ATTACHMENT 1

BRIEFING ON CRBRP
PSAR CHAPTERS 15.5, 15.6, 15.7

FOR THE
NUCLEAR REGULATORY COMMISSION
CRBRP PROGRAM OFFICE

BETHESDA, MARYLAND
APRIL 5, 1982

AGENDA

• INTRODUCTION	J. LONGENECKER
• OVERALL APPROACH	G. H. CLARE
• REFUELING AND COVER GAS RELEASE EVENTS	G. BERG
• Na/NaK SPILLS AND FIRES	R. E. HOTTEL/ C. J. BOASSO
- CODES—SODIUM FIRES	H. M. GEIGER
- CODES—RADIOLOGICAL AND AEROSOL	J. GROSS
• OTHER EVENTS	A. BURKHART/ G. H. CLARE

ATTACHMENT 3

CRBRP PSAR
CHAPTER 15.5, 15.6, 15.7

NUCLEAR REGULATORY COMMISSION
CRBRP PROGRAM OFFICE

OVERALL APPROACH

PRESENTED BY:
GEORGE H. CLARE
LICENSING MANAGER, CRBRP PROJECT
WESTINGHOUSE—LRM
ADVANCED REACTORS DIVISION

APRIL 5, 1982

OVERALL APPROACH

EVENTS INCLUDED IN CHAPTER 15 WERE SELECTED THROUGH

- APPLICATION OF STANDARD FORMAT AND CONTENTS FOR SAR's, LMFBR EDITION, 1974 (USAEC)
- REVIEWS OF TYPICAL LWR CHAPTER 15 EVENTS
- REVIEWS OF FFTF CHAPTER 15 EVENTS
- REVIEWS OF OTHER ANTICIPATED CRBRP EVENTS

THESE EVENTS DEFINE BOUNDARY WORST CASE CONDITIONS ANTICIPATED TO OCCUR DURING CRBRP LIFE, AND FOR WHICH DESIGN MUST PROVIDE ACCOMODATION.

CHAPTER 15 EVENTS WERE INCLUDED IN AN ASSESSMENT TO DETERMINE OVERALL REQUIREMENTS FOR ACCIDENT MONITORING INSTRUMENTATION. INSTRUMENTATION WILL BE PROVIDED FOR THE MONITORING OF ALL EXPECTED AND ANTICIPATED EVENTS

- EVENT WALK-THROUGHS IN CONTROL ROOM
- COMPREHENSIVE EMERGENCY PROCEDURES

CHAPTER 15 PROVIDES DISCUSSIONS SHOWING ADEQUACY OF DESIGN TO PROVIDE ACCOMODATION OF ACCIDENT EVENTS BY ANALYSIS OF BOUNDING EVENTS

- MORE LIKELY OPERATIONAL ANTICIPATED AND EXPECTED OCCURRENCES ADDRESSED BY PROCEDURES AND INSTRUMENTATION PROVIDED.

ATTACHMENT 4

REVIEW OF PSAR CHAPTER 15 - SECTION 15.5 AND PORTIONS OF SECTION 15.7

G. E. BERG

ATOMICS INTERNATIONAL DIVISION
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL CORPORATION

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DISCUSSION SUBJECTS

SECTION 15.5 - FUEL HANDLING AND STORAGE EVENTS

- REACTOR REFUELING SYSTEM EVENTS
- REACTOR AND ENCLOSURE SYSTEMS EVENTS
- POLAR CRANE EVENT

PORTION OF SECTION 15.7 - OTHER EVENTS

- REACTOR REFUELING SYSTEM EVENT
- REACTOR SERVICE BUILDING CRANE EVENT
- INERT GAS PROCESSING SYSTEM EVENTS
- AUXILIARY LIQUID METAL SYSTEM EVENTS
- NUCLEAR ISLAND GENERAL PURPOSE MAINTENANCE SYSTEM EVENT

ORGANIZATION OF DISCUSSION

- SELECTION OF EVENTS COVERED IN PSAR
- REACTOR REFUELING SYSTEM ASSOCIATED EVENTS
  - REACTOR REFUELING SYSTEM
  - REACTOR AND ENCLOSURE SYSTEMS
  - OVERHEAD CRANES

  } 15.5, 15.7.3.1, 15.7.3.2
- INERT GAS PROCESSING SYSTEM EVENTS
  - 15.7.1.4, 15.7.1.5, 15.7.2.4, 15.7.2.8, 15.7.2.9
- AUXILIARY LIQUID METAL SYSTEM EVENTS
  - 15.7.2.6, 15.7.2.7
- NUCLEAR ISLAND GENERAL PURPOSE MAINTENANCE SYSTEM EVENTS
  - 15.7.3.7

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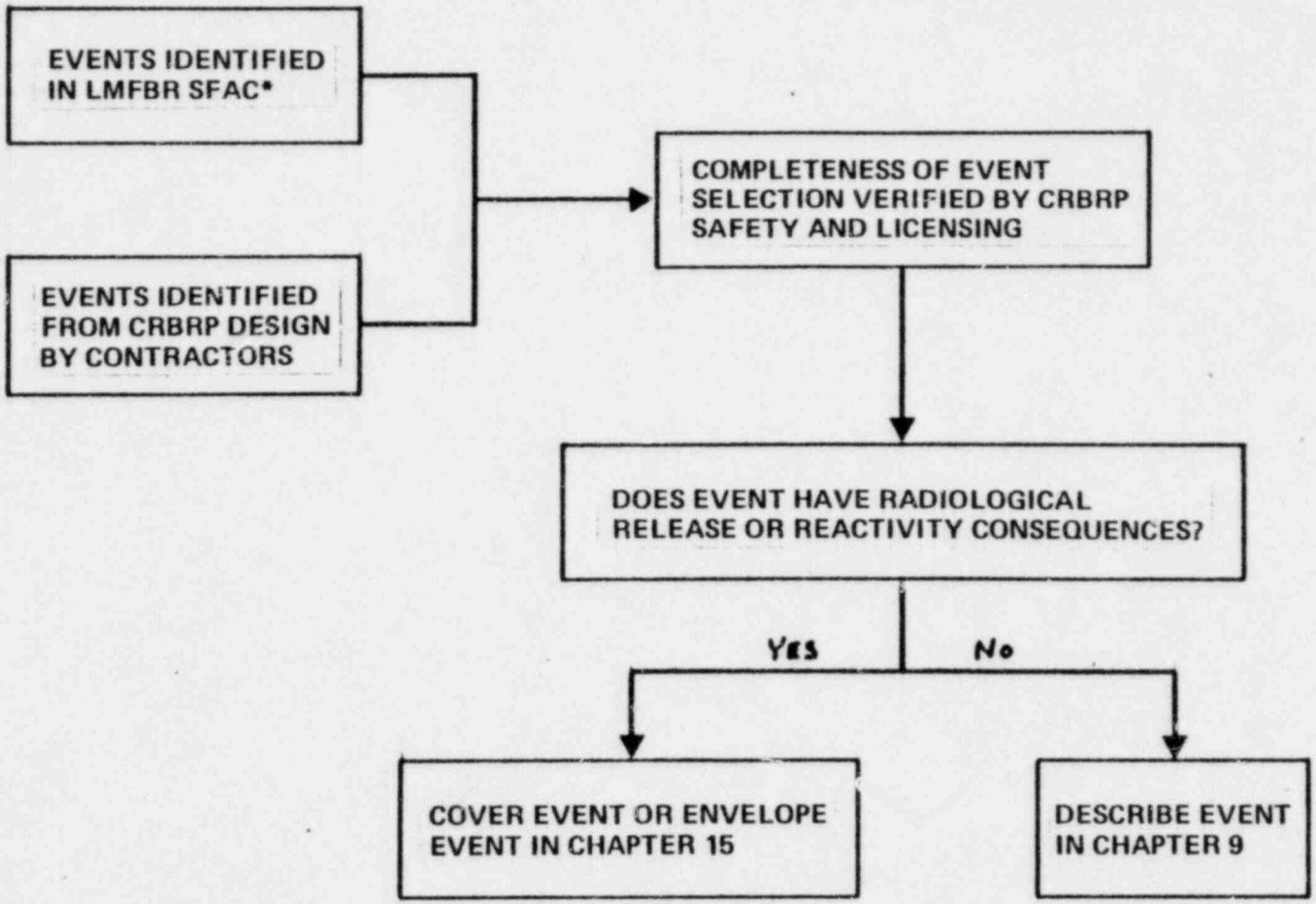
SELECTION OF EVENTS COVERED IN PSAR



*STANDARD FORMAT AND CONTENT (SFAC) OF SAFETY ANALYSIS REPORTS FOR NUCLEAR POWER PLANTS, LMFBR EDITION (1974)

SFAC EVENTS –
FUEL HANDLING AND STORAGE EVENTS

	WHERE EVENTS ANALYZIED IN PSAR CHAPTER 15
(18) FUEL HANDLING ACCIDENT	15.5.2.3
(46) DROPPED FUEL ASSEMBLY	15.5.2.1
(50) INADVERTENT CLOSURE OF FLOOR VALVE ON CANISTER DURING FUEL HANDLING	9.1
(51) FAILURE OF ANY SINGLE ACTIVE COMPONENT IN FUEL HANDLING SYSTEM	9.1
(52) LOSS OF SITE POWER DURING FUEL HANDLING	9.1
(53) FUEL HANDLING MACHINE JAMS	9.1
(54) LEAK IN FUEL STORAGE VESSEL	9.1
(55) FAILURE OF SINGLE ACTIVE COMPONENT IN FUEL STORAGE COOLING SYSTEM	9.1
(56) FAILURE TO SEAT FUEL ASSEMBLY PROPERLY	9.1

SFAC EVENTS –
FUEL HANDLING AND STORAGE EVENTS
(CONTINUED)

	WHERE EVENTS ANALYZIED IN PSAR CHAPTER 15
(57) INADVERTENT OPENING OF FLOOR VALVE WITH SHIELD PLUG REMOVED AND FUEL HANDLING MACHINE NOT IN PLACE	15.5.2.4
(58) LEAK IN FUEL CANISTER	15.7.3.1
(59) INADVERTENT OPENING OF FUEL HANDLING MACHINE VALVE DURING TRANSFER	15.5.2.4
(60) ATTEMPT TO INSERT A FUEL ASSEMBLY INTO OCCUPIED POSITION	15.5.2.2
(61) COLLISION OF FUEL HANDLING MACHINE WITH CONTROL RODS	15.5.3.1
(62) DROPPING SHIPPING CASK FROM MAXIMUM POSSIBLE CRANE HEIGHT	15.7.3.2
(63) COLLISION BETWEEN FUEL HANDLING MACHINE AND CRANE	9.1, 15.5.2.4
(64) LOSS OF ALL POWER TO FUEL HANDLING MACHINE	9.1
(65) REMOVAL OF JAMMED FUEL ASSEMBLY	9.1

SFAC EVENTS–
OTHER EVENTS

	WHERE EVENTS ANALYZIED IN PSAR CHAPTER 15
(15) WASTE GAS DECAY TANK LEAKAGE OR RUPTURE	15.7.2.4, 15.7.2.8, 15.7.2.9
(19) SMALL SPILLS OR LEAKS OF RADIOACTIVE MATERIAL OUTSIDE CONTAINMENT	COVERED BY OTHERS
(20) FUEL CLADDING FAILURE COMBINED WITH INTERMEDIATE HEAT EXCHANGER AND STEAM GENERATOR LEAKS	
(24) LOSS OF ONE (REDUNDANT) D-C SYSTEM	
(25) TURBINE TRIP WITH FAILURE OF GENERATOR BREAKER TO OPEN	
(26) LOSS OF INSTRUMENT AIR SYSTEM	
(28) LEAK IN CONTROL ROD DRIVE HOUSING	
(29) INADVERTENT RELEASE OF OIL IN PUMP SEAL INTO SODIUM	
(31) LEAKS IN INTERMEDIATE HEAT EXCHANGER	
(32) ABNORMALLY HIGH OR LOW COVER GAS PRESSURE	15.7.1.4, 15.7.1.5
(39) FAILURE OF REACTOR VESSEL COVER SEAL	COVERED BY OTHERS

EVENTS NOT IN SFAC OR ENVELOPED BY SFAC EVENTS

REACTOR REFUELING SYSTEM ASSOCIATED EVENTS

- HEAVIEST CRANE LOAD IMPACTS REACTOR CLOSURE HEAD (15.5.3.1)

INERT GAS PROCESSING SYSTEM EVENTS

- NONE

AUXILIARY LIQUID METAL SYSTEM EVENTS

- FAILURE IN THE EVST NaK SYSTEM (15.7.2.6)
- SODIUM COLD TRAP LEAK (15.7.2.7)

NUCLEAR ISLAND GENERAL PURPOSE MAINTENANCE SYSTEM EVENTS

- SODIUM-WATER REACTION IN LARGE COMPONENT CLEANING VESSEL (15.7.3.7)

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DESIGN UPDATES SINCE HALTING LICENSING

- ADDED REACTOR SERVICE BUILDING CONFINEMENT BOUNDARY
  - SAFETY-RELATED HVAC MEETS REGULATORY REQUIREMENTS
  - PROTECTS AGAINST FUEL HANDLING RADIATION RELEASES
  - PROTECTS AGAINST REACTOR CONTAINMENT BUILDING RADIATION RELEASES WHEN EQUIPMENT HATCH IS OPEN (REACTOR IS SHUTDOWN)
- ALL RADIOACTIVE ARGON PURIFICATION SYSTEM (RAPS) COMPONENTS ARE HOUSED INSIDE REACTOR CONTAINMENT BUILDING
  - PROTECTS AGAINST RAPS CRYOSTILL AND NOBLE GAS STORAGE VESSEL RADIATION RELEASES
- HETEROGENEOUS CORE
  - EARLIEST TIME FOR HANDLING SPENT FUEL ASSEMBLIES INCREASED FROM 87 HOURS TO 10 DAYS. REDUCES EXPECTED SOURCE TERM. NO CHANGE IN DESIGN BASIS SOURCE TERMS

DISCUSSION ITEMS FOR EACH SYSTEM

- DESCRIPTION OF SYSTEM
  - HIGHLIGHT AREAS OF INTEREST TO PSAR 15.5 AND 15.7
- BARRIERS TO RELEASE OF RADIOACTIVITY
- GENERAL ASSUMPTIONS AND CALCULATED MODELS
- ENVELOPING EVENTS
- CONSEQUENCES

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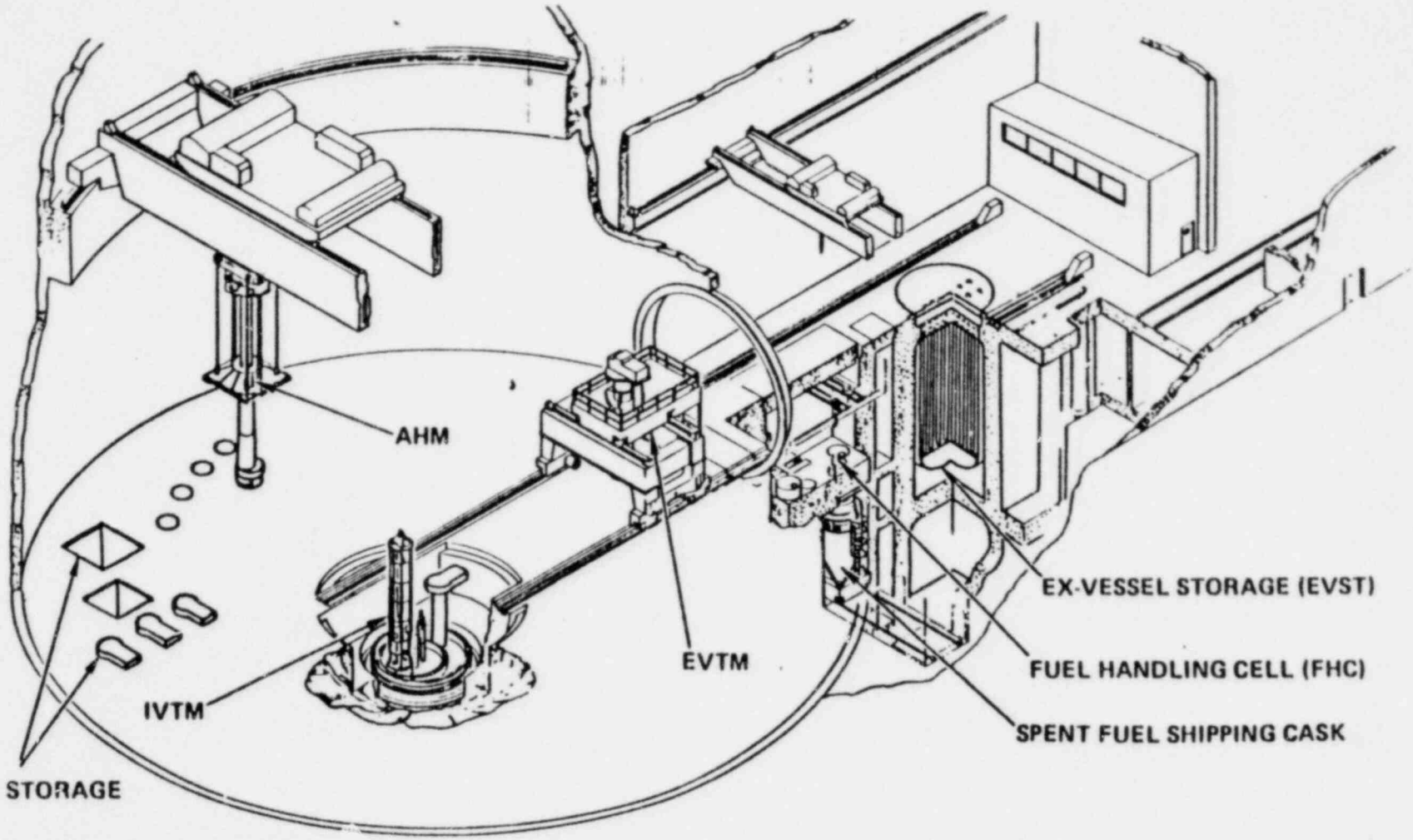
REACTOR REFUELING SYSTEM FUNCTIONS

- THE REACTOR REFUELING SYSTEM CONSISTS OF EQUIPMENT AND FACILITIES TO ACCOMPLISH:
  - REACTOR REFUELING
  - NEW FUEL RECEIPT
  - SPENT FUEL SHIPPING

CRBRP REACTOR REFUELING



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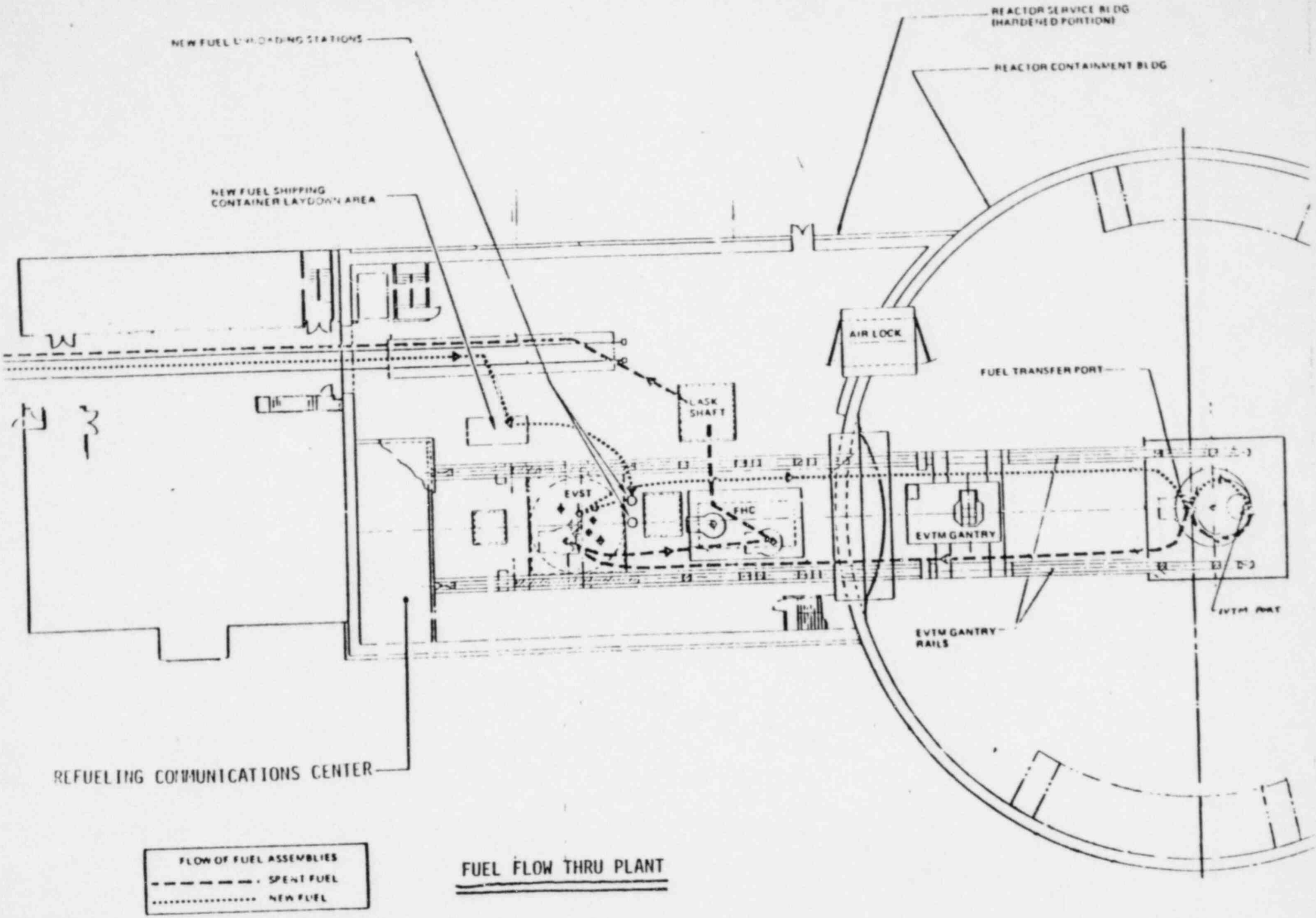


