Westinghouse Electric Corporation
Energy Systems

Box 355
Pittsburgh Pennsylvania 15230-0355

AW-94-593

February 22, 1994

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

ATTENTION: MR. R. W. BORCHARDT

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT: PRESENTATION MATERIALS FROM THE FEBRUARY 22, 1994 MEETING ON AP600 DESIGN CHANGES

Dear Mr. Borchardt:

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-94-593 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-94-593 and should be addressed to the undersigned.

Very truly yours,

N. J. Liparulo, Manager
Nuclear Safety And Regulatory Activities

/nja

cc: Kevin Bohrer NRC 12H5

1525A

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, Manager
Advanced Plant Safety & Licensing

Sworn to and subscribed
before me this 22 day
of February, 1994

Notary Public

Notarial Seal
Rose Marie Payne, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Nov. 4, 1996
Member, Pennsylvania Association of Notaries

(1) I am Manager, Advanced Plant Safety and Licensing, in the Advanced Technology Business Area, 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 NTD-NRC-94-4066, February 22, 1994, being transmitted by Westinghouse Electric Corporation (W) letter and Application for Withholding Proprietary Information from Public Disclosure, N. J. Liparulo (W), to Mr. R. W. Borchardt, 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.

WESTINGHOUSE ELECTRIC CORPORATION

PRESENTATION
TO
UNITED STATES
NUCLEAR REGULATORY COMMISSION

AP600 Design Changes

MONROEVILLE, PA
FEBRUARY 22, 1994

AGENDA

WESTINGHOUSE/NRC MEETING
AP600 DESIGN CHANGES

8:30	INTRODUCTION	J. Butler
8:45	DESIGN CHANGES	T. Schulz
10:45	PRA EVALUATION	T. Schulz
	LUNCH	
12:30	SAFETY ANALYSIS EVALUATIONS	R. Kemper
	• STEAMLINE BREAK	P. Rosenthal
	• STEAM GENERATOR TUBE RUPTURE	U. Bachrach
	• LOCA	R. Kemper
2:30	TEST PROGRAM IMPACT	
	• DESIGN CERTIFICATION TESTING	E. Piplica
	• OTHER TESTS	T. Schulz
4:00	DISCUSSION, MEETING WRAP-UP, ACTION ITEMS	All

INTRODUCTION

J. C. BUTLER
ADVANCED PLANT SAFETY AND LICENSING

INTRODUCTION

- While no changes to the AP600 design (as defined in SSAR) is preferred, some design changes are to be expected

- These changes could arise as a result of:

  - Test program results
  - Resolution of NRC review issues
  - Resolution of Industry issues

- All potential changes undergo a rigorous program review and must receive approval by the AP600 Configuration Control Board (CCB)

- The impact of potential design changes on the design certification review is minimized by prudent review of program impacts and early involvement with NRC

INTRODUCTION

- The AP600 design changes were introduced at a Senior Management meeting on December 22, 1993
- Changes to the ADS Phase B Test Program were discussed with NRC staff on January 25, 1994
- A letter report discussing each change was provided to NRC staff on February 15, 1994
- The purposes of today's meeting are to:
  - continue discussions of AP600 design changes and
  - obtain feedback from NRC staff, including identification of any outstanding issues or concerns

DESIGN CHANGES

T. L. SCHULZ
SYSTEMS ENGINEERING
FEBRUARY 22, 1994

AP600 ADS / CMT CHANGES

- **CMT Changes**
  - Logic Changes
    (PRHR Heat Exchanger, Pressurizer Heater, CVS, ADS)
  - CMT Inlet Diffuser
  - DVI Nozzle Venturi

- **PRHR Heat Exchanger Changes**
  - Inlet Valve Arrangement

- **ADS Changes**
  - Stage 1 Characteristics
  - Stage 2/3 Valve Type/Characteristics
  - Stage 4 Configuration/Type/Characteristics

PRHR HEAT EXCHANGER ACTUATION CHANGE

- **Change**
  - SSAR: actuate on high pressurizer level or high SG level
  - Revised: actuate on CMT actuation

- **Purpose**
  - Increases margin to ADS during SGTR
    - DBA assumptions
  - Increases margin to pressurizer overfill
    - No operator action required on best estimate basis
    - Other changes being investigated to provide additional margin

PRHR HEAT EXCHANGER ACTUATION LOGIC

DESCRIPTION	SIGNAL	SETPOINT
PRHR Heat Exchanger Actuation (via PMS)	- Low SG narrow range level in any SG + low SFW flow after time delay	per SSAR (165 gpm, 60 sec)
	- Low SG WR level in any SG	per SSAR
	- CMT actuation	NA
	- ADS actuation	NA

PRHR HEAT EXCHANGER ACTUATION CHANGE

- **Impacts**

  Safety Analyses

  - SSAR analysis of SGTR shows no ADS actuation
    - SGTR was re-analyzed
    - Margin to ADS actuation significantly increased

  - SSAR analysis of some Non-LOCA shows potential for long term pressurizer overfill
    - Operator action assumed in SSAR
    - Change in PRHR heat exchanger logic prevents pressurizer overfill on best estimate basis

PRHR HEAT EXCHANGER ACTUATION CHANGE

- **Impacts** (continued)

  PRA

  - Minor impact on reliability of isolating PRHR heat exchanger after PRHR heat exchanger tube rupture
  - Isolation reliability limited by I&C common mode failure and operator failures

PRHR HX ACTUATION CHANGE

- **Impacts** (continued)

  Test Program

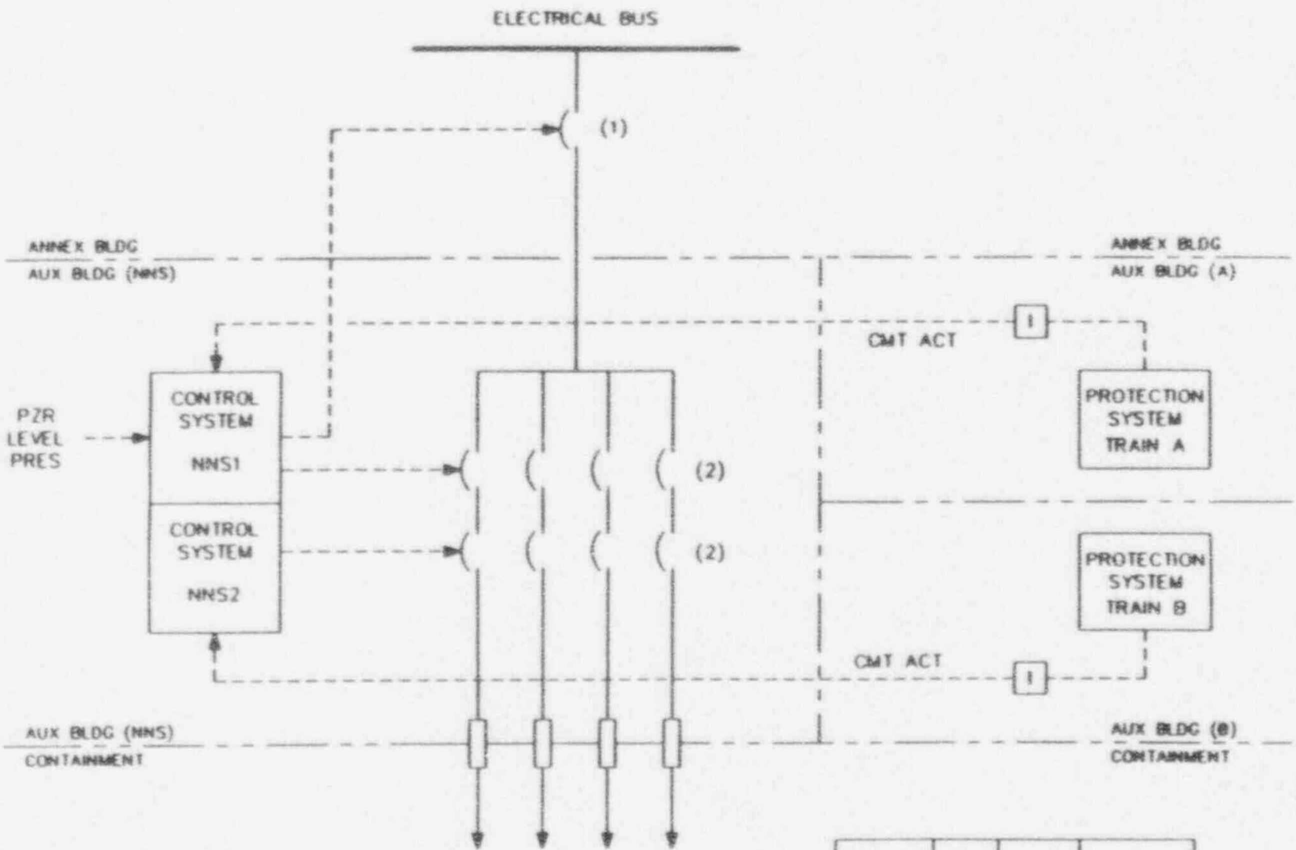
  - CMT Separate Effect Test
    - No impact on range of parameters to be tested
  - ADS Phase B Test
    - No impact on range of parameters to be tested
  - SPES-2 Test
    - Minor impact on control logic
    - Will be incorporated for all matrix tests
  - OSU Test
    - Minor impact on control logic
    - Will be incorporated for all tests

PRESSURIZER HEATER LOGIC CHANGE

- **Change**
  - SSAR: no block on CMT actuation
  - Revised: block pressurizer heater operation on CMT actuation
    - Nonsafety related automatic block (3 way redundant)
    - Local manual block provides backup

- **Purpose**
  - Increases margin to ADS and SG overfill during SGTR and pressurizer overfill during non-LOCAs
    - No operator action required on best estimate basis
    - With DBA assumptions, auto heater block can fail
      - Long term heater operation be blocked
      - Operators can open breakers locally

PRESSURIZER HEATER BREAKER ARRANGEMENT



Breaker	Size	Class	Number
(1)	300	NNS	5
(2)	50	NNS	52

NOTE: This figure illustrates one of five groups of Pzr heaters.

PRESSURIZER HEATER LOGIC CHANGE

- **Impacts**

  <u>Safety Analysis</u>

  - SSAR analysis of SGTR and non-LOCA does not include pressurizer heater operation
  - Operators have long time to open breakers, if required

  <u>PRA</u>

  - No impact
    - Pressurizer heaters not modeled
    - Pressurizer heater operation does not affect success criteria

PRESSURIZER HEATER LOGIC CHANGE

- **Impacts** (continued)

Testing Program

- CMT Separate Effect Test
  - No impact on range of parameters to be tested
- ADS Phase B Test
  - No impact on range of parameters to be tested
- SPES-2 Test
  - Minor impact on control logic
  - Will be incorporated for all matrix tests
- OSU Test
  - Minor impact on control logic
  - Will be incorporated for all tests

CVS MAKEUP LOGIC CHANGE

- **Change**
  - SSAR: both CVS pumps start on CMT actuation
  - Revised: one CVS pump starts/stops on pressurizer level
    - Post CMT actuation setpoints
    - Maximum CVS makeup flow
    - Nonsafety related logic
- **Purpose**
  - Increases margin to pressurizer overfill during non-LOCAs
    - No operator action required on best estimate basis

CVS MAKEUP LOGIC

DESCRIPTION	SIGNAL	SETPOINT
Normal RCS Makeup (1) (via PLS)	Low pressurizer level relative to programmed level starts makeup; higher level stops makeup	start - 0% (1) stop - 18% (1)
Post CMT Actuation RCS Makeup (2) (via PLS)	CMT actuation + low pressurizer level starts makeup, higher level stops makeup	start - 10% level stop - 20% level

Notes:

(1) One CVS pump starts with suction from boric acid and makeup water blended to match RCS boron concentration. Flow is controlled to a fixed flowrate, at [TBD] gpm. Start / stop pressurizer levels (percent of level span) are relative to programmed level.

(2) One CVS pump starts with suction from boric acid tank. Flowrate is not controlled; valve will be full open to provide maximum flow. Start / stop pressurizer levels are absolute values (percent of level span).

CVS MAKEUP LOGIC CHANGE

- **Impacts**

  Safety Analysis

  - SSAR SGTR and non-LOCA analysis includes maximum CVS makeup from both pumps where conservative
  - Re-analysis also includes maximum CVS makeup from both pumps where conservative

  PRA

  - Minor impact on CVS reliability
    - Operators can start second pump
    - I&C common mode failure of PMS/PLS is limiting

CVS MAKEUP LOGIC CHANGE

- **Impacts** (continued)

  Testing Program

  - CMT Separate Effect Test
    - No impact on range of parameters to be tested
  - ADS Phase B Test
    - No impact on range of parameters to be tested
  - SPES-2 Test
    - Minor impact on CVS makeup logic
    - Will be incorporated for appropriate tests
  - OSU Test
    - Minor impact on CVS makeup logic
    - Will be incorporated for appropriate tests

ADS STAGE 1 SETPOINT CHANGE

- **Change**
  - SSAR: CMT level 1500 ft3
  - Revised: CMT level 1350 ft3

- **Purpose**
  - Increases margin to ADS during SGTR and steam line breaks

ADS STAGE 1 SETPOINT CHANGE

- **Impacts**

  Safety Analysis

  - SSAR SGTR and SLB analysis does not maximize potential for ADS
  - Re-analysis includes more limiting assumptions
    - Change increases margin to ADS
  - LOCA impact evaluated
    - Limiting LOCA is DVI break
    - Re-analyzed with good results

  PRA

  - No impact, does not affect ADS success criteria

ADS STAGE 1 SETPOINT CHANGE

- **Impacts** (continued)

  <u>Testing Program</u>

  - CMT Separate Effect Tests, ADS Phase B Tests
    - No impact on range of parameters to be tested
  - SPES-2 Tests
    - Minor impact on control setpoints
    - Will be incorporated for all matrix tests
  - OSU Tests
    - Minor impact on control setpoints
    - Will be incorporated for all tests

ADS STAGE 2 / 3 ACTUATION CHANGE

- **Change**

  - SSAR: actuates on CMT level

  - Revised: actuates on ADS stage 1 plus timers

- **Purpose**

  - Removes dependance on CMT level for ADS stage 2 / 3
    - CMT level measurement difficult for stage 2 / 3
    - CMT can be hot -> flashing

