Long

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

(8)

MAY 25 1982

MEMORANDUM FOR: G. N. Lauben, Section Leader, Section A, Reactor Systems Branch, DSI

FROM. J. K. Long, Section A, Reactor Systems Branch, DSI

SUBJECT: SASA PROGRAM QUARTERLY REVIEW ME TING ON APRIL 13-14

Attached are copies of a few of the key documents distributed at the subject meeting which will be of interest to RSB and CSB. I have a few more details in my office for those interested. Some of the main developments are summarized below.

Oak Ridge is pursuing the study of the BWR accident where scram discharge volume fails. The attached summary of the study emphasizes the need for operator action to achieve recovery. In addition, University of Tennessee is developing mathematical models of the suppression pool.

Sandia has initiated a review of PWR containment management for severe accidents. Some comparisons between their Zion review and NUREG-0850 were presented. Pressurized thermal shock was also investigated.

EG&G at Idaho have extended their studies of station blackout, SG tube ruptures and depressurization without PORVs. In the latter case, they have completed their analysis with RELAP 4 Mod 7 and have suggested that RELAP 5 will be necessary if they are to refine the work further. We have agreed that this should be done.

The LANL thermal hydraulics neutronics studies of boron dilution have been completed using TRAC, and a draft report is attached. They have not included operator dose estimates and I repeated our need for this information. The main dose pathway appears to be radially outward through the vessel and then upward through the gap between vessel and shielding. LANL has also studied the behavior of noncondensable gases relevant to the development of procedures for the use of high point vents.

XA Copy Has Been Sent to PDR

J. K. Long
Section A
Reactor Systems Branch, DSI

cc: J. Meyer
G. Mazetis
T. Marsh
W. Hodges
W. Butler (CSB)
B. Sheron
T. Speis
B. Agrawal (RES) w/o encl.

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SASA PROGRAM REVIEW AGENDA
Room 130, Willste Building, 7915 Eastern Avenue
Silver Spring, Maryland
April 13-14, 1982

April 13, 1982

9:00 AM	Introductory Remarks Agenda Review Actions since January 20, 1982 Funding Status	R. Curtis
9:30 AM	PBF Test Results - Interface with SASA	J. M. Broughton
10:15 AM	Break	
10:30 AM	Severe Core Damage Analysis Program (SCDAP) - Interface with SASA	T. Howe
11:15 AM	Progress Reports (each lab. to provide 10 minute summary of succinct written list of accomplishments since January 20, 1982	
11:15 AM	INEL	
11:25 AM	LANL	
11:35 AM	SNL	
11:45 AM	ORNL	
12:00 NOON	Lunch	
1:15 PM	Detailed Progress Reports	
	INEL	J. Hunter, R. Schultz

- Brown's Ferry Station Blackout Results
  Scram discharge volume analysis using RELAP5
- Depressurization of CE Plants without PORVS
- Characterization of 2-loop plants for SGTR
- B&W behavior under LOFW Conditions with multiple failures
- Concept of science of Accident Management

April 13, 1982

2:15 PM	LANL - Unmitigated Boron Dilution Results (W. Plants) - Vessel Head High Point Vents Results (B&W and W. Plants)	N. DeMuth
3:00 PM	Break	
3:15 PM	SNL - Pressurized Thermal Shock - BackEnd Analysis & Results - Program Plan for PWR Containment Accident Management Strategy	J. Darby, E. Hoskins
4:15 PM	Comments by NRR representatives	
4:30 PM	- Adjourn	

Room 1133 - Willste Building

April 14, 1982

9:00 AM	ORNL	
	- Status on Station Blackout, Fission Product Transport Analysis	S. Hodge
	- BWR Scram discharge volume break analysis before core uncovery	S. Hodge
	- BWR Scram discharge volume break analysis after core uncovery	S. Greene
	- Status on Pressure Suppression Pool Modeling	D. Cook
10:00 AM	Break	
10:15 AM	Regulatory Concerns in BWR ATWS	C. Graves
11:15 AM	Human Factors - SASA Interface	J. Jenkins
11:30 AM	Lunch	
1:00 PM	Discussion of Accident Management and SASA's role in it - Highlights of ANS meeting on PRA - Status on information exchange with the French - Discussion on New Plant Analysis for SASA	P. Curtis
1:45 PM	SASA Calculational Log SASA Program Plan Review BWR Long Range SASA Plan (IPEP VS 8 BWR sequences) Bypass Sensitivity Study, core voiding in small break situation "State-of-the-Art" of T-H Code to model ATWS	J. Hunter
2:15 PM	Development of accident simulation and management technique	M. DeMuth
2:30 PM	Information Gathering Scheme Resolution of Pressurized Thermal Shock Study	J. Darby
2:45 PM	Discussion on MARK II containments Discussion on Cooperation with Battelle Columbus on MARCH2 Code	S. Hodge
3:00	Adjourn	

Conclusions - action items

SCRAM DISCHARGE VOLUME BREAK
ACCIDENT SEQUENCE ANALYSIS

S. A. HODGE

S. R. GREENE

OAK RIDGE NATIONAL LABORATORY

SASA PROGRAM REVIEW MEETING

SILVER SPRING, MD

APRIL 13 - 14, 1982

SCRAM DISCHARGE VOLUME BREAK

ANALYSIS

- SMALL-BREAK LOCA OUTSIDE CONTAINMENT
- OPERATOR ACTION IS CRUCIAL TO SAFE RECOVERY

THE TENNESSEE VALLEY AUTHORITY (TVA) COOPERATED FULLY WITH THE STUDY AND PROVIDED INVALUABLE ASSISTANCE –

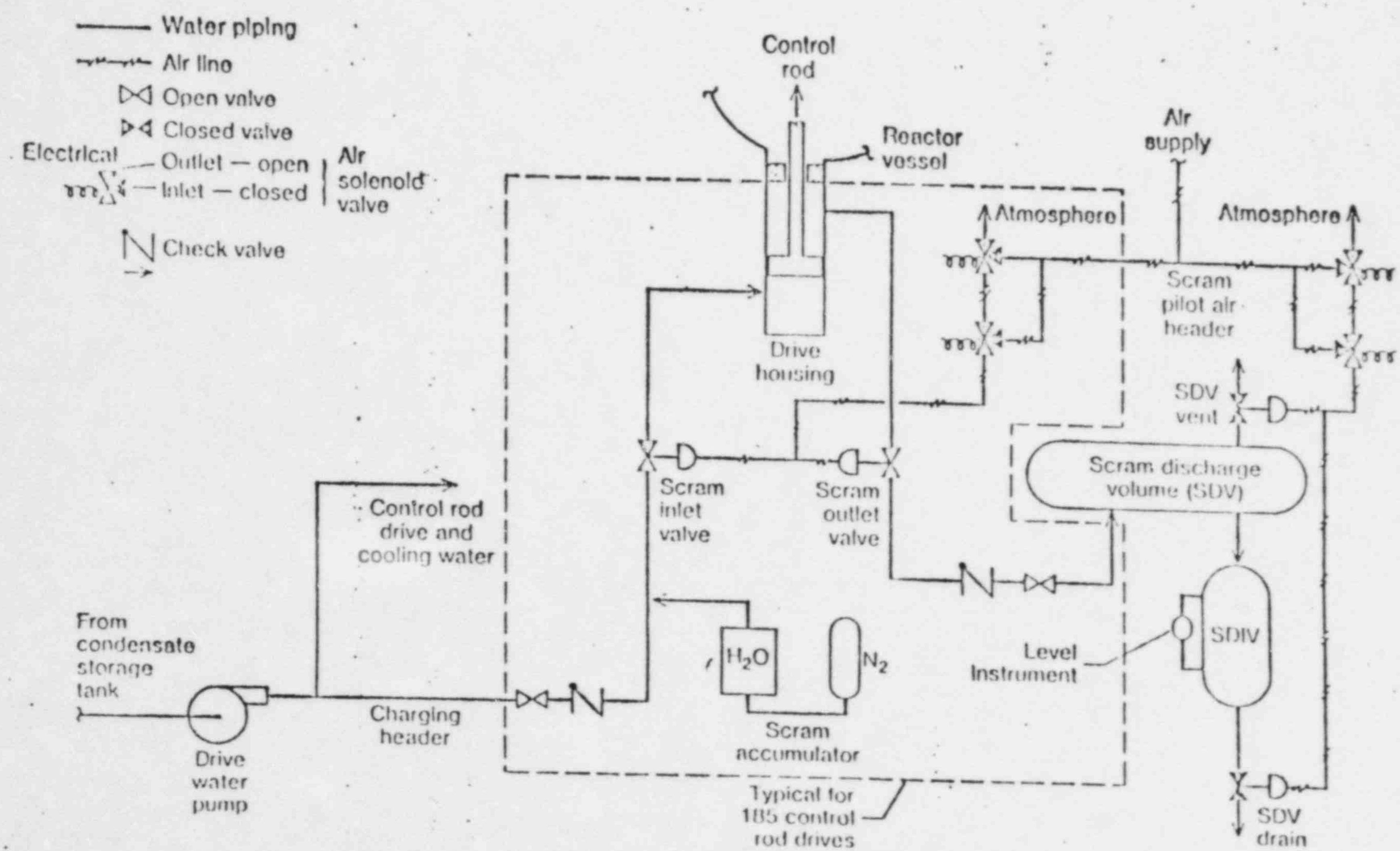
- PLANT DRAWINGS AND TECHNICAL DATA
- OPERATOR TRAINING MANUALS AND OPERATING INSTRUCTIONS
- TWO PLANT VISITS AND CONTINUING DIALOGUE WITH OPERATORS
- REVIEW OF ASSUMPTIONS, CALCULATIONS, AND FINDINGS FOR ACCURACY.

THE PRESENTATION IS IN 3 PARTS

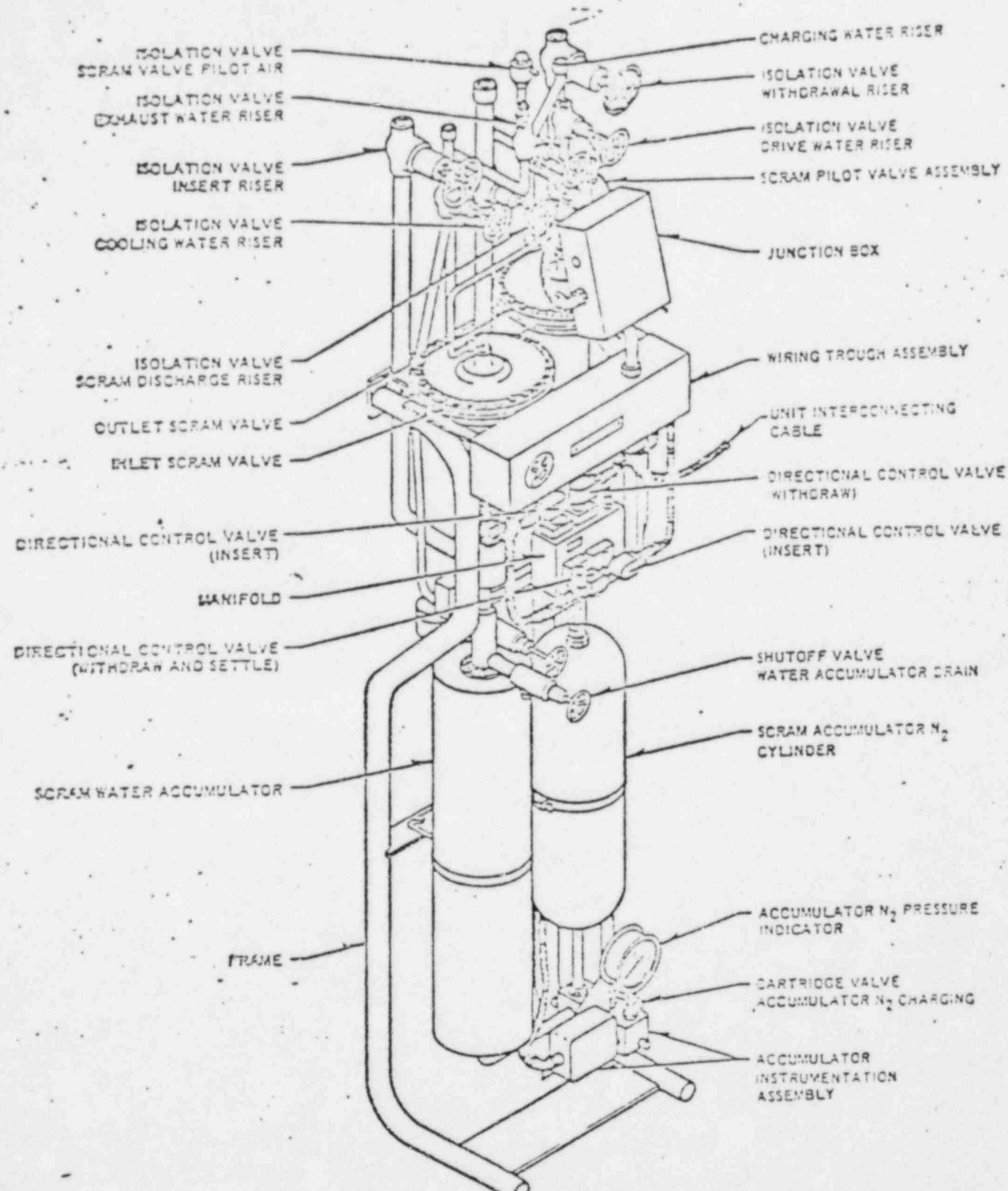
1. BACKGROUND — S. A. HODGE

2. FRONT-END ANALYSIS — S. A. HODGE

3. DEGRADED-CORE ANALYSIS — S. R. GREENE



BWR Scram Hydraulic System (scrammed valve lineup)



Control Rod Drive Hydraulic Control Unit (component assembly)