FUEL FLOW THRU PLANT

REACTOR REFUELING SYSTEM ASSOCIATED EVENTS - ENVELOPING EVENTS

- COVER GAS RELEASE DURING REFUELING (15.5.2.4) ENVELOPES:
  - FUEL ASSEMBLY DROPPED WITHIN REACTOR VESSEL DURING REFUELING (15.5.2.1)
  - HEAVIEST CRANE LOAD IMPACTS REACTOR CLOSURE HEAD (15.5.2.5)
  - COLLISION OF EVTM WITH CONTROL ROD DRIVE MECHANISM (15.5.3.1)
  - OTHER COVER GAS RELEASE EVENTS (9.1)
- SINGLE FUEL ASSEMBLY CLADDING FAILURE AND SUBSEQUENT FISSION GAS RELEASE DURING REFUELING (15.5.2.3) ENVELOPES:
  - DAMAGE OF FUEL ASSEMBLY DUE TO ATTEMPT TO INSERT A FUEL ASSEMBLY INTO AN OCCUPIED POSITION (15.5.2.2)
  - LEAK IN A CORE COMPONENT POT (15.7.3.1)
  - OTHER FUEL ASSEMBLY FAILURE EVENTS (9.1)
- SPENT FUEL SHIPPING CASK DROPPED FROM MAXIMUM POSSIBLE HEIGHT (15.7.3.2)
  - OTHER SHIPPING CASK DROPS

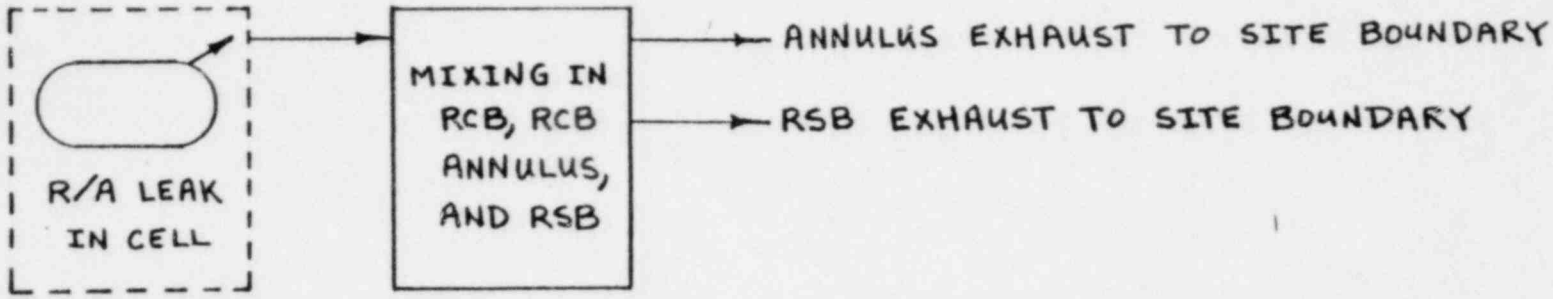
REACTOR REFUELING SYSTEM ASSOCIATED EVENTS - BARRIERS TO RELEASE OF RADIOACTIVITY

- FUEL ASSEMBLY CLADDING
  - DESIGNED FOR REACTOR OPERATION. FUEL HANDLING AND STORAGE MECHANICAL AND THERMAL LOADS ARE MILD BY COMPARISON
- LOW-LEAKAGE EQUIPMENT CONTAINMENT BOUNDARIES
  - DESIGN BASIS IS CLADDING FAILURE OF ALL PINS IN SINGLE FUEL ASSEMBLY
  - SEISMIC CATEGORY 1
- REACTOR SERVICE BUILDING CONFINEMENT BOUNDARY
  - CONTROLLED AND LIMITED RELEASE TO ENVIRONMENT
  - 10% OF NORMAL EXHAUST FLOW RATE
  - FULL FLOW HEPA FILTERS AND CHARCOAL ADSORBERS

REACTOR REFUELING SYSTEM ASSOCIATED EVENTS - GENERAL ASSUMPTIONS

- MAXIMUM SPENT FUEL ASSEMBLY FISSION PRODUCT INVENTORY
  - . END OF EQUILIBRIUM CYCLE
  - . MAXIMUM POWER FUEL ASSEMBLY
- DESIGN BASIS RELEASE FROM FUEL ASSEMBLIES
  - . 1% FAILED FUEL IN REACTOR
  - . 100% OF PINS IN SINGLE FUEL ASSEMBLY FAIL IN FUEL HANDLING EQUIPMENT OR STORAGE
- RADIOACTIVE DECAY AND/OR COVER GAS CLEANUP TO EARLIEST POSSIBLE (NOT PLANNED) HANDLING TIME
  - . REACTOR COVER GAS CONTAINMENT BOUNDARY PENETRATION (30 HOURS)
  - . SPENT FUEL ASSEMBLY HANDLING BY EX-VESSEL TRANSFER MACHINE (36 HOURS)
- WORST SHORT-TERM ATMOSPHERIC DISPERSION
- NO CREDIT FOR REACTOR SERVICE BUILDING CONFINEMENT BOUNDARY

CALCULATIONAL MODEL



GOVERNING EQUATION : $\frac{dI}{dt} = -\lambda I - \frac{Q}{V} I$

TOTAL RADIOACTIVITY RELEASED : $\frac{Q}{V}\int I\,dt = \frac{Q I_o}{Q+\lambda V}\left[1 - e^{-\left(\frac{Q}{V}+\lambda\right)t}\right]$

WHERE:
- I IS THE RADIOACTIVITY (CURIE)
- t IS TIME (DAY)
- λ IS THE DECAY CONSTANT (1/DAY)
- Q IS THE FLOW RATE (CUBIC FT./DAY)
- V IS THE VOLUME (CUBIC FEET)

TABLE 15.5.2.4-1

OFF-SITE DOSES FROM COVER GAS RELEASE
DURING REFUELING

		Dose (REM)*	
		Site Boundary (2 hr. -0.42 mi.)	LPZ (30 days-2.5 mi.)
	D_β (Skin)	4.0×10^{-3}	1.1×10^{-3}
49	D_γ (Whole Body)	4.4×10^{-3}	1.2×10^{-3}

49 * Integrated exposure based on puff release.

TABLE 15.5.2.3-4

OFF-SITE DOSES DUE TO FUEL FAILURE IN EVTM

		Dose (REM)	
	10CFR100	SB (2 hr) (0.417 mi)	LPZ (30 days) (5.0 mi)
CASE 1 - 36 hours Decay Time (Extremely Unlikely)			
Cloud			
D_β (Skin)		5.87-03*	2.07-04
D_γ (Whole Body)	25	1.54-03	4.25-04
Inhalation			
Lung	75	3.7-02	1.5-02
Thyroid	300	1.89	0.121
Whole Body Inhalation	25	7.47-03	2.90-03

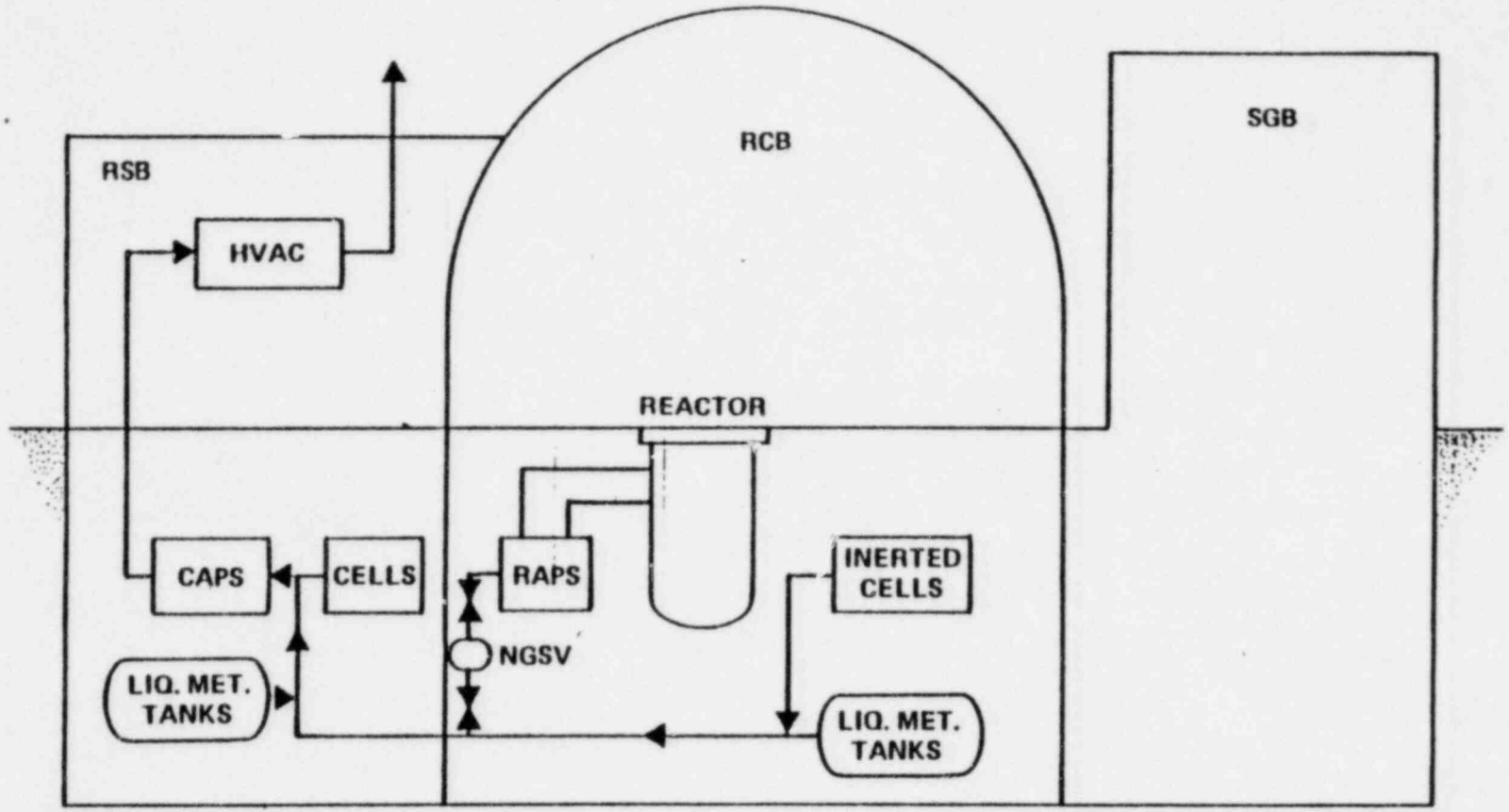
Table 15.7.3.2-2

Off-Site Doses (REM) Due to Fuel Failure and SFSC Leakage

ORGAN	10CFR100 GUIDELINE	2 HOURS SB (0.42 MILES)	30 DAYS LPZ (5.0 MILES)
Cloud			
D (Whole Body)	25	9.64-7*	1.19-6
Inhalation			
Lung	75	1.29-8	1.59-8
Thyroid	300	4.39-4	5.41-4
Whole Body Inhalation	25	8.89-7	1.13-6

59 12

CRBRP CELL ATMOSPHERE PROCESSING SYSTEM



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INERT GAS PROCESSING SYSTEM EVENTS - ENVELOPING EVENTS

- RUPTURE OF RAPS CRYOSTILL (15.7.2.4) OR RAPS NOBLE GAS STORAGE VESSEL (15.7.2.8) ENVELOPES:
  - . RUPTURE OF ANY RAPS COMPONENT (9.5)
- RUPTURE OF CAPS COLD BOX (15.7.2.9) ENVELOPES:
  - . RUPTURE OF ANY CAPS COMPONENT (9.5)
- FAILURE OF PLUG SEALS AND ANNULI (15.7.3.4) ENVELOPES:
  - . OFF-NORMAL COVER GAS PRESSURE IN THE REACTOR PRIMARY COOLANT BOUNDARY (15.7.1.4)
  - . OFF-NORMAL COVER GAS PRESSURE IN THE IHTS (15.7.1.5)

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INERT GAS PROCESSING SYSTEM EVENTS - BARRIERS TO RELEASE OF RADIOACTIVITY

RAPS CRYOSTILL AND NOBLE GAS STORAGE VESSEL

- SAFETY CLASS 3, SEISMIC CATEGORY 1, ASME CODED VESSELS
- STEEL-LINED, LOW-LEAKAGE CELLS
- REACTOR CONTAINMENT BUILDING (RCB) CONTAINMENT BOUNDARY
- REACTOR SERVICE BUILDING (RSB) CONFINEMENT BOUNDARY WHEN RCB EQUIPMENT HATCH IS OPEN

CAPS COLD BOX

- SAFETY CLASS 3, SEISMIC CATEGORY 1, ASME CODED VESSEL
- STEEL-LINED, LOW-LEAKAGE CELL
- REACTOR SERVICE BUILDING (RCB) CONFINEMENT BOUNDARY

INERT GAS PROCESSING SYSTEM EVENTS - GENERAL ASSUMPTIONS

RAPS CRYOSTILL AND NOBLE GAS STORAGE VESSEL

- MAXIMUM INVENTORY OF RADIOACTIVITY
  - . REACTOR OPERATION WITH 1% FAILED FUEL
  - . CRYOSTILL OPERATION FOR 1 YEAR
- CRYOGENIC LIQUID IMMEDIATELY VAPORIZED
- RELEASE ASSUMED TO OCCUR DURING REFUELING (RCB HATCH OPEN)
  - . RSB CONFINEMENT BOUNDARY IN OPERATION
- WORST SHORT-TERM ATMOSPHERIC DISPERSION (PSAR 2.3.4.2)
- NO CREDIT FOR LINED CELL LEAK TIGHTNESS

CAPS COLD BOX

- MAXIMUM INVENTORY DURING NORMAL AND ANTICIPATED OPERATION
  - . REFUELING SOURCE TERM
- RADIOACTIVITY IMMEDIATELY DESORBED FROM CRYOGENIC CHARCOAL BED
- WORST SHORT-TERM ATMOSPHERIC DISPERSION
- NO CREDIT FOR LINED CELL LEAK-TIGHTNESS OR RSB CONFINEMENT BOUNDARY

TABLE 15.7.2.4.-1

RUPTURE OF THE RAPS CRYOSTILL

Refueling Door Open - No Cell Leak Tightness Assumed

Isotope	Initial Inventory in the Cryostill (Ci)	Radioactivity Released From the Plant in 2 Hours (Ci)	0 to 2 Hours Whole Body Site Boundary Dose (Rem)
Xe133	4.67×10^5	3.92×10^4	1.38
Xe135	8.79×10^4	6.89×10^3	1.33
Kr88	1.66×10^3	1.11×10^2	0.169
Total	5.57×10^5	4.62×10^4	2.88

*There is an additional contribution of 0.09 rem from the daughter product of Kr88, which is Rb88.

TABLE 15.7.2.9-1

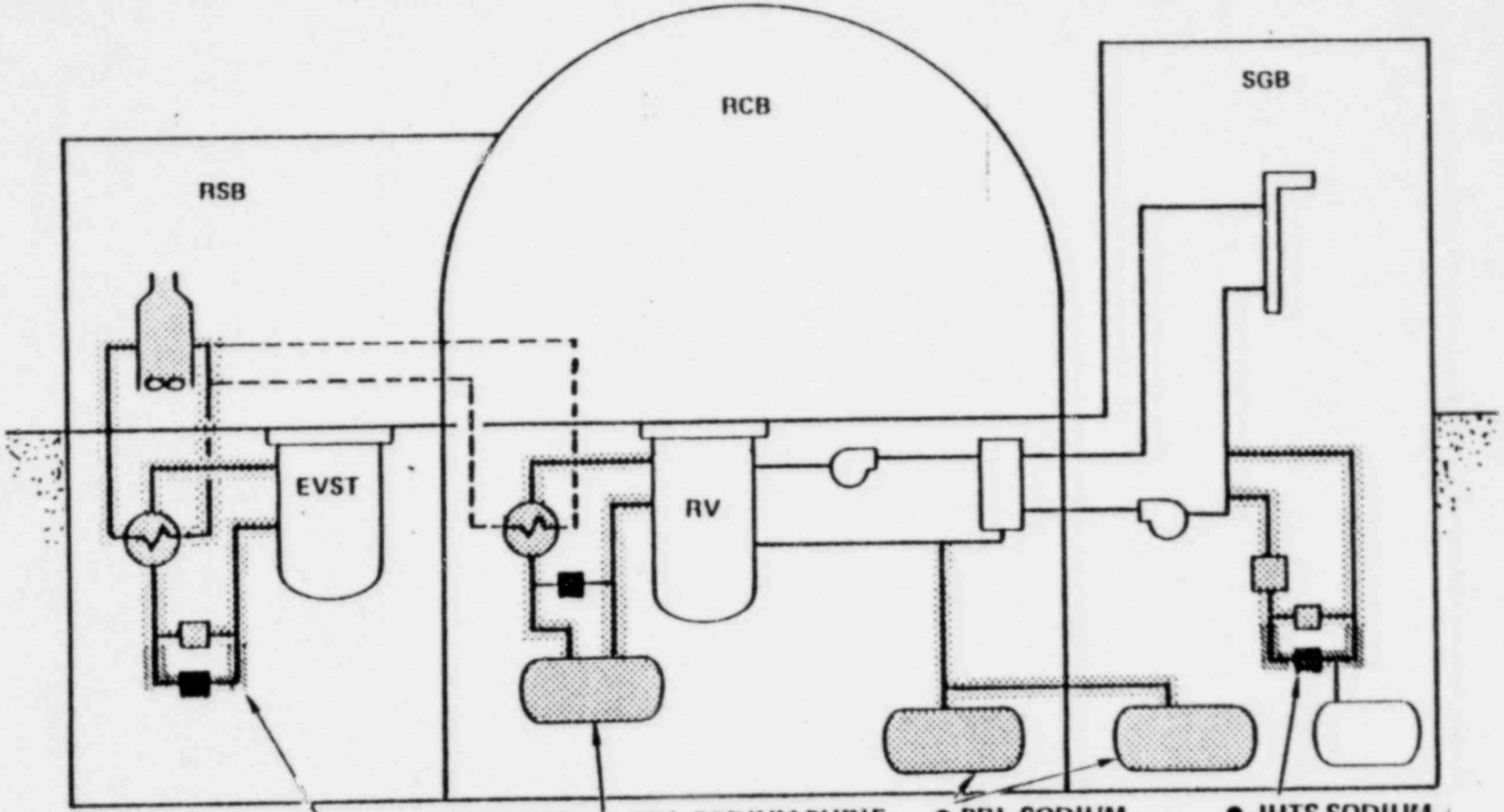
RUPTURE OF THE CAPS DELAY BEDS

Delay Beds Inventory Immediately Released from the RSB

Isotope	Initial Inventory on the Delay Beds (Ci)	Radioactivity Released From the Plant In 2 Hours (Ci)	0 to 2 Hours Whole Body Site Boundary Dose (Rem)
Xe133m	33	33	1.1×10^{-3}
Xe133	4.1×10^{3}	4.1×10^{3}	0.14
Total	4.1×10^{3}	4.1×10^{3}	0.14

CRBRP

AUXILIARY LIQUID METAL SYSTEMS



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AUXILIARY LIQUID METAL
SYSTEM EVENTS - ENVELOPING EVENTS

- LEAKAGE FROM SODIUM COLD TRAPS (15.7.2.7) ENVELOPES:

  . LEAKS IN ALL AUXILIARY LIQUID METAL COMPONENTS (9.3)

- SODIUM SPILLS (15.6) ENVELOPES:

  . FAILURE (LEAK OR RUPTURE) IN THE EVST NaK SYSTEM (15.7.2.6)

    (NOTE: 15.6 IS REFERENCED FOR AEROSOL QUANTITY ENVELOPE ONLY. EVST NaK IS NONRADIOACTIVE)