  - CMT level measurement used for ADS stage 1 / 4
    - CMT level measurement not difficult for stage 1 / 4
    - CMT cold or constant pressure -> no flashing

ADS ACTUATION LOGIC

DESCRIPTION	SIGNAL	SETPOINT
First Stage ADS		
- First Stage Actuation, Isolation Valve Actuation	- CMT actuation signal + Low-1 CMT level in either CMT	67% CMT volume
- First Stage Control Valve Actuation	- 1st Stage actuation + time delay	20 sec delay
Second Stage ADS		
- Second Stage Actuation, Isolation Valve Actuation	- 1st Stage actuation + time delay	60 sec delay
- Second Stage Control Valve Actuation	- 2nd Stage actuation + time delay	30 sec delay
Third Stage ADS		
- Third Stage Actuation, Isolation Valve Actuation	- 2nd Stage actuation + time delay	120 sec delay
- Third Stage Control Valve Actuation	- 3rd Stage actuation + time delay	30 sec delay
Fourth Stage ADS		
- Fourth Stage A Actuation, Isolation Valve Actuation	- 3rd Stage actuation + time delay + low-2 CMT level in either CMT	120 sec delay 20% CMT vol.
- Fourth Stage A Control Valve Actuation	- 4th Stage A actuation + time delay	30 sec delay
- Fourth Stage B Actuation, Isolation Valve Actuation	- 4th Stage A actuation + time delay	30 sec delay
- Fourth Stage B Control Valve Actuation	- 4th Stage B actuation + time delay	30 sec delay

ADS STAGE 2 / 3 ACTUATION CHANGE

- **Impacts**

  Safety Analysis

  - Only impacts accidents where ADS occurs -> LOCAs
  - Spurious ADS and DVI line break were re-analyzed
    - Improved performance compared to SSAR

  PRA

  - No impact
  - Does not affect modeling of ADS

ADS STAGE 2 / 3 ACTUATION CHANGE

- **Impacts** (continued)

  Test Program

  - CMT Separate Effect Tests
    - No impact on range of parameters to be tested
  - ADS Phase B Tests
    - No impact on range of parameters to be tested
  - SPES-2 Tests
    - Minor impact on control logic
    - Will be incorporated for all matrix tests
  - OSU Tests
    - Minor impact on control logic
    - Will be incorporated for all tests

CMT INLET DIFFUSER CHANGE

- **Change**
  - SSAR: CMT did not have inlet diffuser
  - Revised: inlet diffuser is added to CMT
    - Extension of inlet pipe, end capped
- **Purpose**
  - CMT tests showed rapid steam condensation
    - Occurred with cold CMT and high steam flows
    - Only impacts larger LOCAs ($\geq$DVI break)
    - Period of reduced CMT injection and pressure spikes
  - Improve CMT performance
    - CMT tests show diffuser improves performance

CMT INLET DIFFUSER

(a,c)

CMT INLET DIFFUSER CHANGE

- **Impacts**

  <u>Safety Analysis</u>

  - Only impacts larger LOCAs
  - DVI break re-analyzed
    - Larger 1st CMT node simulated larger mixing volume
    - Analysis with this and other changes show improved performance to SSAR

  <u>PRA</u>

  - No impact
  - System modeling and success criteria unchanged

CMT INLET DIFFUSER CHANGE

- **Impacts** (continued)

  Test Program

  - CMT Separate Effect Tests, SPES-2 Tests, OSU tests Tests
    - No additional impact, diffuser already incorporated
  - ADS Phase B Test
    - No impact on range of parameters to be tested

DVI NOZZLE VENTURI CHANGE

- **Change**
  - SSAR: DVI nozzle has no venturi
  - Revised: DVI nozzle has venturi
- **Purpose**
  - Improves DVI LOCA performance
  - No change in injection capability
    - Very small L/D
    - CMT and accumulator have adjustable orifices

DVI NOZZLE VENTURI

(a,c)

DVI NOZZLE VENTURI CHANGE

- **Impacts**

  Safety Analysis

  - Only impacts DVI LOCAs
    - No change in injection capability
  - DVI LOCA was re-analyzed (with other changes)
    - Limiting event; 1 CMT, accumulator, IRWST line spill
    - SSAR analysis shows brief core uncovery
    - Re-analysis (with other changes) shows no core uncovery

  PRA

  - No impact
  - System modeling and success criteria unchanged

DVI NOZZLE VENTURI CHANGE

- **Impacts** (continued)

  Test Program

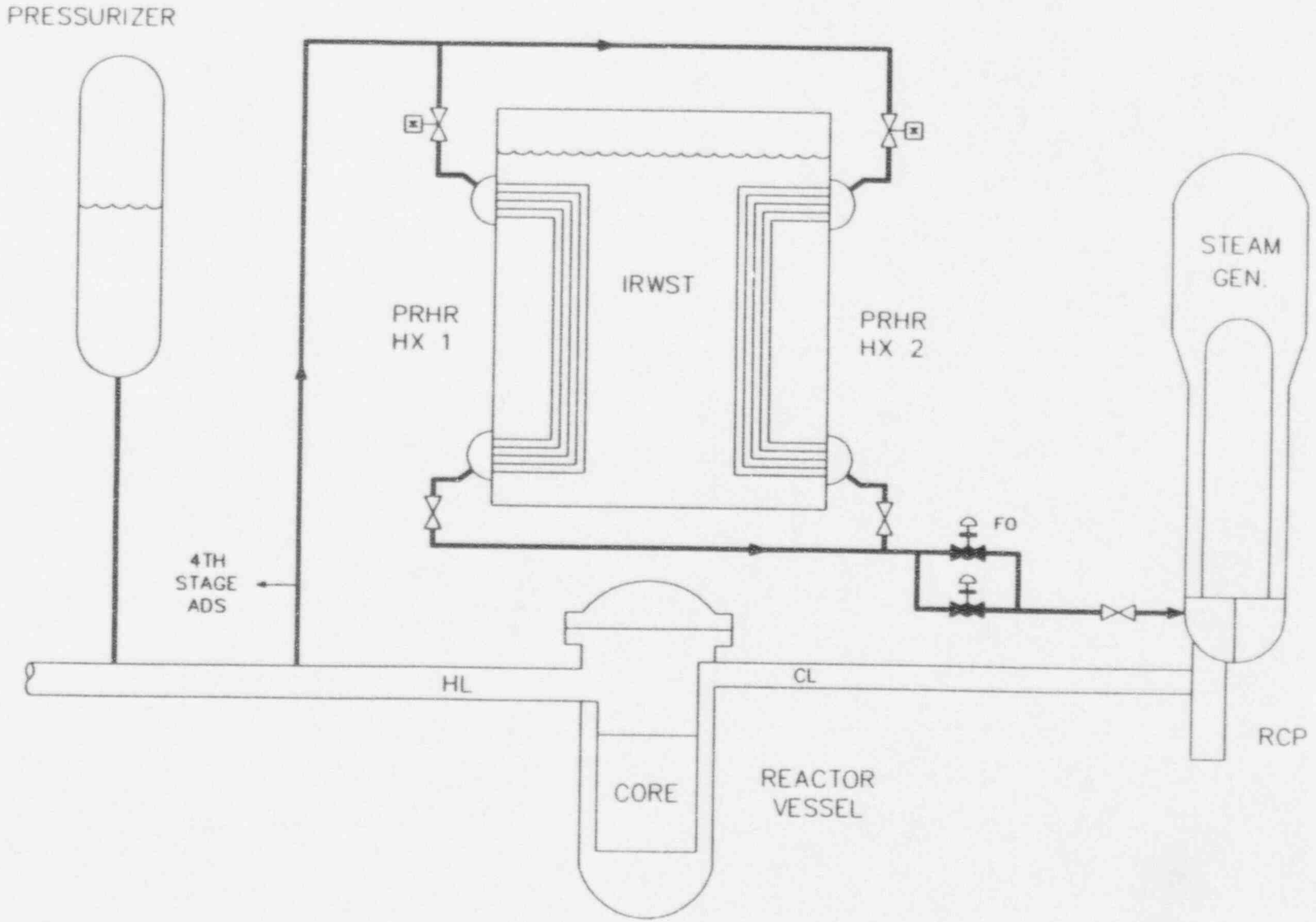
  - CMT Separate Effect Tests
    - No impact on range of parameters to be tested
  - ADS Phase B Tests
    - No impact on range of parameters to be tested
  - SPES-2 Tests
    - Will be incorporated in DVI test
  - OSU Tests
    - Will be incorporated in DVI test

PRHR HEAT EXCHANGER INLET VALVE CHANGE

- **Change**
  - SSAR: inlet to PRHR HX has common MOV and individual manual valves
  - Revised: inlet to PRHR HX has individual MOVs
    - Power removal not normally required

- **Purpose**
  - Improves reliability of PRHR heat exchanger
    - Chance of blocking both heat exchangers reduced, no common valve
  - Reduces chance of violating PRHR heat exchanger tech spec
    - During IST of PRHR heat exchanger outlet control valves, inlet MOV closed
    - SSAR design; failure of 1 valve causes plant shutdown
    - Revised design; 2 failures needed to cause plant shutdown

PRHR HEAT EXCHANGER SYSTEM SKETCH



PRHR HEAT EXCHANGER VALVE CHANGE

- **Impacts**

Safety Analysis

- No impact
  - No change to limiting single failure
  - System performance unaffected

PRA

- No impact on PRHR heat exchanger reliability
  - Inlet valves not modeled (normally open, position alarms, ..)

- Small impact on PRHR heat exchanger isolation reliability
  - Have to close two MOV instead of 1 MOV
  - Limiting failures are I&C common mode failure and operator action

PRHR HEAT EXCHANGER VALVE CHANGE

- **Impacts** (continued)

  Test Program

  - CMT Separate Effect Tests
    - No impact on range of parameters to be tested
  - ADS Phase B Tests
    - No impact on range of parameters to be tested
  - SPES-2 Tests
    - No impact, PRHR HX performance unaffected
  - OSU Tests
    - No impact, PRHR HX performance unaffected

ADS VALVE CHANGES

- **Change**

  - SSAR:

ADS stage 1
ADS stage 2/3
ADS stage 4

(a,c)

  - Revised:

ADS stage 1
ADS stage 2/3
ADS stage 4

REVISED ADS DESIGN

(a,c)

ADS STAGE 1/2/3 EXAMPLES

(a,c)

ADS STAGE 4 EXAMPLES

(a,c)

ADS VALVE CHANGES

- **Purpose**
  - Addresses industry problems with MO gate valves
    - NRC concerns on AP600 ADS
    - Utility concerns on AP600 ADS
  - Allows for flexibility in selecting ADS valve type
    - Accommodates changing valve technology
  - Improves design margin
    - Limiting single failure is smaller valve
    - More flow area provided, especially 4th stage

ADS VALVE CHANGES

- **Impacts**

  Safety Analysis

  - Only affects accidents with ADS -> LOCAs
  - Spurious ADS and DVI line break were re-analyzed
    - Improved performance compared to SSAR

  PRA

  - Sensitivity study performed
  - Two different examples evaluated
  - Insignificant change in CDF

ADS VALVE CHANGES

- **Impacts** (continued)

  Test Program

  - CMT Separate Effect Tests
    - No impact on range of parameters to be tested
  - ADS Phase B Tests
    - Reconfigured as "systems" test
    - Use different size orifice/nozzles to simulate range of valves
  - SPES-2 Tests
    - Orifices simulating ADS valves will be re-sized
    - 4th stage discharge will be headered together
  - OSU Tests
    - Orifices simulating ADS valves will be re-sized
    - 4th stage discharge will be changed

PRA IMPACT OF ADS CHANGES

T. L. SCHULZ
SYSTEMS ENGINEERING
FEBRUARY 22, 1994

PRA IMPACT OF ADS CHANGES

- **PRA Importance of ADS**
  - Inspection of dominant cutsets shows
    - Many contain ADS failures
    - Most failures are of actuation; I&C, operator
    - First cutset with valve failure is #135 (2.15E-10/yr)

- **ADS Sensitivity Study**
  - Study was performed to quantify impact of ADS changes
  - Two different ADS designs were evaluated
    - See examples shown in change description
    - Success criteria was revised
  - Four fault trees were re-quantified
    - Important to PRHR HX tube rupture
    - First cutsets with ADS hardware failures
    - Full depressurization, auto/manual actuation

PRA IMPACT OF ADS CHANGES

- **Revised ADS Success Criteria**

  - AP600 ADS design has multiple failure capability
    - Can tolerate complete failure of stages 1/2/3 or 4

  - Smaller stage 2/3 reduces reliability
    - Success was 3 of 4 stage 2/3 paths
    - Success is now 4 of 4 stage 2/3 paths

  - More stage 4 paths improves reliability
    - Success was 1 of 2 stage 4 paths
    - Success is now 2 of 4 stage 4 paths

- **Added Pressure Interlock to 4th Stage**

  - SSAR design assumed 4th stage valves could be designed so they could not physically open at normal RCS pressures

  - Revised ADS design uses interlock with RCS pressure
    - Modeled in PRA sensitivity studies

PRA IMPACT OF ADS CHANGES

- **ADS Sensitivity Study Results**

	SSAR	EXAMPLE 1	EXAMPLE 2
ADS Stage 2/3	MO gate	MO globe	MO globe
ADS Stage 4	AO gate	AO gate	squib
Fault Tree ADN	2.77E-3	2.77E-3	2.77E-3
Fault Tree ADC	3.32E-3	3.32E-3	3.32E-3
Fault Tree ADS	2.91E-5	4.86E-5	4.93E-5
Fault Tree ADA	5.79E-4	6.09E-4	6.09E-4

- **Change in AP600 CDF is Insignificant**
  - ADS mechanical failures account for CDF of 1.4E-9/yr (.4% of total)

SAFETY ANALYSIS EVALUATIONS

R. M. KEMPER
ADVANCED AND VVER PLANT SAFETY ANALYSIS

AP600 SSAR Chapter 15 Accident Analyses

- Condition II / III / IV Design Basis Events
- Deterministic Analyses
- Standard LOCA, non-LOCA Analysis Computer Codes Utilized

SAFETY ANALYSIS EVALUATIONS

- The SSAR Chapter 15 Analyses were evaluated in conjunction with the Passive Safeguards System Design Changes

- Selected events modeling affected systems were reanalyzed
  - Steamline break
  - Steam generator tube rupture
  - Small break LOCA (DVI line break, Inadvertant ADS)