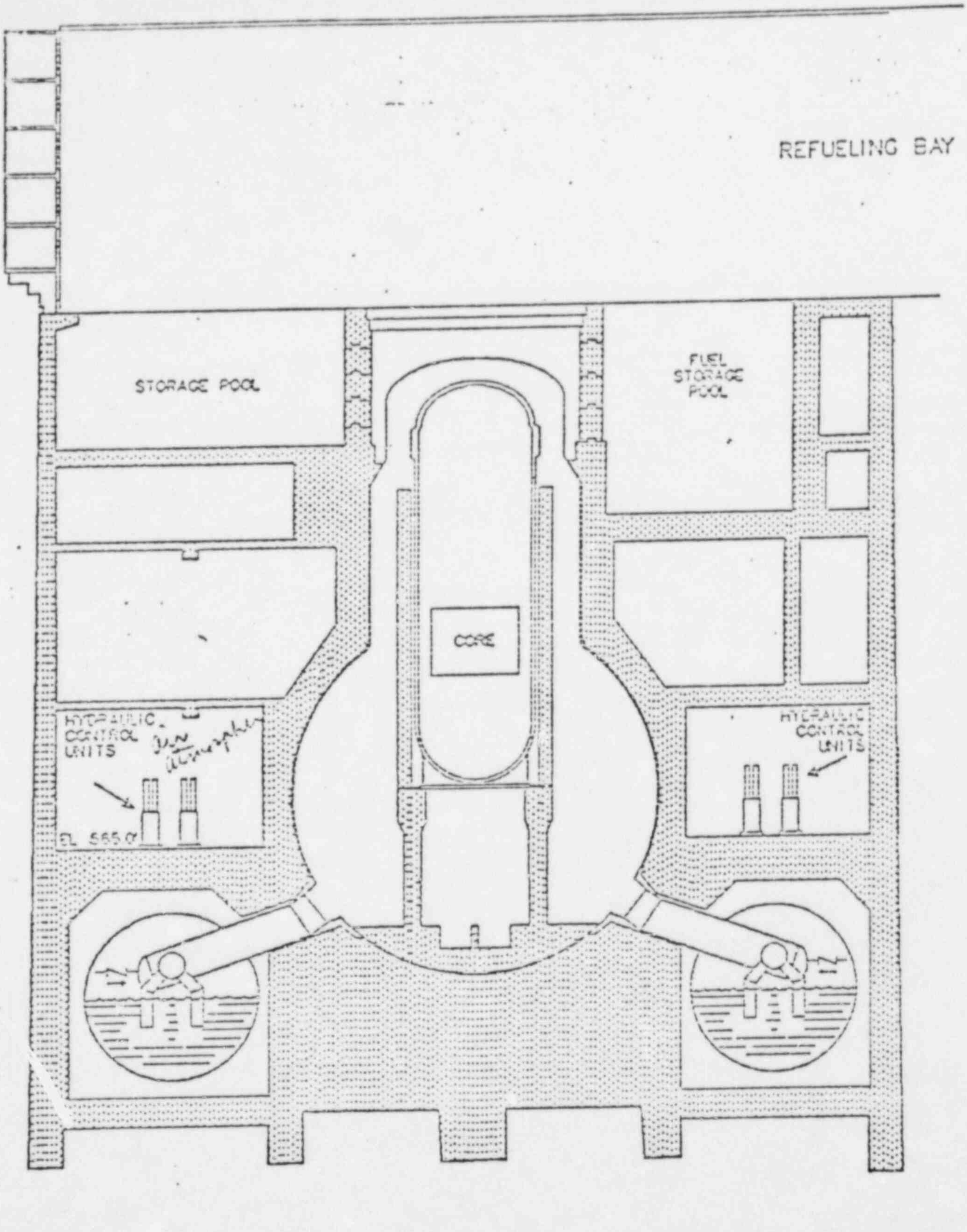
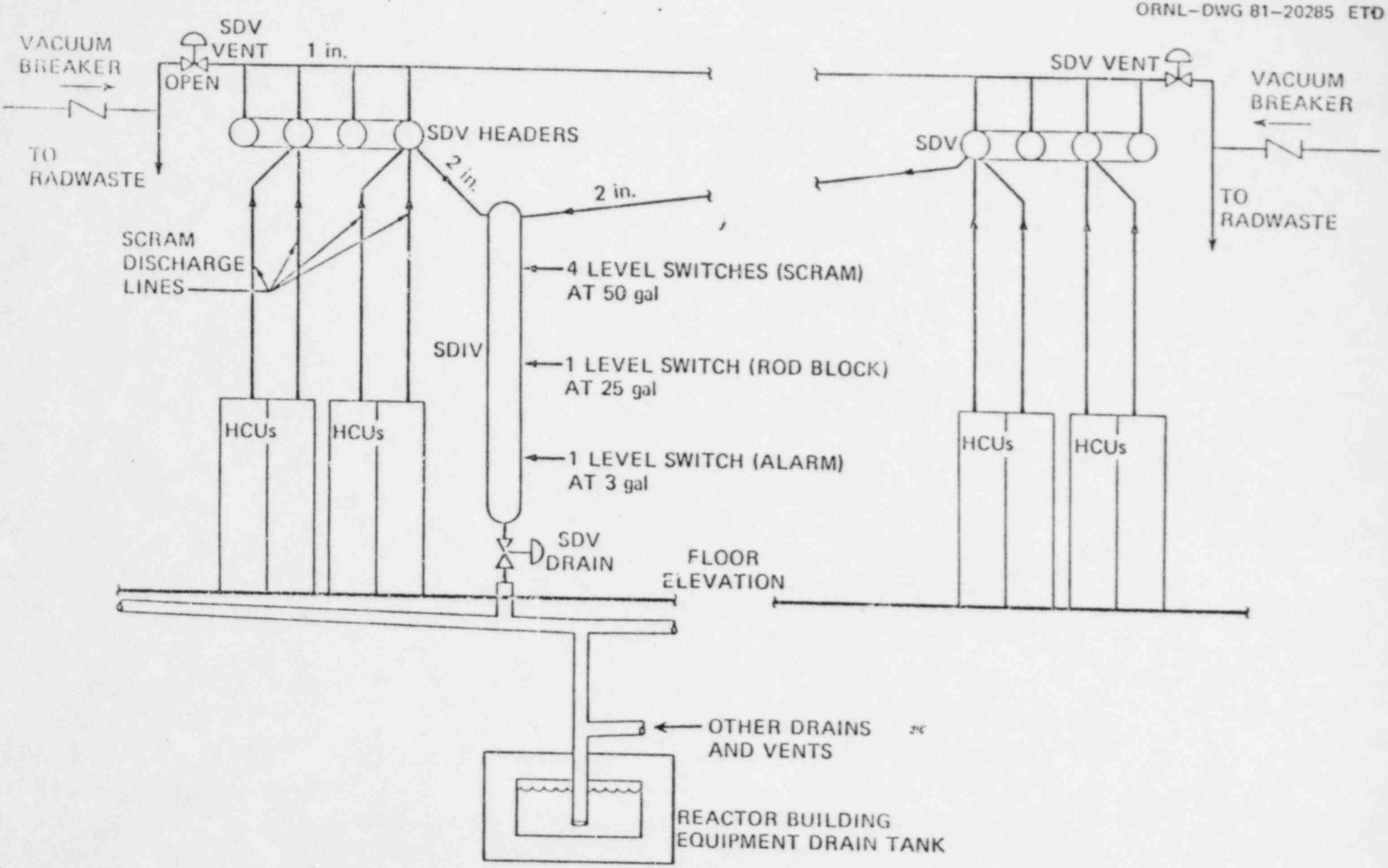


Fig. E.5 Location of Hydraulic Control Units for the Unit 1 Section of the Reactor Building

ORNL-DWG 81-20285 ETD



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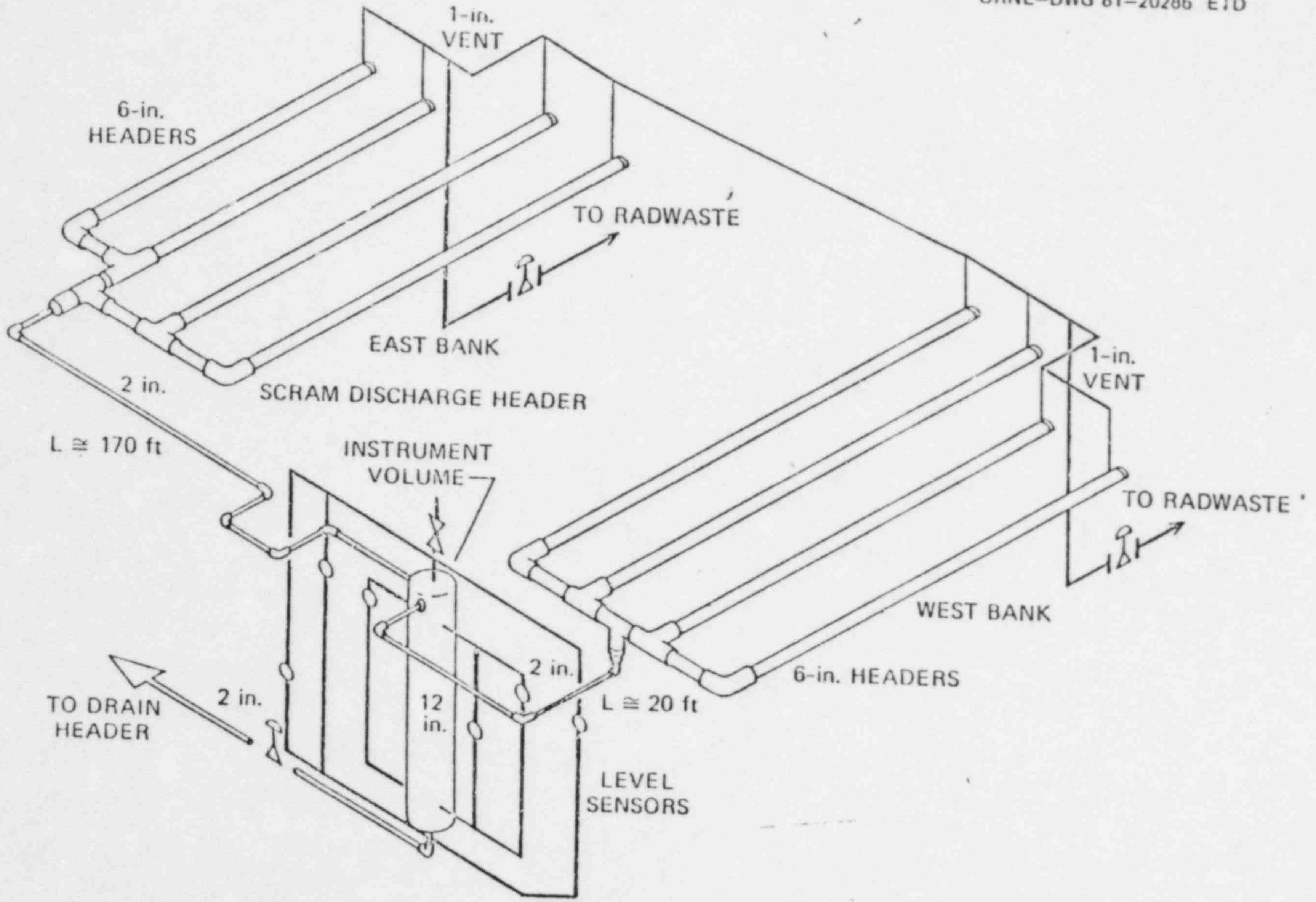


ORNL-DWG 82-5179 ETD

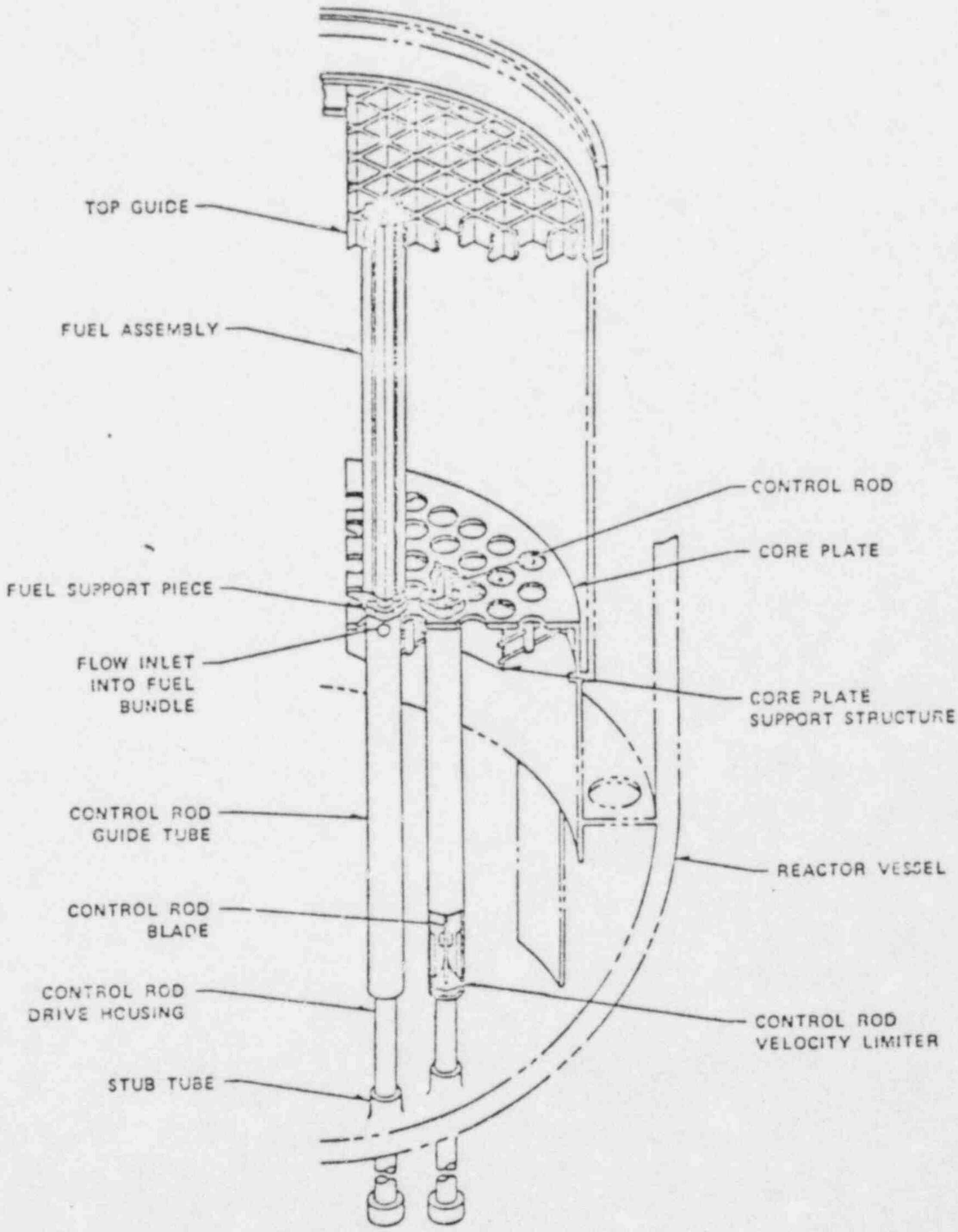


Fig. B.6 BWR Fuel Assembly Support

PART II

EVENTS OF ACCIDENT SEQUENCE BEFORE CORE UNCOVERY

WORK PERFORMED BY
R. M. HARRINGTON

ASSUMPTIONS

- SCRAM IS INITIATED BY HIGH MAIN STEAM LINE RADIATION
  - --- MSIVs SHUT
  - --- FEEDPUMPS TRIP
  - --- CONDENSATE AND CONDENSATE BOOSTER PUMPS CONTINUE TO RUN
- SDV PIPING RUPTURES 30 SEC. AFTER SCRAM
- LEAKAGE IS CONSTRAINED ONLY BY THE CRD MECHANISM SEALS
  - --- 550 GPM INITIALLY
  - --- AFTER 90 MIN., EFFECTIVE LEAKAGE AREA INCREASES DUE TO SEAL EROSION
  - --- SEALS COMPLETELY REMOVED AFTER 8 HRS.
- NO OPERATOR ACTION
  - --- LEVEL MAINTAINED BY HPCI SYSTEM
  - --- PRESSURE LIMITED BY AUTOMATIC RELIEF VALVE ACTUATION