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AUXILIARY LIQUID METAL SYSTEM EVENTS - BARRIERS TO RELEASE OF RADIOACTIVITY

- COLD TRAP DURING HANDLING FOR REMOVAL
  - SAFETY CLASS 3, SEISMIC CATEGORY 1, ASME CODED VESSELS
  - ALL SODIUM IN COLD TRAP IS FROZEN BEFORE DEINERTING LINED CELL
  - NaK COOLING JACKET (DRAINED OF NaK BEFORE COLD TRAP REMOVAL)
  - VESSEL SURROUNDED BY SEISMIC CATEGORY 1 STEEL SUPPORT/SHIELD
  - REACTOR CONTAINMENT BUILDING (RCB) CONTAINMENT BOUNDARY
  - REACTOR SERVICE BUILDING (RSB) CONFINEMENT BOUNDARY WHEN RCB EQUIPMENT HATCH IS OPEN OR COLD TRAP IS STORED IN RSB

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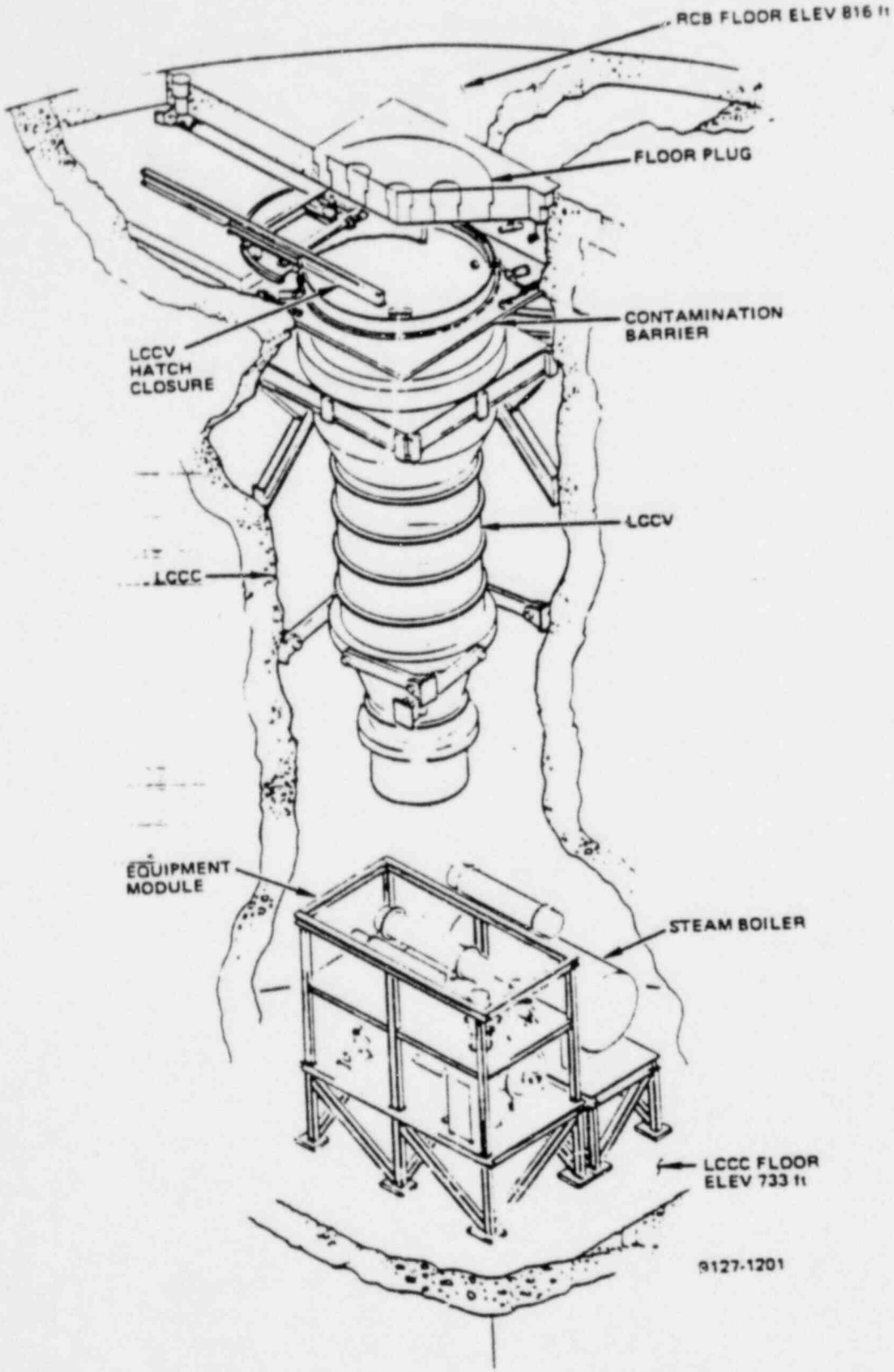
AUXILIARY LIQUID METAL SYSTEM EVENTS - GENERAL ASSUMPTIONS

- COLD TRAP LEAK
  - MAXIMUM INVENTORY OF RADIOACTIVITY
    - 15-YEAR OPERATION WITH 1% FAILED FUEL
    - ENTIRE COLD TRAP INVENTORY IS SPILLED
  - CELL IS INERTED (2% OXYGEN)
    - SODIUM REACTS WITH ALL AVAILABLE OXYGEN
    - LEAKAGE FROM CELL 100%/DAY AT 10 PSIG PLUS OVERPRESSURE
    - SOFIRE-2 AND HAA-3 USED FOR FIRE AND AEROSOL ANALYSIS IN CELL
  - REACTOR CONTAINMENT BUILDING LEAKAGE AT OVERPRESSURE OF 1 PSIG
    - RCB FALLOUT AND PLATEOUT NEGLECTED
    - HVAC FILTRATION NEGLECTED
    - NO SOURCE OF OVERPRESSURE IDENTIFIED
  - WORST SHORT-TERM ATMOSPHERIC DISPERSION
    - ATMOSPHERIC FALLOUT IS NEGLECTED

TABLE 15.7.2.7-1

OFF-SITE DOSE RESULTING FROM A POSTULATED COLD TRAP FIRE

Organ	2 Hour Dose (Rem) At Site Boundary (0.42 Mile)	30 Day Dose (Rem) LPZ (5.0 Miles)
Bone	1.02×10^{-3}	3.03×10^{-4}
Lung	7.51×10^{-4}	2.22×10^{-4}
Thyroid	4.17×10^{-5}	1.23×10^{-3}
Whole Body	7.81×10^{-5}	2.31×10^{-5}
Skin	5.13×10^{-7}	1.51×10^{-7}



Isometric View of the PSR&D System

Na OR NaK REMOVAL PROCESS DESCRIPTION

BASIC STEPS:

- o INERTING -- PREVENT OXIDATION OF Na OR NaK
- o PREHEATING -- PREVENT CONDENSATION OF H_2O
- o WVN-Na REACTION -- PREVENT OVER HEATING AND CONTROL H_2
- o RINSING -- REMOVE CREVICE Na AND REACTION PRODUCTS
- o DRYING -- COMPLETE REMOVAL OF WATER
- o COOLING -- HANDLING

NUCLEAR ISLAND GENERAL PURPOSE MAINTENANCE
EQUIPMENT EVENT - ENVELOPING EVENTS

- SODIUM-WATER REACTION IN LARGE COMPONENT CLEANING VESSEL (15.7.3.7) ENVELOPES:

  - SODIUM-WATER REACTION IN SMALL COMPONENT AUTOCLOVE AND INTERMEDIATE SODIUM REMOVAL SYSTEM (9.2)

  - ALL OTHER MAINTENANCE EQUIPMENT EVENTS ARE COVERED AS PART OF THE ACCIDENT ANALYSIS OF THE COMPONENT BEING MAINTAINED, E.G., COLD TRAPS (15.7.2.7)

NUCLEAR ISLAND GENERAL PURPOSE MAINTENANCE SYSTEM EVENTS -
BARRIERS TO RELEASE OF RADIOACTIVITY

- SODIUM-WATER REACTION IN LARGE COMPONENT CLEANING VESSEL
  - INSTRUMENTATION TO ASSURE COMPLETION OF SODIUM REACTION BEFORE INTRODUCTION OF WATER
  - SEISMIC CATEGORY 1, ASME SECTION VIII CODED VESSEL WITH RUPTURE STRENGTH >3 TIMES SODIUM-WATER REACTION PRESSURE
  - REACTOR CONTAINMENT BUILDING (RCB) CONTAINMENT BOUNDARY
  - REACTOR SERVICE BUILDING (RSB) CONFINEMENT BOUNDARY WHEN RCB EQUIPMENT HATCH IS OPEN

NUCLEAR ISLAND GENERAL PURPOSE MAINTENANCE SYSTEM EVENTS -
SODIUM WATER REACTION EVENT ASSUMPTIONS

- MAXIMUM INVENTORY OF RADIOACTIVITY AND SODIUM
  - LARGEST QUANTITY OF PRIMARY SYSTEM SODIUM PRESENT ON ANY COMPONENT (REACTOR CLOSURE HEAD INTERMEDIATE ROTATING PLUG) TO BE CLEANED IN 30 YEAR PLANT LIFE
  - REACTOR CLOSURE HEAD INTERMEDIATE ROTATING PLUG IS NOT EXPECTED TO BE CLEANED DURING LIFE OF PLANT
- COMPLETE RELEASE OF ALL RADIOACTIVITY CONTAINED IN REACTED SODIUM
  - 10 DAYS DECAY
- REACTOR CONTAINMENT BUILDING EQUIPMENT HATCH OPEN
  - IODINE AND PARTICULATES REDUCED BY HVAC FILTERS AND ADSORBERS
  - INSTANTANEOUS RELEASE TO ENVIRONMENT

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Table 15.7.3.7-1

Release From LCCV - Potential Site Boundary Doses

Organ	10 CFR 100*	SB (0.41 Mi)*
Whole Body	25	1×10^{-2}
Thyroid	300	5×10^{-2}
Bone	150+	1.2×10^{-2}
Lung	75+	1×10^{-2}

+Not covered in 10 CFR 100; used as guideline values.
*Rem

23

INTRODUCTION
PSAR 15.6—SODIUM SPILL ACCIDENTS

- BASIS FOR SODIUM FIRES SELECTED
  - DESIGN BASIS PIPE BREAKS AND TANK RUPTURES CLASSIFIED AS EXTREMELY UNLIKELY EVENTS AND ANALYZED AS FAULTED EVENTS.
  - SPILL SELECTED FROM LARGEST OR HIGHEST PRESSURE SODIUM PIPE IN CELL AT LOCATION PRODUCING WORST CASE SPILL ON A CELL BASIS.
- SYSTEMS ASSUMED TO BE OPERATING AT MAXIMUM NORMAL OPERATING TEMPERATURE AND PRESSURE.
- INSTANTANEOUS RUPTURE OF SODIUM TANKS

INTRODUCTION
PSAR 15.6—SODIUM SPILL ACCIDENTS (CONT.)

- DESCRIPTION OF COMPUTER CODES AND ANALYSIS TECHNIQUES
  - SODIUM FIRES CODES
  - SODIUM AEROSOL BEHAVIOR CODE
  - RADIOLOGICAL ANALYSES
- RESULTING ACCIDENT CONSEQUENCES
  - PRESSURES, TEMPERATURES
  - AEROSOLS
  - OFF-SITE DOSES
- PLANT FEATURES TO ACCOMMODATE

PSAR CHAPTER 15.6 ACCIDENTS
BRIEFING FOR
NUCLEAR REGULATORY COMMISSION
CRBRP PROGRAM OFFICE

OVERVIEW

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APRIL 5, 1982

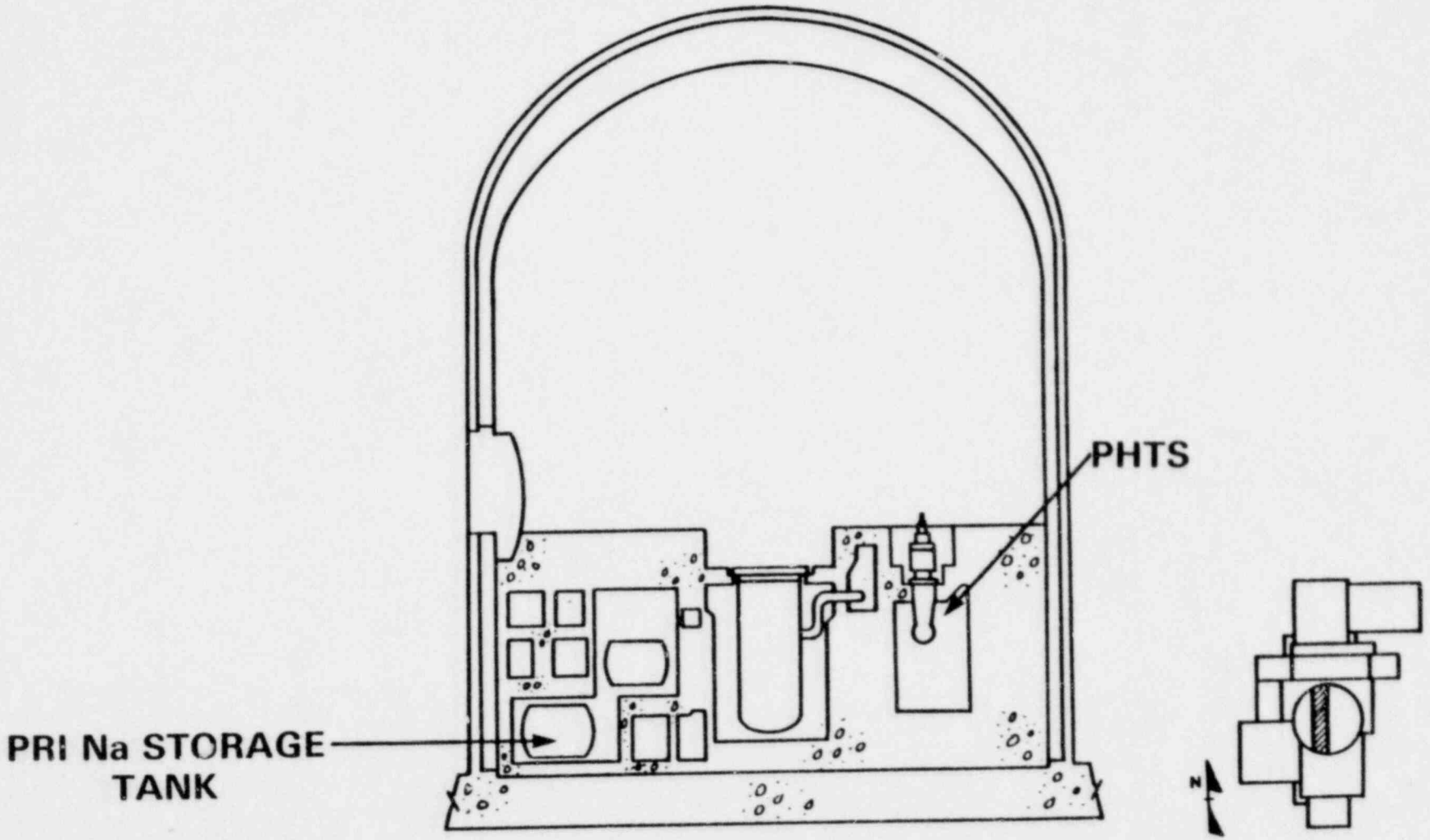
ACCIDENTS TO BE DISCUSSED

- RCB DESIGN BASIS ACCIDENT
  - SECTIONS 6.2 AND 15.6.1.1 OF PSAR
  - SODIUM POOL FIRE IN DE-INERTED LINED CELL INTERFACING WITH RCB ATMOSPHERE
- PHTS CELL DESIGN BASIS ACCIDENT
  - SECTION 15.6.1.4 OF PSAR
  - SODIUM SPRAY/POOL FIRE IN INERTED LINED CELL
- SGB DESIGN BASIS ACCIDENT
  - SECTIONS 6.2.7 AND 15.6.1.5 OF PSAR
  - SODIUM SPRAY/POOL FIRE IN AIR-FILLED CATCH PAN CELL

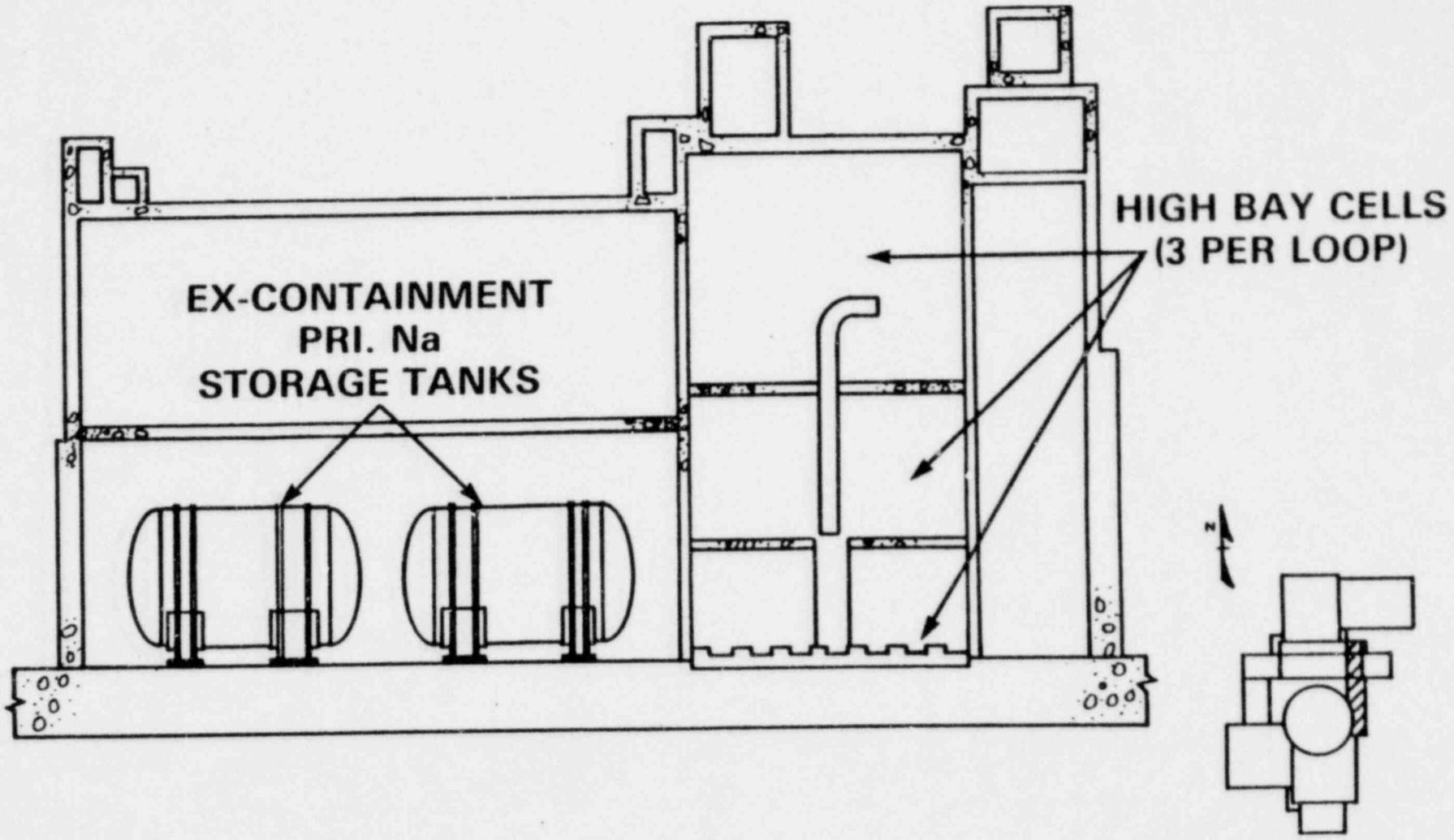
ACCIDENTS BRIEFLY SUMMARIZED

- FAILURE OF EX-VESSEL SODIUM COOLING SYSTEM DURING OPERATION
  - SECTION 15.6.1.2 OF PSAR
  - SAME TYPE ACCIDENT AS PHTS CELL DESIGN BASIS ACCIDENT
- FAILURE OF EX-CONTAINMENT PRIMARY SODIUM STORAGE TANK ACCIDENT
  - SECTION 15.6.1.3 OF PSAR
  - SAME TYPE ACCIDENT AS PHTS CELL DESIGN BASIS ACCIDENT WITH ONLY POOL FIRE ANALYSIS

PRIMARY SODIUM STORAGE TANK & PHTS CELLS IN RCB REACTOR CONTAINMENT BUILDING (RCB)