SAFETY ANALYSIS EVALUATIONS

STEAMLINE BREAK

P. W. ROSENTHAL
ADVANCED AND VVER PLANT SAFETY ANALYSIS

STEAMLINE BREAK

- **Identified changes with potential impact**
  - Do changes affect modeled components or functions
- **PRHR HX actuation signal**
  - Delete high pressurizer & high SG level signals
  - Add signal on CMT actuation
- **ADS stage 1 actuation**
  - Reduce CMT level setpoint
  - In volume: from 1500 to 1350 ft^3 (CMT volume = 2000 ft^3)
- **CMT inlet diffuser - a new component**
- **DVI nozzle venturi - a new component**

STEAMLINE BREAK

- **PRHR heat exchanger actuation signal change**
  - Limiting steamline break cases
  - SG water level typically falls to <u>low</u> level setpoint
  - Pressurizer water level falls initially; restored by CMTs and/or accumulators
  - Conservative core response cases start PRHR at time zero - maximizes cooldown & negates design change effect on analysis

- **PRHR actuation change: no effect on limiting steamline break core response analysis**

STEAMLINE BREAK

- **ADS Stage 1 Actuation**

  - Initiating signal: CMT level
  - Design goal: no ADS actuation on any non-LOCA event (including Conditions 3 & 4)
  - Design requirement: no ADS actuation on any Condition 2 events
  - Examined spectrum of cases for ADS actuation; limiting case: concerns with modified SSAR case

    - Smaller break: 0.4 vs. 1.4 ft^2 in SSAR
    - Reduced condensation: 10% of SSAR
    - Reduced minimum CMT volume: 1590 vs. 1890 ft^3 in SSAR

- **1350 ft^3 setpoint provides additional margin to ADS actuation for non-LOCA events**

STEAMLINE BREAK

- **CMT inlet diffuser**

  - Based on pre-operational test data: diffuser does not affect CMT draindown behavior when steam is injecting from the pressurizer balance line
  - For limiting CMT drain down case, flow into CMT is steam via the pressurizer balance line
  - CMT inlet diffuser has no impact on limiting steamline break modeling

- **DVI Nozzle Venturi**

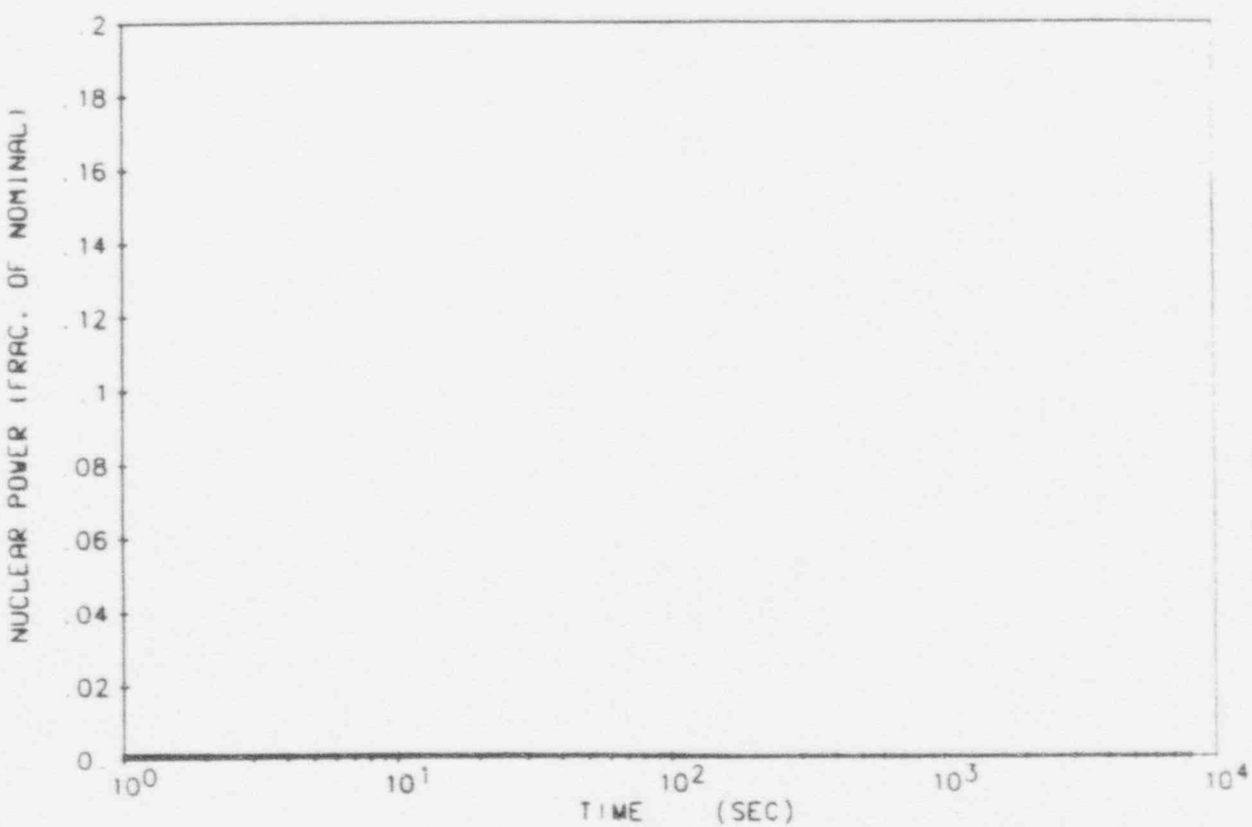
  - Mitigates DVI LOCA
  - Orifices in discharge lines allow adjustments; total resistance from CMTs and accumulators will not change due to DVI venturi
  - Steamline break analysis unaffected by venturi

Sequence of Events - Steamline Break with Offsite Power Available

Event	Time (Seconds)
0.4 ft^2 double-ended steamline rupture occurs	0
Reactor and turbine assumed tripped	0
PRHR heat exchanger assumed to actuate	0
Low steamline pressure SIS setpoint reached	2.5
Steamline isolation	14.5
Feedwater isolation	14.5
Reactor coolant pumps trip	17.5
CMT actuation	24.5
Startup feedwater isolated to all SGs	28.9
Accumulators actuate	1046
Faulted steam generator blowdown ends	~2600