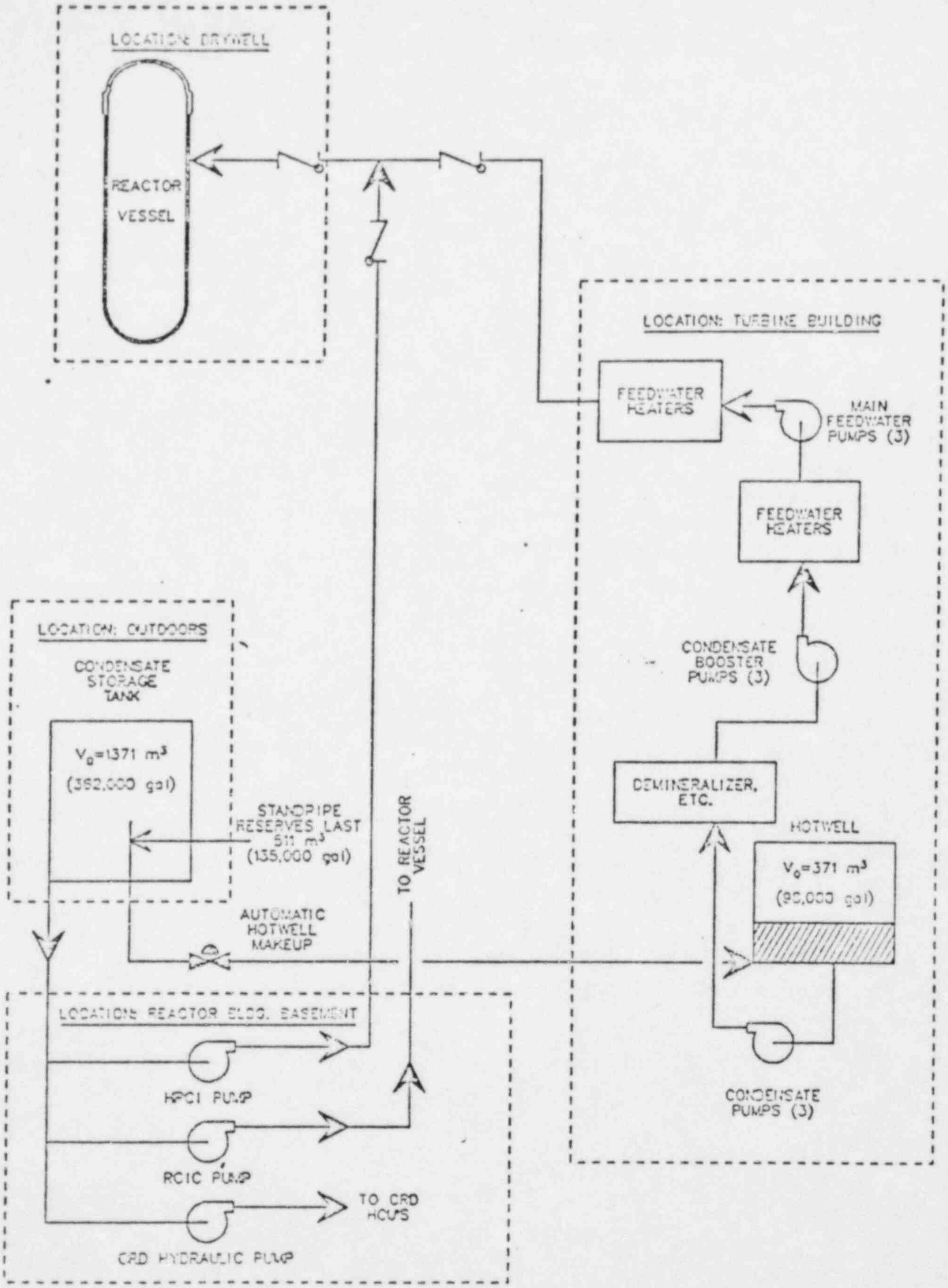


Fig. 3.4 Reactor Vessel Injection Paths for Scram Discharge Volume Break

MAJOR EVENTS DURING FIRST 8 HOURS

TIME	EVENT
0	REACTOR TRIP ON 3 X N HIGH MAIN STEAM RADIATION
30 s	SDV BREAK
3.2 m	HPCI AND RCIC INITIATION ON LOW REACTOR VESSEL WATER LEVEL
3.9 h	VESSEL PRESSURE GOES BELOW COMBINED HEAD OF CONDENSATE PUMP AND CONDENSATE BOOSTER PUMP: CONDENSATE FROM HOTWELL BEING PUMPED INTO REACTOR VESSEL
4.6 h	REACTOR VESSEL FULL
5.2 h	HOTWELL EMPTY, CBP TRIPPED ON LOW SUCTION PRESSURE, VESSEL INJECTION STOPS
7.3 h	CORE BEGINNING TO BE UNCOVERED

Fig 3.1

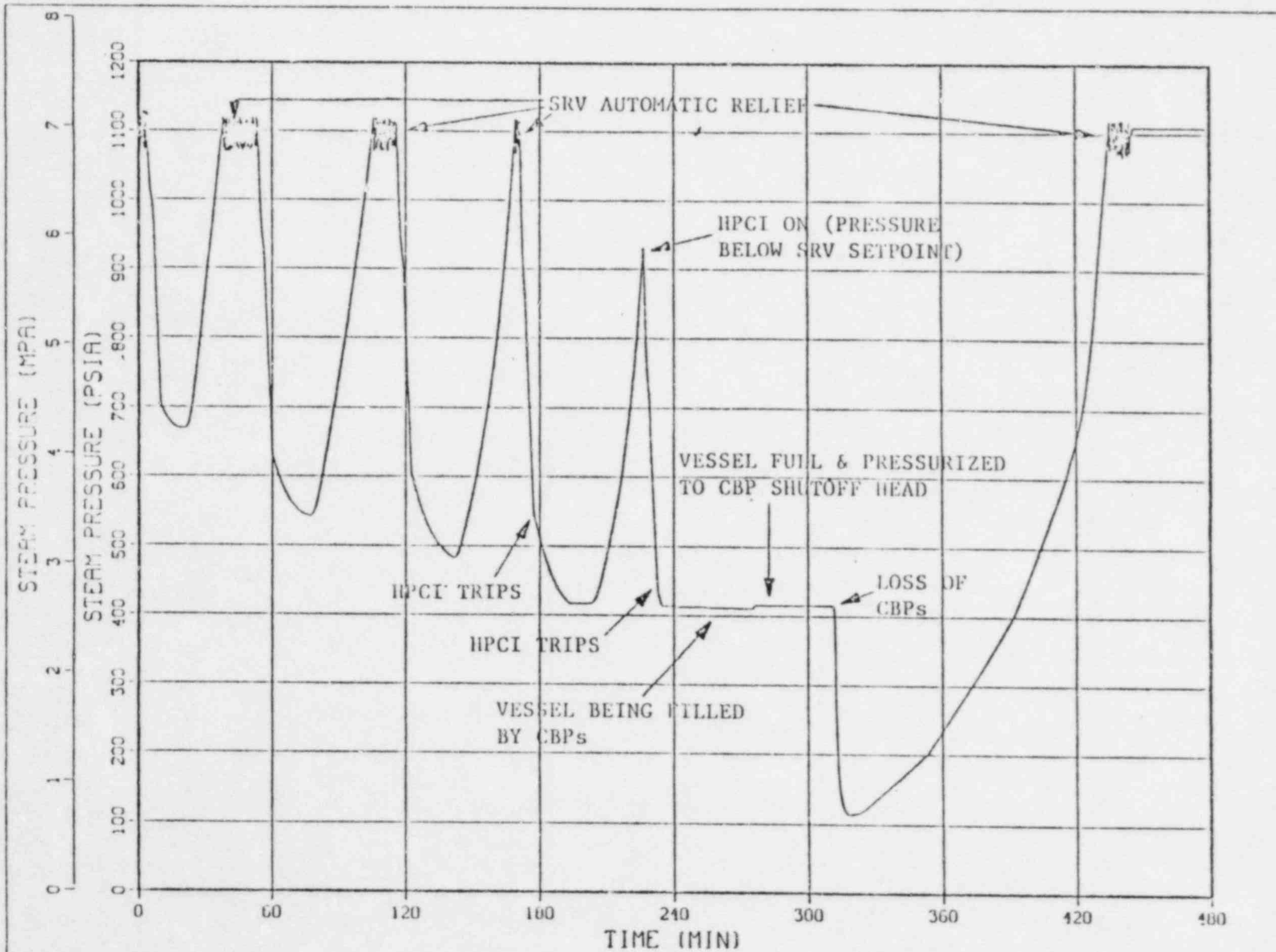


Fig. 3.1 SDV break sequence without operator action - reactor vessel pressure

Fig 3.5

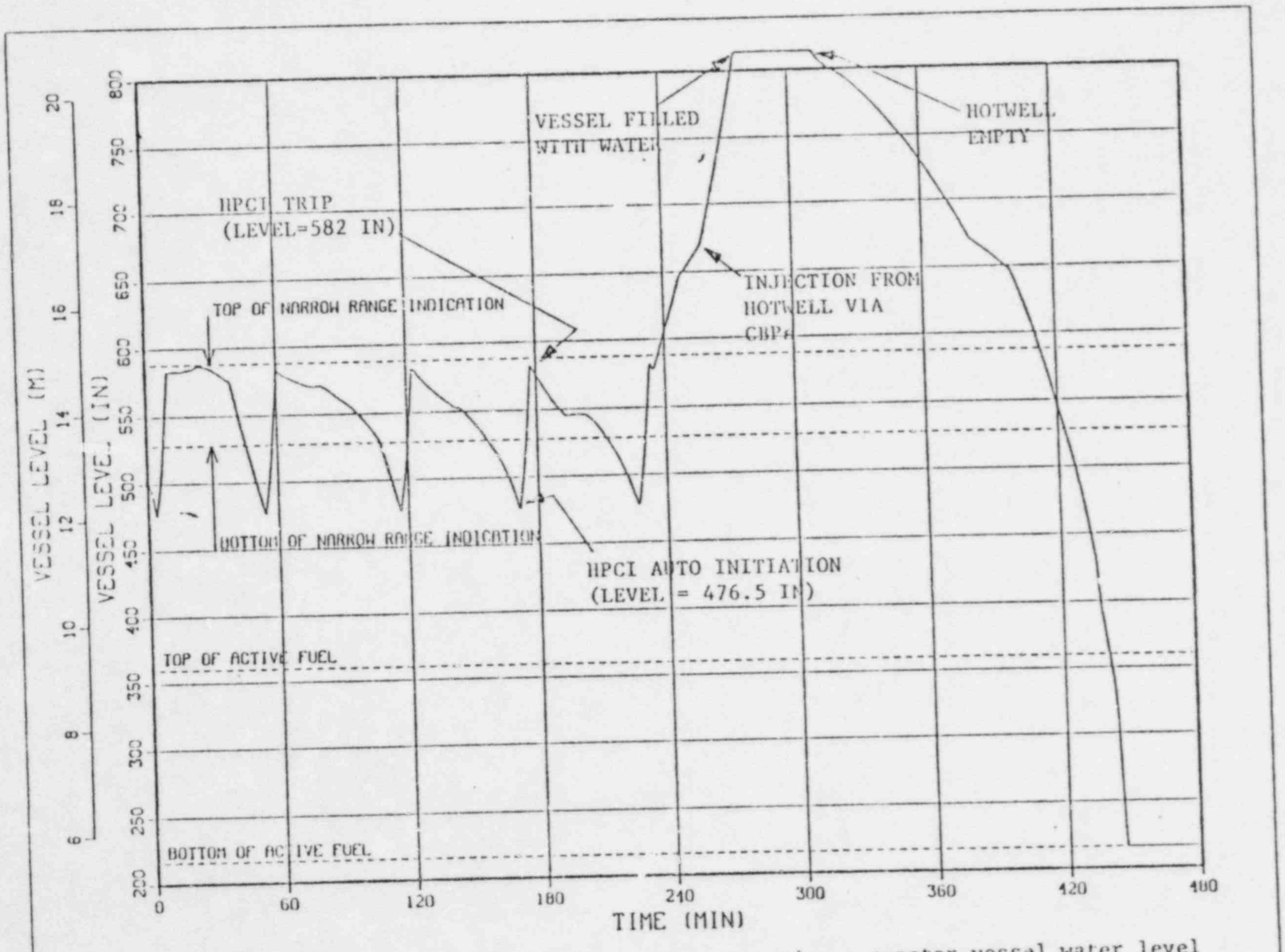


Fig. 3.5 SDV break sequence without operator action - reactor vessel water level

Fig 3.10

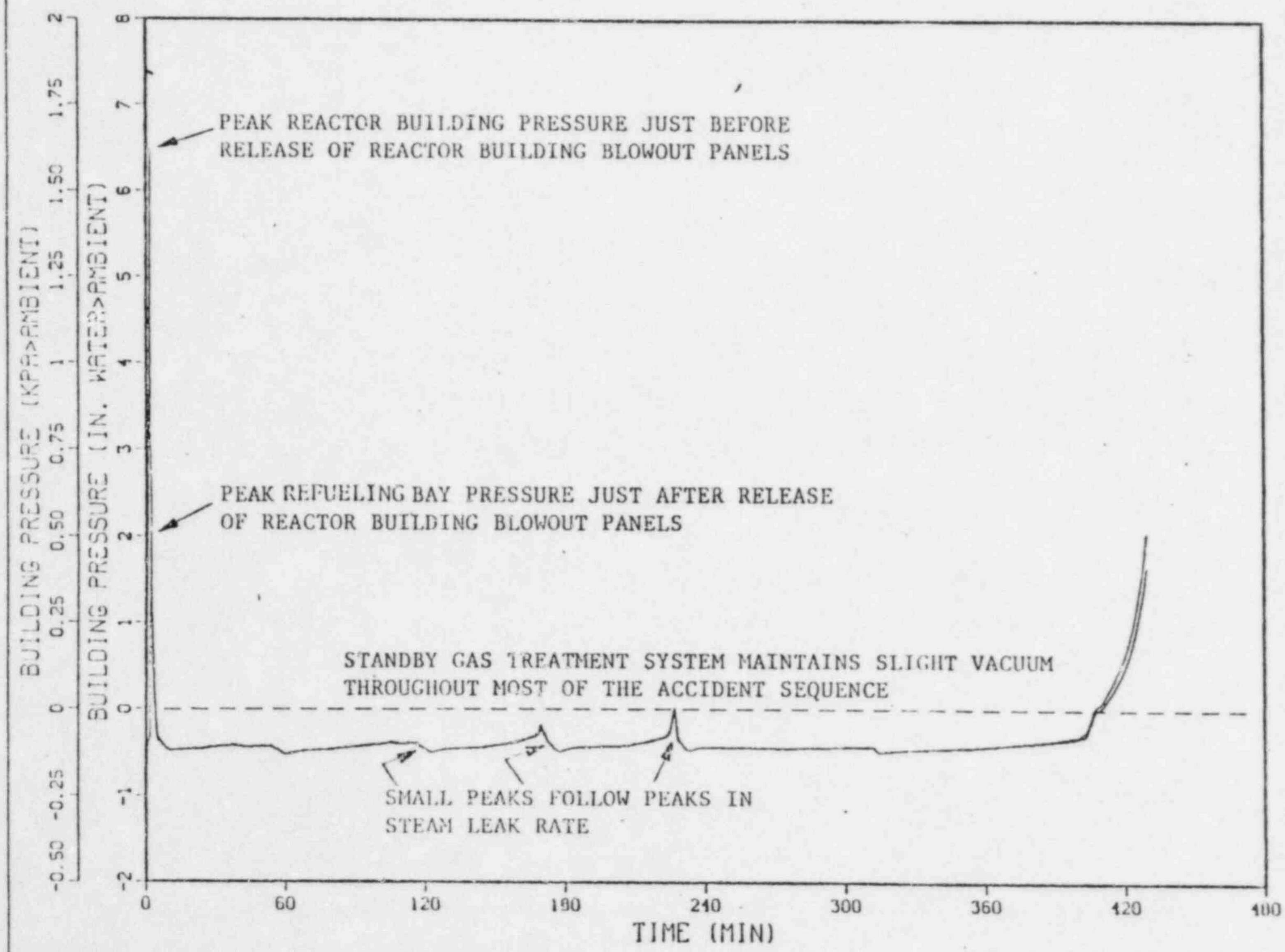


Fig. 3.10 SDV break sequence without operator action - reactor building and refueling floor pressures.

