440.472	Please explain the liquid reflux flow links and how their use affects level swell, bubble rise, steam production, and fuel cooling.	Westinghouse Letter NTD-NRC-95-4594
RAI 440.473	Please explain how the mixture level overshoot logic does not introduce errors into the NOTRUMP solution that could change the results or conclusions of an AP600 analysis.	Westinghouse Letter NTD-NRC-95-4587; WCAP-14807, Revision 1 Section 2.8
RAI 440.474	Provide the derivations and the expressions for the equations comprising the implicit bubble rise model. Provide level swell calculations varifying this model.	WCAP-14807, Revision 1 Section 2.9 for equations, Section 3.6 for benchmark, Section 4 for level swell
RAI 440.475	Provide a mathematical description of modified pump model and comparison of the old to new model.	WCAP-14807, Revision 1 Section 2.10 for equations, Section 3.7 for comparison
RAI 440.476	Describe mathematically the implicit treatment of gravitational head and provide verification analysis.	WCAP-14807, Revision 1 Section 2.11 for equations, Section 3.4 for verification benchmark
RAI 440.477	Provide new levelizing drift velocity correlation and provide a benchmark for model.	WCAP-14807, Revision 1 Section 2.12 for correlation, Section 3.3 for benchmark
RAI 440.478	Provide a sample calculation showing how the birthing region works.	After the preliminary calculations, this model was no longer used. The preliminary calculations were redone without this model, and therefore the model description is not included in WCAP-14807. As a result, the RAI no longer applies.
RAI 440.479	Provide a comparison of the NOTRUMP Shah condensation model prediction to condensation test data demonstrating applicability of the model to the range of conditions expected in AP600.	Westinghouse Letter NTD-NRC-96-4626
RAI 440.480	Provide a comparison of the results of the as implemented Zuber critical heat flux correlation to test data over the range of conditions expected for AP600 small break LOCAs.	Westinghouse Letter NTD-NRC-96-4626

RAI 440.481	Provide comparisons of the new NOTRUMP two-phase friction multiplier to separate effects and/or integral test data below 250 psia to justify the new models extrapolation formulation.	Westinghouse Letter NTD-NRC-95-4598: WCAP-14807, Revision 1, Section 2.16
RAI 440.482	Provide benchmark of the new critical flow model versus critical flow tests to verify the model. Describe how the model treats the transition from choked to unchoked conditions.	Westinghouse Letter NTD-NRC-96-4630: WCAP-14807, Revision 1, Section 2.13 describes the transition from choked to unchoked conditions.
RAI 440.483	Provide results of a sample fill and drain calculation to demonstrate the Fluid Node Stacking Logic and provide a mathematical description of the logic.	WCAP-14807, Revision 1 Section 2.18 for description, Section 3.8 for demonstration
RAI 440.484	Show the effect of the changes to the transition boiling correlation on peak clad temperature.	Westinghouse Letter NTD-NRC-95-4594
RAI 440.485	Describe the coding and model changes included in the preliminary ADS test simulations and CMT test simulations	Westinghouse Letter NTD-NRC-96-4630: These simulations were redone and included in WCAP-14807, Revision 1
RAI 440.486	Explain why in the preliminary OSU simulations the upper head drains prematurely in the tests.	Westinghouse Letter NTD-NRC-95-4598: These simulations were redone and included in WCAP-14807, Revision 1
RAI 440.487	For the analyses in the OSU Preliminary Validation Report (PVR), provide comparisons of the NOTRUMP liquid levels in the core and upper plenum versus test data.	
RAI 440.488	Discuss the NOTRUMP overprediction of the integrated break flow for the OSU PVR calculation.	
RAI 440.489	Explain why the NOTRUMP code underpredicts the PRHR heat transfer in the OSU PVR and justify how this model results in conservative AP600 SBLOCA ECCS performance predictions.	
RAI 440.490	Explain why the NOTRUMP code overpredicts the downcomer liquid level during this OSU PVR calculation and justify the model result for AP600 plant calculations.	

RAI 440.491	Provide the core inlet and core bypass mass flow rate predictions for the NOTRUMP code.	
RAI 440.492	Provide the core inlet and bypass mass flow rate predictions for the blind two inch cold leg balance line break in the OSU PVR. Also provide the liquid level plots for the upper plenum and core region and the void distribution in the core region.	
RAI 440.493	Discuss the NOTRUMP fast depressurization rate for OSU PVR calculations including the break flow discharge coefficient and the steam generator heat transfer.	
RAI 440.494	Discuss the impact of the delayed CMT-2 drainage on the core/upper plenum level response for the OSU PVR calculation.	
RAI 440.495	Provide the upper plenum and core liquid level plots for this test along with the void distribution in the core.	
RAI 440.496	For this OSU PVR calculation explain why the code overpredicts the liquid inventory in the downcomer and justify that this will not lead to non-conservative predictions of the liquid level in the vessel for AP600 plant calculations.	
RAI 440.497	Explain the statement that the NOTRUMP code allows a "short spurt of flow at the break" in reference to Figure 5.3-22 of the OSU PVR.	
RAI 440.498	For this OSU PVR case, explain the reasons for the highly oscillatory behavior in the PRHR inlet flow calculated by NOTRUMP and why the code predicts a much higher PRHR flow rate.	
RAI 440.499	Can the NOTRUMP code model nitrogen entering the RCS? If not, justify the omission of nitrogen effects on AP600 response following small break LOCAs.	
RAI 440.500		
RAI 440.501		
RAI 440.502		
RAI 440.503		
RAI 440.504		

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RAI 440.505		
RAI 440.506		
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