AIR-FILLED SODIUM COMPONENT CELLS IN SGB



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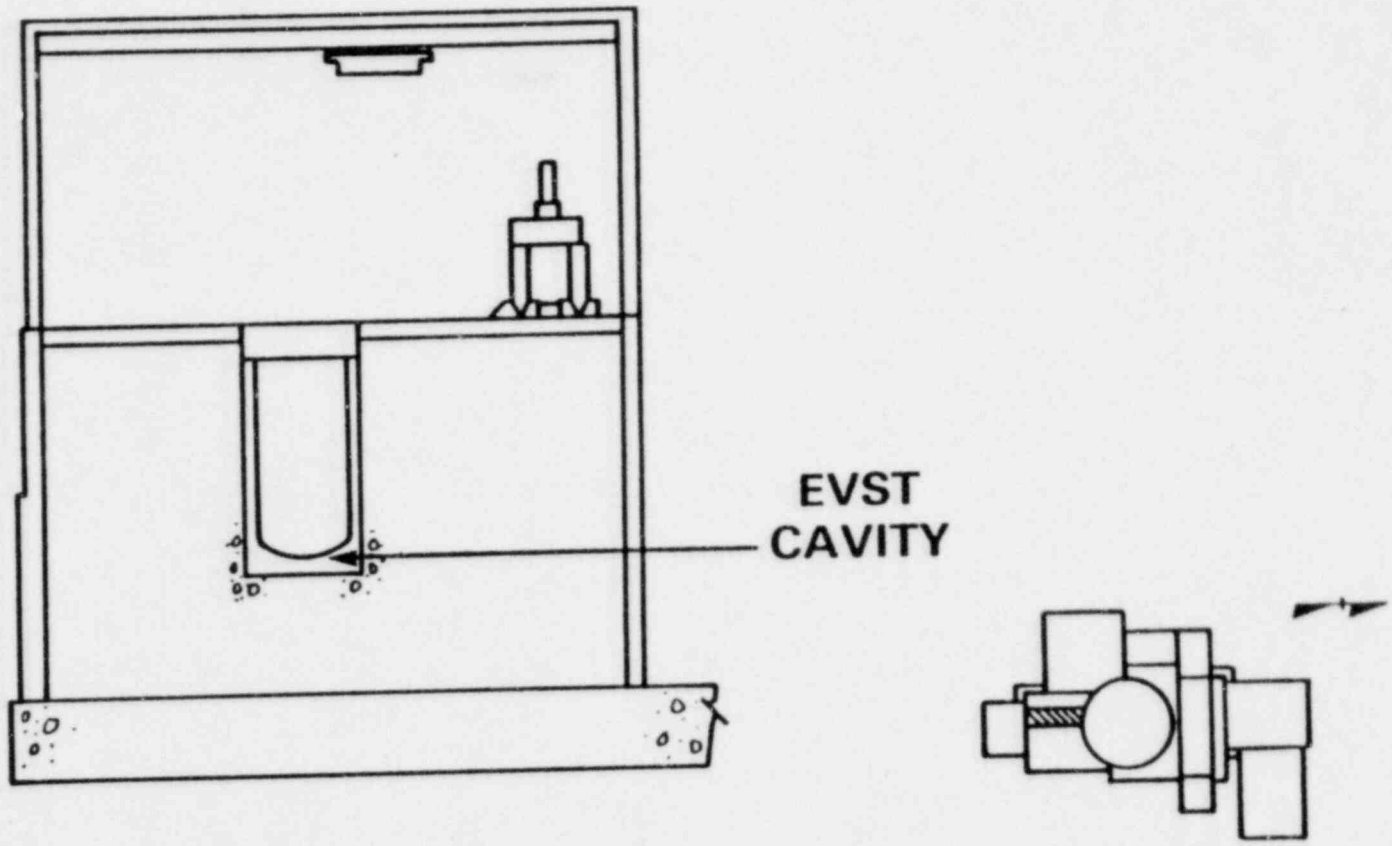
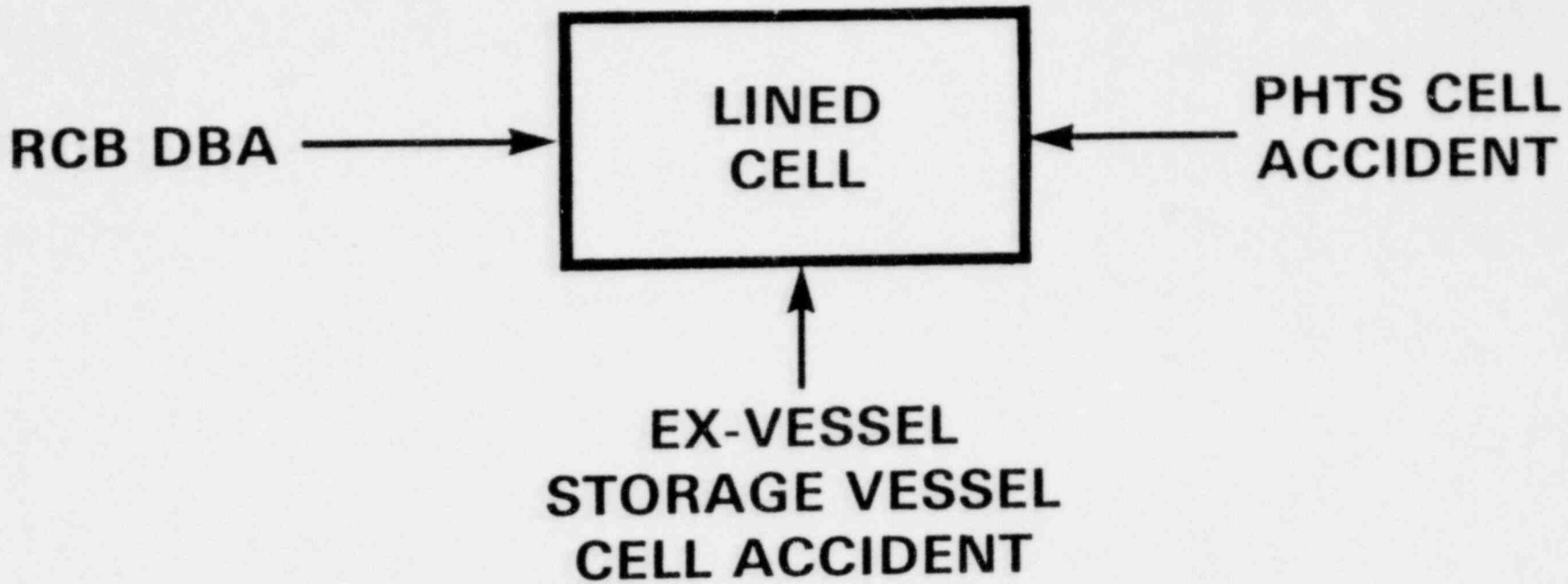
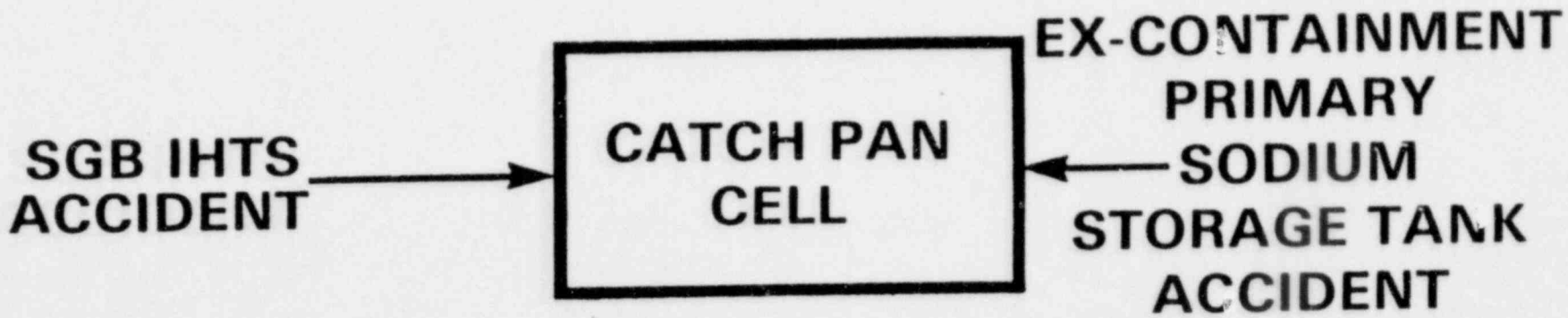
EVST CAVITY CELL IN REACTOR SERVICE BUILDING (RSB)

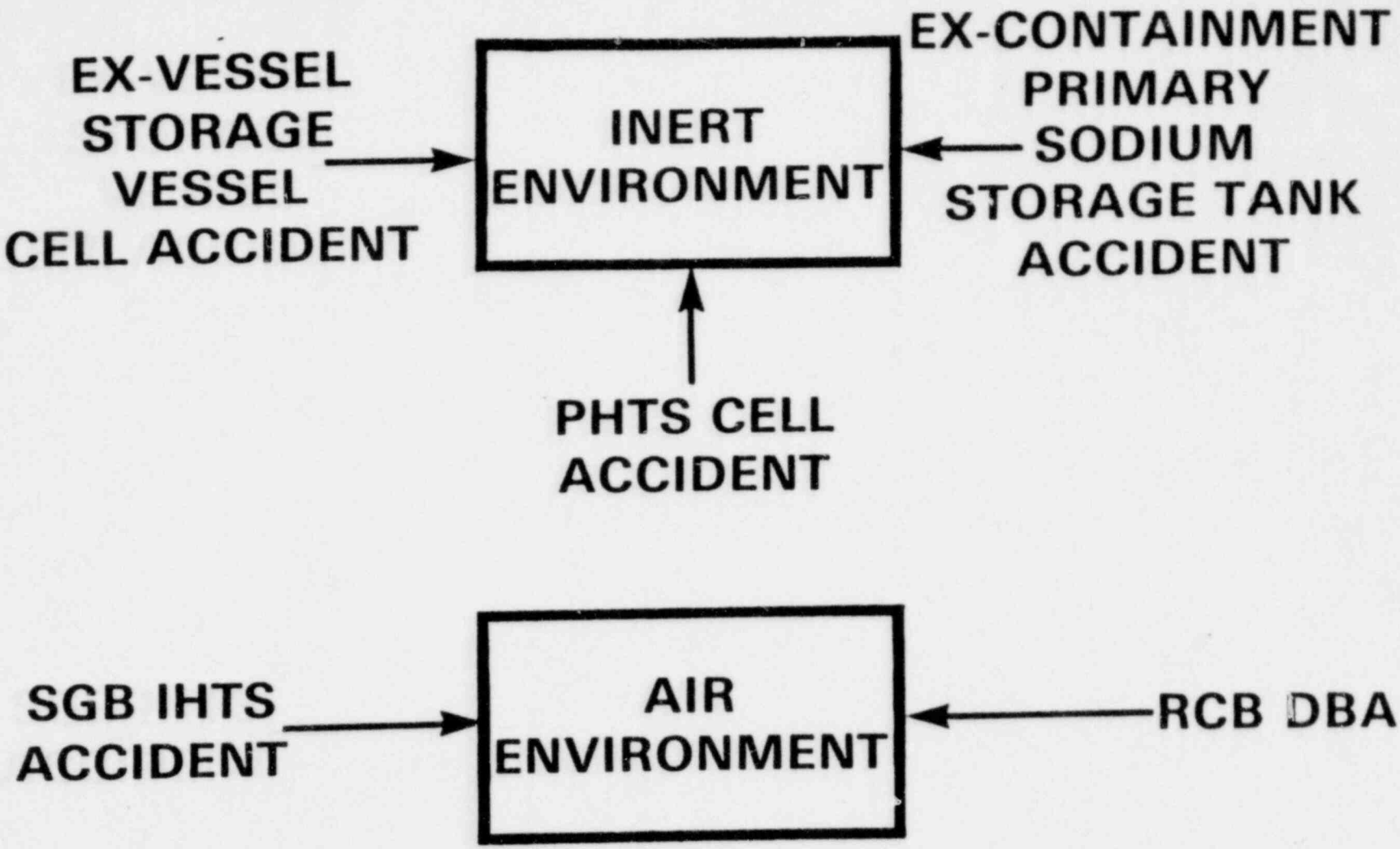


ACCIDENT LOCATIONS





ACCIDENT ENVIRONMENTS



DESIGN BASIS ACCIDENT FOR REACTOR CONTAINMENT BUILDING

- POSTULATED INSTANTANEOUS NON-MECHANISTIC RELEASE OF MAXIMUM AVAILABLE SODIUM VOLUME FROM THE PRIMARY SODIUM STORAGE TANK (35,000 GALLONS)
- POSTULATED DE-INERTED CELL ENVIRONMENT FOR MAINTENANCE WITH PRIMARY SODIUM STORAGE TANK FILLED WITH 400°F SODIUM.
- ALL AVAILABLE OXYGEN IN CONTAINMENT IS REACTED WITH SODIUM. THIS RESULTS IN BURNING OF APPROXIMATELY 23,000 GALLONS OF SODIUM.
- ACCIDENT OCCURS AT END OF PLANT LIFE MAXIMIZING PRIMARY SODIUM COOLANT RADIOLOGICAL ACTIVITY.

THE RCB DESIGN BASIS ACCIDENT IS ANALYZED USING

- GE SOFIRE
- HAA-3 CODE
- RADIOLOGICAL ASSESSMENT CALCULATIONS

PSAR CHAPTER 15.6 ACCIDENT
BRIEFING FOR
NUCLEAR REGULATORY
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RCB DESIGN BASIS ACCIDENT

- OVERALL ANALYSIS APPROACH
- SODIUM FIRE ANALYSIS CODE
  (GE SOFIRE)

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APRIL 5, 1982

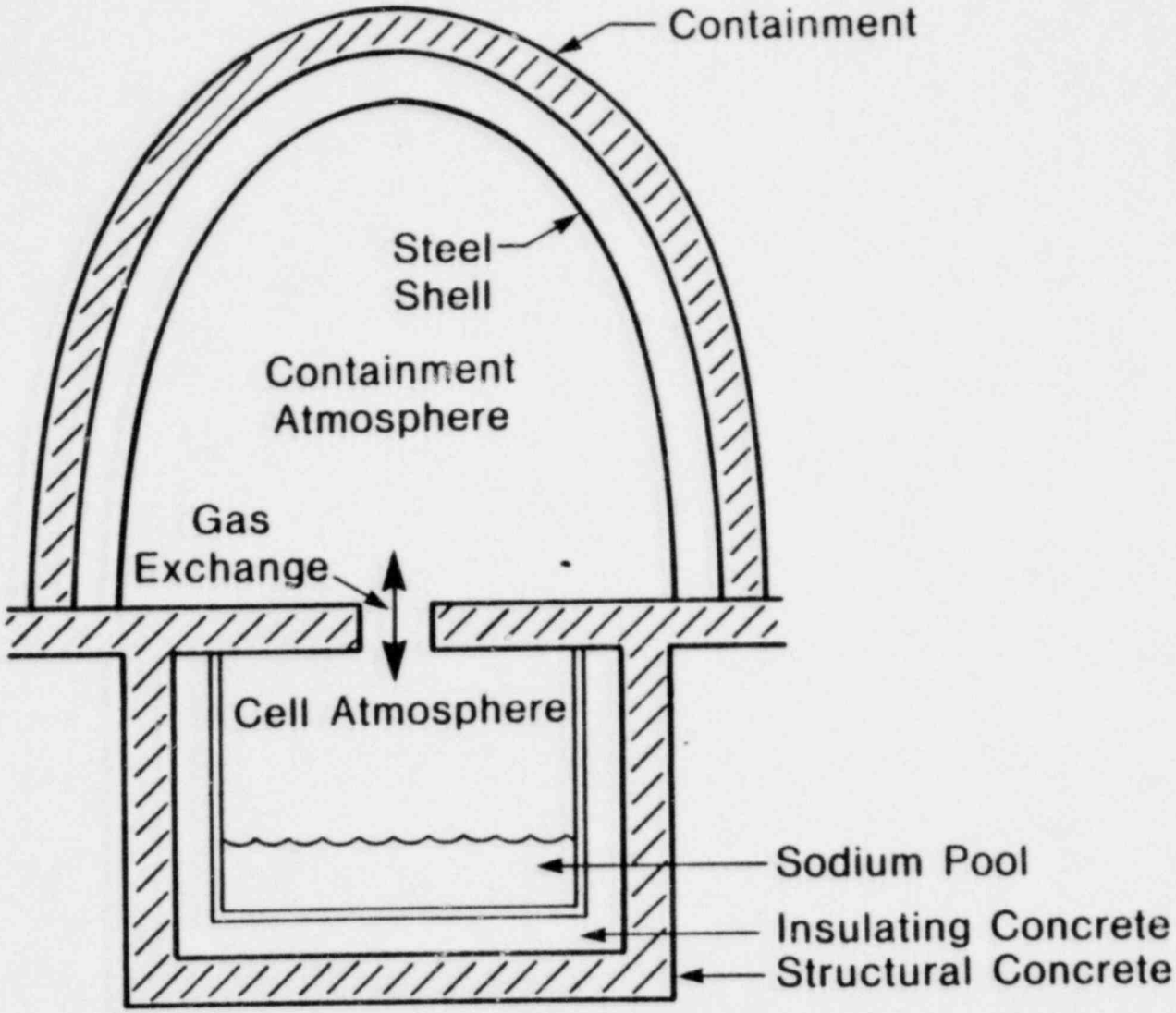
GESOFIRE CODE DISCUSSION

- Purpose of Code
- Discussion of Code model
- Input parameters
- Analysis assumptions

PURPOSE OF GESOFIRE CODE

- Model consequences of pool fire
- Cell atmospherically connected to containment
- Significant effects determined
  - Cell temperature
  - Containment pressure & temperature
  - Structural temperatures
  - Sodium burning rate