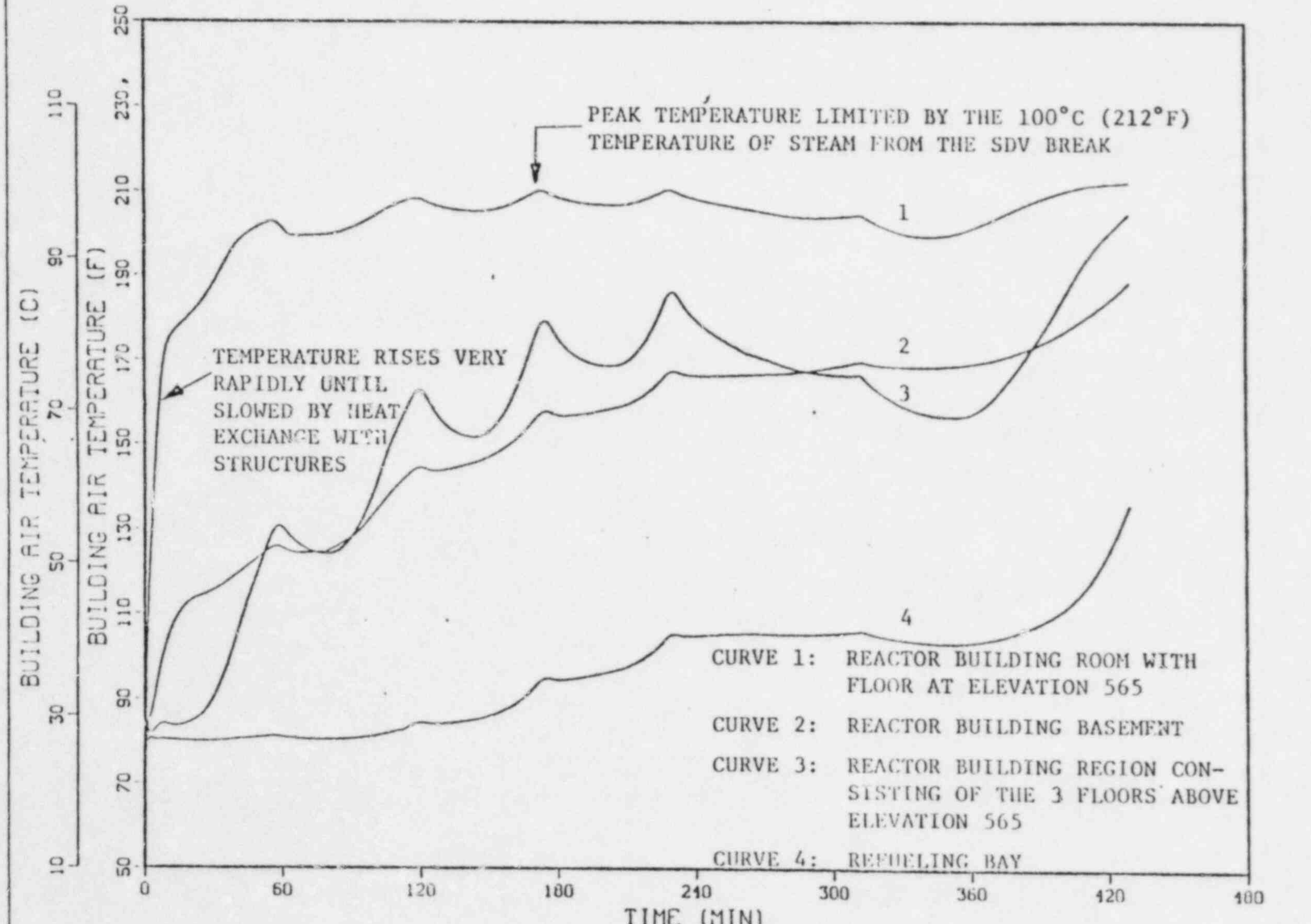
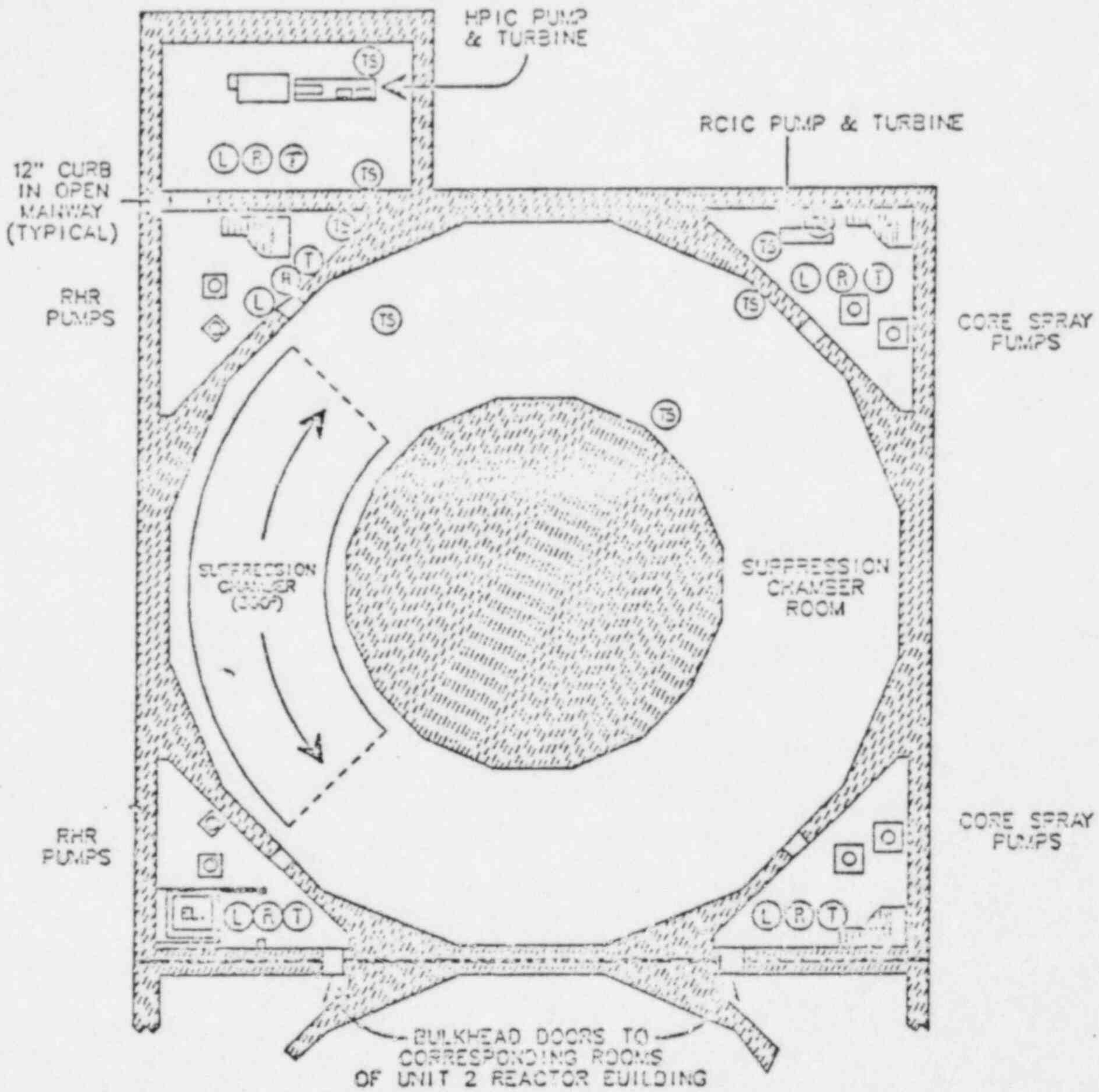


Fig. 3.11 SDV break sequence without operator action - reactor building and refueling bay atmosphere temperatures



L = WATER FLOODING DETECTORS

T = ROOM AIR TEMPERATURE SENSORS

TS = AIR TEMPERATURE SENSORS NEAR RCIC OR HPIC STEAM LINES

R = RADIATION MONITOR

Fig. 4.3 Browns Ferry Unit 1 Basement Leak Detection Sensors

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Fig 3.13

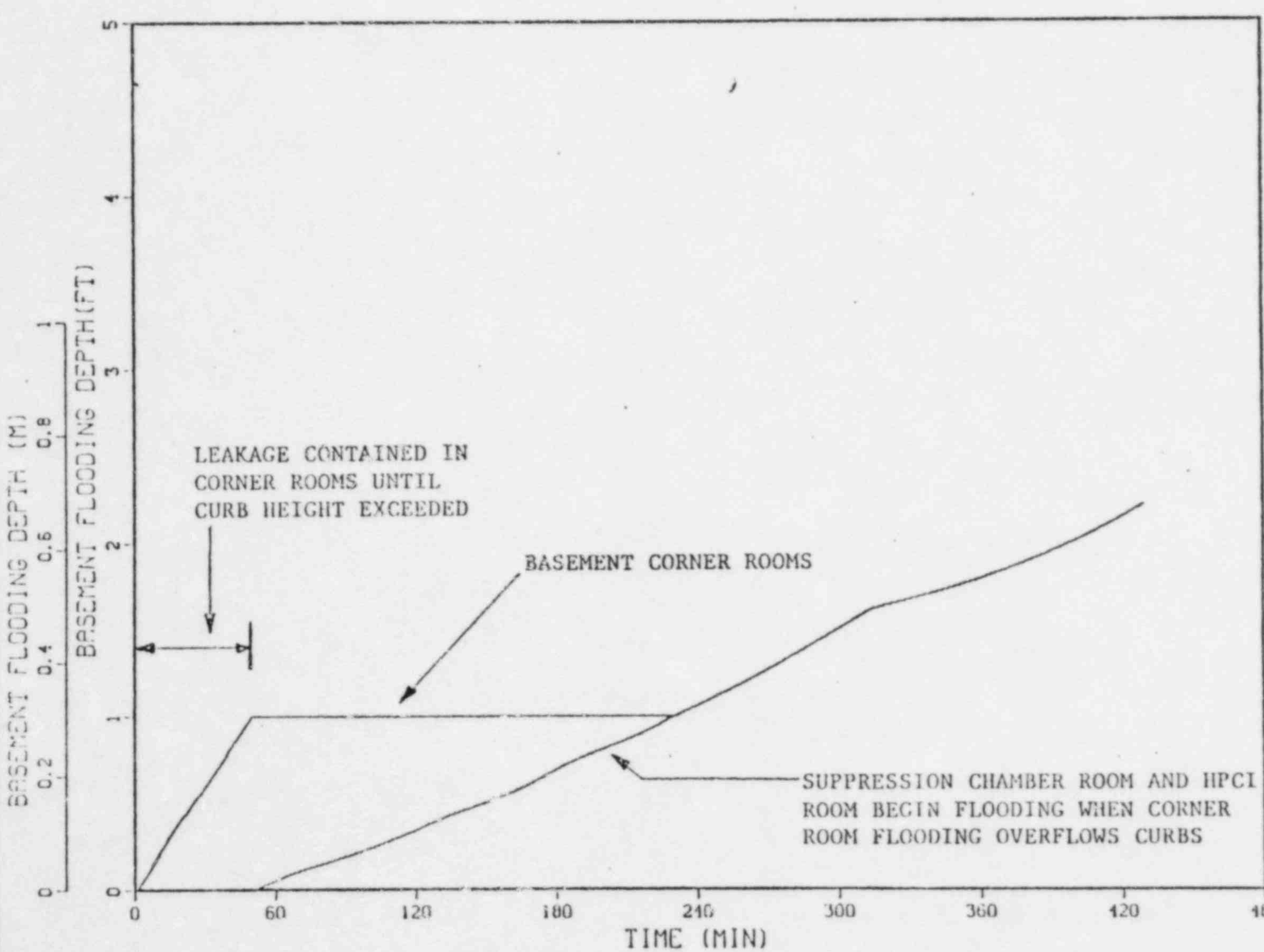

Fig. 3.13 SDV break sequence without operator action - depth of flooding in reactor building basement