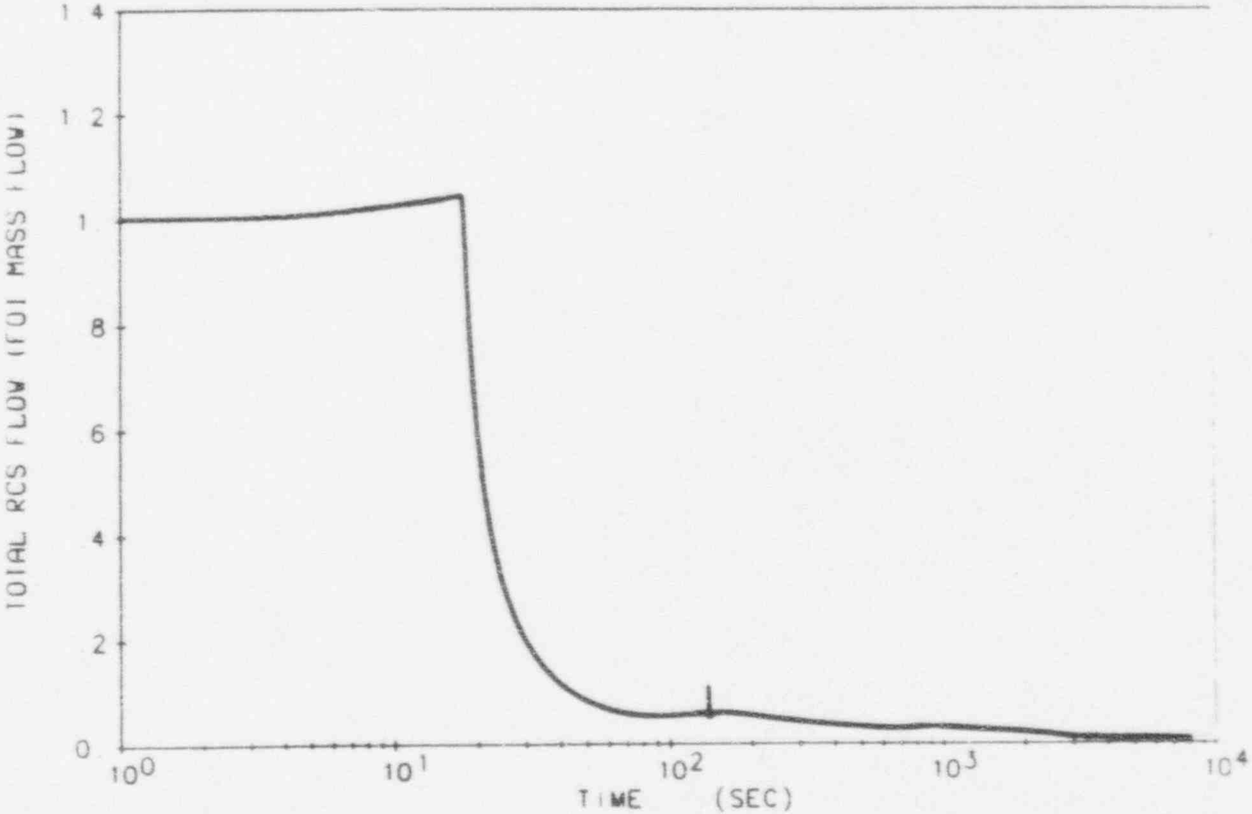
STEAMLINE BREAK

Nuclear Power Transient



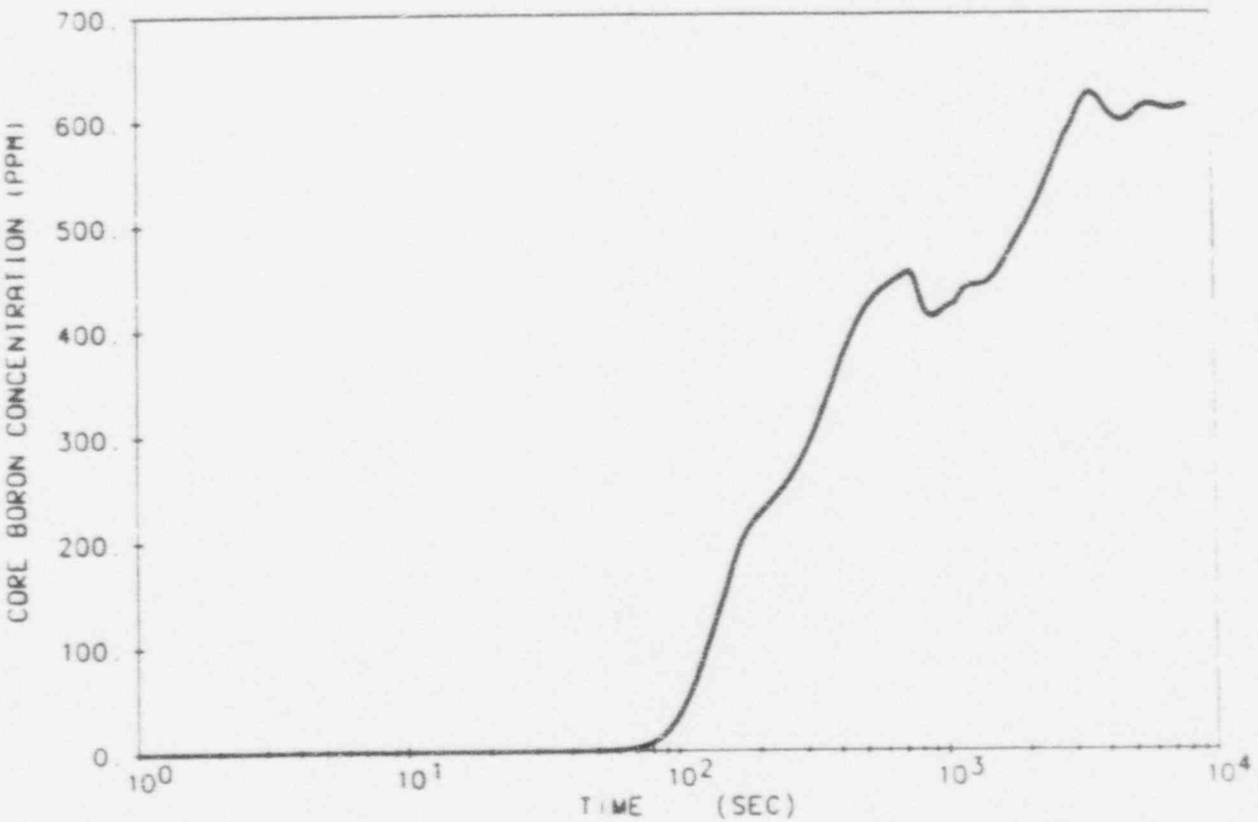
STEAMLINE BREAK

Core Flow Transient



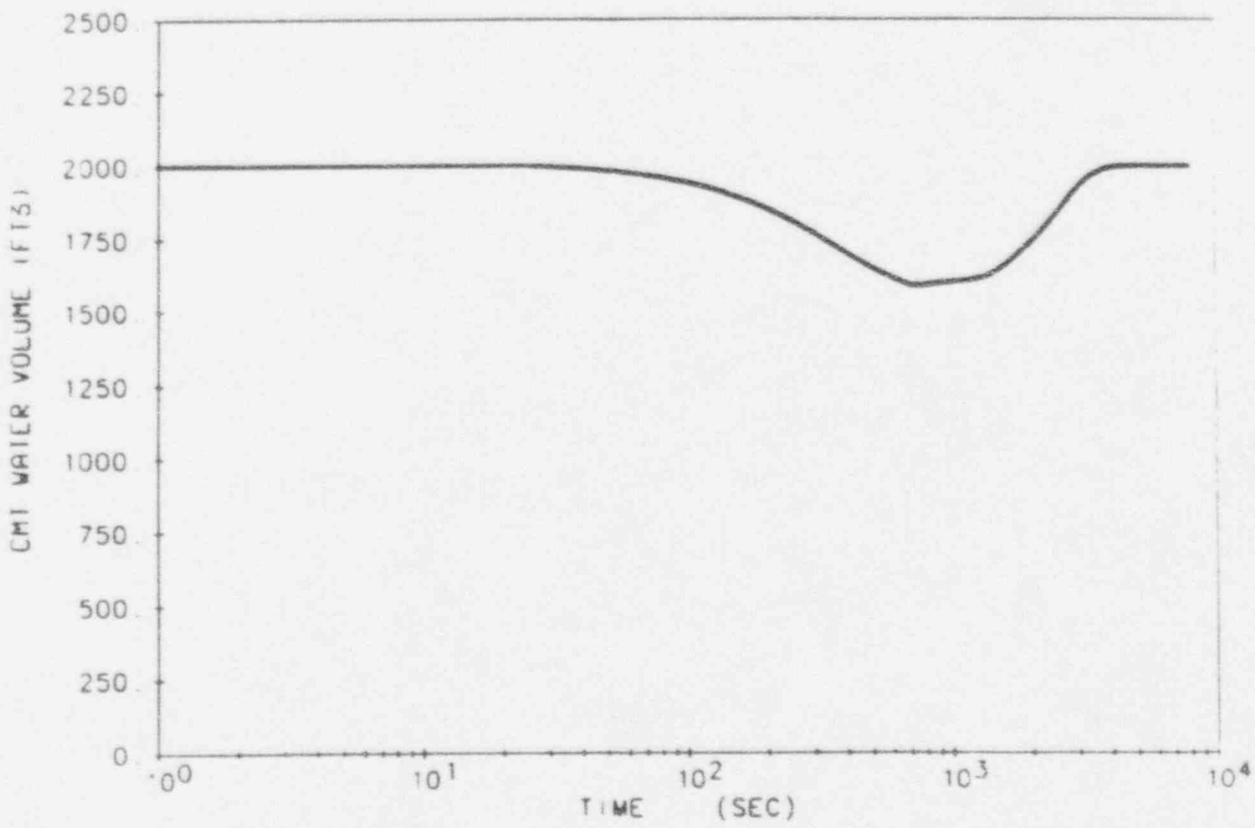
STEAMLINE BREAK

Core Boron Transient



STEAMLINE BREAK

Core Makeup Tank Water Volume



SAFETY ANALYSIS EVALUATIONS

STEAM GENERATOR TUBE RUPTURE

U. BACHRACH
ADVANCED AND VVER PLANT SAFETY ANALYSIS

STEAM GENERATOR TUBE RUPTURE

DESIGN CHANGES THAT IMPACT SGTR ANALYSIS

PRHR HX ACTUATION SIGNAL

- Assures PRHR Actuation For SGTR
- No Longer Dependant On SG Level
- Provides Benefit For Offsite Doses

AUTOMATIC PRESSURIZER HEATER BLOCK

- Facilitates Pressure Equalization between Primary And Secondary

CVS CONTROLS POST CMT ACTUATION

- Provides Benefit By Reducing Break Flow

ADS STAGE 1 ACTUATION

- Lower Setpoint Increases Margin To ADS Actuation

STEAM GENERATOR TUBE RUPTURE

PRHR HX ACTUATION SIGNAL ANALYSIS

- SSAR: INITIATES PRHR ON HIGH SG LEVEL SIGNAL
- ANALYSIS HAS BEEN PERFORMED WITH REVISED PRHR INITIATION LOGIC
  - PRHR initiation on CMT actuation signal
  - Analysis assumptions and single failure identical to SSAR analysis
  - Transient progression not significantly changed
    - Sequence of events compared in Table 1
    - Break flow transient plots compared in Figure 1
  - Benefit for offsite dose analysis due to reduced break flow and steam releases
  - Integrated break flow and steam releases compared in Table 2

FIGURE 1
COMPARISON OF PRIMARY TO SECONDARY BREAK FLOW

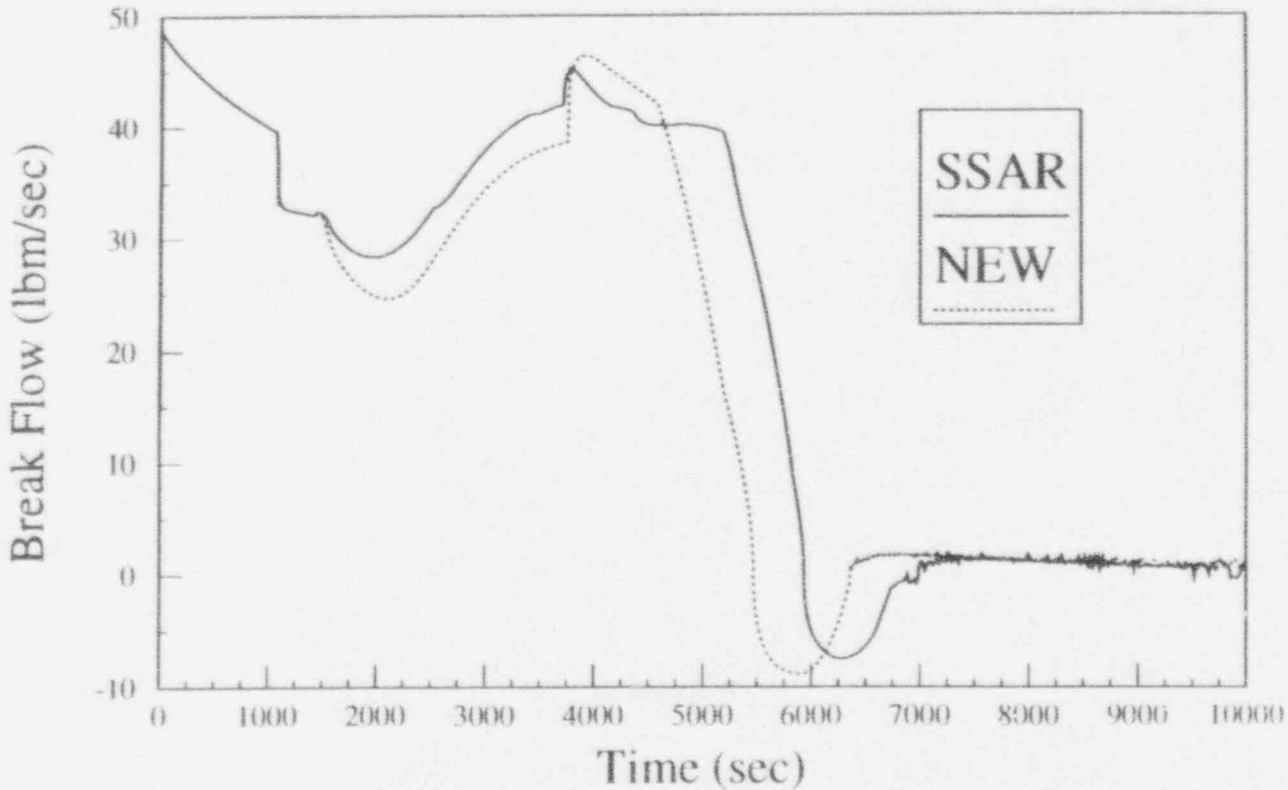


TABLE 1
COMPARISON OF SEQUENCE OF EVENTS

EVENT	SSAR Time (sec)	NEW Time (sec)
Double Ended SG Tube Rupture	0	0
Reactor Trip On Low Pressurizer Pressure	1074	1074
CMT Actuation On Low-1 Pressurizer Pressure	1411	1411
PRHR Initiation On CMT Actuation (+ Delay)	-------	1471
Faulted SG PORV Fails Open	3706	3742
Faulted SG PORV Block Valve Closed On Low Steamline Pressure	4346	4000
CVS And Startup Feedwater Isolated On High-2 SG Level	5174	4576
PRHR Initiation on High-2 SG Level	5234	-------
Break Flow Terminated And Stable Condition Reached	10000	10000

TABLE 2
COMPARISON OF INTEGRATED BREAK FLOW AND STEAM RELEASE

	LOFTTR2 Integrated Break Flow (lbm) At			LOFTTR2 Faulted Loop Integrated Steam Release (lbm) At	
	PORV Failure	7200 Sec	10000 Sec	PORV Failure	7200 Sec
SSAR	136262	209781	212362	33710	118700
NEW	129945	183897	186940	27480	59610

ANALYSIS FOR ADS ACTUATION CONCERNS

- Assumptions That Minimize CMT Water Volume
  - No CVS Flow
  - Reduced CMT Condensation
  - Faulted SG PORV Fails Open

- Minimum CMT Water Volume > 1500 ft^3

SAFETY ANALYSIS EVALUATIONS