GESOFIRE MODEL

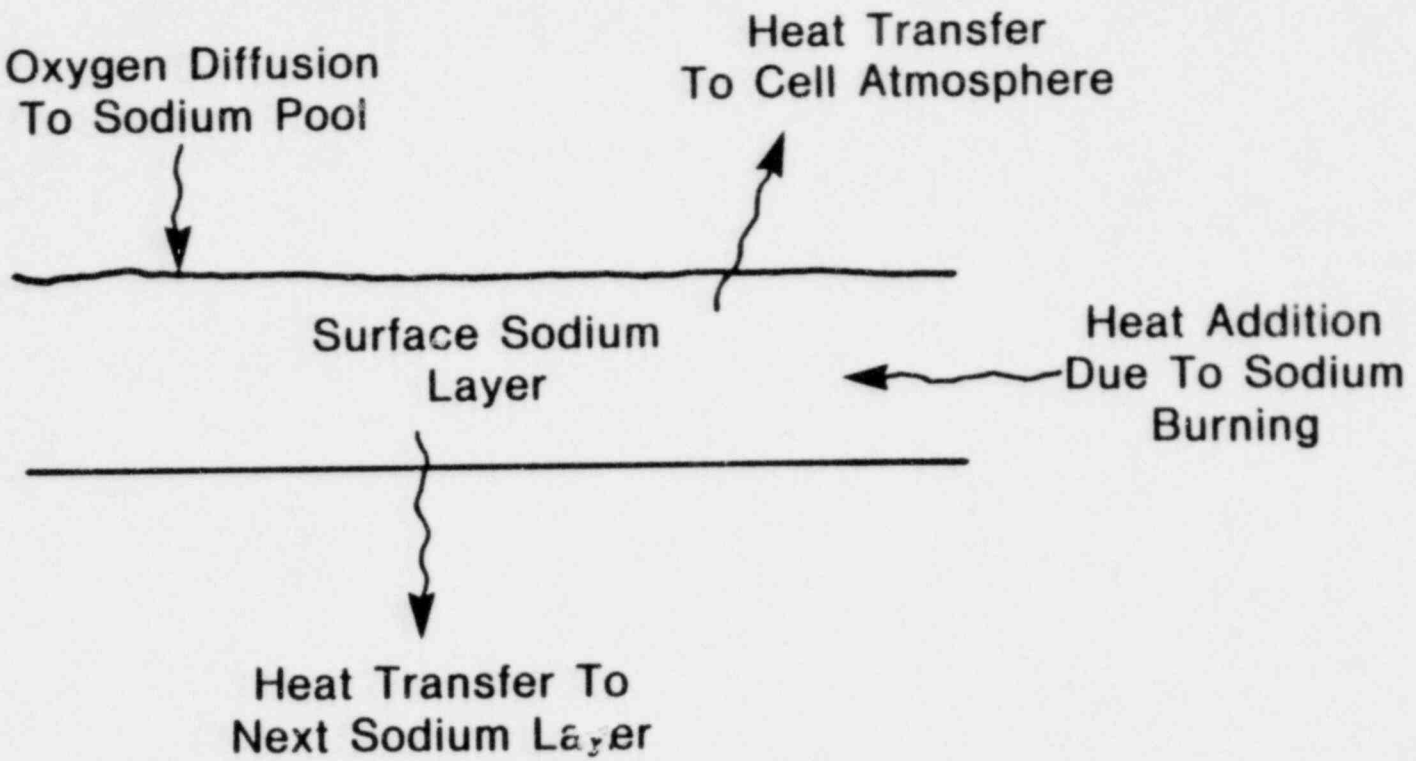


7017-4

GESOFIRE CODE FEATURES

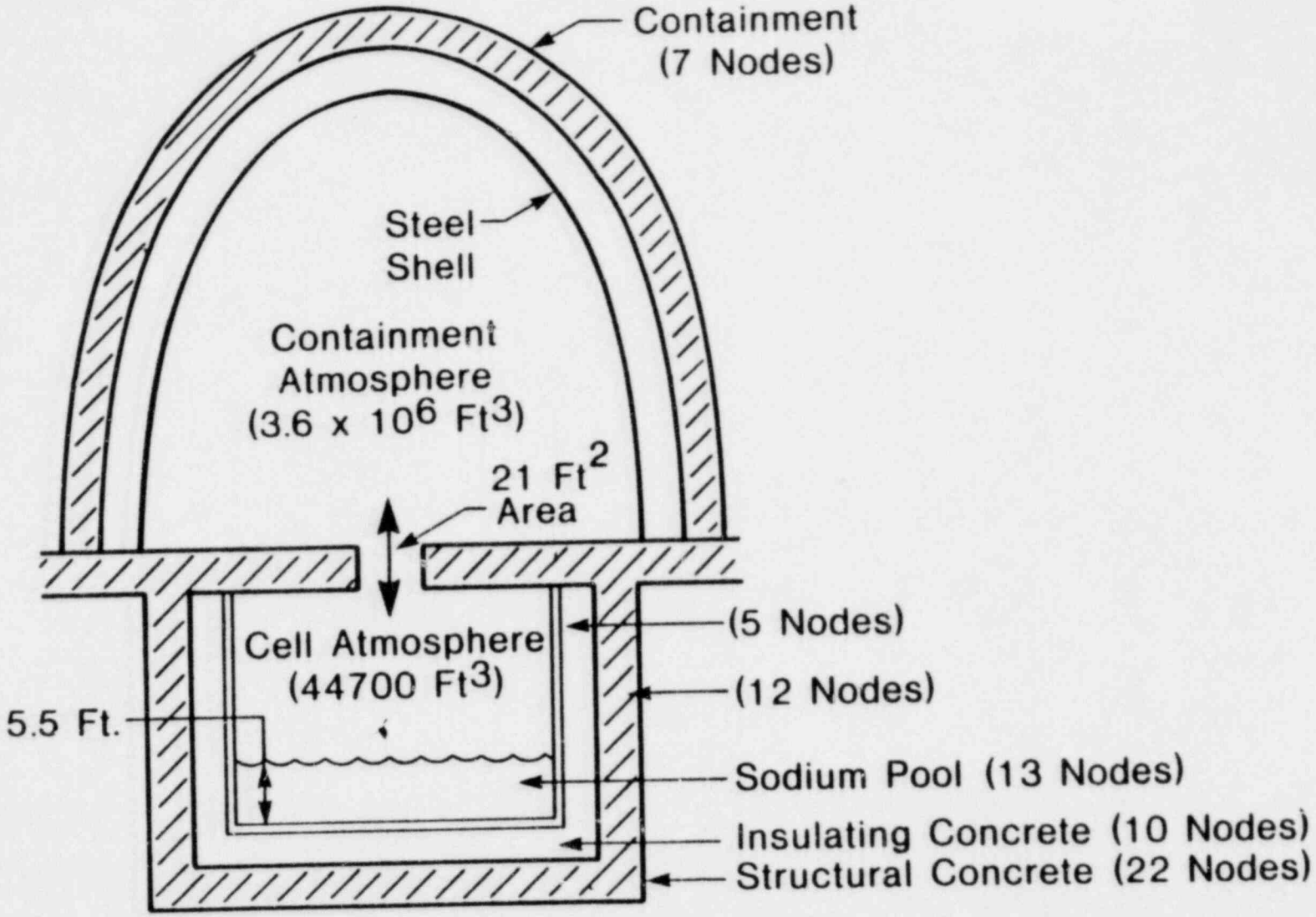
- Pool burning model
- Gas & energy exchange between cell & containment
- Heat transfer paths
  - Pool to cell floor & cell gas
  - Cell gas to cell walls
  - Containment gas to containment shell

GESOFIRE POOL BURNING MODEL



7017-6

GESOFIRE INPUT PARAMETERS FOR THE RCB DBA



7017-5

GESOFIRE ANALYSIS ASSUMPTIONS

- Pool burning only
- Direct connection from cell to containment
- 1-D heat transfer through structures
- No heat sinks due to equipment in cell or containment

PSAR CHAPTER 15.6 ACCIDENT
BRIEFING FOR
NUCLEAR REGULATORY
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ALL 15.6 ACCIDENTS

- AEROSOL BEHAVIOR CODE (HAA-3)
- RADIOLOGICAL ASSESSMENT

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HAA-3

A. What Is The HAA-3 Code And How Is It Used?

B. How Does HAA-3 Work?

C. What Assumptions Are Implicit In The HAA-3 Calculational Techniques?

D. What Assumptions Are Implicit In The HAA-3 Input Data?

WHAT IS THE HAA-3 CODE AND HOW IS IT USED?

1. HAA-3 Is A Heterogeneous Aerosol Agglomeration Code Which Predicts Aerosol Behavior And Transport Following Hypothetical LMFBR Accidents.

2. The Code Is Used To Calculate Potential Off-Site Doses From Design Basis Events.

3. HAA-3 Is Used To Determine The Aerosol Activity Level Within The RCB For Determination Of Containment Isolation Setpont Trip Time.

HOW DOES HAA-3 WORK?

1. Calculates Number Density Of Suspended Aerosol (Particles/cc).

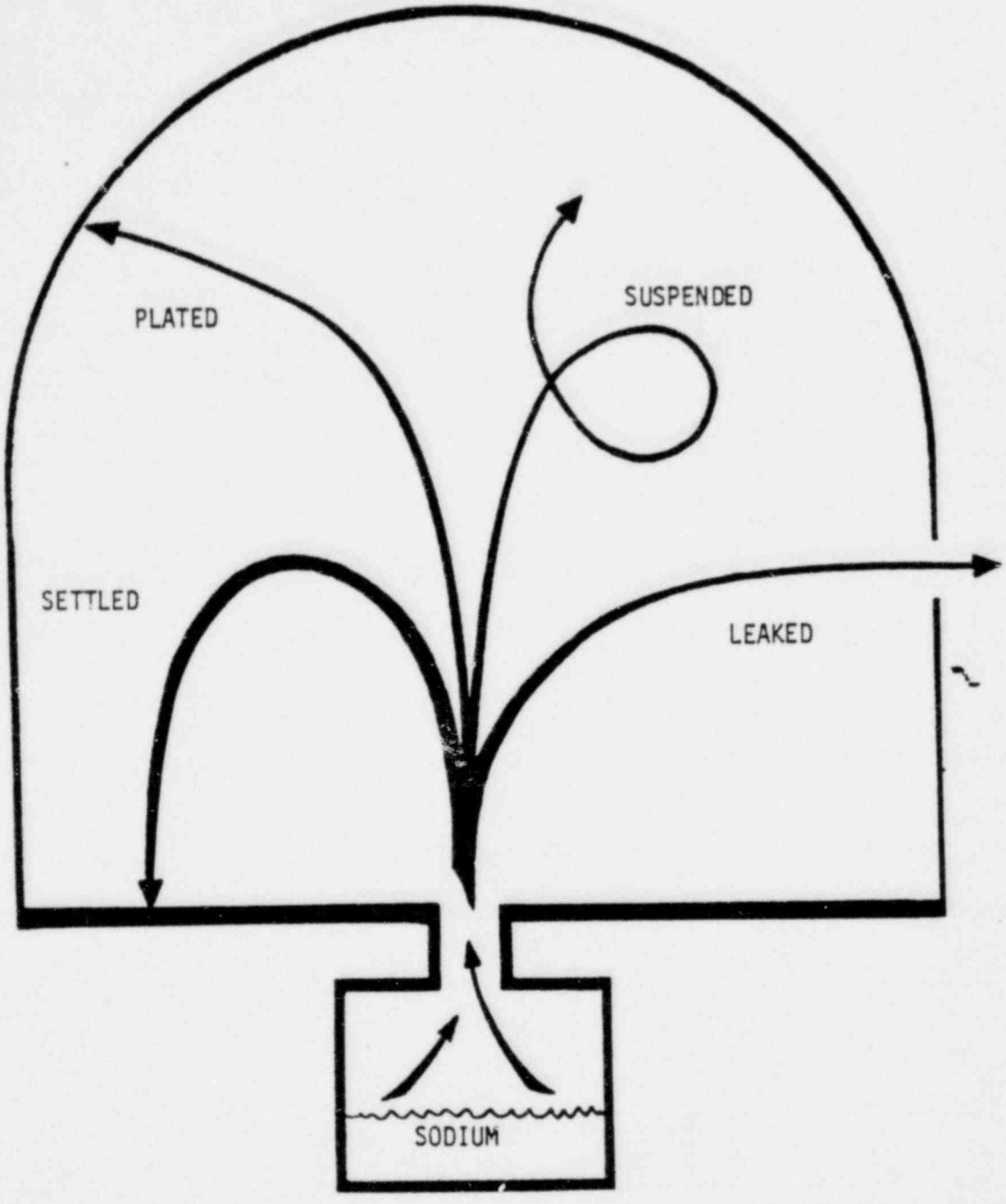
2. The Source Of Suspended Mass Is The Source Generation Rate Generated From The GESOFIRE Sodium Burning Rate.

3. Mass Is Distributed To 4 Different Regions: Plated, Settled, Leaked And Suspended.

4. The Amount of Plated Mass Is Determined By The Experimentally Determined Wall Plating Parameter, Δ.

5. The Settling Rate Of The Aerosol Is Determined By The Size Of The Particles Which Grow Through Agglomeration.

6. The Source Of Leaked Mass Is The Suspended Aerosol. Leakrate Is An Input Parameter.



HAA-3 DISTRIBUTION MODEL

WHAT ASSUMPTIONS ARE IMPLICIT IN THE HAA-3 CALCULATIONAL TECHNIQUES?

1. Homogeneous And Instantaneous Distribution Of Suspended Aerosol.

2. Aerosol Particle Size Distribution Function Is Log-Normal.

3. Ignores Agglomeration Caused By Aerosol Turbulence.

4. Ignores Plating Caused By Thermophoresis.

WHAT ASSUMPTIONS ARE IMPLICIT IN THE HAA-3 INPUT DATA?

1. Only 27% Of The Sodium Aerosol Produced Becomes Airborne In The RCB.

2. Sodium Aerosol Production Stops When The GESOFIRE Calculated Pool Surface Temperature Reaches The Solidification Point.

3. The Aerosol Is 100% Sodium Monoxide.

4. Containment Isolation On Radiation.

5. Leakrate From The RCB Prior To Containment Isolation Is 14000 cfm.

6. Leakrate From The RCB After Containment Isolation Is Proportional To The $\sqrt{\Delta P}$ Such That The Rate Is .1% Vol/Day At 10 psig.

CALCULATION OF OFF-SITE DOSES

1. USES SITE MEASURED METEOROLOGY IN PSAR CHAPTER 2.3.

2. DOSE COMMITMENT FACTORS ARE FROM NUREG-0172.

3. BREATHING RATES ARE FROM REGULATORY GUIDE 1.4.

4. MASS OF LEAKED AEROSOL IS DETERMINED BY HAA-3.

5. ACTIVITY OF SODIUM AEROSOL FROM PRIMARY COOLANT IS BASED ON 30 YEARS REACTOR OPERATION AND 1% FAILED FUEL.

6. $$\text{INHALATION DOSE} = \left[\text{LEAKED NA MASS}\right] \times \left[\text{DOSE COMMITMENT FACTOR OF ISOTOPE}\right] \times \left[\text{BREATHING RATE}\right] \times \left[\frac{X}{Q}\right] \times \left[\text{ACTIVITY OF ISOTOPE IN NA}\right]$$

7. $$\text{EXTERNAL WHOLE BODY DOSE} = .25 \times \left[\frac{X}{Q}\right] \times \left[\text{LEAKED NA MASS}\right] \times \left[\gamma\ \text{ENERGY PER DISINTEGRATION OF ISOTOPE}\right] \times \left[\text{ACTIVITY OF ISOTOPE IN NA}\right]$$

PSAR CHAPTER 15.6 ACCIDENTS
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CRBRP PROGRAM OFFICE

RCB DESIGN BASIS ACCIDENT
- **RESULTS**
- **FEATURES TO ACCOMMODATE**

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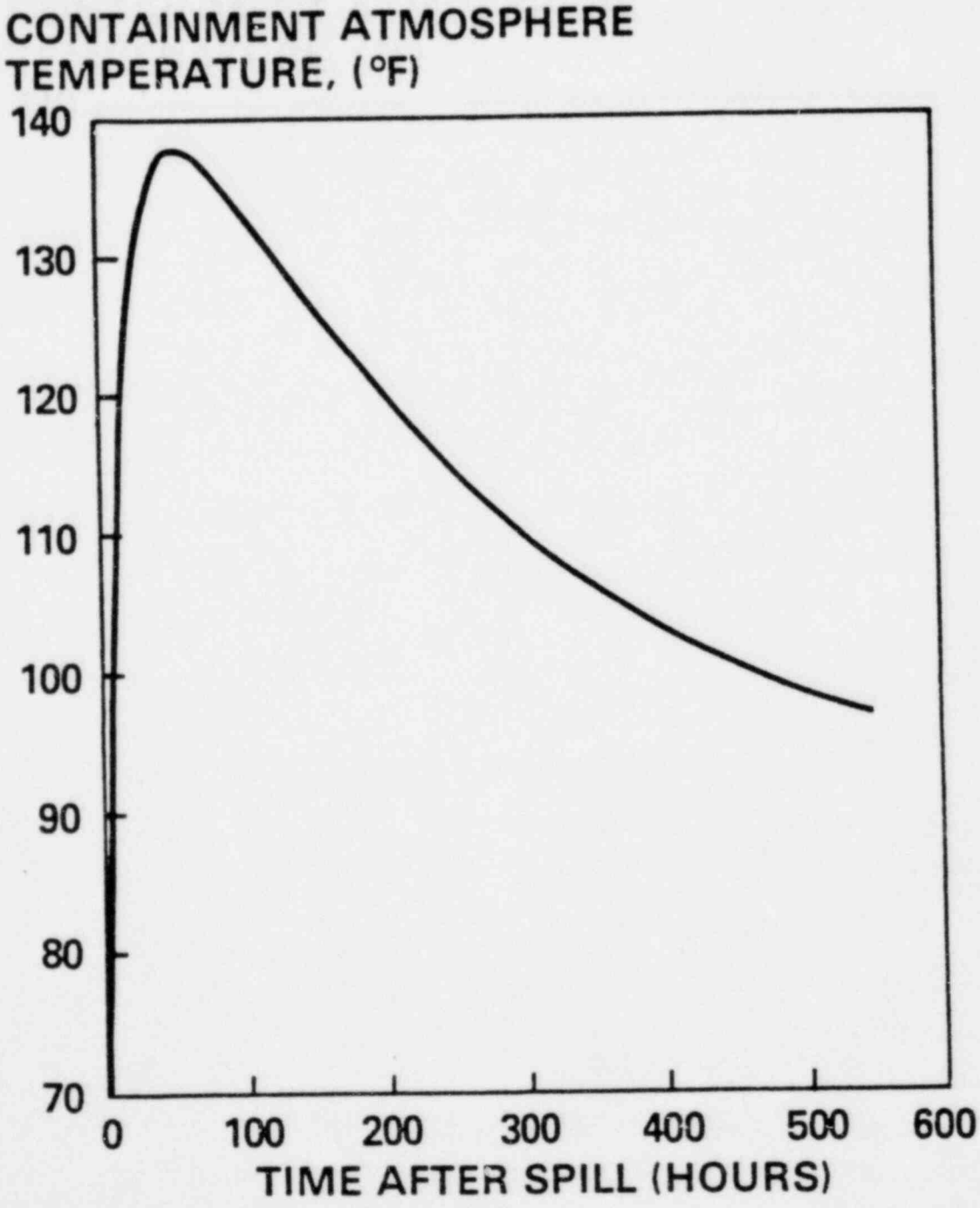
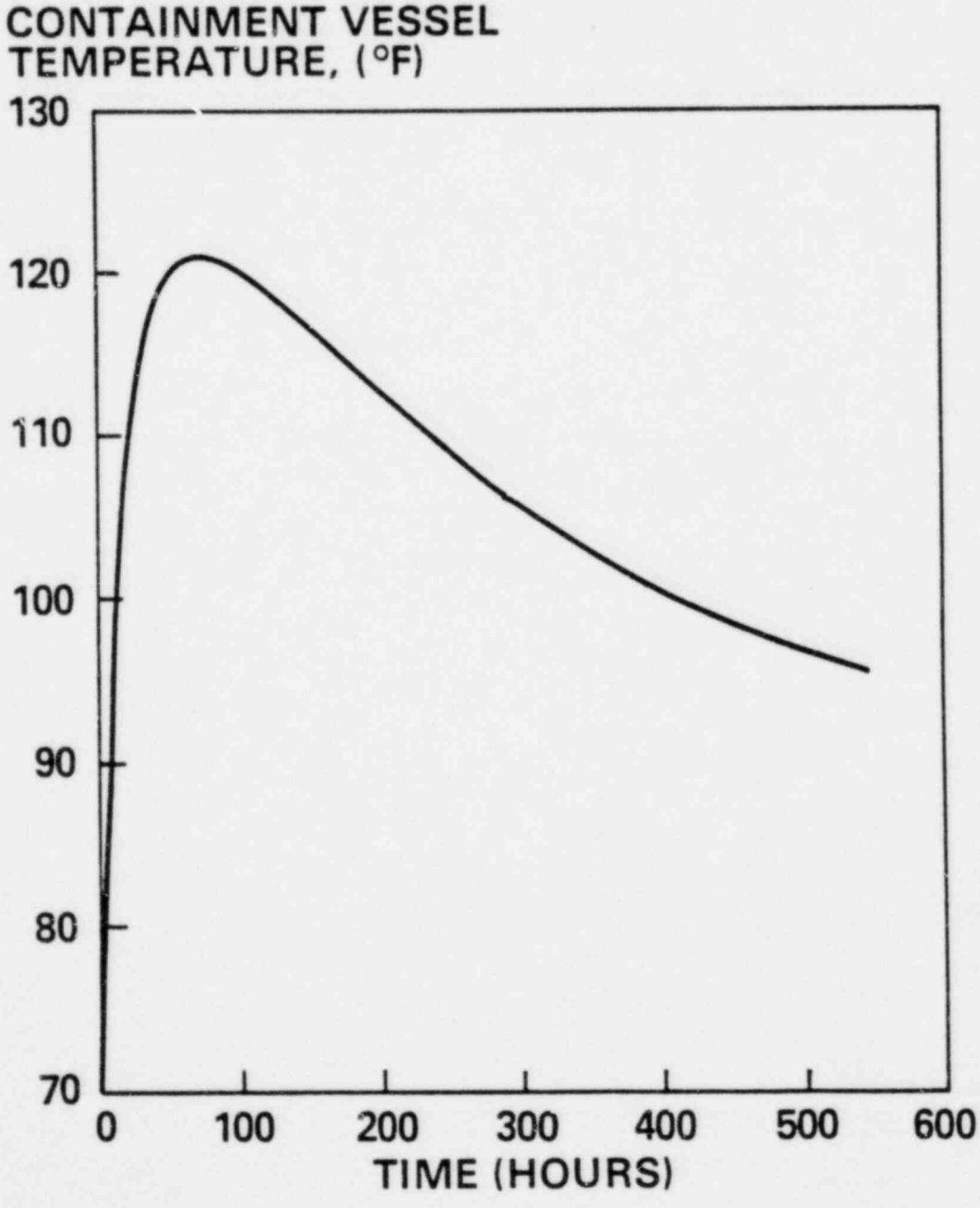
ADVANCED REACTORS DIVISION
APRIL 5, 1982