SEQUENCES WITH OPERATOR ACTION

- SLOW DEPRESSURIZATION
- FAST DEPRESSURIZATION

5.1

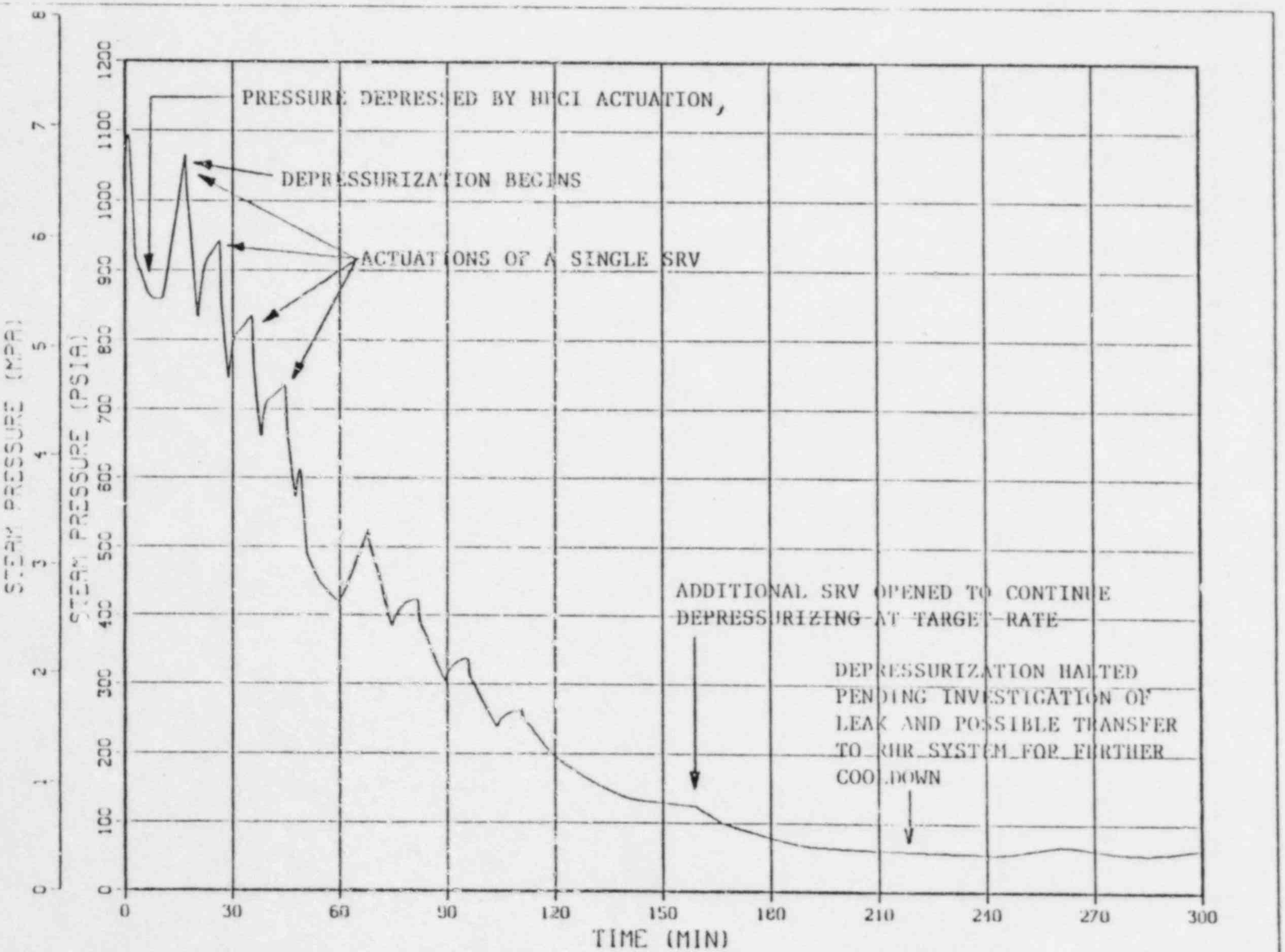

Fig. 5.1 SDV Break Operator-Action Sequence with Slow Depressurization - Reactor Vessel Pressure

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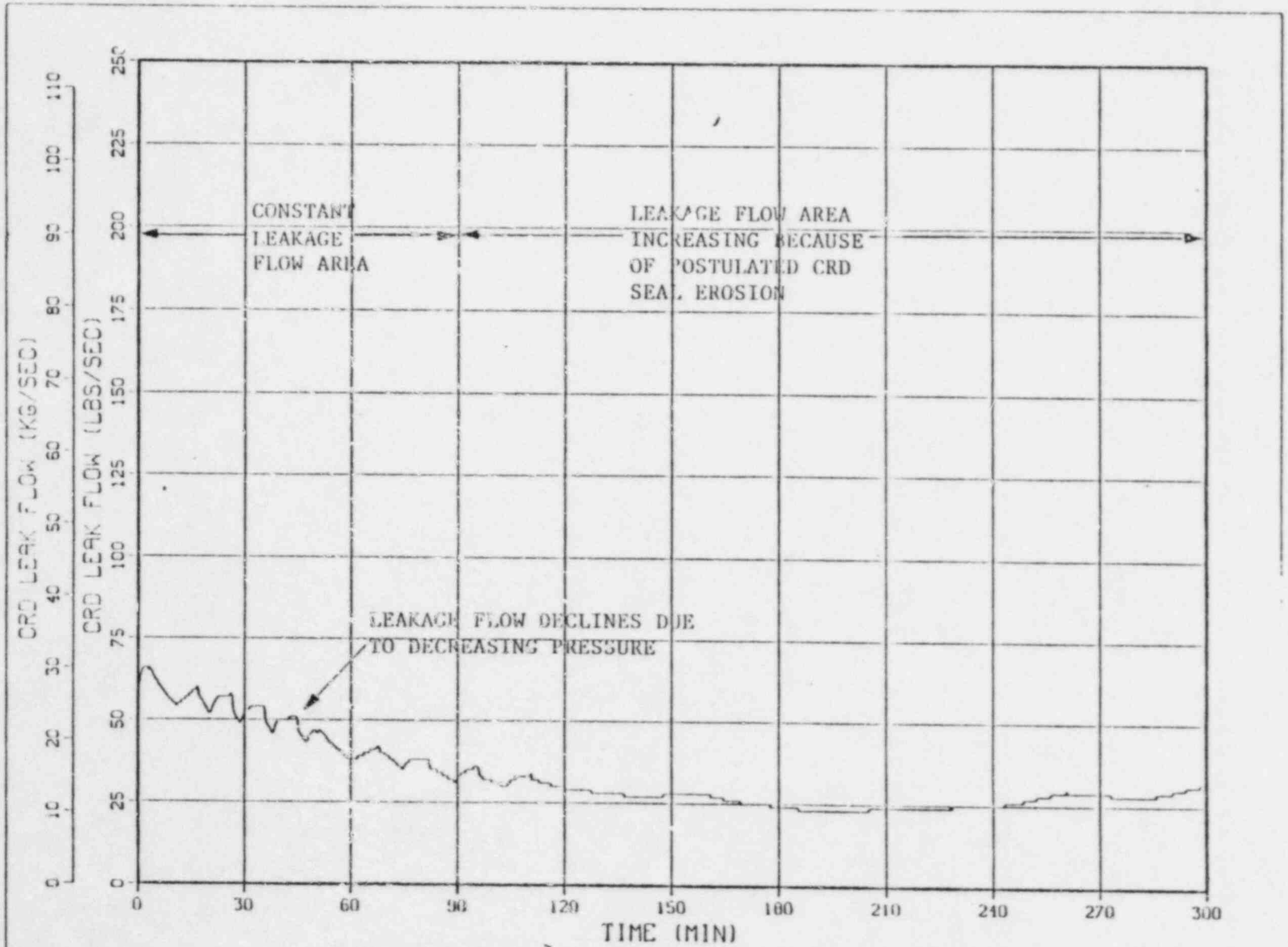

Fig. 5.3 SDV Break Operator-Action Sequence with Slow Depressurization - Leakage

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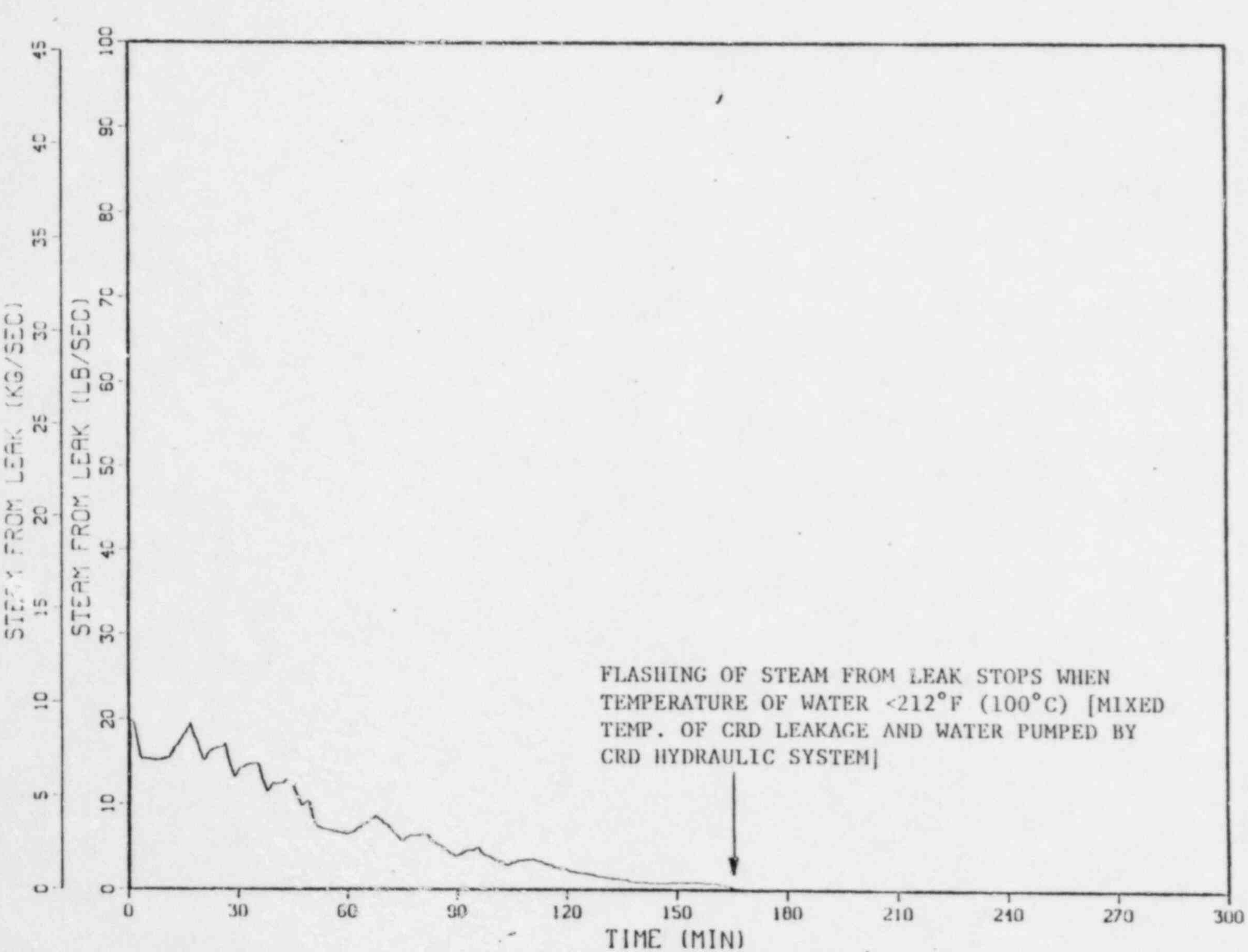

Fig. 5.6 SDV Break Operator-Action Sequence with Slow Depressurization - Rate Of Steam Flashing Into Reactor Building

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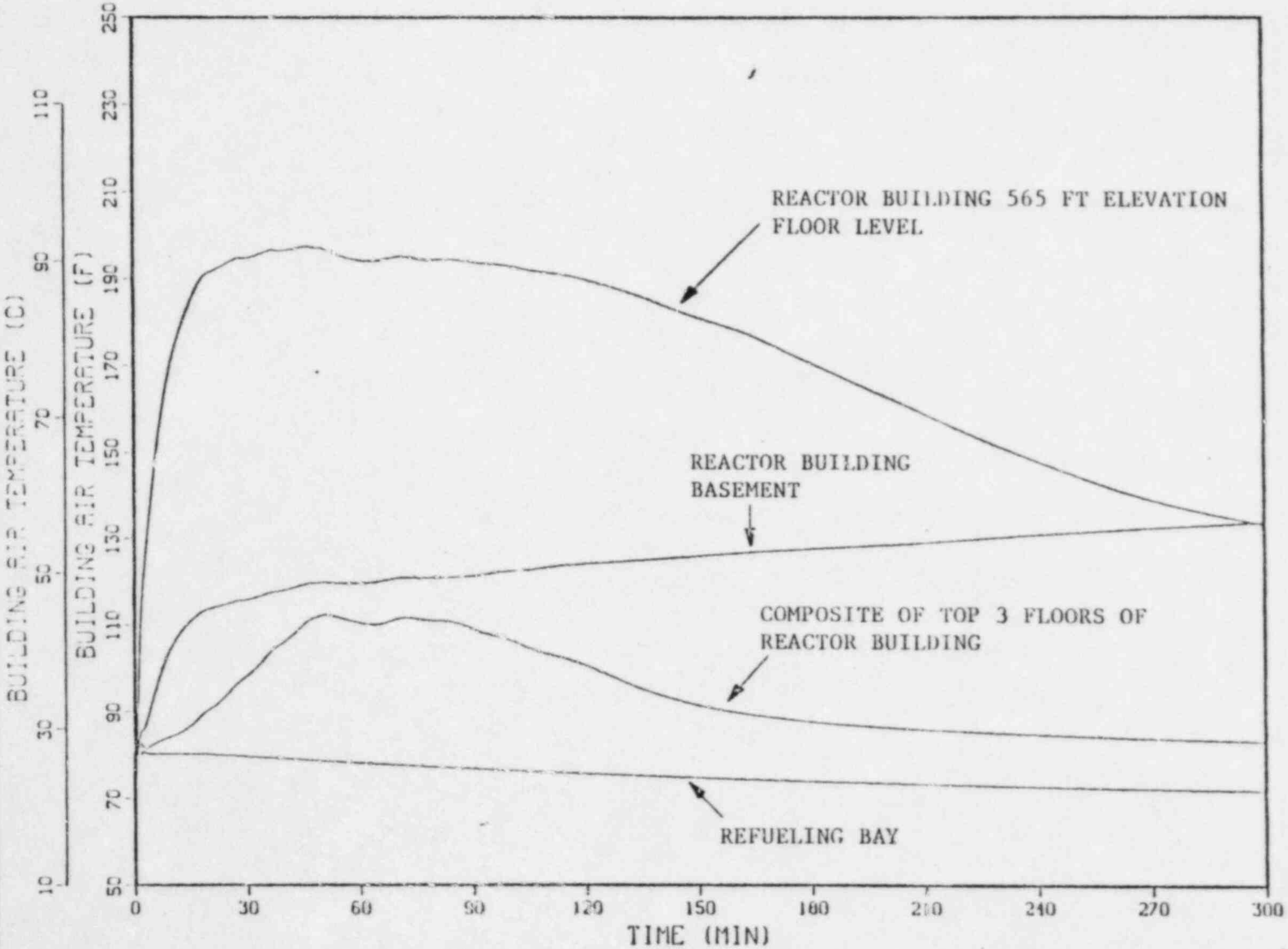

Fig. 5.8 SDV Break Operator-Action Sequence with Slow Depressurization - Building Atmosphere Temperatures