LOSS OF COOLANT ACCIDENTS

R. M. KEMPER
ADVANCED AND VVER PLANT SAFETY ANALYSIS

LOCA EVALUATION

- AP600 SSAR LOCA Analysis considers a spectrum of breaks from a one-inch equivalent diameter size to a DEHLG
- Large Break LOCAs are analyzed with the Best Estimate WCOBRA/TRAC Code
  - CQD now under NRC review
  - C_D = 0.8 DECLG break is limiting in calculated PCT
  - Passive core cooling system changes have insignificant impact on large break LOCAs
- Small Break LOCAs are analyzed with NOTRUMP
  - Appendix K evaluation model analysis
  - Changes made to model passive safety systems

LOCA EVALUATION

- SSAR NOTRUMP Break Spectrum Includes

  - Inadvertent ADS actuation
  - 1-inch cold leg break
  - 2-inch cold leg break
  - 2-inch DVI line break
  - 2-inch cold leg pressure balance line break
  - DEDVI line break (2*6.8-inch equivalent diameter)
  - Double ended cold leg pressure balance line break (same size as DEDVI)

- Result Highlights:

  - Core uncovery is predicted only during the very early portion of the DEDVI break (PCT of 1009°F non-limiting)

  - All cases achieve stable IRWST injection with margin to core uncovery

LOCA EVALUATION

- The Passive Safeguards System Changes Affect Small Break LOCAs
  - Direct vessel injection line venturi limits DEDVI break area
  - ADS changes have impact
    - First stage actuation setpoint
    - Second/third stage actuation via timers
    - More fourth stage venting capability with single failure assumed
  - PRHR actuation on CMT signal
    (vs. ADS stage 1 CMT level signal
    in SSAR)

LOCA EVALUATION

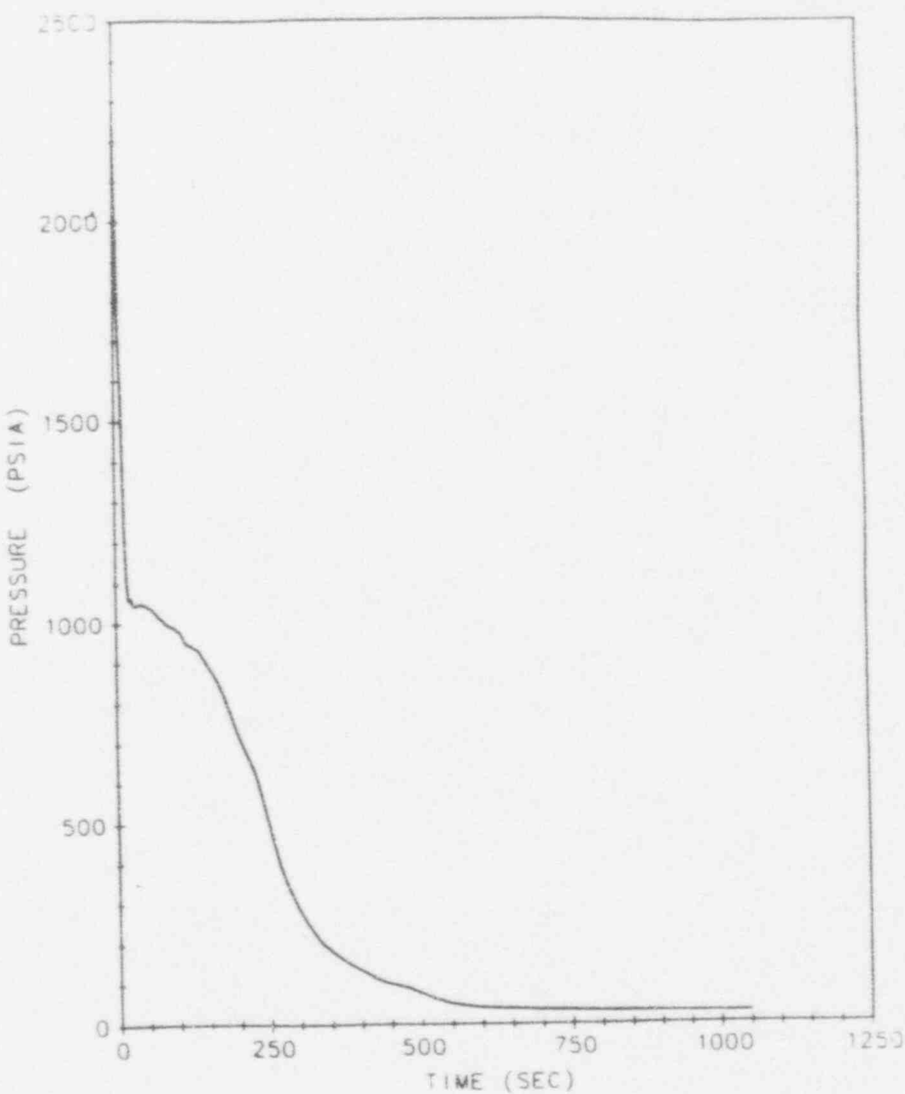
- The Limiting Small Break LOCA SSAR Cases were Analyzed with NOTRUMP Modeling the Design Changes
- DEDVI break for minimum safety injection availability
  - Inadvertent ADS actuation for test of ADS venting capability
- No Active Systems Modeled
- Single Active Failure Assumed Exacerbates Limiting Phenomena
  - A first/third stage ADS valve combination for the DEDVI case
  - One fourth stage ADS valve for the inadvertent ADS case
- Appendix K Evaluation Model Approach as in SSAR

DEDVI Break Sequence of Events

Case	SSAR	New design with venturi
Break open	0.0 seconds	0.0 seconds
Reactor trip signal	3.5 seconds	7.2 seconds
"S" signal	4.2 seconds	8.65 seconds
Reactor coolant pumps start to coast down	20.4 seconds	24.85 seconds
ADS stage 1	75 seconds	164.2 seconds
Accumulator injection starts	117 seconds	206 seconds
ADS stage 2	135 seconds	234.2 seconds
ADS stage 3	255 seconds	354.2 seconds
ADS stage 4	375 seconds	474.2 seconds
in containment refuelling water storage tank injection starts	1839 seconds	1178.7 seconds