CONTAINMENT ATMOSPHERE TEMPERATURE-PRIMARY SODIUM IN-CONTAINMENT STORAGE TANK FAILURE DURING MAINTENANCE



CONTAINMENT VESSEL TEMPERATURE-PRIMARY SODIUM IN-CONTAINMENT STORAGE TANK FAILURE DURING MAINTENANCE



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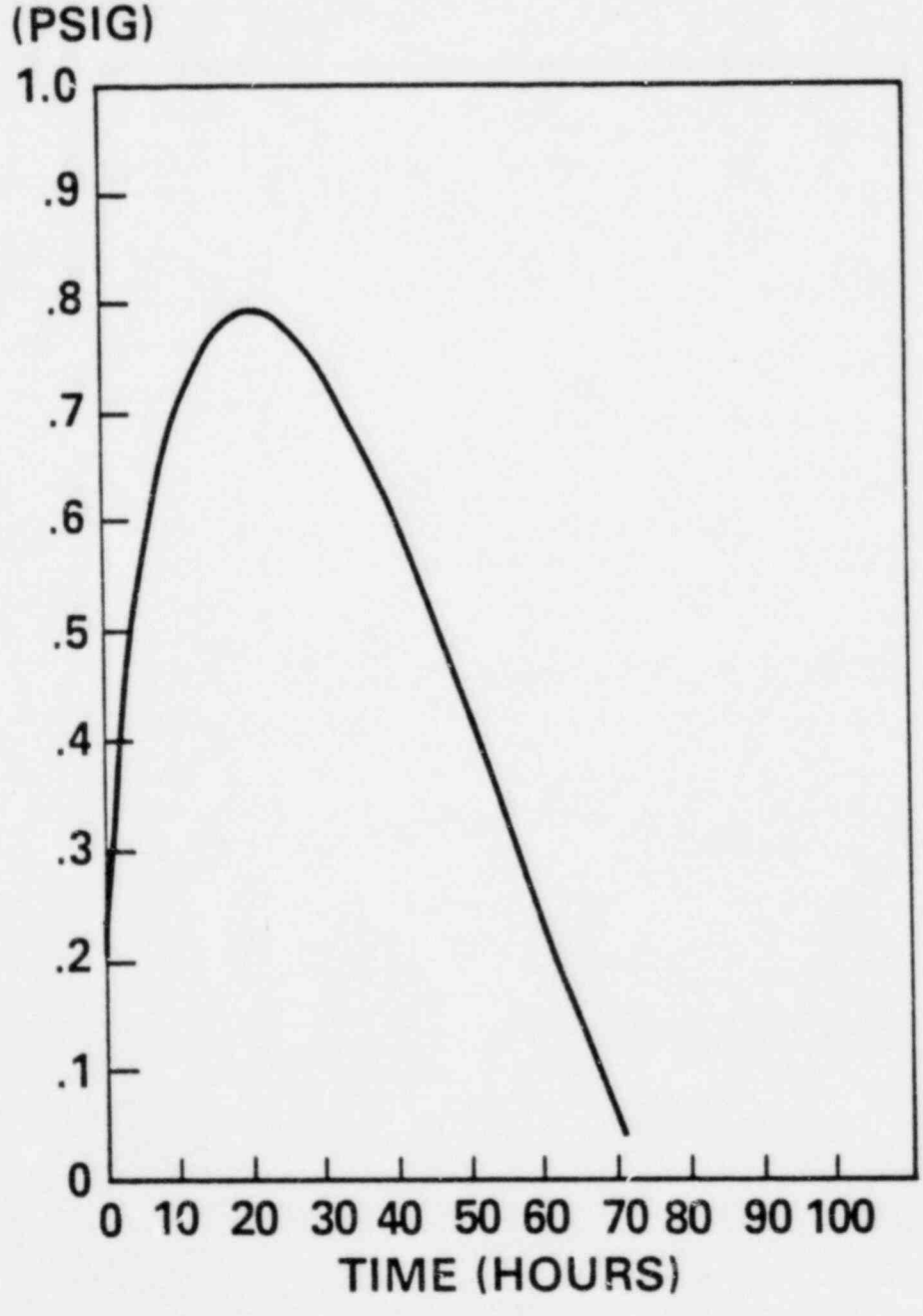
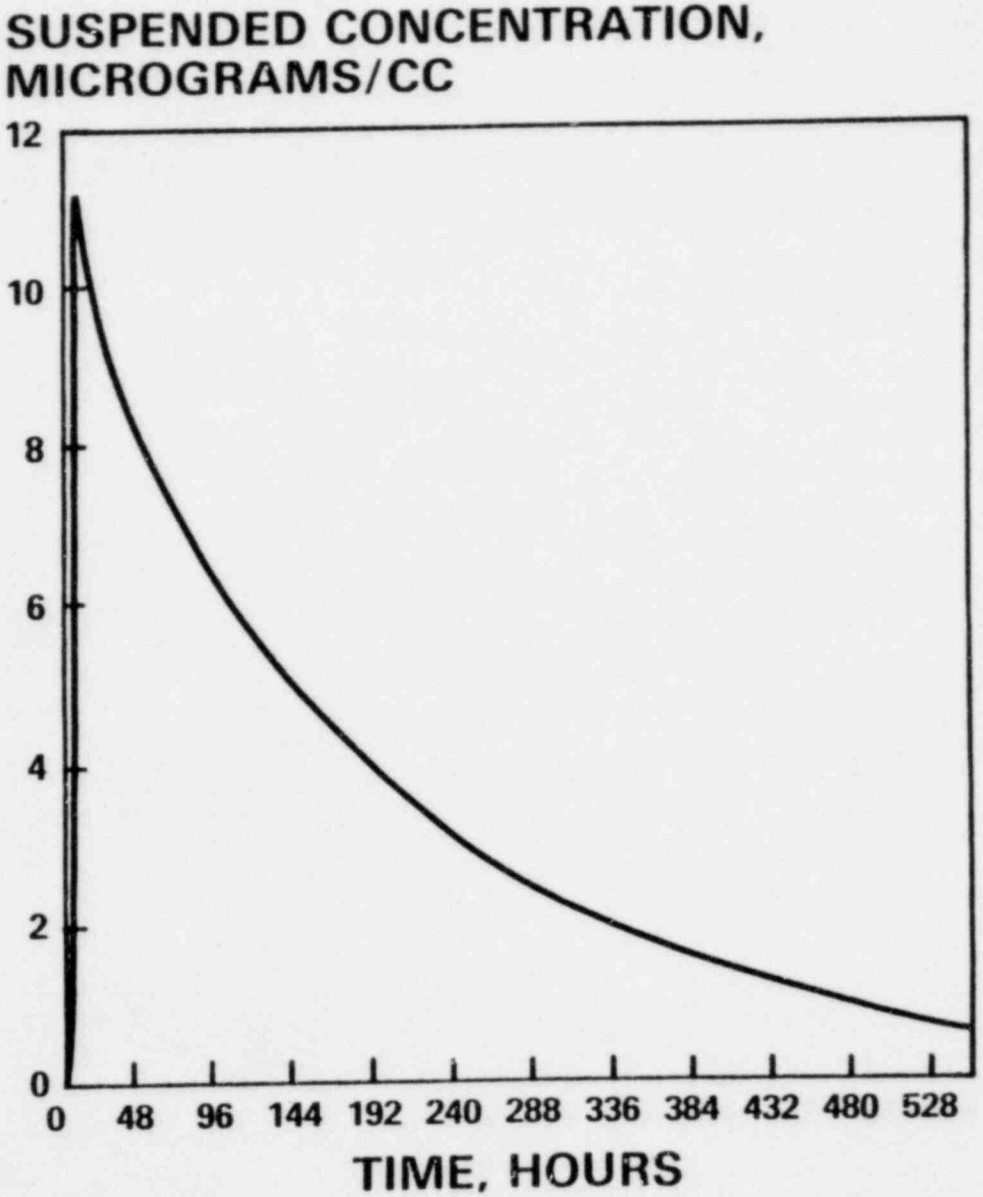
CONTAINMENT ATMOSPHERE PRESSURE-PRIMARY SODIUM IN-CONTAINMENT STORAGE TANK FAILURE DURING MAINTENANCE



CONTAINMENT AEROSOL CONCENTRATION



POTENTIAL OFF-SITE DOSES

TOTAL OF 3.4Kg OF AEROSOL RELEASED TO THE EXTERNAL ENVIRONMENT

		DOSE (REM)	
ORGAN	10CFR100	SITE BOUNDARY (0.42 MI) 2-HOUR	LOW POPULATION ZONE (2.5 MI) 30 DAYS
• WHOLE BODY**	25	2.14 E-2*	3.43 E-3
• THYROID	300	8.01 E-2	1.28 E-2
• BONE	150 +	2.88 E-2	4.61 E-2
• LUNG	75 +	1.61 E-2	2.57 E-3

* 2.14E-2 = 2.14×10^{-2}

** INCLUDES BOTH INHALATION AND EXTERNAL GAMMA EXPOSURE

\+ NRC GUIDANCE PER MAY 6, 1976, LETTER

FEATURES TO ACCOMMODATE

- STEEL LINED CELLS TO PREVENT SODIUM CONCRETE INTERACTIONS
- INSULATING CONCRETE BEHIND CELL LINERS TO PROTECT STRUCTURAL CONCRETE
- ASME SECTION III, DIVISION 1 CLASS MC CONTAINMENT VESSEL DESIGNED TO 10 PSIG AND 250°F
- CONTAINMENT ISOLATION
- RCB DESIGN LEAK RATE OF 0.1% VOLUME PER DAY AT 10 PSIG
- NEGATIVE PRESSURE IN CONTAINMENT/CONFINEMENT ANNULUS SPACE WITH CONTAINMENT/CONFINEMENT PENETRATIONS DESIGNED FOR BYPASS LEAKAGE LESS THAN 0.001% VOLUME PERCENT PER DAY
- CONTAINMENT/CONFINEMENT ANNULUS FILTRATION SYSTEM
- REACTOR SCRAM ON LOW SODIUM LEVEL IN THE REACTOR VESSEL

PHTS CELL DESIGN BASIS ACCIDENT

- PIPE BREAK BASED ON A NON-MECHANISTIC SHARP EDGED CIRCULAR ORIFICE WHOSE AREA IS EQUAL TO ONE-HALF THE PIPE DIAMETER TIMES ONE-HALF THE PIPE WALL THICKNESS
- CRITERION IS FOR PIPING WITH LOW INTERNAL PRESSURE AS SPECIFIED BY BRANCH TECHNICAL POSITION MEB 3-1, "POSTULATED BREAK AND LEAKAGE LOCATIONS IN FLUID SYSTEM PIPING OUTSIDE CONTAINMENT"
- PLANT AT FULL POWER OPERATING CONDITIONS WITH SODIUM AT ~1000°F
- TOTAL SPILL VOLUME OF 35,000 GALLONS WITH LEAK RATES RANGING FROM 947 GPM TO 58 GPM.

THE PHTS CELL DESIGN BASIS ACCIDENT IS ANALYZED USING

- SPRAY-3B CODE
- SOFIRE-2 CODE
- HAA-3 CODE
- RADIOLOGICAL ASSESSMENT CALCULATIONS

PSAR CHAPTER 15.6 ACCIDENT

BRIEFING FOR

NUCLEAR REGULATORY COMMISSION

CRBRP PROGRAM OFFICE

PHTS CELL DESIGN BASIS ACCIDENT

- OVERALL ANALYSIS APPROACH
- SODIUM FIRE ANALYSIS CODES
  - SPRAY-3A
  - SOFIRE-II

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APRIL 5, 1982

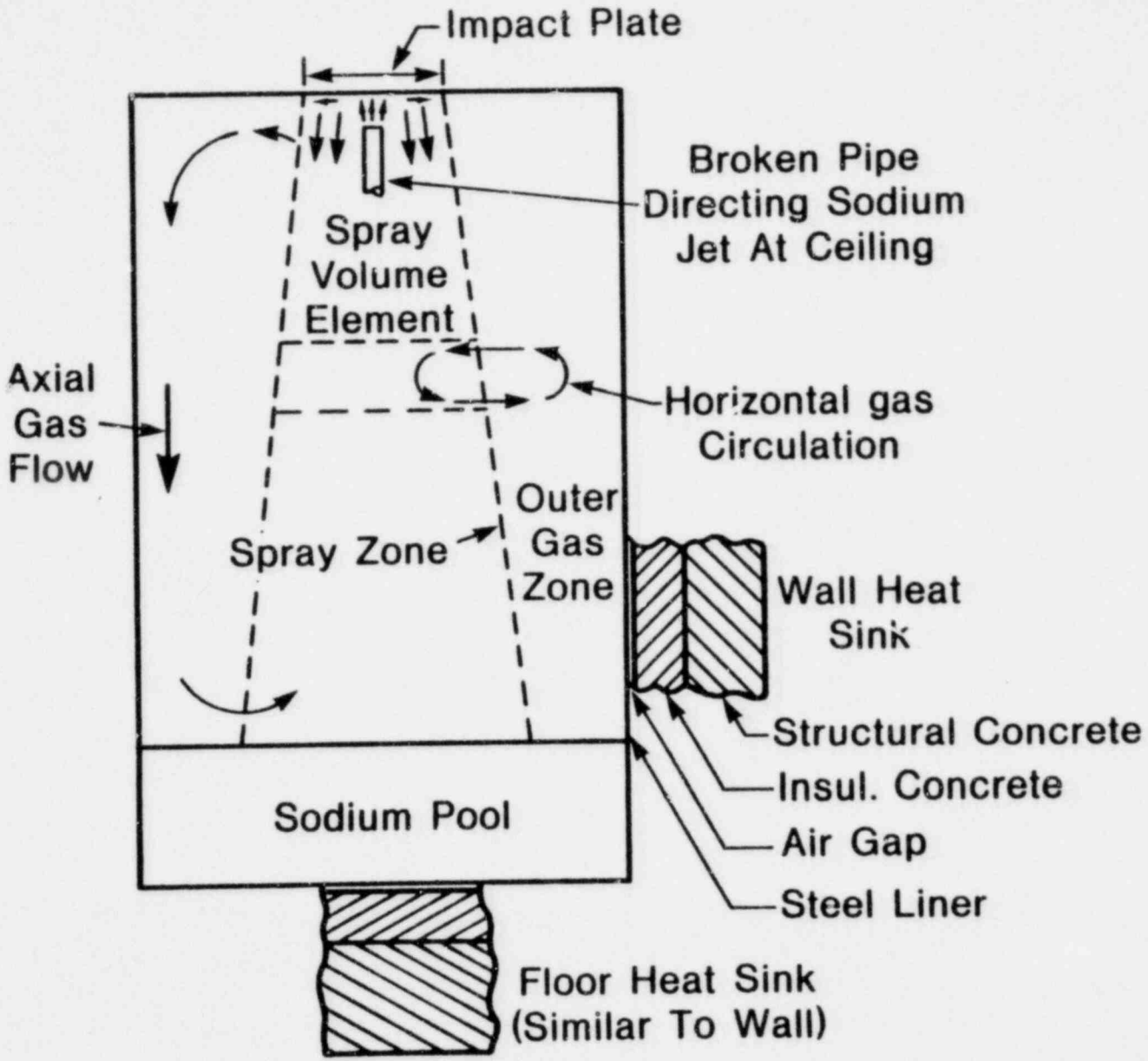
SPRAY CODE DISCUSSION

- Introduction
- Discussion of Spray Code model
- Rationale for input parameters
- Limitations of the Spray Code

SPRAY CODE

- Model consequences of sodium spray releases
- Significant effects determined
  - Cell pressure & temperature
  - Pool temperature
  - Sodium burning rate
- Provide initial conditions for pool fire analysis

SPRAY CODE MODEL



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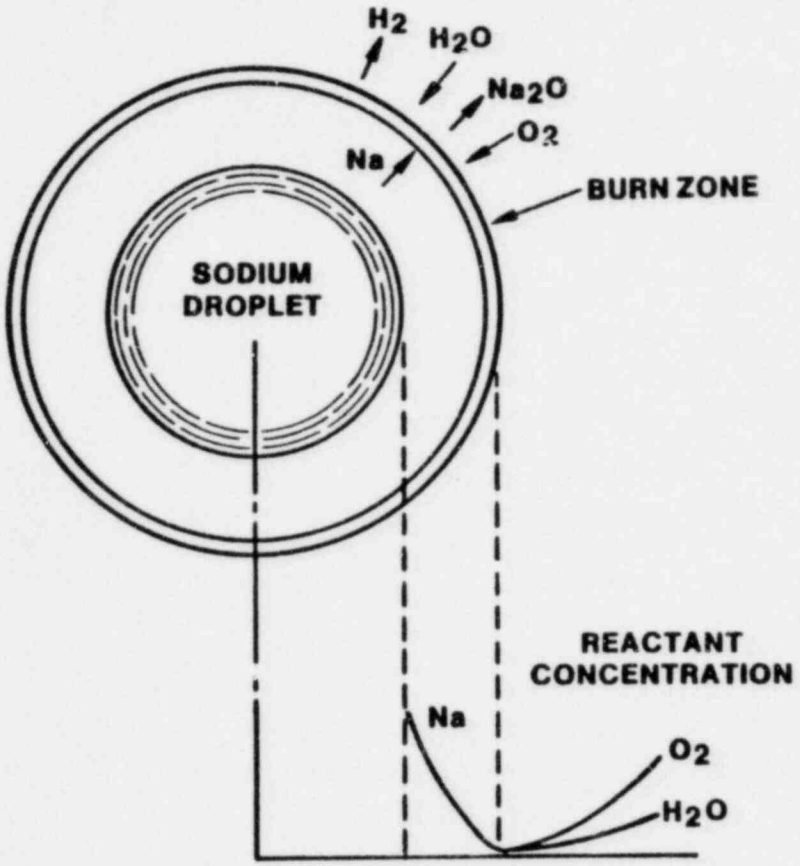
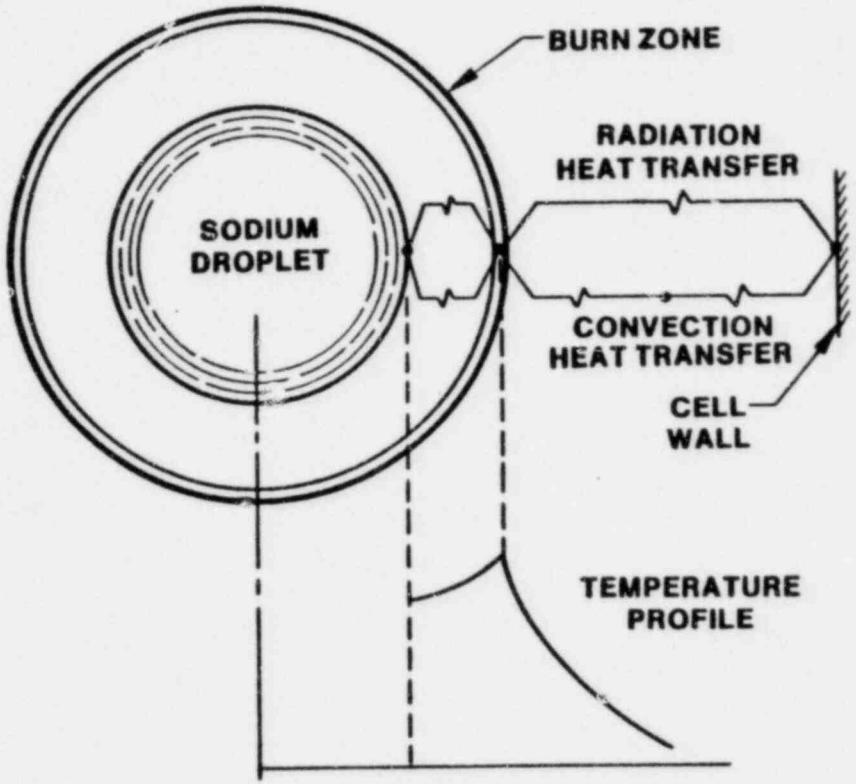
REACTION MODEL FOR SODIUM DROPLET



HEAT TRANSFER PATHS FOR SODIUM DROPLET



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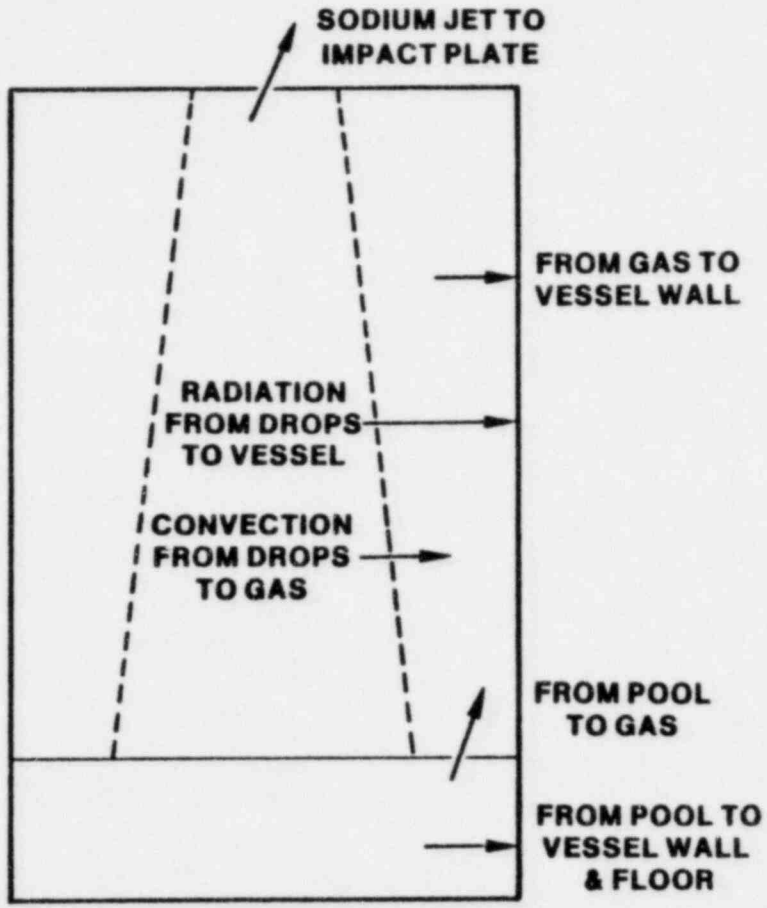
HEAT TRANSFER PATHS