Fig 5.10

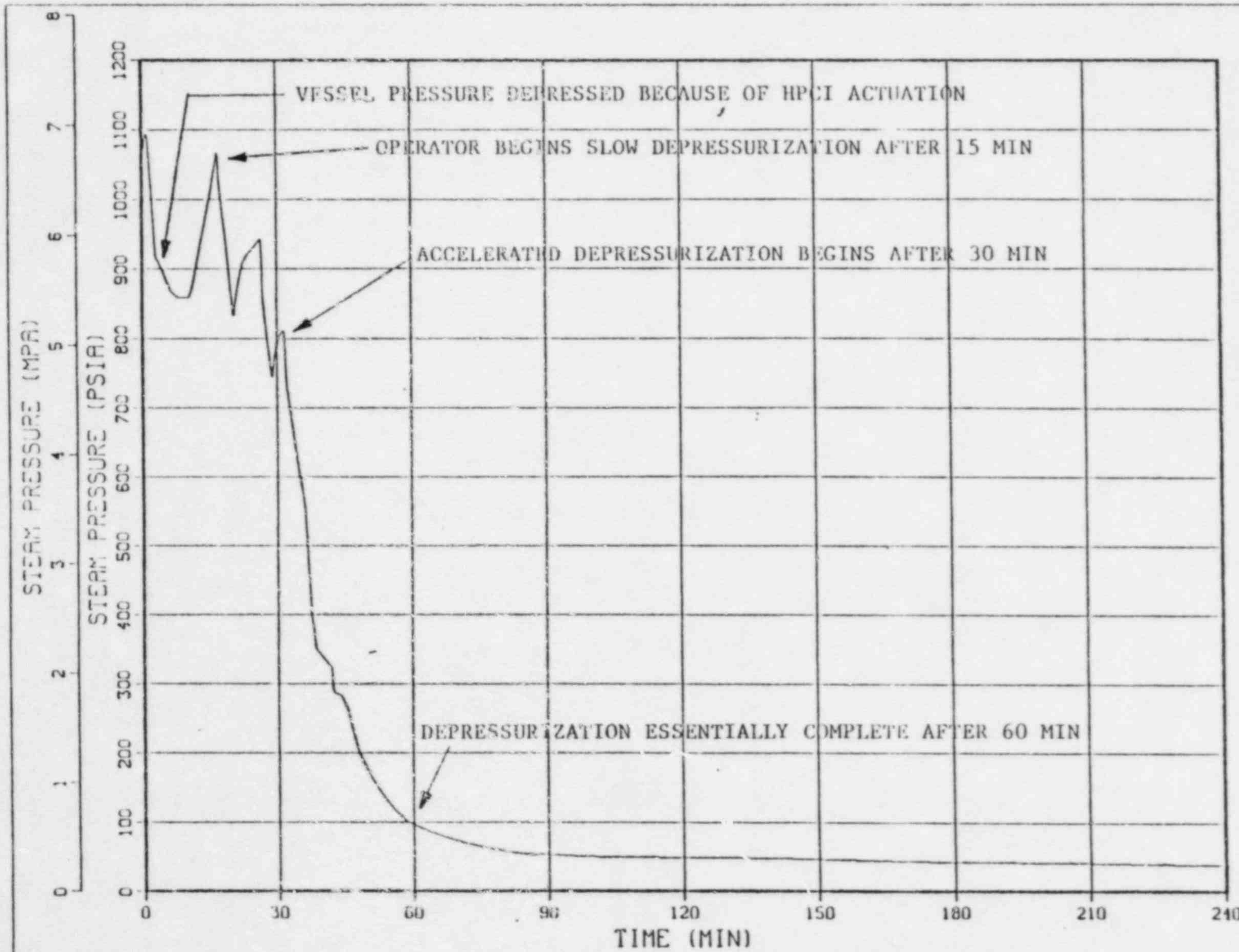

Fig. 5.10 SDV Break Operator-Action Sequence With Fast Depressurization - Reactor Vessel Pressure

5.12

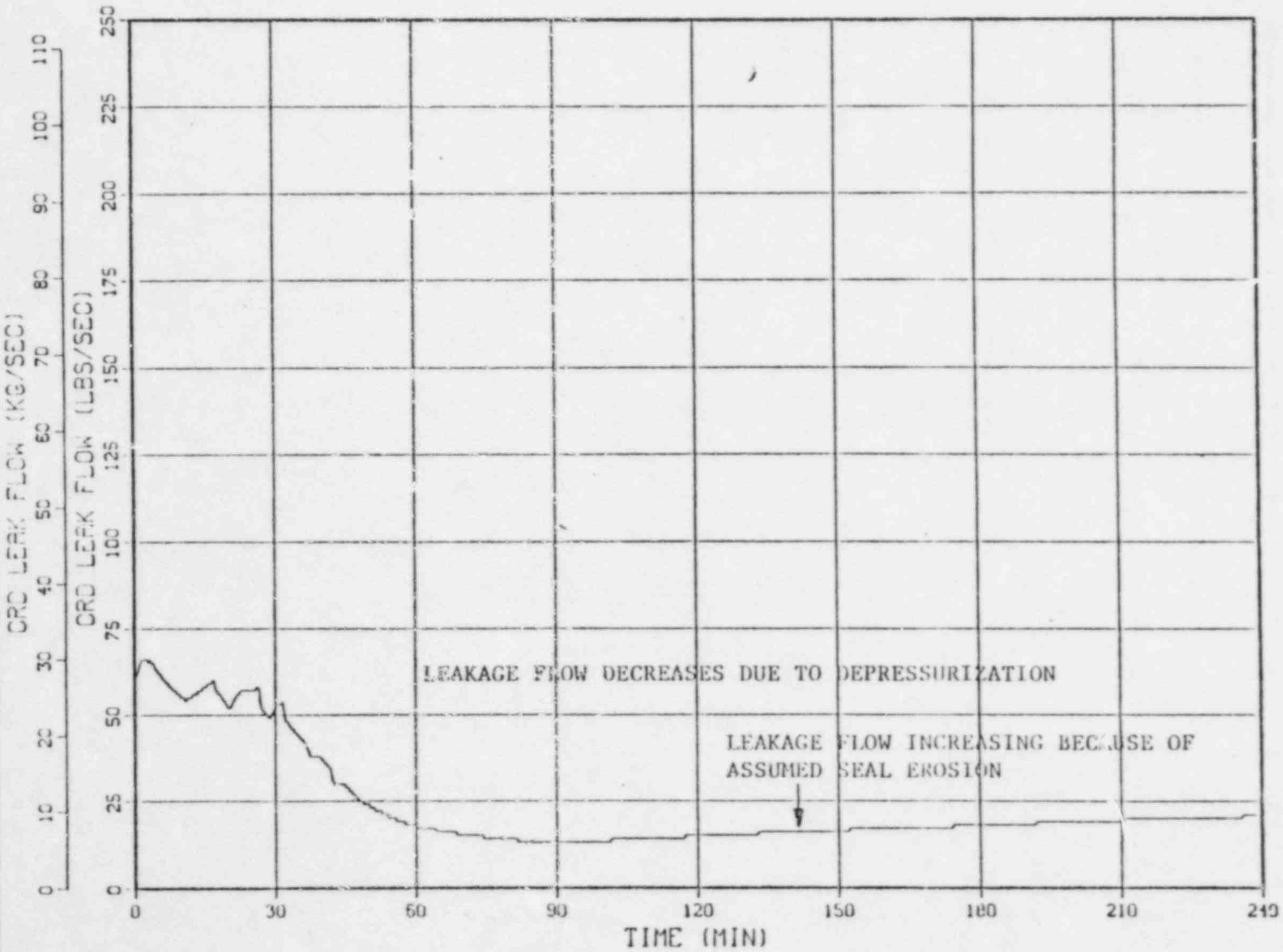

Fig. 5.12 SDV Break Operator-Action Sequence With Fast Depressurization - CRD Leakage Flow

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5.15

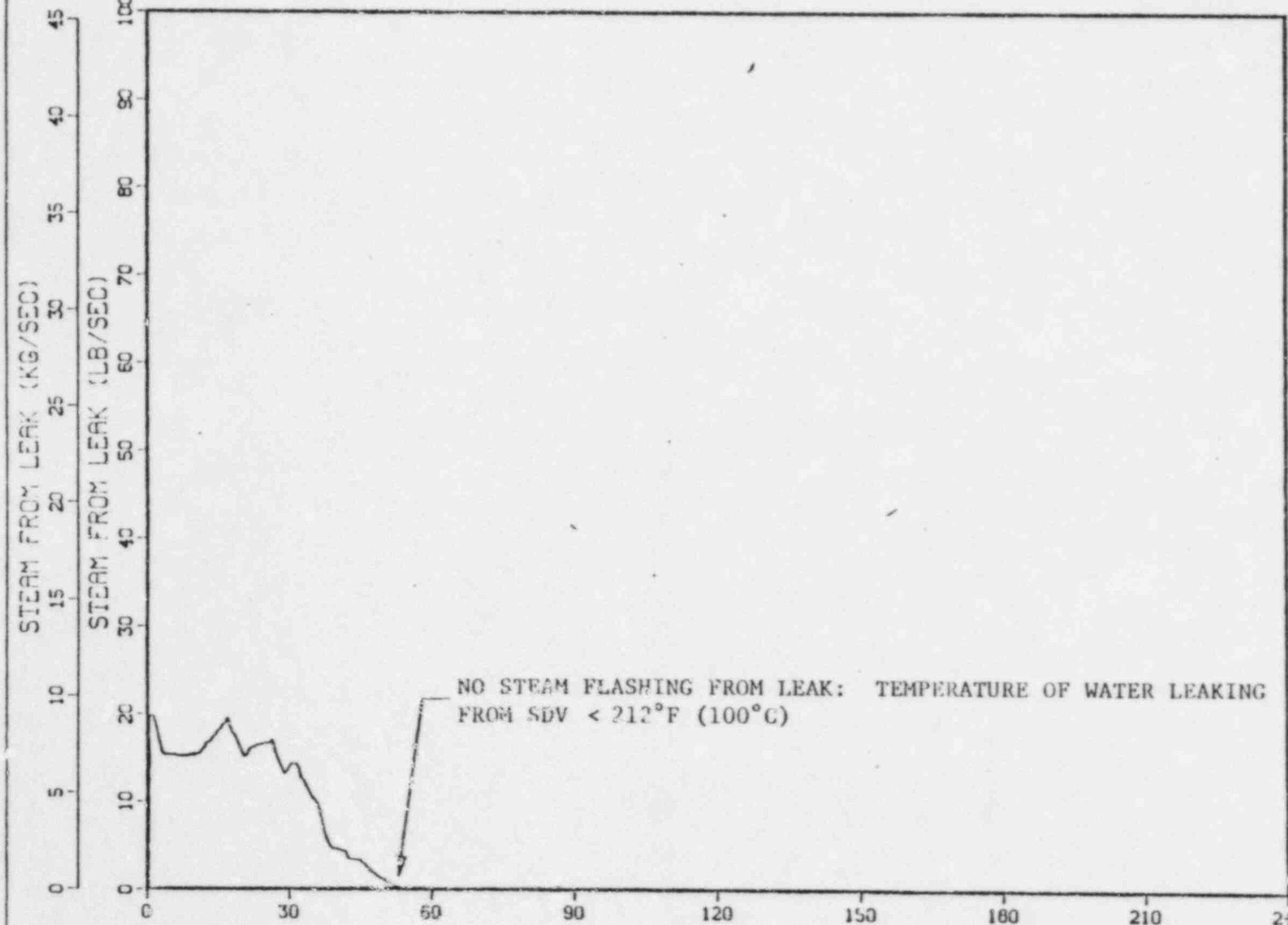

Fig. 5.15 SDV Break Operator-Action Sequence With Fast Depressurization - Steam Flow From Leak

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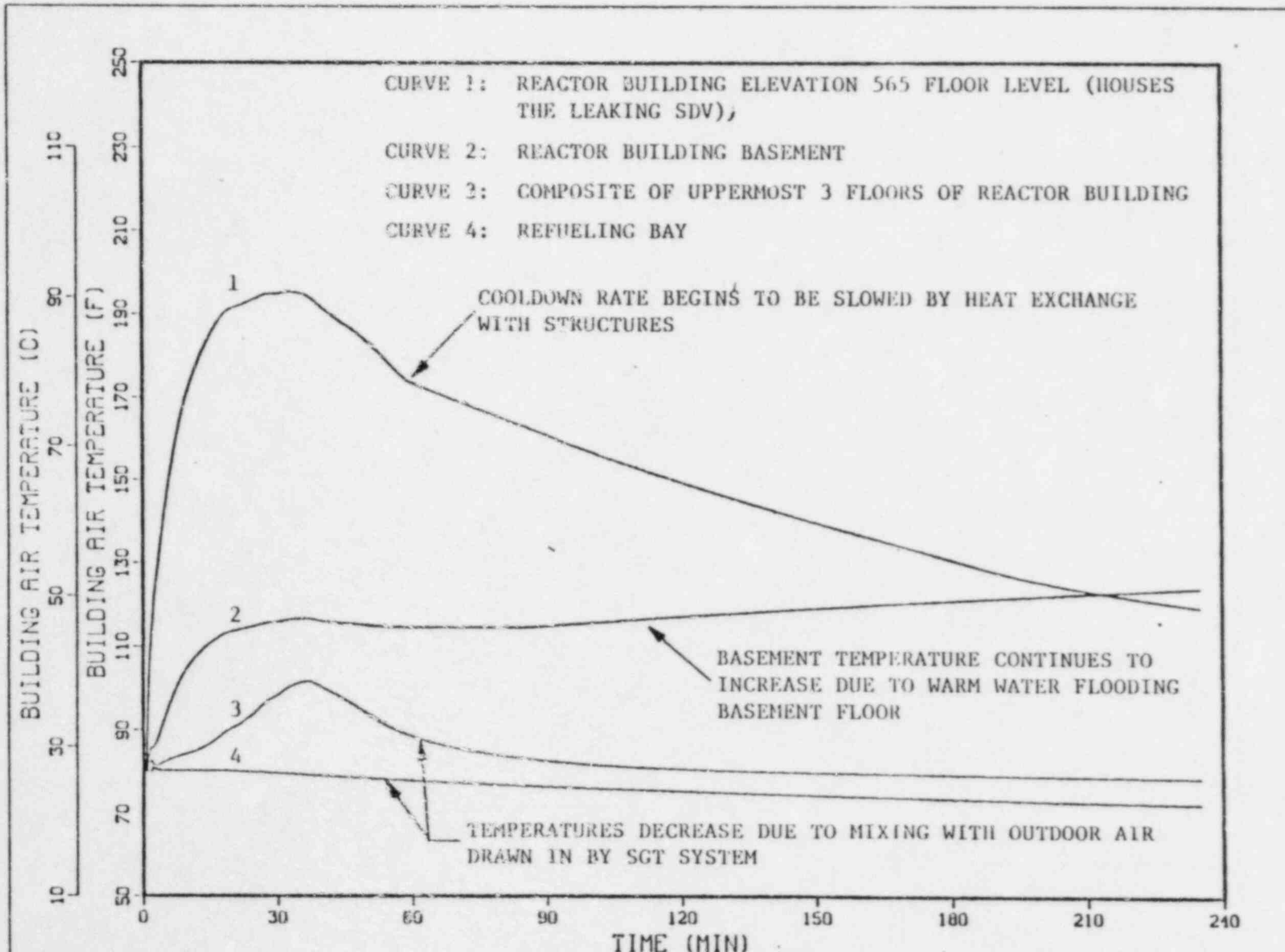

Fig. 5.17 SDV Break Operator-Action Sequence With Fast Depressurization - Reactor Building Atmosphere Temperature

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CONCLUSIONS

- ACCIDENT MUCH LESS SERIOUS WITHOUT SEAL EROSION
    - □ 16 HOURS TO INJECTION FAILURE
    - □ CAUSE IS BASEMENT FLOODING
- WITHOUT OPERATOR ACTION
    - □ INJECTION FAILS AT 5.2 HR.
    - □ CAUSE: VESSEL FILL
HOTWELL EMPTY
    - □ PRESSURIZED BOILOFF
    - □ CORE UNCOVERED AT 7.3 HR.