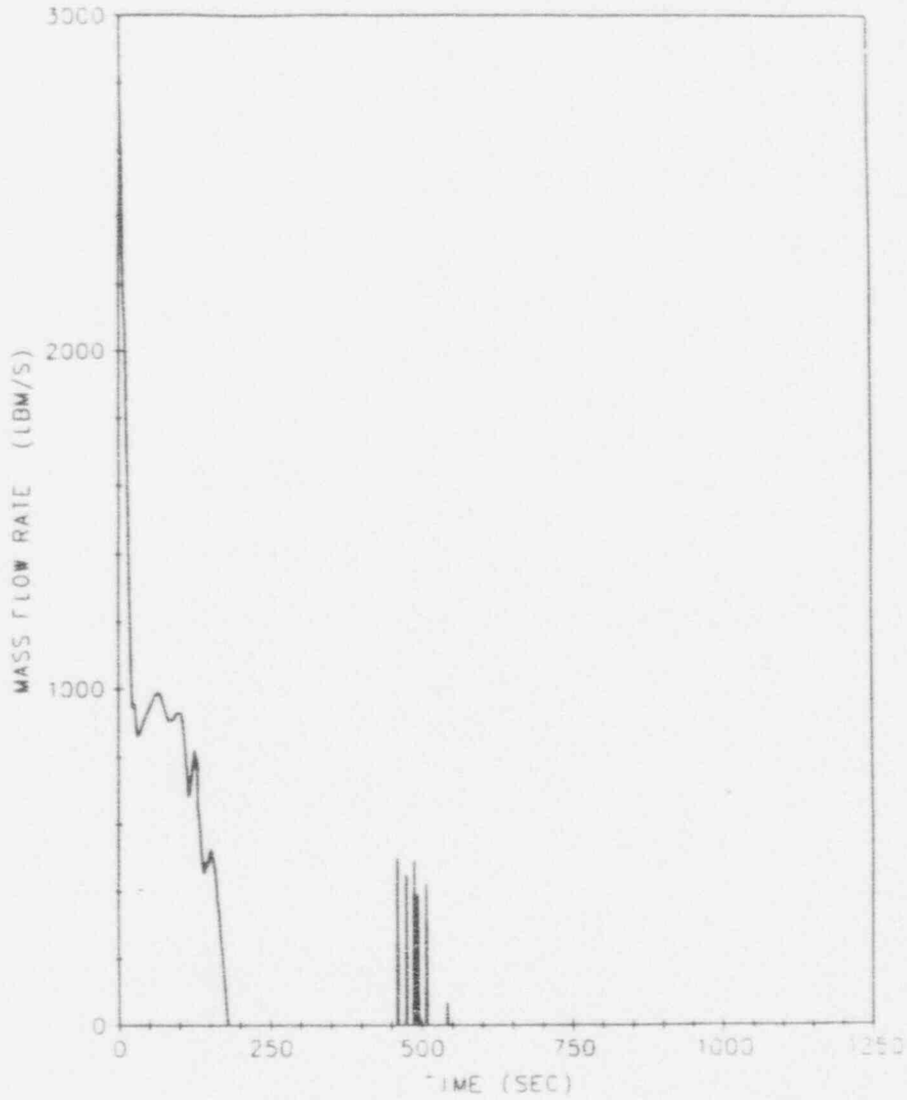
LOCA EVALUATION

DEDVI Break, Upper Plenum Pressure



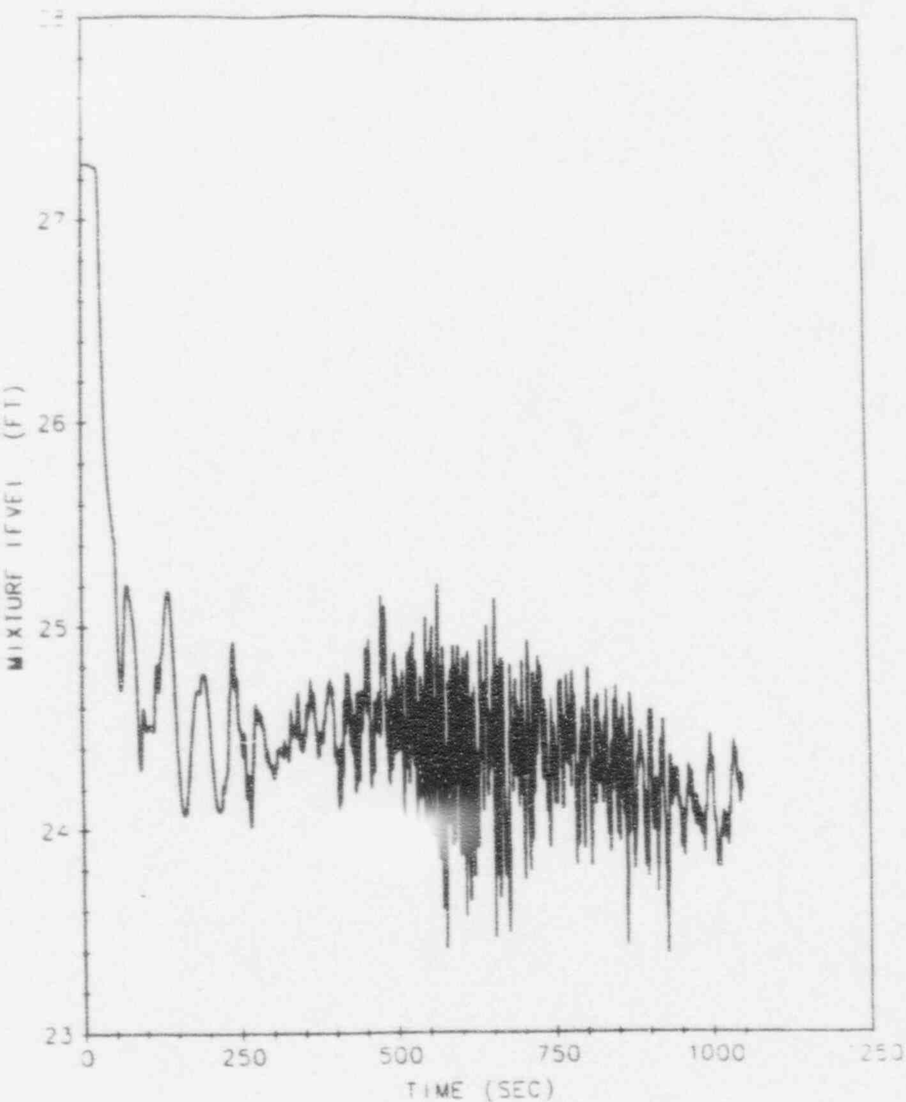
LOCA EVALUATION

DEDVI Break, Break Liquid Flow Rate



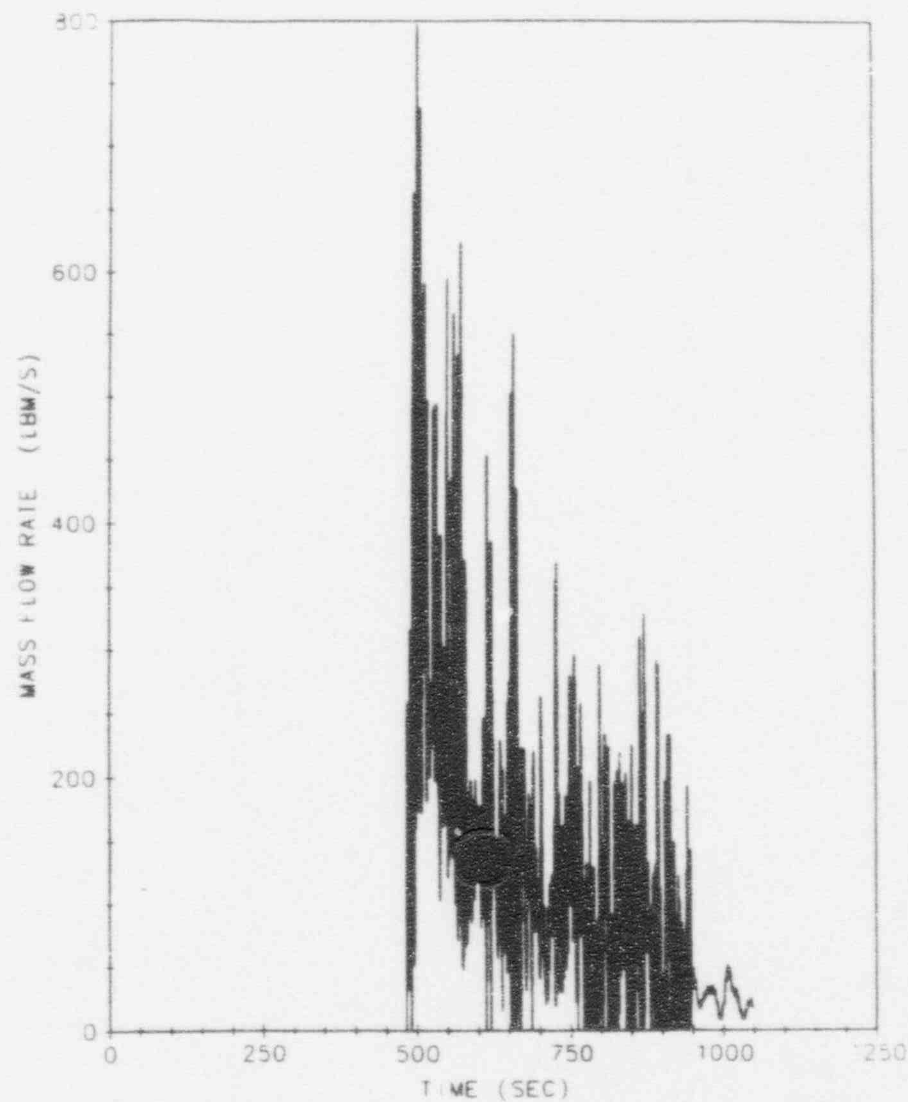
LOCA EVALUATION

DEDVI Break, Core Stack Mixture Level



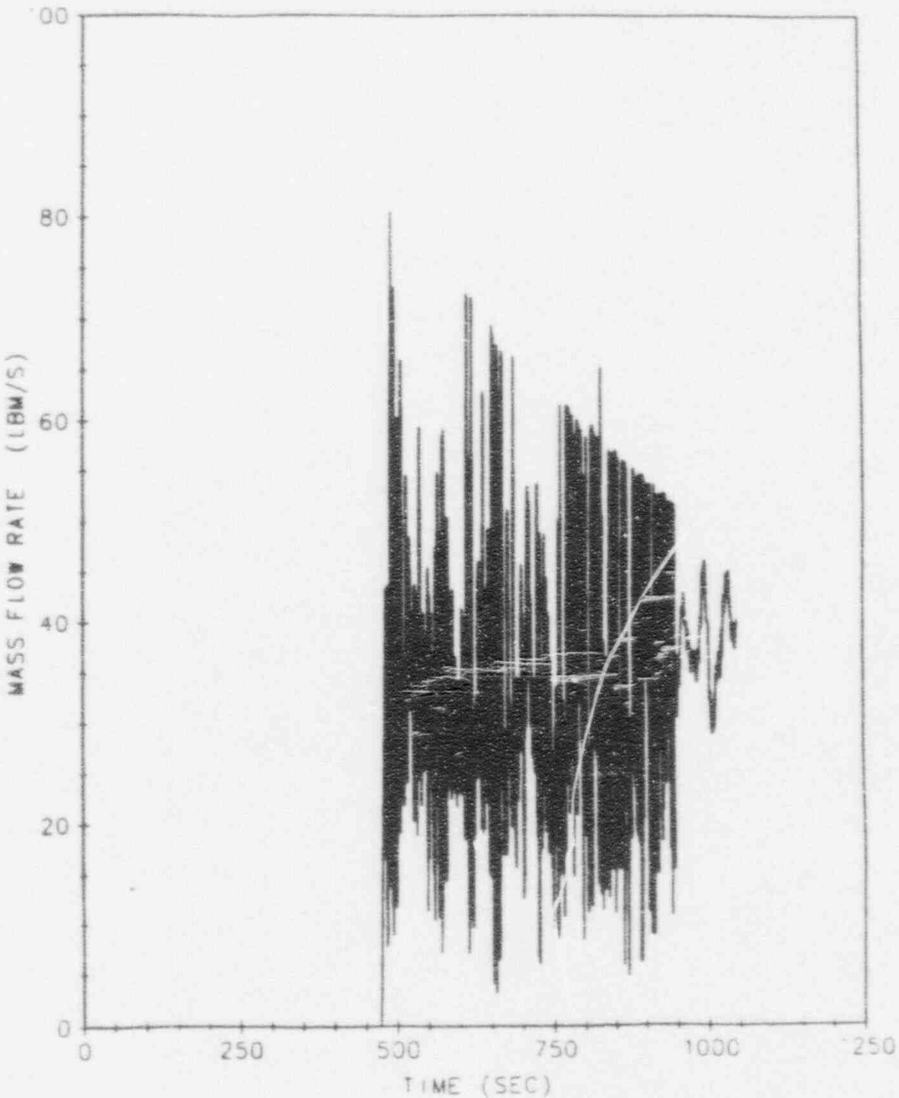
LOCA EVALUATION

DEDVI Break, ADS Stage 4 Liquid Mass Flow Rate



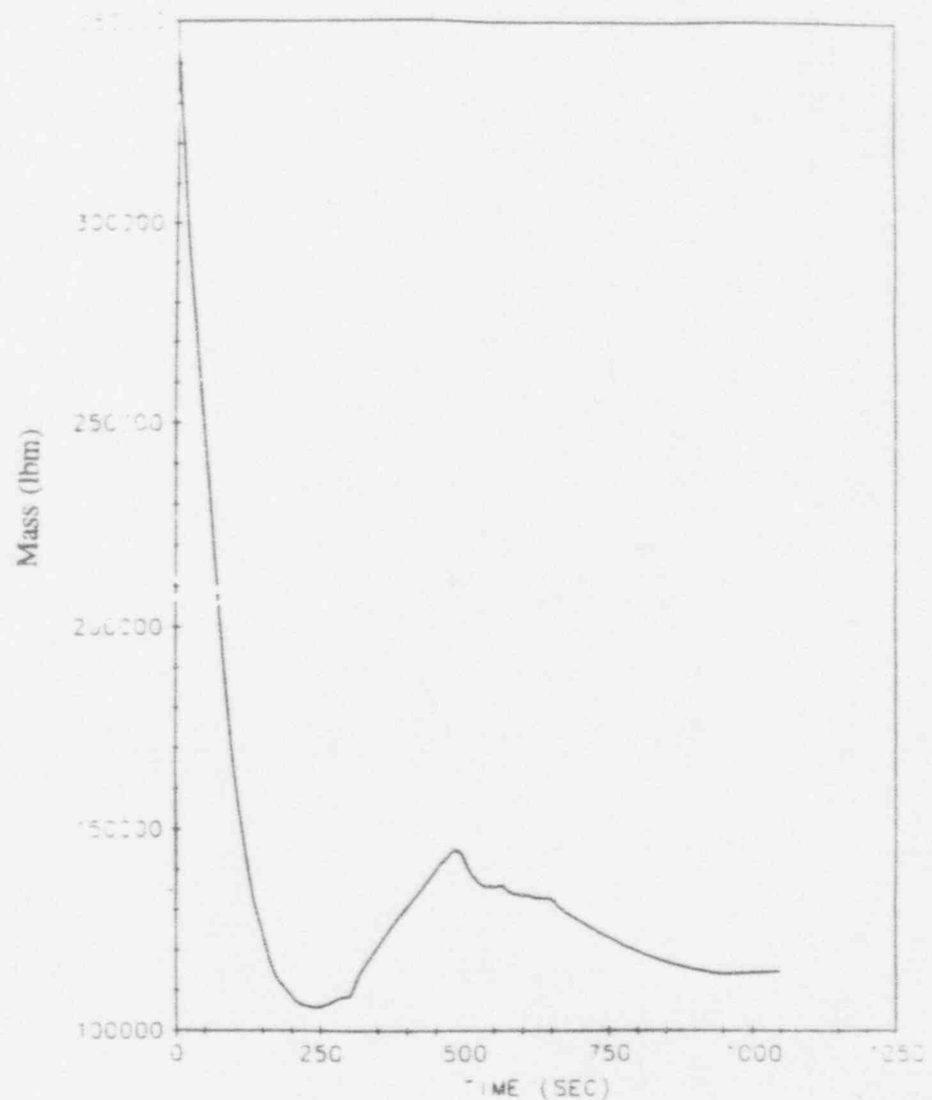
LOCA EVALUATION

DEDVI Break, ADS Stage 4 Vapor Mass Flow Rate



LOCA EVALUATION

DEDVI Break, Primary Mass Inventory



LOCA EVALUATION

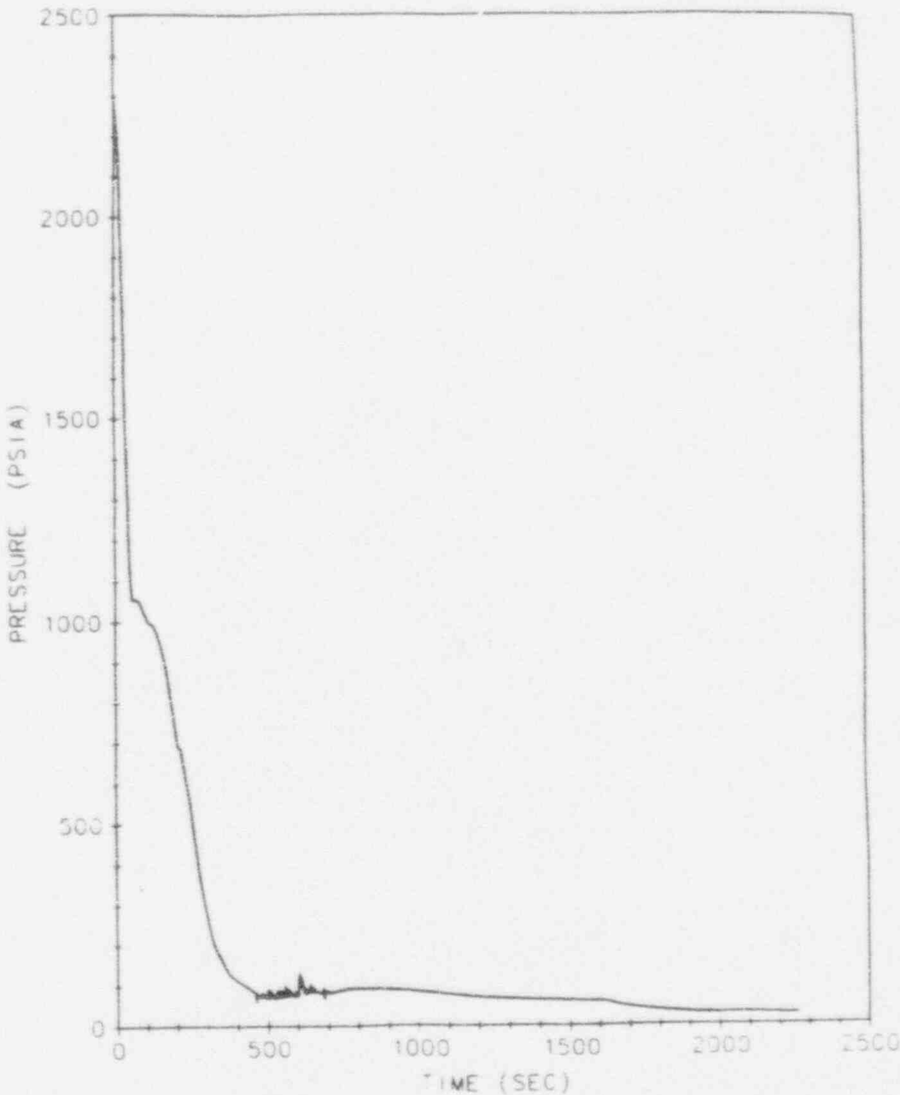
AP600

Inadvertent ADS Actuation Sequence of Events

Case	SSAR	New Design
Inadvertent opening of the ADS valve	0.0 seconds	0.0 seconds
Reactor trip signal	28.5 seconds	25.6 seconds
"S"signal	33.5 seconds	28.97 seconds
Reactor coolant pumps start to coast down	49.7 seconds	45.2 seconds
Accumulator injection starts	633 seconds	204 seconds
PRHR Actuation	726 seconds	30.2 seconds
ADS stage 2	916 seconds	70 seconds
Accumulator empty	1325 seconds	565 seconds
ADS stage 3	1390 seconds	190 seconds
ADS stage 4	1902 seconds	1617 seconds
Core make up tank empty	2260 seconds	1967 seconds
In containment refuelling water storage tank injection starts	2792 seconds	2176 seconds