STANDARD SPRAY INPUT PARAMETERS

- Drop diameter = 0.18″
- Spray volume = 33% of cell volume
- Oxygen concentration = 2%
- Water vapor concentration = 1000 ppm

SPRAY CODE LIMITATIONS

- One dimensional gas motion
- Single drop size

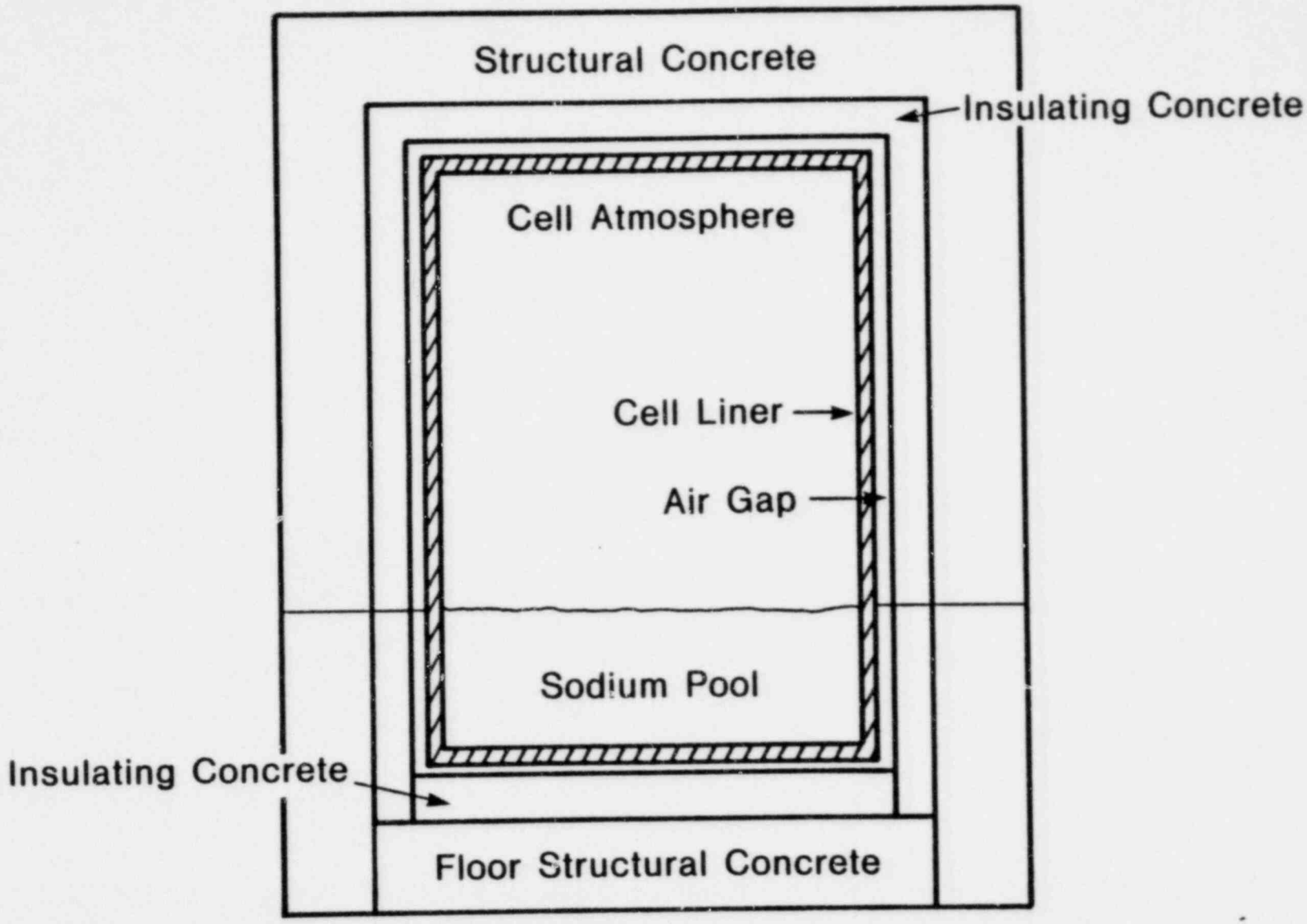
SOFIRE CODE DISCUSSION

- Purpose of Code
- Discussion of Code model
- Input parameters

PURPOSE OF SOFIRE CODE

- Model consequences of pool fire in single cell
- Significant effects determined:
  - Cell temperature & pressure
  - Structural temperatures
  - Sodium burning rate

SOFIRE II MODEL



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TYPICAL INPUT PARAMETERS

- Initial atmospheric conditions from spray
- Initial concrete temperature from spray

PSAR CHAPTER 15.6 ACCIDENTS
BRIEFING FOR
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PHTS CELL DESIGN BASIS ACCIDENT

- RESULTS
- FEATURES TO ACCOMMODATE

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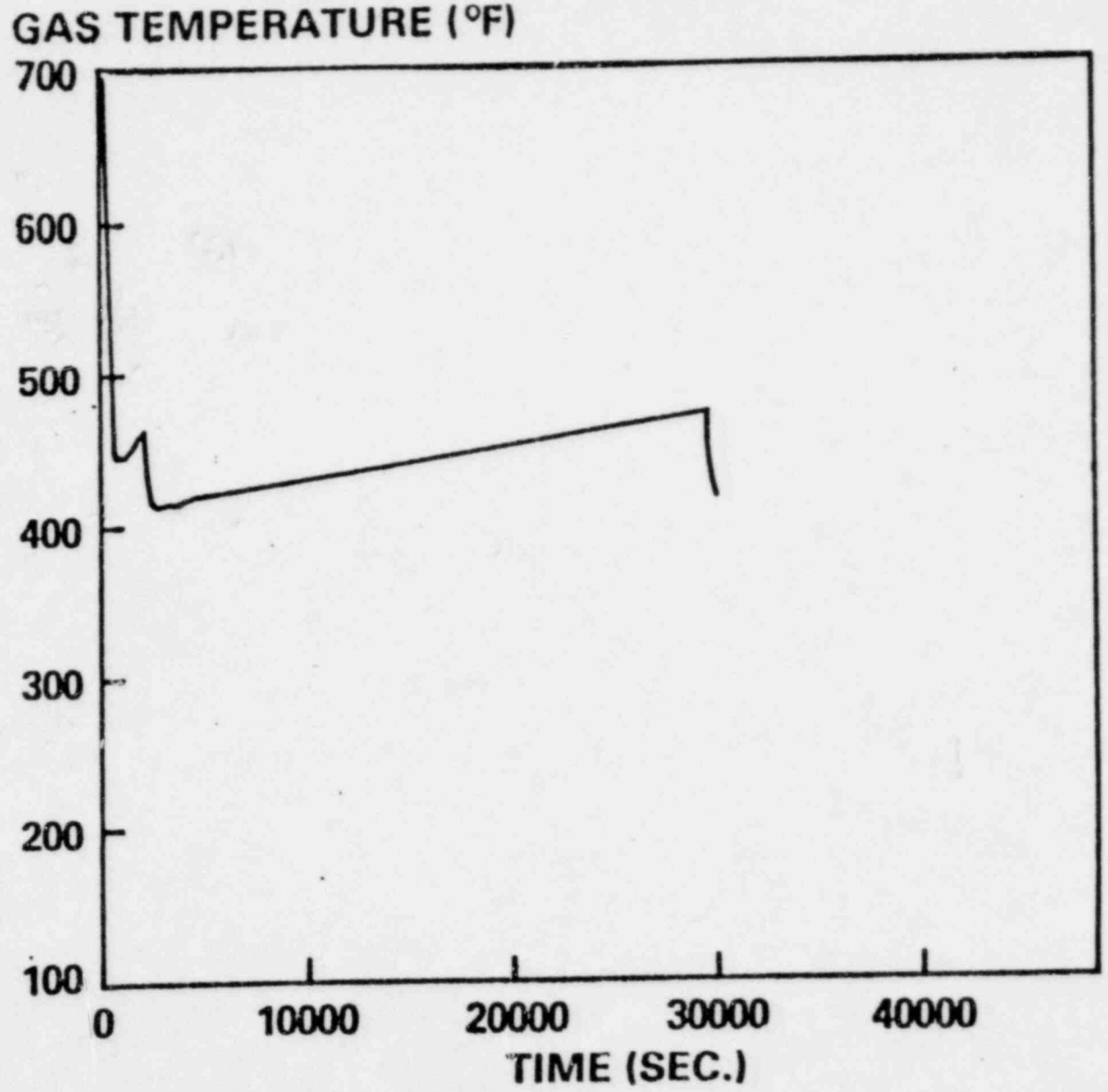
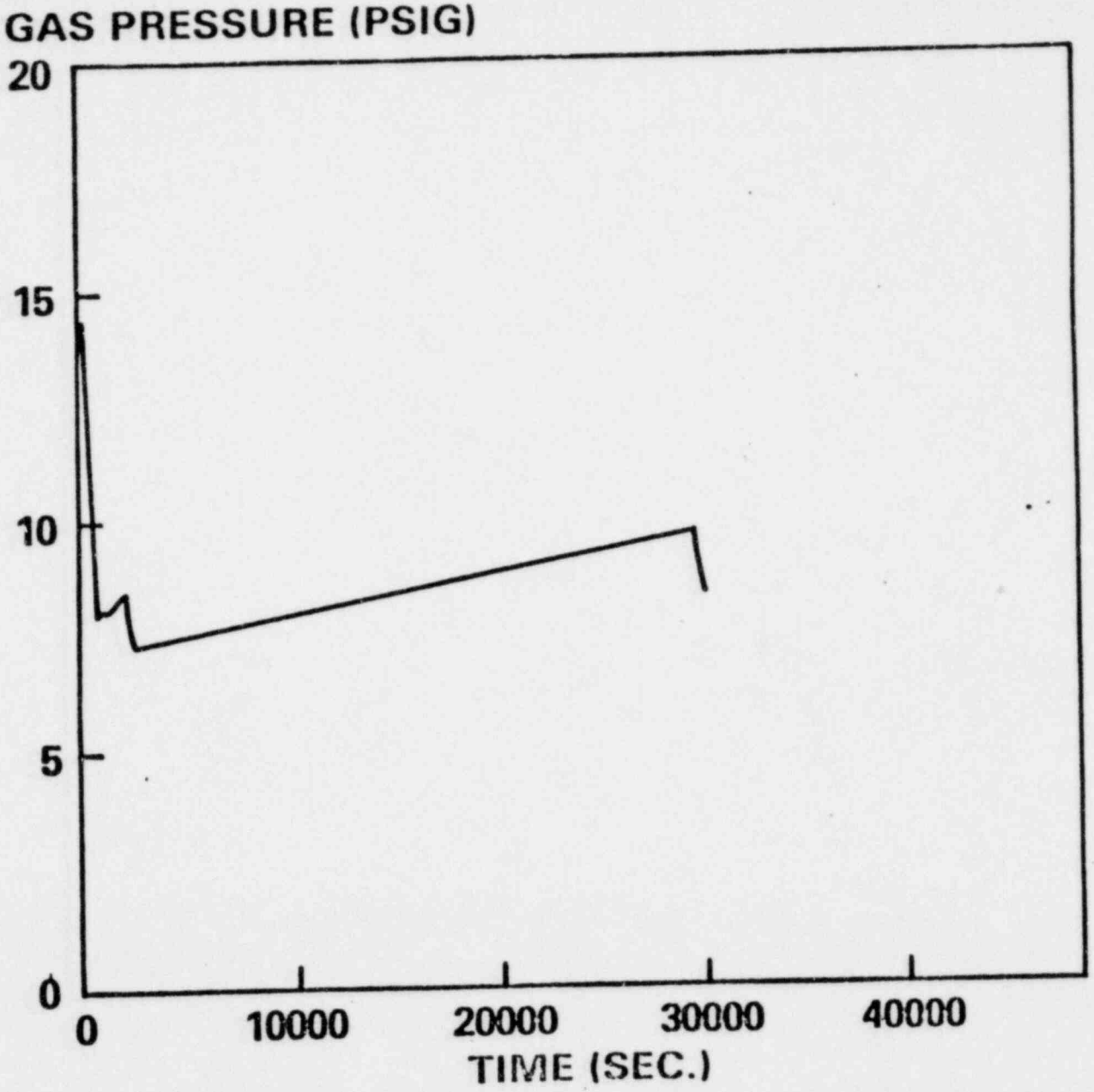
ADVANCED REACTORS DIVISION
APRIL 5, 1982

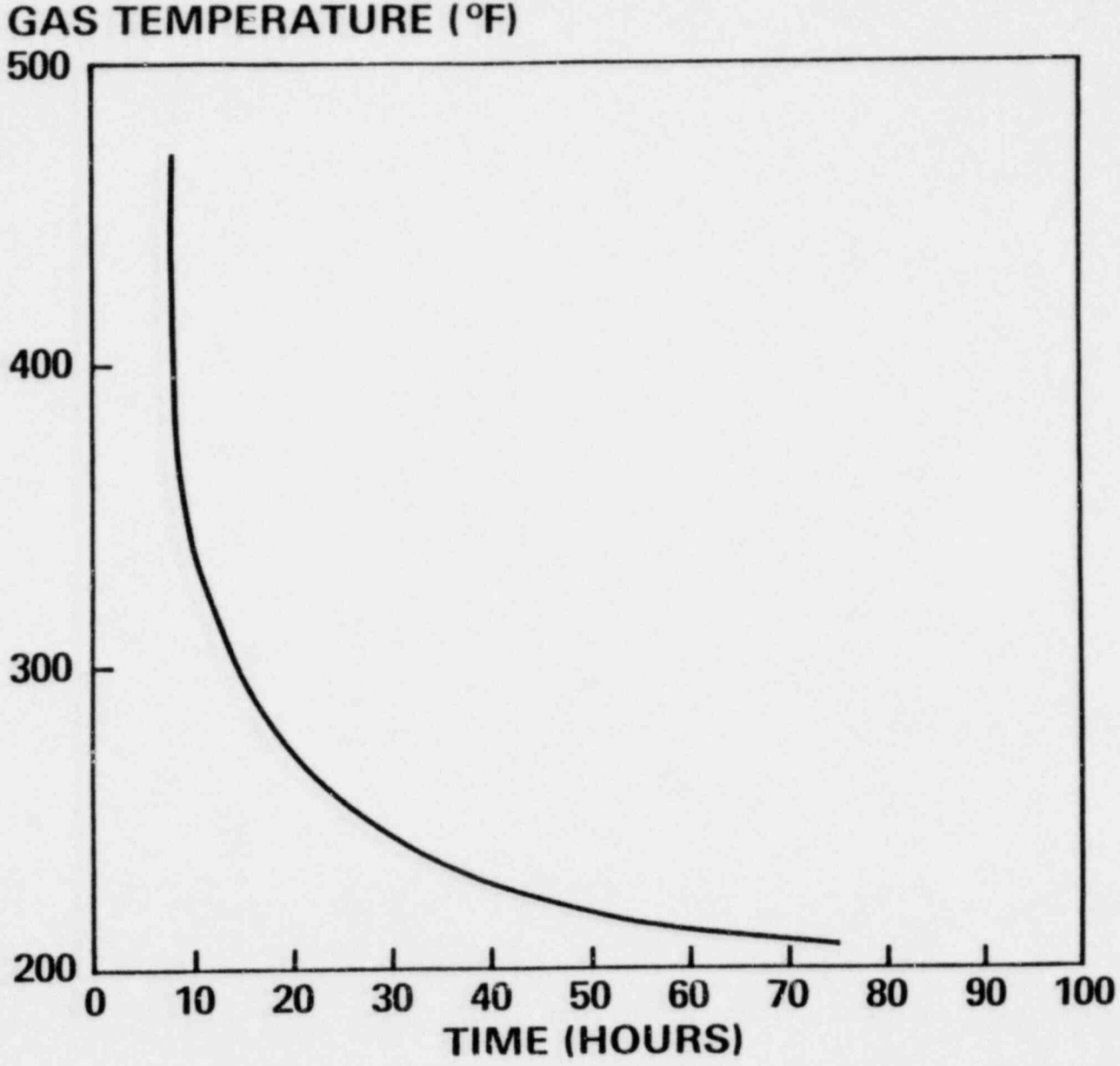
PHTS CELL GAS TEMPERATURE (SPRAY PHASE)



PHTS CELL GAS PRESSURE (SPRAY PHASE)



PHTS CELL GAS TEMPERATURE (SOFIRE PHASE)