CONCLUSIONS (CONT)

WITH OPERATOR ACTION

- SBLOCA RECOGNIZED WITHIN 30 MIN
    - RB FLOODING ALARMS
    - RB TEMPERATURE ALARMS
    - RB RADIATION ALARMS
- SDV BREAK WITHIN 60 MIN
    - CRD TEMPERATURE ALARMS
    - ABNORMAL ROD POSITION INDICATION
- CONTROL ROOM ALARMS AND INSTRUMENTS AUGMENTED BY
    - REPORTS OF PERSONS ON SCENE
    - REPORT OF RADWASTE CONTROL ROOM OPERATOR.

CONCLUSIONS (CONT)

OPERATOR ACTIONS

- OVERRIDE SCRAM SIGNAL AND RESET SCRAM
- DEPRESSURIZE
  - □ REQUIRED BY EOI FOR HIGH MAIN STEAM LINE RADIATION (100 F°/h)
  - □ NOT REQUIRED BY EOI FOR SBLOCA OUTSIDE CONTAINMENT

    ---UNLESS > 5000 GPM

STUDY RECOMMENDATIONS

- FUTURE DESIGNS SHOULD INCLUDE PROVISION FOR:

  - ☐ INDICATION OF THE NUMBER OF CRD HIGH TEMPERATURE ALARMS

  - ☐ INDICATION OF THE SCRAM DISCHARGE VOLUME PRESSURE

  - ☐ REALIGNMENT OF CRD HYDRAULIC SYSTEM AFTER SCRAM

  - ☐ HIGH-LEVEL TRIP OF CONDENSATE BOOSTER PUMPS

RECOMMENDATIONS (CONT)

- EMERGENCY OPERATING INSTRUCTIONS

  - SHOULD REQUIRE VESSEL DEPRESSURIZATION FOR SBLOCA OUTSIDE CONTAINMENT.

  - SHOULD CAUTION OPERATOR TO PREVENT VESSEL FILL.

SASA PROGRESS REPORT

PRESENTED AT
SILVER SPRING, MARYLAND
APRIL 13-14, 1982

J.L. DARBY
F.E. HASKIN

SANDIA ACCOMPLISHMENTS SINCE JANUARY

*PRESSURIZED THERMAL SHOCK STUDIED

*ZION FINAL REPORT COMPLETED

*MARCH MODS REPORT BEING COMPLETED

*3 PAPERS WRITTEN

*PWR CONTAINMENT PLAN DEVELOPED

*CONTACT WITH MAINE YANKEE MADE

HIGHLIGHTS OF WORK

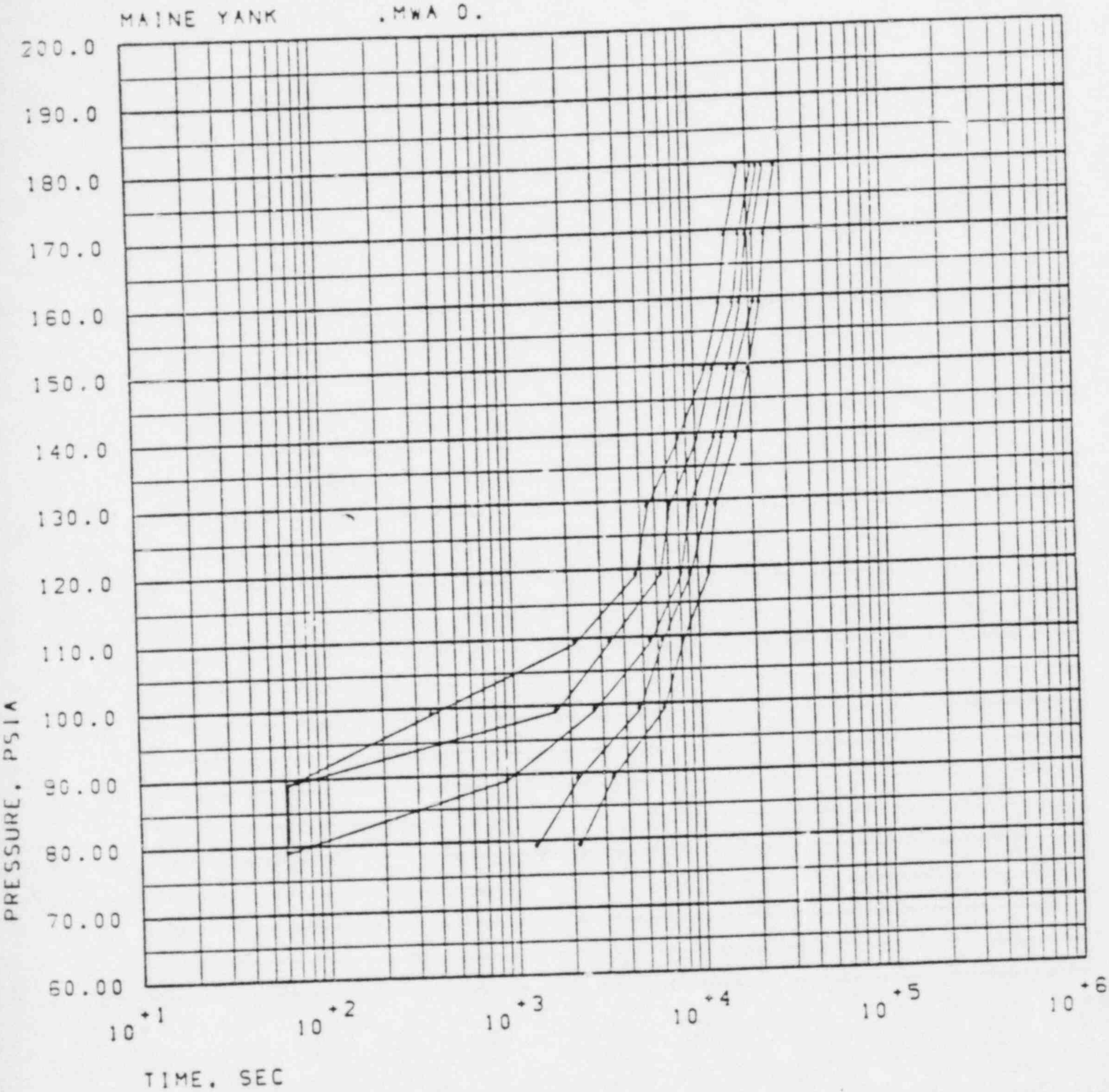
*THERMAL SHOCK
  -CONTAINMENT WILL NOT FAIL AT
   MINIMUM TIME

*CONTAINMENT VENTING CAN NEGATE H_2 BURN

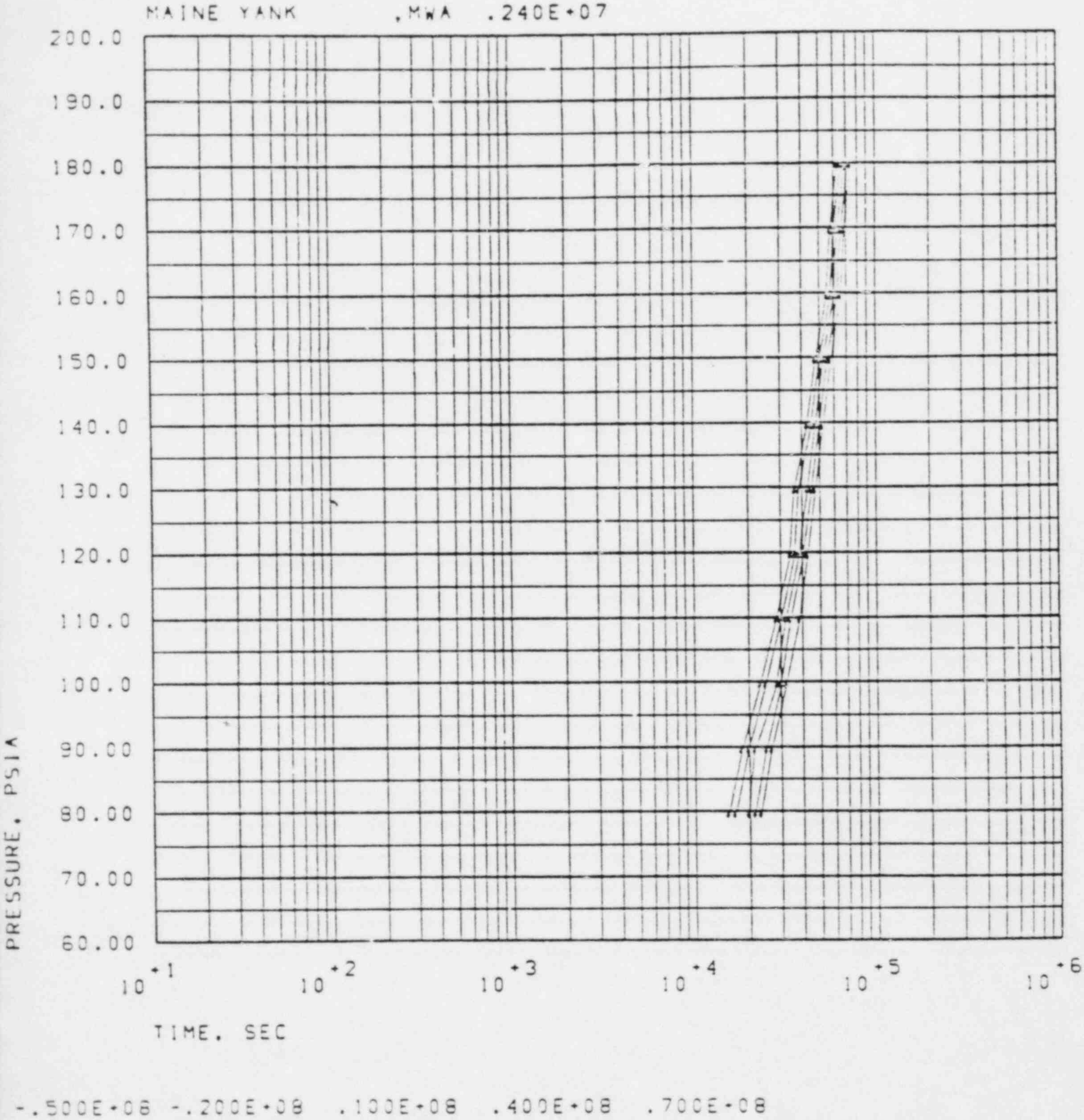
THERMAL SHOCK-CONTAINMENT

*H2 RELEASED LATER THAN IN LARGE LOCA
 -CONT. FAILURE DUE TO BURN NOT AT MINIMUM TIME

*OVERPRESSURE NOT AT MINIMUM TIME
 -ECCS FOR SMALL LOCA
 -MUCH WATER ADDED IN SG OVERCOOLING



.500E+08 -.200E+08 .100E+08 .400E+08 .700E+08



MAINE YANK .MWA .240E+07
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.00
80.00
70.00
60.00
PRESSURE, PSIA
10+1
10+2
10+3
10+4
10+5
10+6
TIME, SEC
-.500E+08 -.200E+08 .100E+08 .400E+08 .700E+08

SNL SASA RPT ON ZION VERSUS NUREG-0850

*MULTICOMPARTMENT CORRAL VS SINGLE COMPARTMENT CORRAL

*DIFFERENT PUFF RELEASE ESTIMATES

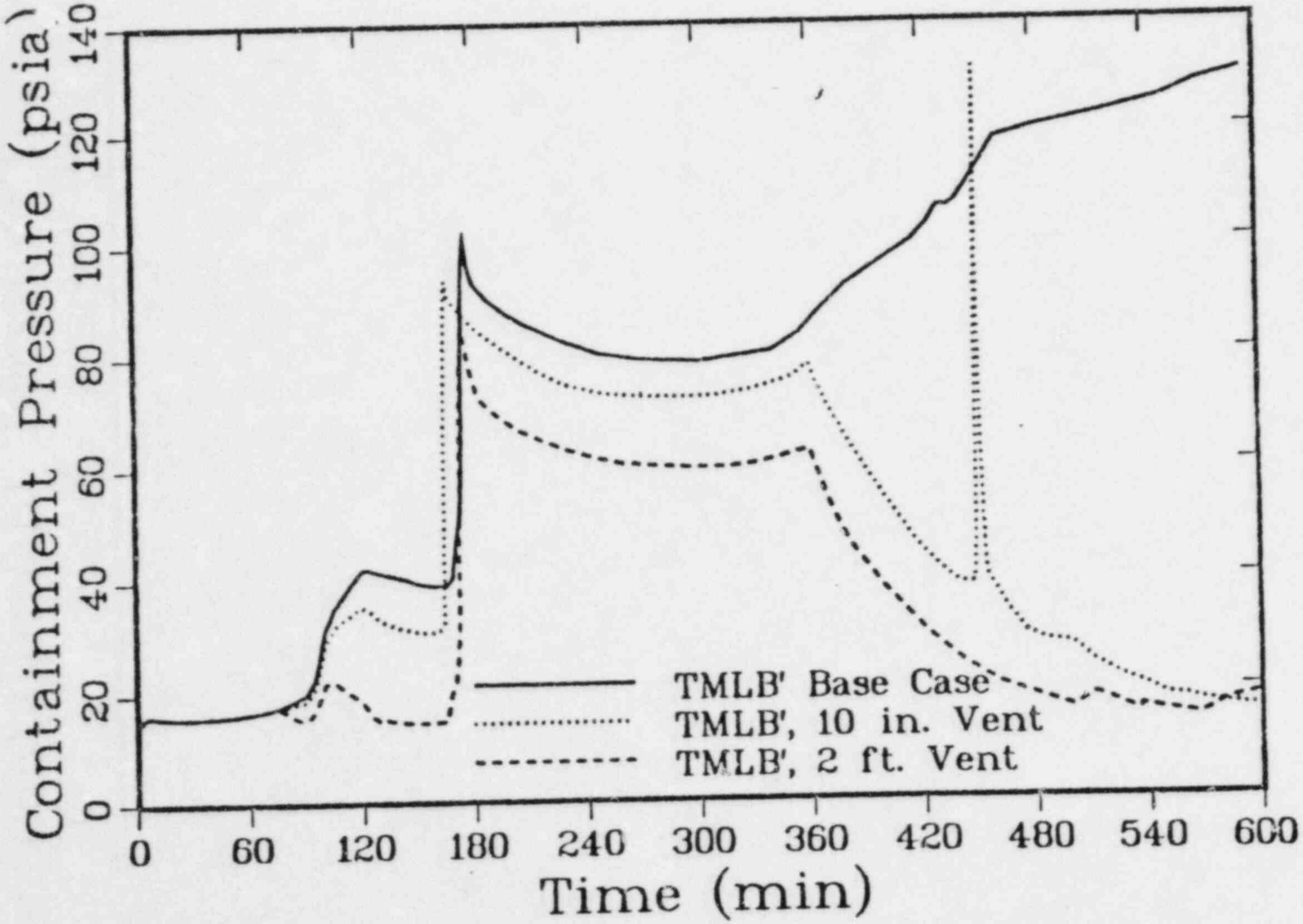
*0.1 VS 1.0 PER CENT PER DAY LEAKAGE FOR ISOLATED CONT.