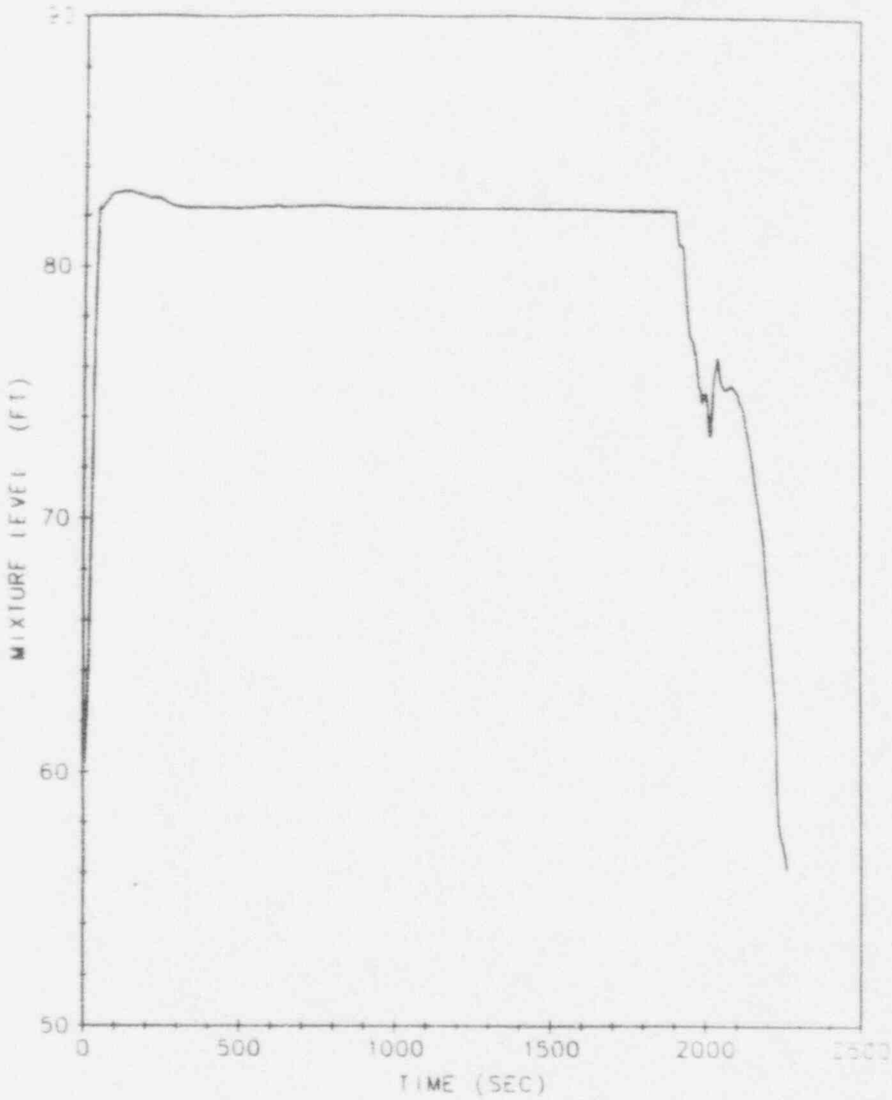
LOCA EVALUATION

Inadvertent ADS Actuation, Downcomer Pressure



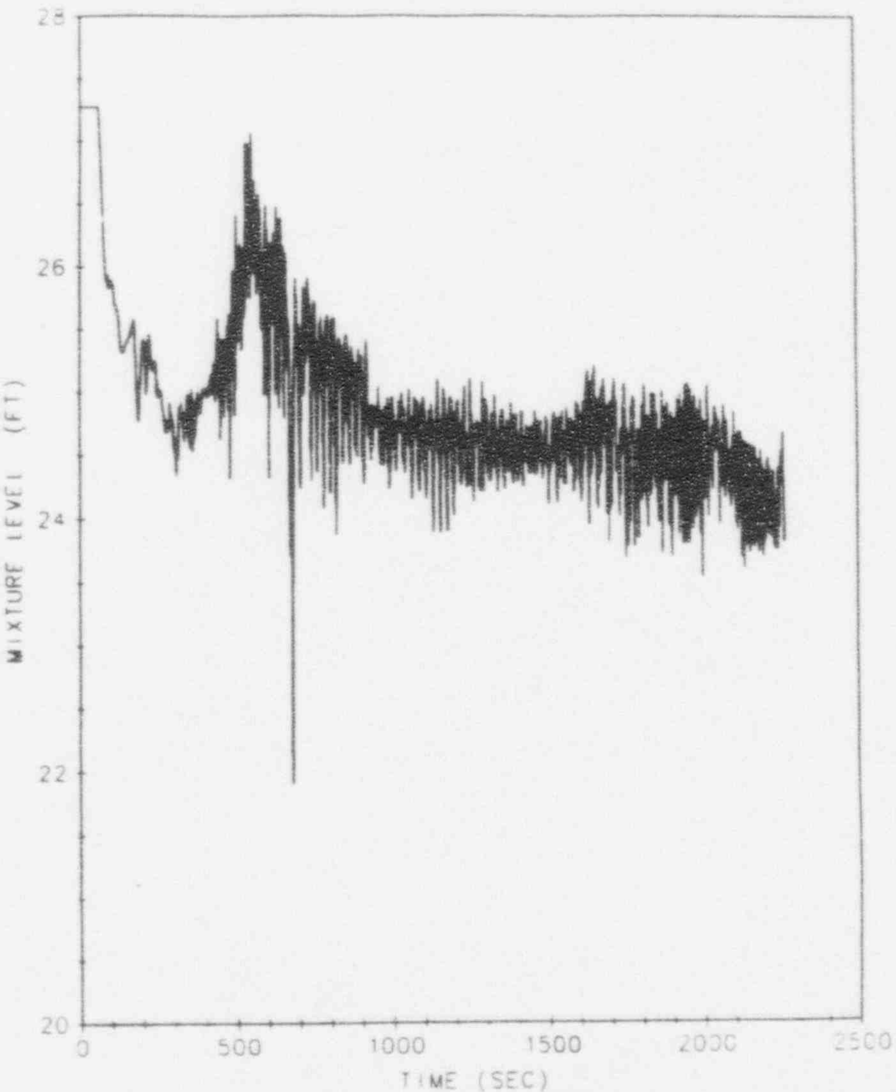
LOCA EVALUATION

Inadvertent ADS Actuation, Pressurizer Mixture Level



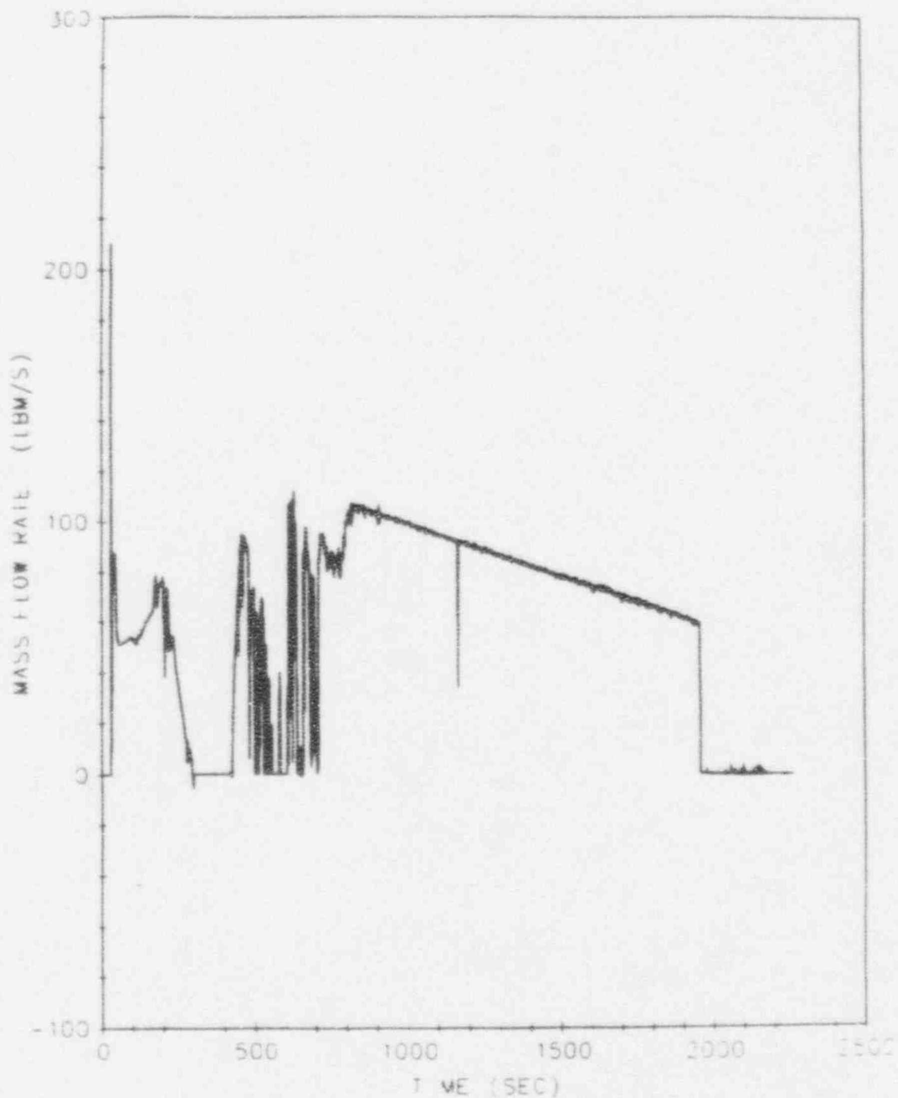
LOCA EVALUATION

Inadvertent ADS Actuation, Core Stack Mixture Level



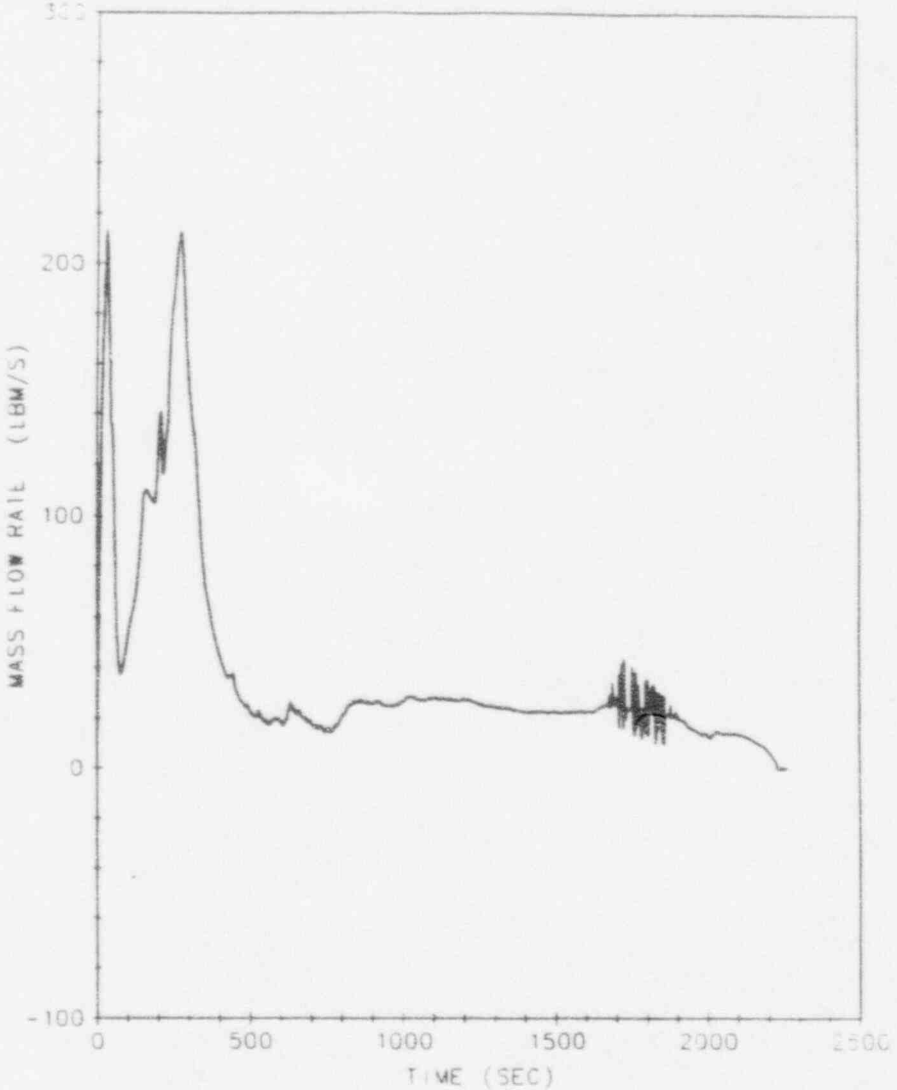
LOCA EVALUATION

Inadvertent ADS Actuation, Loop 1, CMT to DVI Flow Rate



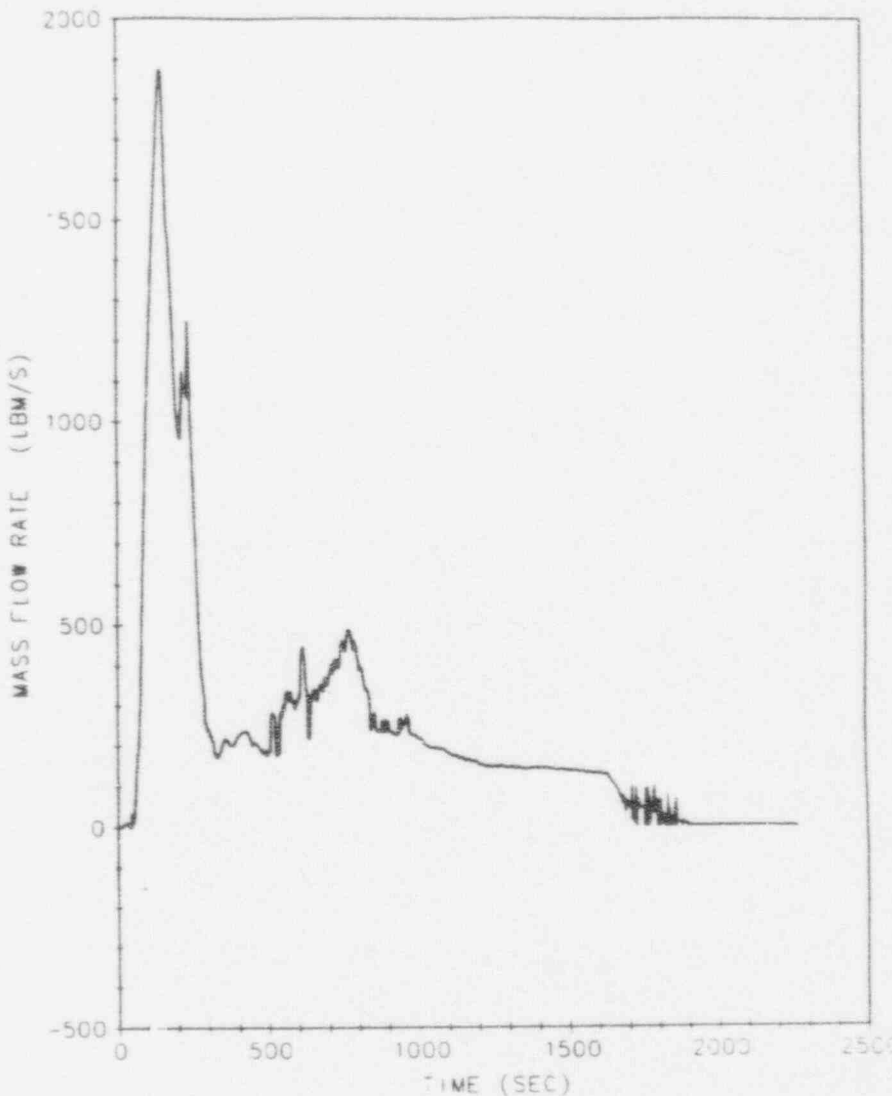
LOCA EVALUATION

Inadvertent ADS Actuation, ADS 1-3 Vapor Flow Rate



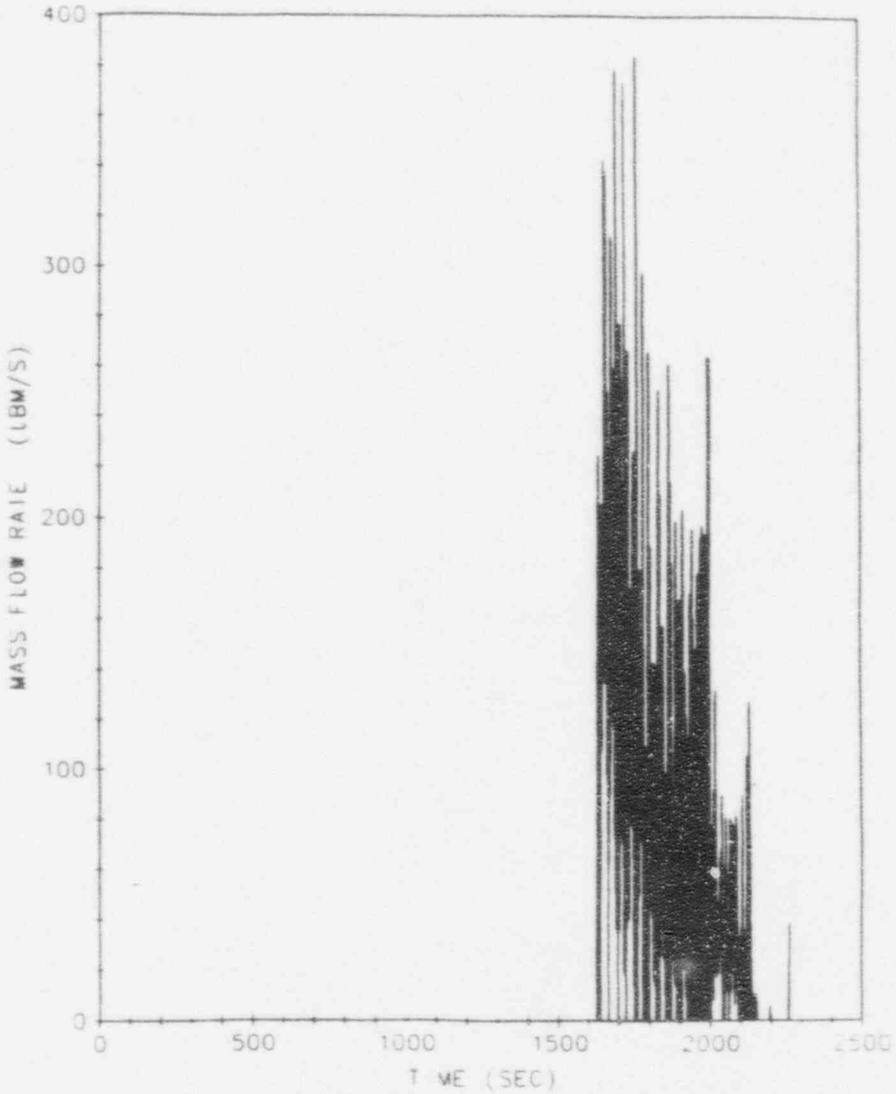
LOCA EVALUATION

Inadvertent ADS Actuation, ADS 1-3 Liquid Flow Rate



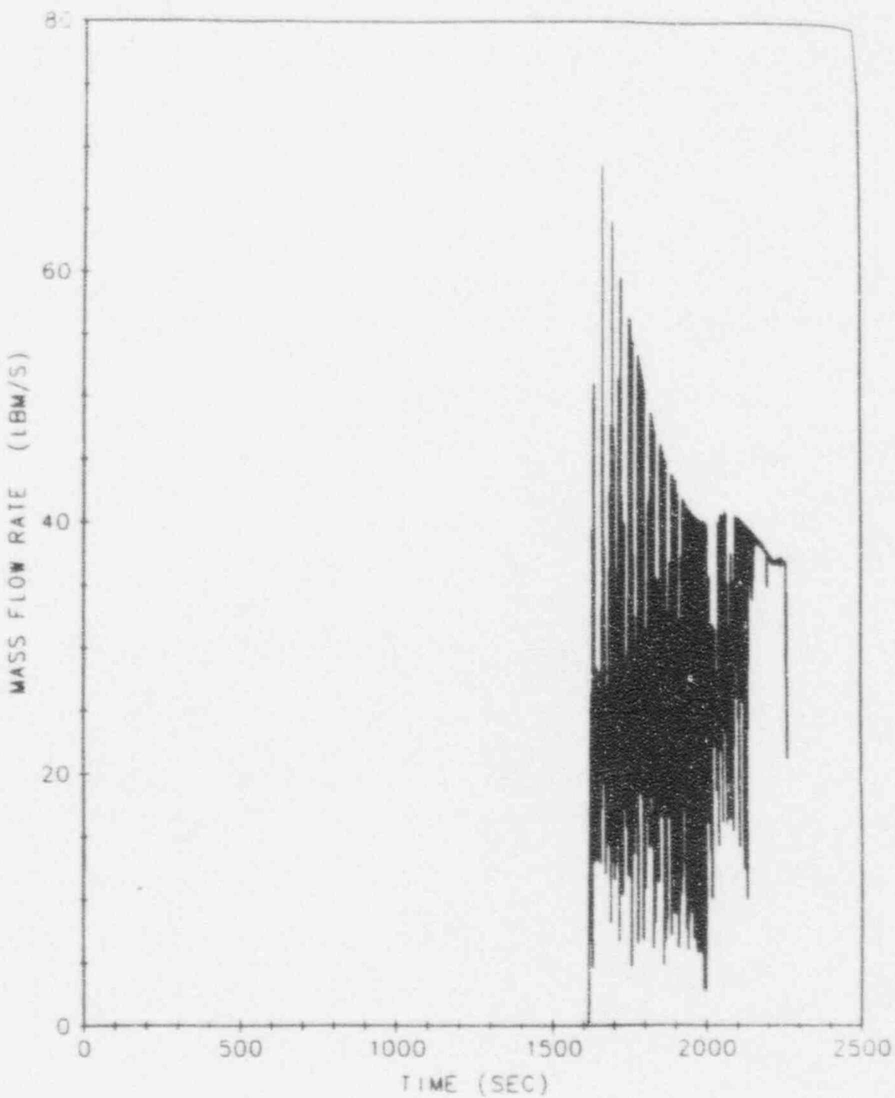
LOCA EVALUATION

Inadvertent ADS Actuation, ADS 4 Liquid Mass Flow Rate



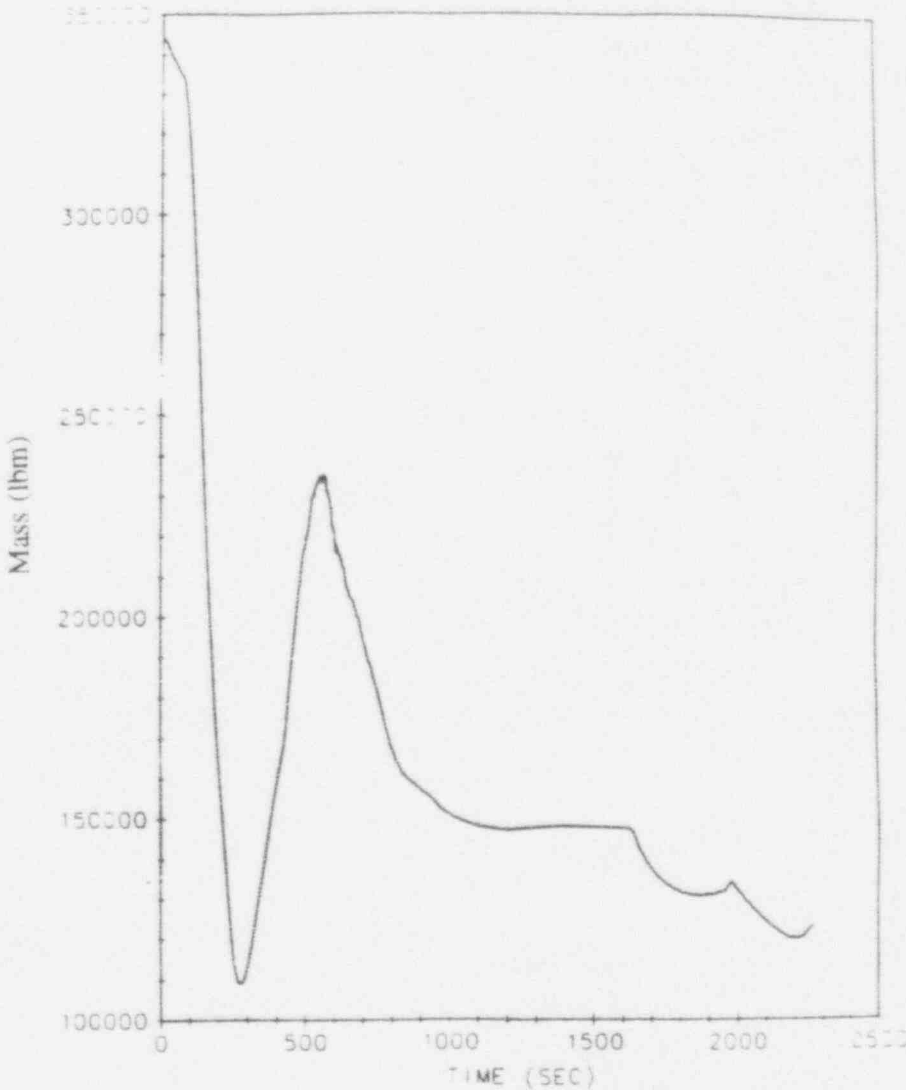
LOCA EVALUATION

Inadvertent ADS Actuation, ADS 4 Vapor Mass Flow Rate



LOCA EVALUATION

Inadvertent ADS Actuation, Primary Mass Inventory



LOCA EVALUATION

- Conclusions
  - The passive core cooling system design changes:
    - Beneficially impact small break LOCA events
    - Do not affect large break LOCAs
  - The SSAR cases remain bounding for the new design

TEST PROGRAM IMPACT

DESIGN CERTIFICATION TEST PROGRAM

E. J. PIPLICA, MANAGER
TEST ENGINEERING

DESIGN CERTIFICATION TESTS

- Each AP600 test program has been systematically investigated to assess the impact of each design change

  - Hardware changes

    - Test articles
    - Test instrumentation
    - Facility support systems

  - Software changes

    - Test matrix
    - Test operating procedures
    - Initial test conditions
    - Control logic

  - Test Schedule

CORE MAKEUP TANK TESTS

- Minimal impact
  - No hardware changes required
  - Minor software changes
  - No effect on test schedule

- Hardware changes have already been made to the facility
  - Depressurization capability improved by adding a two inch line and globe valve off of the steam/water reservoir
  - A steam distributor has been installed in the Core Makeup Tank for all matrix testing

CORE MAKEUP TANK TESTS (continued)

- Software changes will be incorporated in the Operating Procedures
  - Depressurization rates
  - Flow draindown rates

- Test matrix was modified to include additional natural circulation and depressurization tests will be specified for each test

DESIGN CERTIFICATION TESTS

INTEGRAL SYSTEMS TESTS AT OREGON STATE UNIVERSITY

- Some impact
  - Hardware changes required
  - Software changes will be incorporated

- Hardware changes
  - A steam distributor installed in the CMT for all matrix testing
  - The Break and ADS Measurement System will be reconfigured to accommodate flow from both 4th stages for single ended breaks and will be headered together for DEG breaks
  - The DVI line venturi will be installed
  - New orifices required for ADS Stages 1,2 and 3
  - Additional orifices required for Stage 4, w/o single failure of one Stage 4 valve

DESIGN CERTIFICATION TESTS

INTEGRAL SYSTEMS TESTS AT OREGON STATE UNIVERSITY (continued)

- Software changes
  - Control logic will be implemented to reflect the revised AP600 design
  - Test operating procedures will be written to include the revised AP600 logic changes
  - No changes are required to the test matrix

DESIGN CERTIFICATION TESTS

INTEGRAL SYSTEMS TESTS AT SPES-2

- Status
  - The first matrix test at SPES-2 (reference 2 inch SBLOCA) was performed as configured for the current AP600 design
  - The facility has been modified to incorporate the revised AP600 configuration
  - The first matrix test will be rerun pending completion of repairs to the seals on the power channel
  - All subsequent tests will be performed with the revised design changes incorporated
- Impact
  - Minor hardware changes required
  - Software changes have been incorporated
  - No schedule impact

DESIGN CERTIFICATION TESTS

INTEGRAL SYSTEMS TESTS AT SPES-2 (continued)

- Hardware changes
  - A steam distributor has been installed in the Core Makeup Tank for all matrix testing
  - Both 4th stages have been headered together
  - The DVI line venturi will be installed as part of the break package for the DEC DVI line break
  - New orifices have been installed for ADS Stages 1,2 and 3
  - New orifices have been installed for ADS Stage 4. Single failure of one 4th stage valve is assumed

INTEGRAL SYSTEMS TESTS AT SPES-2 (continued)

- Software changes
  - Control logic has been modified to reflect the revised AP600 design
  - Test operating procedures have been/will be written to include the revised AP600 logic changes
  - No changes are required to the test matrix

DESIGN CERTIFICATION TESTS

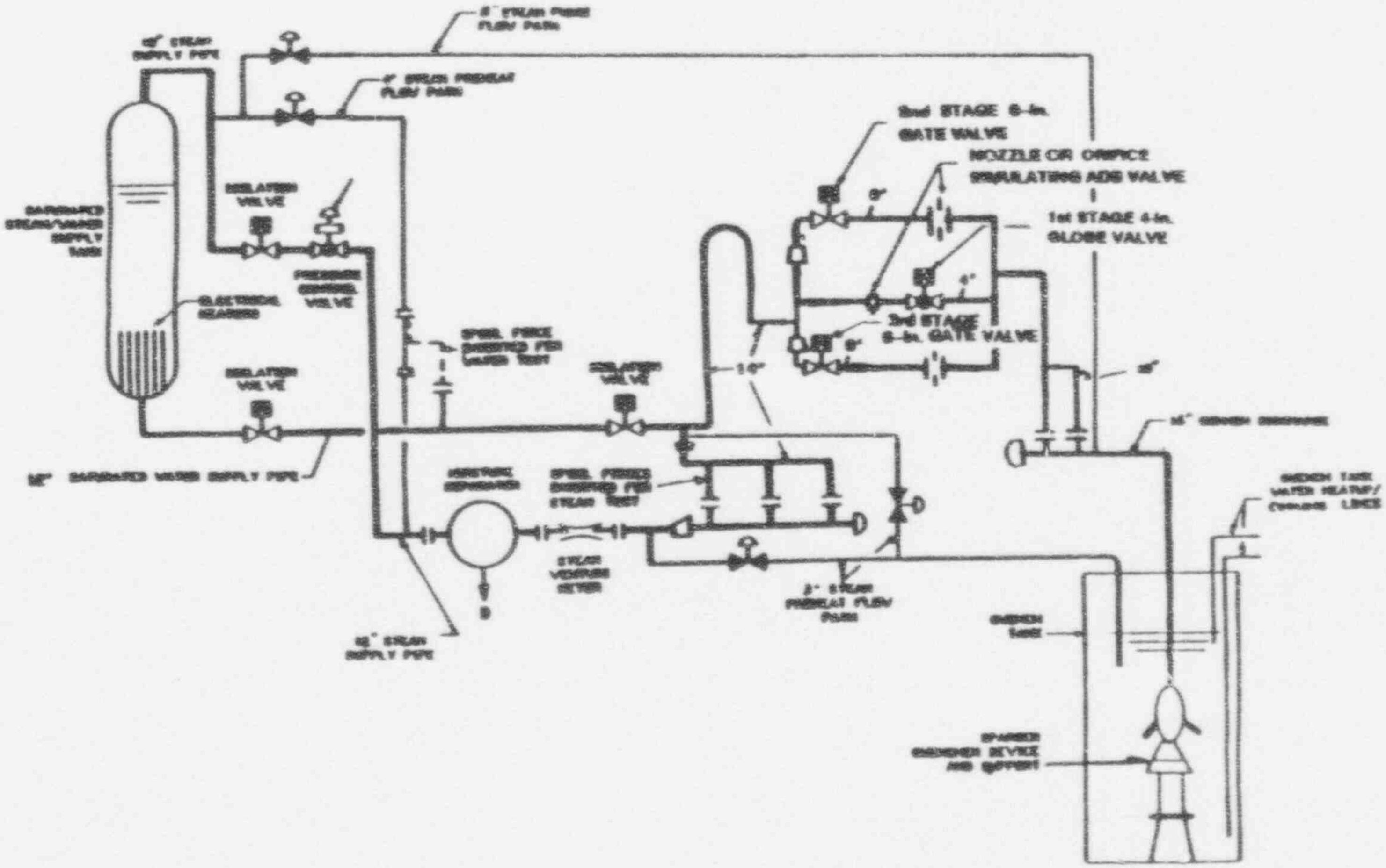
AUTOMATIC DEPRESSURIZATION SYSTEMS TESTS AT VAPORE

- Minimal Impact
  - Minor hardware changes required
  - Software changes have been incorporated
  - No schedule impact

- Hardware changes
  - The valve piping package has been redesigned to accommodate spool pieces to represent the isolation valve in stage 1 and the control valves in stages 2 and 3
  - Orifices will be used to represent minimum vent capability and a flow nozzle will be used to represent maximum vent capability

DESIGN CERTIFICATION TESTS

ADS Phase B Test Facility Schematic



ADS Phase B Test Valve Package Configuration

[ ](a,c

AUTOMATIC DEPRESSURIZATION SYSTEMS TESTS AT VAPORE (continued)

- Software changes
  - Pre-test analysis of the facility is being performed to establish the initial test conditions and operating parameters
  - The test matrix has been restructured to provide data over a range of thermal/hydraulic conditions representing both high resistance (minimum vent capability) and low resistance (maximum vent capability)

DESIGN CERTIFICATION TESTS

SUMMARY

- All Design Certification Tests have been evaluated with respect to the revised AP600 design and, in general, the impact on the tests is minimal

- The Design Certification Tests have been or will be modified to reflect the revised AP600 design changes

- All matrix testing will be performed with the revised AP600 design changes incorporated

ADS VALVE TESTS

T. L. SCHULZ
SYSTEMS ENGINEERING

ADS VALVE TESTING

- **Several ADS Valve Tests Will Be Performed**
  - Outside of design certification
  - Includes tests to support
    - Valve type selection
    - Valve qualification
    - Valve production
    - Plant pre-operational testing
    - Plant in-service testing

ADS VALVE TESTING

- **ADS Valve Type Selection Testing**
  - Full sized, prototypical stage 1/2/3 valves
  - Different valve types and vendors
  - Installed in full sized, prototypical ADS pipe package
  - Flow conditions will bound ADS operation
  - Data collected; valve thrust during open/close and visual wear
  - Objectives are to provide data
    - Support decision on type of valve
    - For valve specification
    - For later valve equipment qualification

ADS VALVE TESTING

- **ADS Valve Qualification Testing**
  - Analysis of valve/operator
    - ASME design report (pres/temp, nozzle loads, seismic)
    - Operator sizing analysis
    - Weak link analysis
  - Functional testing of valve/operator
    - Dimensional inspection
    - Test safety functions under conditions determined by ADS Phase B system tests and by ADS Valve Type Selection tests
  - Operator qualification
    - Tests based on IEEE-382
      - Aging (cyclic, vibration, environmental)
      - Seismic
      - Special (MO effects)

ADS VALVE TESTING

- **ADS Valve Production Testing**

    - For each valve:
        - Hydrostatic test of body and seat
        - Leakage test of seat, backseat, packing
        - Stroke test; design DP, no flow

- **ADS Valve Testing During Pre-Operational Testing**

    - Baseline tests (static stroke)
    - Stroke tests (design DP, low flow)
    - Blowdown test; intermediate pres, 1st plant only

- **ADS Valve In-service Testing**

    - Periodic tests; at power every [TBD] months, static stroke test
    - Flow test; every refueling, stroke test with partial DP, low flow

- OPEN DISCUSSION
- MEETING WRAP-UP
- ACTION ITEMS