*SNL ACKNOWLEDGES AC ISOL. VALVE IN DIESEL SPRAY PUMP DSCHG. LINE

*SNL ASSUMED BYPASS OF FAN COOLER FILTERS POSSIBLE

*SNL DISAGREES WITH FACTOR OF 2 CONCLSN. FOR MITIG. FEATURE EFF.

*SNL DISSCUSES MORE OPERATOR ACTIONS



Containment Pressure (psia)
0
20
40
60
80
100
120
140
0
60
120
180
240
300
360
420
480
540
600
Time (min)
TMLB' Base Case
TMLB', 10 in. Vent
TMLB', 2 ft. Vent

MARCH-S1, SANDIA INPUT TO MARCH2

*PRIMARY SYSTEM MODELS
- -USER SPECIFIED BLOWDOWN
- -IMPRVD. HEAT TRANS. INCLD. IN CORE THERMAL RADIATION MODELS
- -IMPROVED FLASHING MODEL

*CONTAINMENT ANALYSIS MODELS
- -MECHANISTIC CONDENSING HEAT TRANSFER CORRELATION
- -H2 BURN IMPROVEMENTS

*CORCON INCORPORATION

*NEW OR IMPROVED SUPPORT MODULES

PWR CONTAINMENT MANAGEMENT STUDY

JUSTIFICATION

- SEVERE ACCIDENTS DOMINANT RISK
- RADIOLOGICAL CONSEQUENCES FROM SEVERE ACCIDENTS DEPEND ON CONTAINMENT INTEGRITY
- CONTAINMENTS WERE NOT SPECIFICALLY DESIGNED FOR SEVERE ACCIDENTS
- CONTAINMENT RESPONSE MODELING FOR SEVERE ACCIDENTS RAPIDLY DEVELOPING
- NEED CURRENT, SYSTEMATIC STUDY OF CONTAINMENT LOADINGS, FAILURE MODES, AND OPERATOR ACTIONS

PWR CONTAINMENT MANAGEMENT STUDY

PRODUCTS

1. Methodology for analyzing PWR containment management strategies.

2. Documented analyses of containment behavior under severe accident conditions for three distinct PWR containment types.

3. Documented discussion of important uncertainties and their effects.

4. Documented guidance on containment management strategies for PWR's.

PWR Containment Management Study
(Sandia SASA Effort)

Justification

Probabilistic risk assessment studies have determined that risk from reactor accidents is dominated by severe core damage accidents. Radiological consequences from such accidents can range from minor to major depending on the degree to which radionuclides released from the core are retained within containment. Core damage accidents have not been considered in the design requirements for containment. A systematic study of containment loadings and of operator actions which could affect containment integrity during severe accidents is therefore warranted.

Tasks

1. Select accident sequences for analyses for each of the following three PWR containment types: ice condenser, large dry atmospheric, large dry subatmospheric. The following types of accident sequences will be addressed: containment bypass, containment leakage, no containment heat removal, and delayed containment heat removal. Specific accident sequence identification, as necessary, will be based on risk analyses. The following specific plants will be used to provide information necessary to perform detailed analyses: Watts Bar and Sequoyah (ice condenser), Zion (large dry atmospheric), and Surry (large dry subatmospheric). These plants were selected based on the amount of design information and risk study results already available to Sandia.

2. Estimate thresholds for containment failure due to static and dynamic loads for the following containment structures: Watts Bar, Zion, and Surry. Penetrations will be considered to the extent that design information is available.

3. Analyze containment integrity for each containment type under a range of accident sequences. Assume that no mitigative steps are taken by operators. Determine plant-state information available to the operator during these accidents.

4. Repeat the analyses of Task 3, but include operator mitigation. Identify mitigative strategies that help preserve containment. Also, identify strategies that may degrade containment integrity. Determine plant-state information available to the operator and determine how promising mitigative strategies should be initiated based on this information.

5. For situations in which no promising operator mitigative strategy can be identified, propose new systems to help preserve containment and estimate their effectiveness. Determine plantstate information upon which actuation of proposed systems, if necessary, should occur. This task will be coordinated with other systems design studies studies at Sandia.

6. Identify uncertainties in the analyses and evaluate their impact and relative importance on: containment loading, containment failure mode probabilities, containment failure thresholds, and operator guidelines. Provide recommendations for future research to resolve important uncertainties.

Products

1. Methodology for analyzing PWR containment management strategies.

2. Documented analyses of containment behavior under severe accident conditions for three distinct PWR containment types.

3. Documented discussion of important uncertainties and their effects.

4. Documented guidance on containment management strategies for PWR's.

PWR CONTAINMENT MANAGEMENT STUDY

PLANT SELECTION

- LARGE DRY - ZION
- ICE CONDENSER - WATTS BAR/SEQUOYAH
- SUB-ATMOSPHERIC - SURRY

REASONS

- PROTOTYPES
- INFORMATION AVAILABILITY
- COORDINATION WITH OTHER RESEARCH PROGRAMS

EMPHASIS

- WATTS BAR/SEQUOYAH

PWR CONTAINMENT MANAGEMENT STUDY

RELATED SANDIA RESEARCH PROGRAMS

- FILTERED-VENTED CONTAINMENT DESIGN
- SEVERE ACCIDENT EVALUATION
- STRUCTURAL SAFETY MARGIN FOR CONTAINMENT
- COMBUSTIBLE GAS IN CONTAINMENT
- HYDROGEN PROGRAM
- HYDROGEN BURN SURVIVAL - ANALYSIS
- HYDROGEN BURN SURVIVAL - EXPERIMENT
- SEVERE ACCIDENT RULEMAKING RESEARCH
- MOLTEN CORE INTERACTION (CORCON)
- IN-CORE PHENOMENOLOGY
- HIGH TEMPERATURE FISSION PRODUCT CHEMISTRY
- CORE DEBRIS BEHAVIOR
- DEBRIS BED COOLABILITY
- CONTAIN CODE DEVELOPMENT

PWR CONTAINMENT MANAGEMENT STUDY

TASKS

THERMAL-HYDRAULICS

- DEVELOP PLANT MODELS
- SELECT BASE SEQUENCES
- HANDS-OFF ANALYSES
- ANALYZE OPERATOR ACTIONS

STRUCTURAL ANALYSES

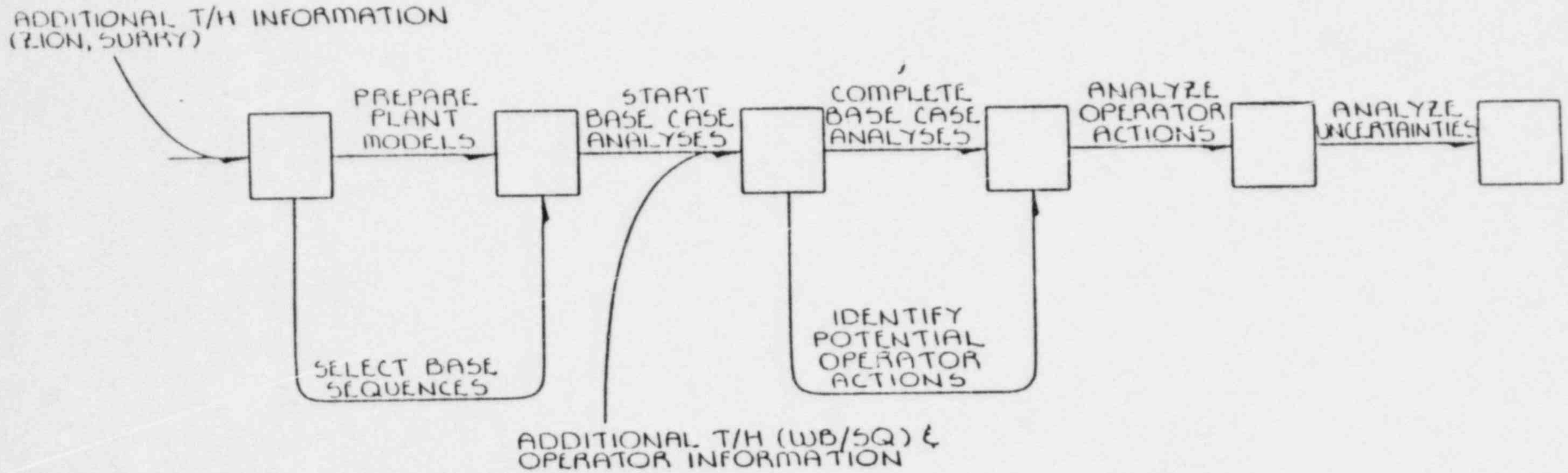
- ULTIMATE CAPACITY
- LARGE PENETRATIONS
- TYPICAL PENETRATIONS
- CYLINDER-BASEMAT JUNCTION

OPERATOR ACTIONS

MITIGATING FEATURES

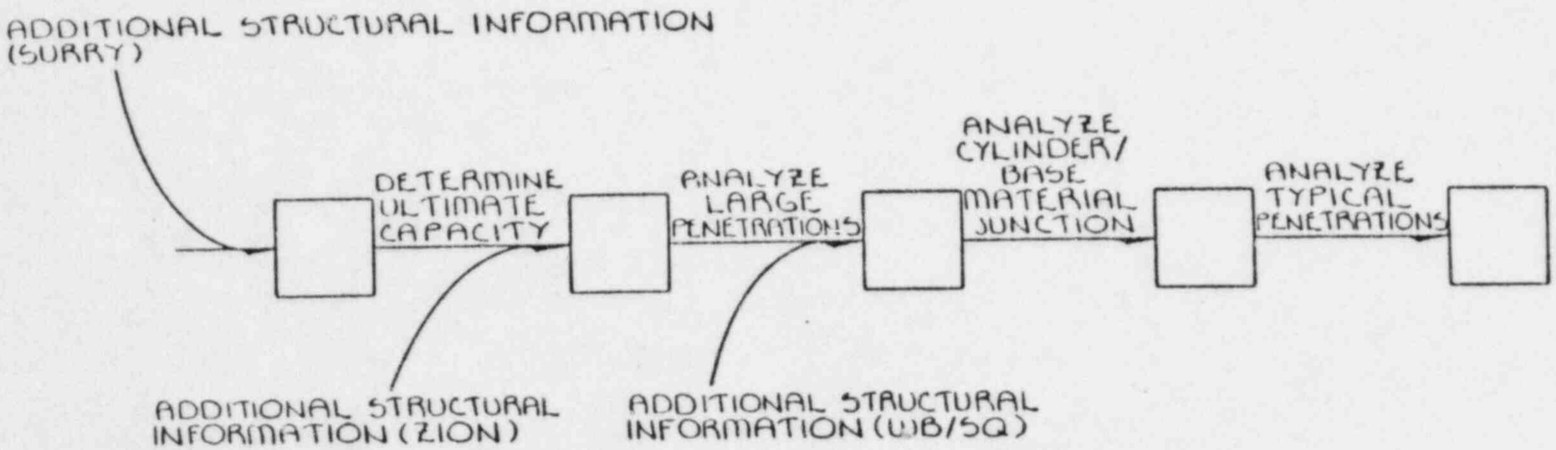
UNCERTAINTIES

PWR CONTAINMENT MANAGEMENT STUDY : T/H TASKS



DURATIONS: WB/SQ = 29 WEEKS (ON CRITICAL PATH)
ZION = 19 WEEKS (OFF CRITICAL PATH)
SURRY = 24 WEEKS (ON CRITICAL PATH)

PWR CONTAINMENT MANAGEMENT STUDY: STRUCTURAL TASKS



DURATIONS: (NOT ON CRITICAL PATH)
WB/SQ = 16 WEEKS
ZION = 14 WEEKS
SURRY = 16 WEEKS

PWR CONTAINMENT MANAGEMENT STUDY

MAJOR MILESTONES	DATE
START	01/22/82
ZION DRAFT	01/07/83
WATTS BAR/SEQUOYAH DRAFT	01/25/83
SURRY DRAFT	09/01/83
CONSOLIDATED DRAFT	11/04/83
PUBLISH FINAL REPORT	02/21/84

PWR CONTAINMENT MANAGEMENT STUDY

1. COMPLETE, UP-TO-DATE FSAR

2. GENERAL EQUIPMENT LOCATION DRAWINGS

3. P&ID'S AND SYSTEM DESCRIPTIONS

4. ELECTRICAL SINGLE LINES

5. RADIOLOGICAL TECH SPECS.

6. STRUCTURAL INFORMATION

	ULTIMATE	LARGE PENETRATION	JUNCTION	TYPICAL PENETRATION
ZION	HAVE	NEED	HAVE	NEED
WB/SQ	PART	PART	NEED	NEED
SURRY	NEED	NEED	NEED	NEED

PWR CONTAINMENT MANAGEMENT STUDY

- INFORMATION TO IMPROVE PLANT SPECIFICITY

    1. CONTAINMENT INTERNAL DETAILS
    2. KEY COMPONENT PERFORMANCE DATA
    3. BASEMAT CONCRETE COMPOSITION
    4. EMERGENCY OPERATING PROCEDURES
    5. CONTROL CIRCUIT ELEMENTARY DIAGRAMS

INFORMATION RESTRAINTS

	STRUCTURAL	T/H & OP
WB/SQ	06/30/82	06/30/82
ZION	L10/08/82	*
SURRY	L03/15/82	02/01/83

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*CURRENT PLAN ASSUMES NO ADDITION T/H INFORMATION WILL BE OBTAINED FOR ZION.

PWR CONTAINMENT MANAGEMENT STUDY

- IDEAL INFORMATION

    1. UTILITY COORDINATOR
    2. PLANT VISITS
    3. OPEN ACCESS
    4. UTILITY REVIEW