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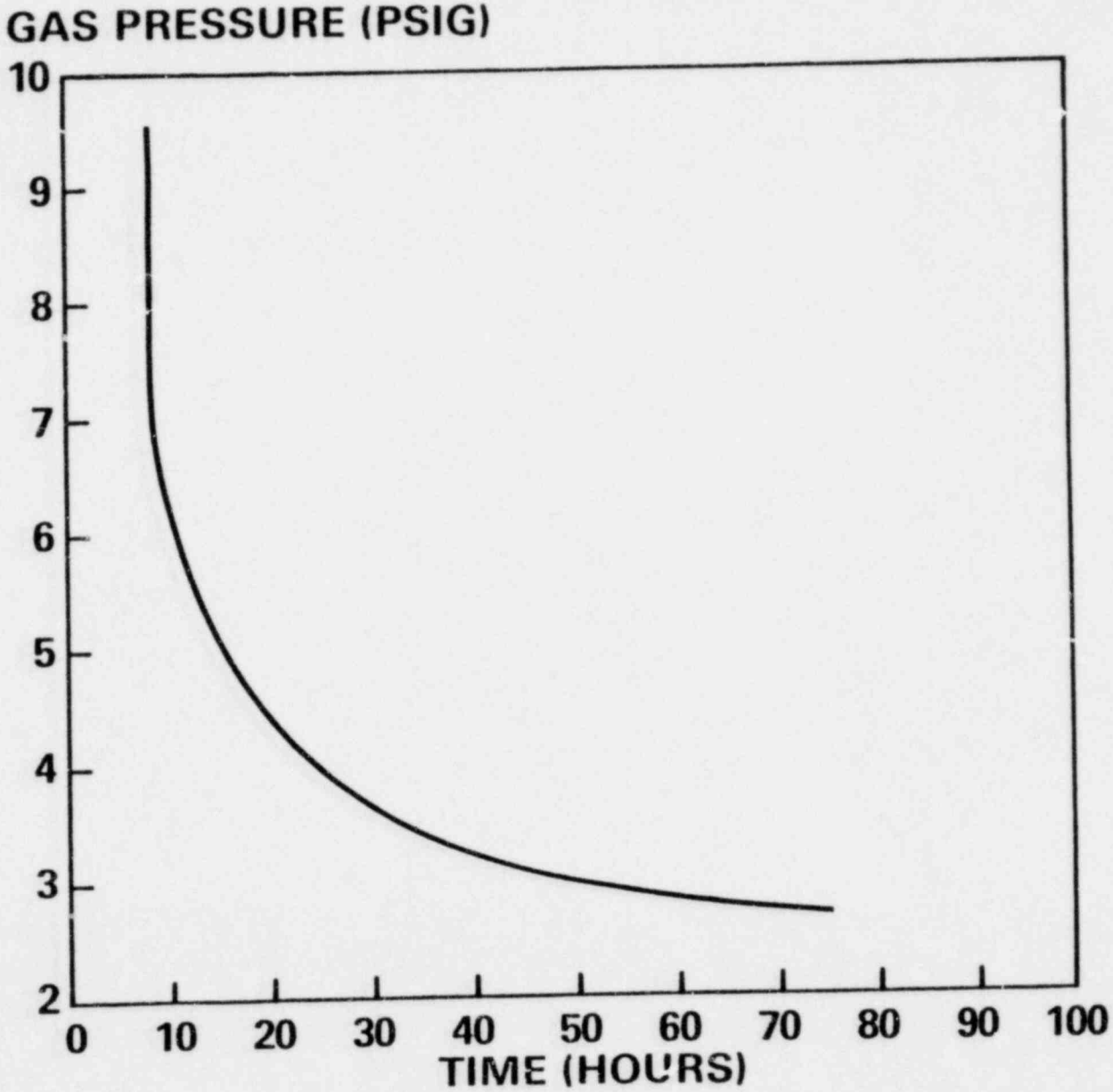
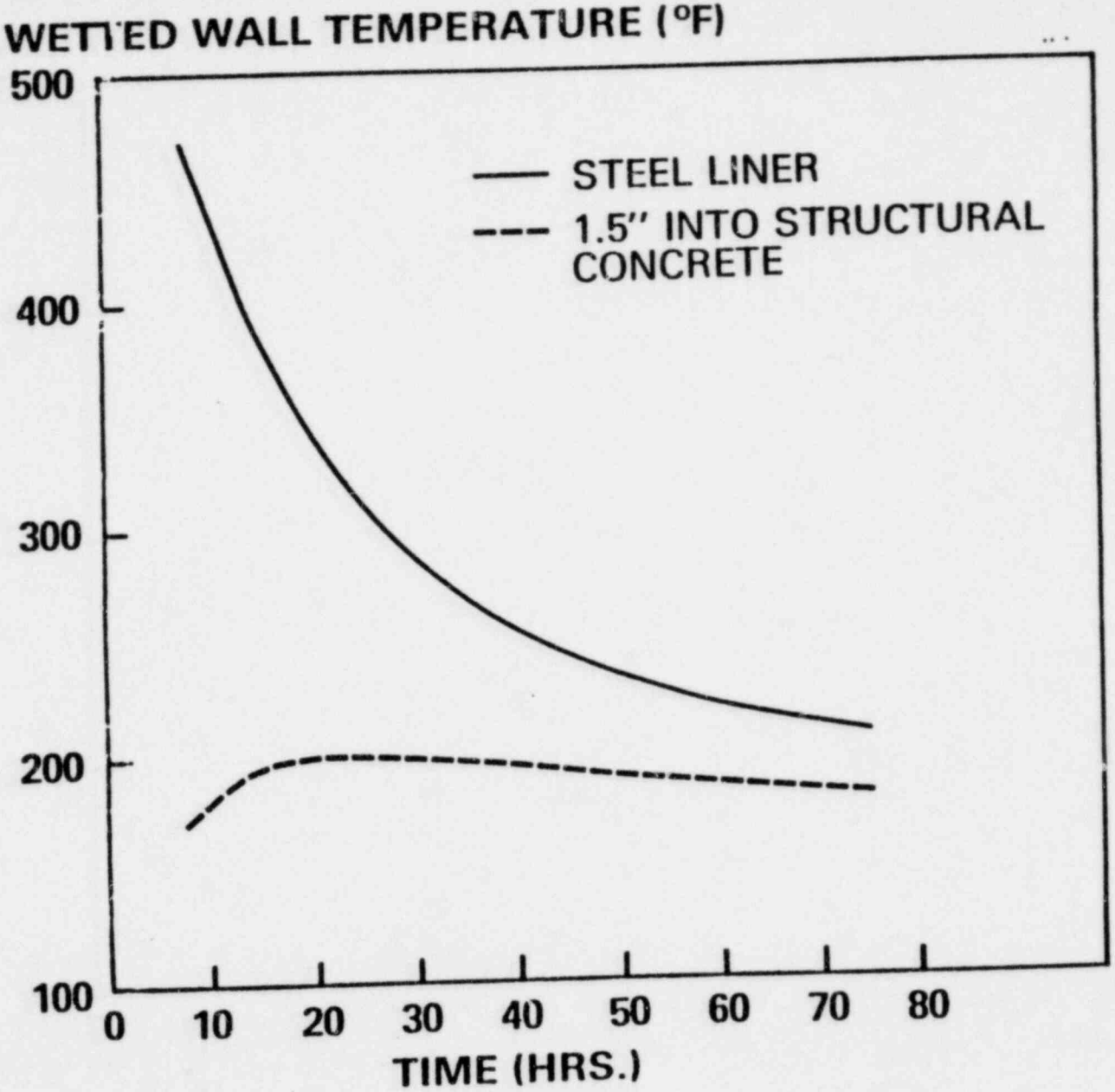
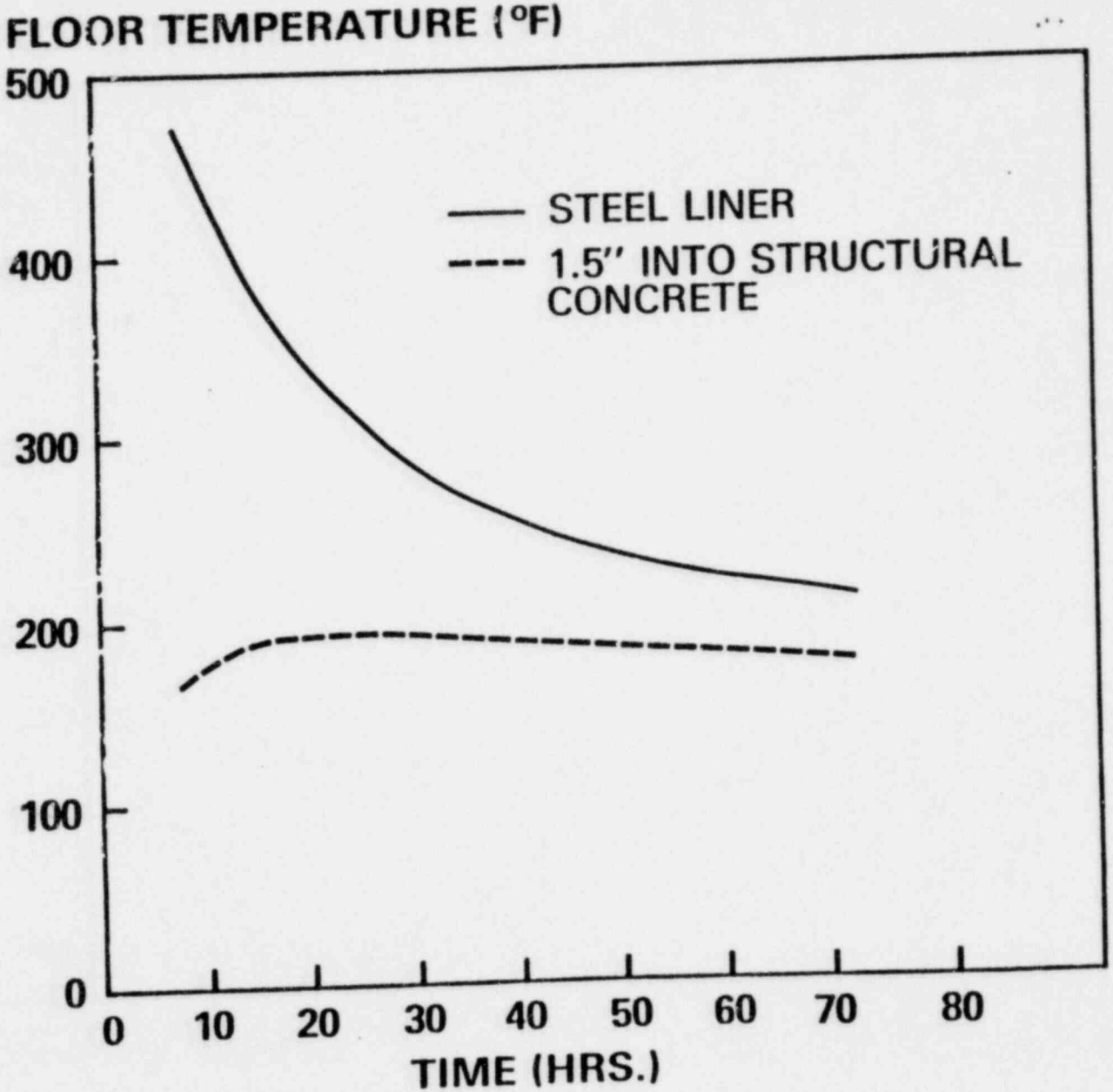
PHTS CELL GAS PRESSURE (SOFIRE PHASE)



PHTS CELL WALL TEMPERATURE



PHTS CELL FLOOR TEMPERATURE



POTENTIAL OFF-SITE DOSES

APPROXIMATELY 5 GRAMS OF AEROSOL RELEASED TO THE EXTERNAL ATMOSPHERE

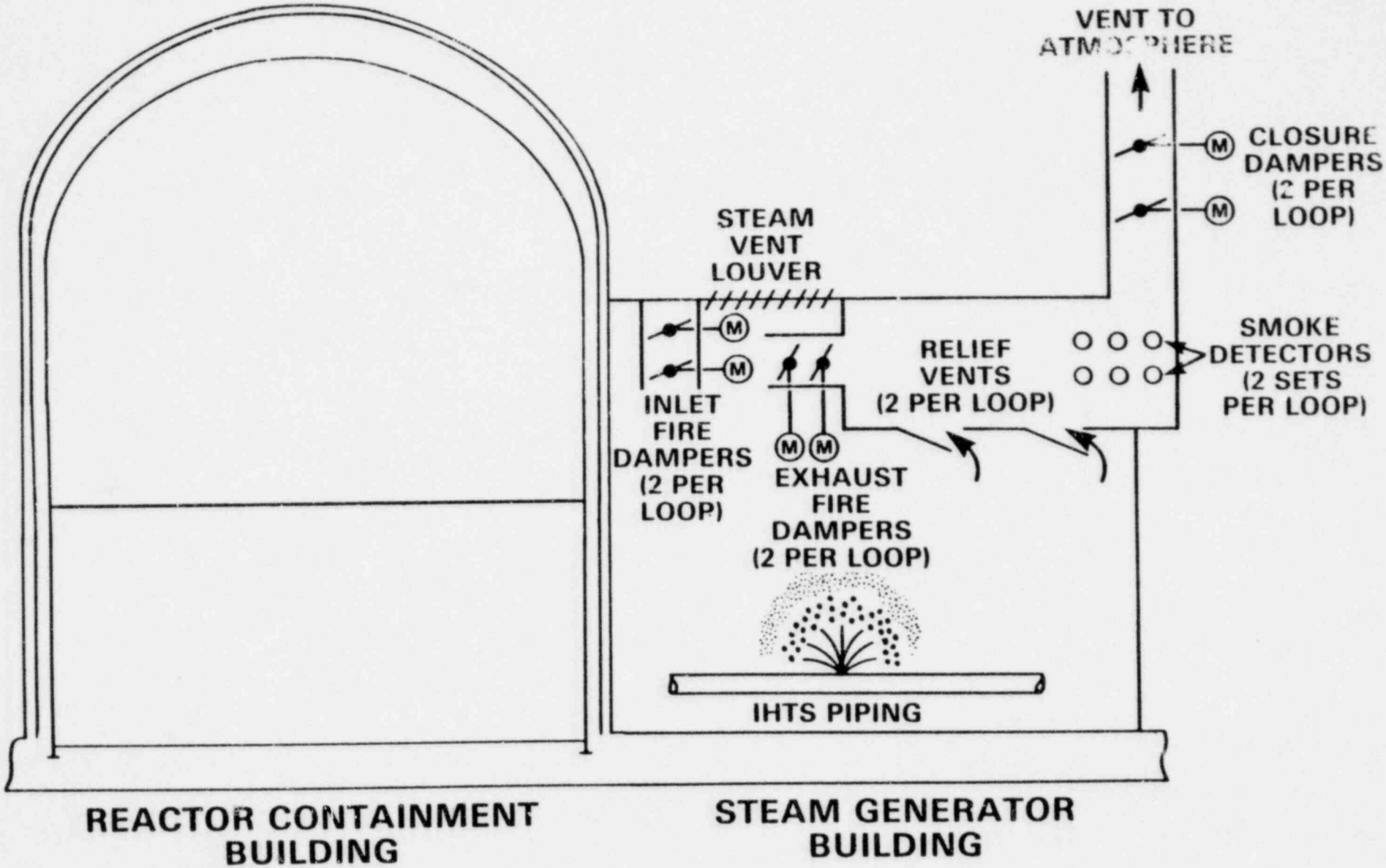
	DOSE (REM)		
ORGAN	10CFR100	SB (0.2 MI) 2-HOUR	LPZ (2.5 MI) 30 DAYS
• WHOLE BODY**	25	9.89 E-5*	1.97 E-5
• THYROID	300	8.30 E-5	1.64 E-5
• BONE	150 +	1.12 E-4	2.20 E-5
• LUNG	75 +	3.27 E-5	6.44 E-6

* 9.89 E-5 $= 9.89 \times 10^{5}$

** INCLUDED BOTH INHALATION AND EXTERNAL GAMMA EXPOSURE.

\+ NRC GUIDANCE PER MAY 6, 1976, LETTER

CRBRP AEROSOL MITIGATION SYSTEM



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MITIGATION OF IHX LEAK

- SHUTDOWN OF REACTOR 8.5 MINUTES AFTER INITIATION OF IHTS SODIUM LEAK.
- OPERATOR ACTION WITHIN 2 HOURS TO SHUTDOWN PRIMARY PUMP PONY MOTOR ASSOCIATED WITH FAULTED IHTS LOOP.
- OPERATOR ACTION WITHIN 24 HOURS TO VENT PRIMARY LOOP ASSOCIATED WITH FAULTED IHTS LOOP.

THE IHTS DESIGN BASIS ACCIDENT IS ANALYZED USING

- SPCA CODE
- SPRAY-3B CODE
- HAA-3 CODE
- RADIOLOGICAL ASSESSMENT CALCULATIONS

PSAR CHAPTER 15.6 ACCIDENT
BRIEFING FOR
NUCLEAR REGULATORY
COMMISSION
CRBRP PROGRAM OFFICE

SGB DESIGN BASIS ACCIDENT

- OVERALL ANALYSIS APPROACH
- SODIUM FIRE ANALYSIS CODE (SPCA)

PRESENTED BY:
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WESTINGHOUSE—RM
ADVANCED REACTORS DIVISION
APRIL 5, 1982

SPCA CODE DISCUSSION

- Introduction
- Code model
- Analysis assumptions

PSAR CHAPTER 15.6 ACCIDENTS
BRIEFING FOR
NUCLEAR REGULATORY
COMMISSION
CRBRP PROGRAM OFFICE

SGB DESIGN BASIS ACCIDENT

- RESULTS
- FEATURES TO ACCOMMODATE

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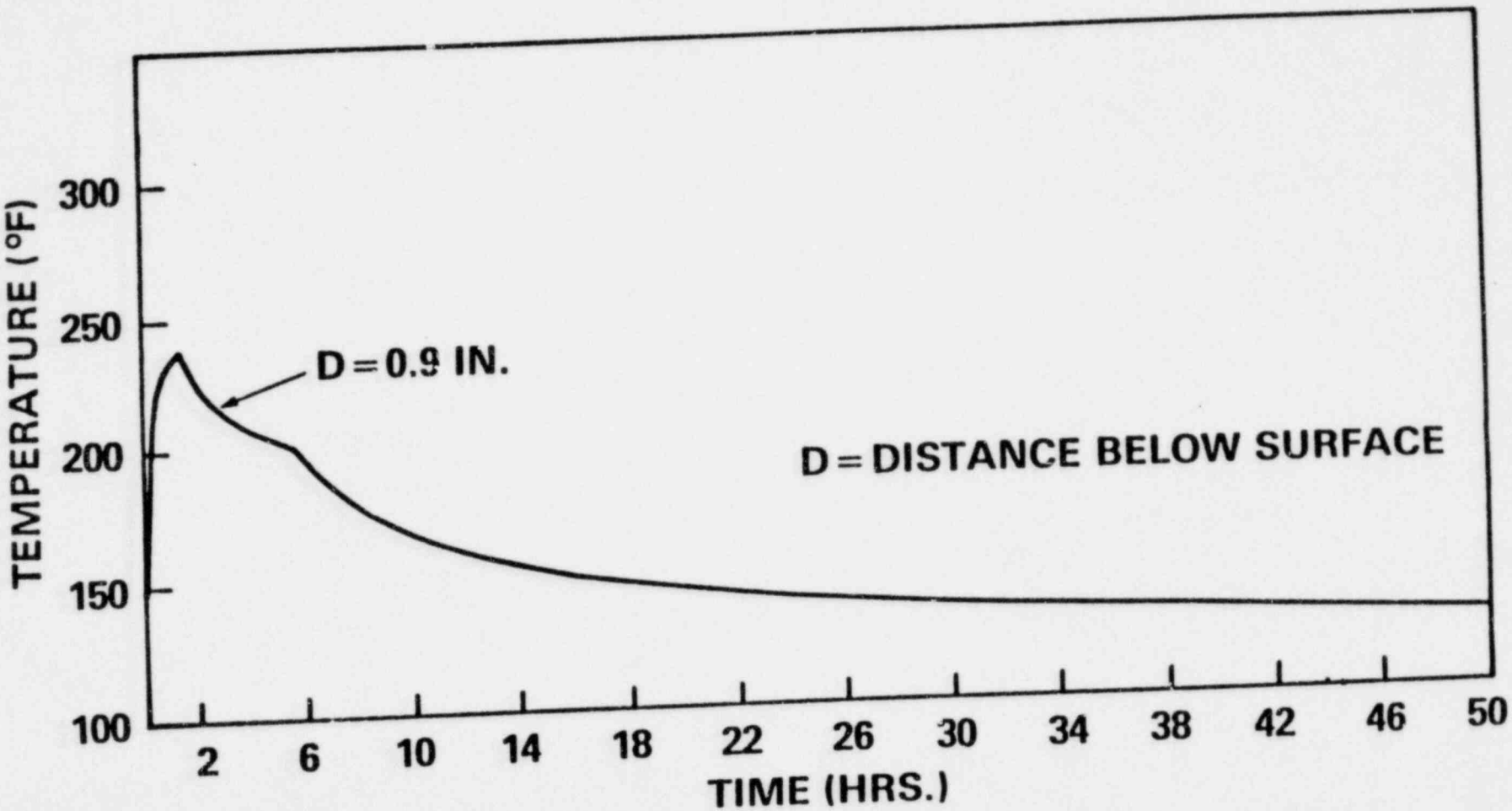
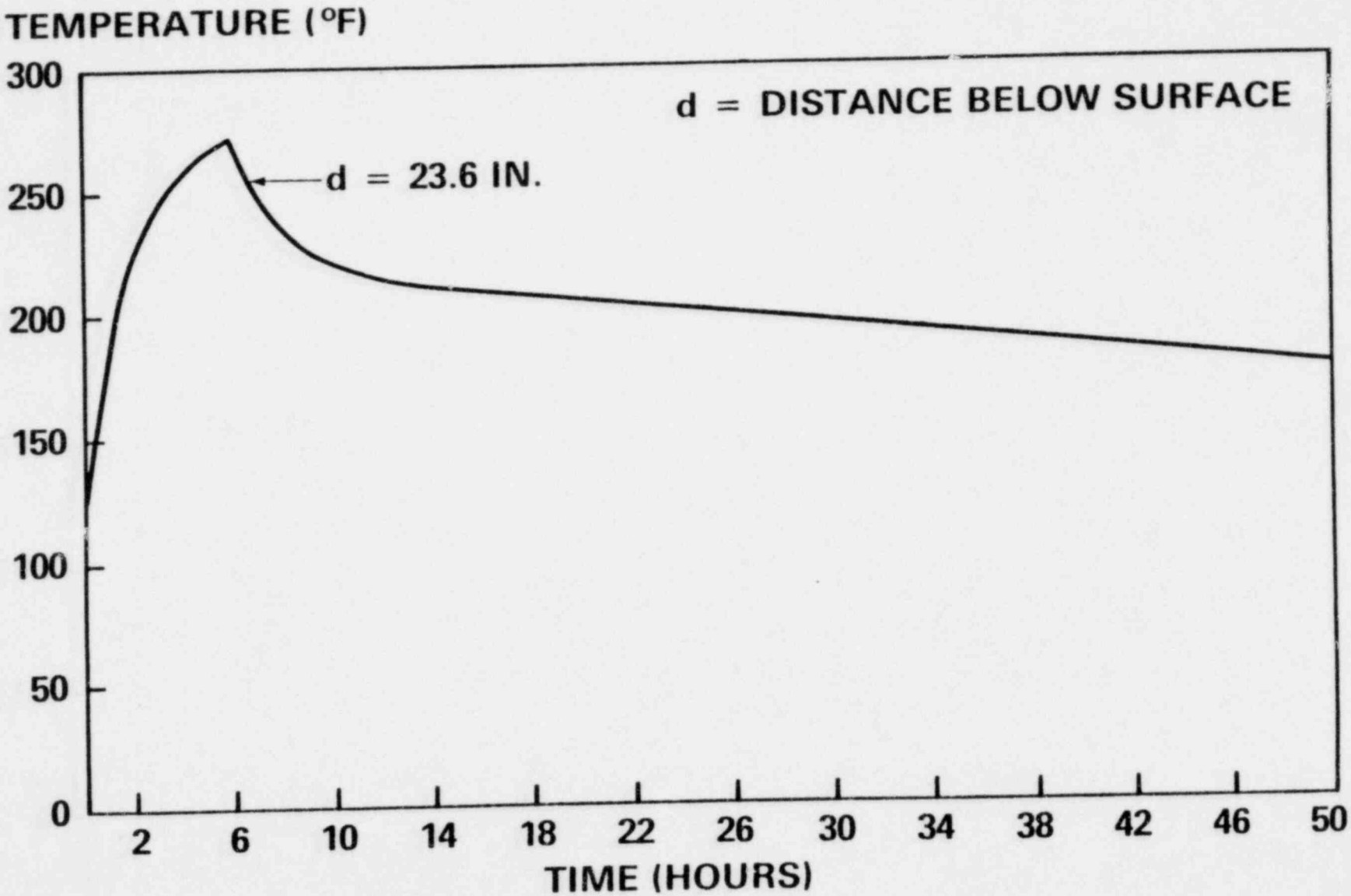
PEAK WALL TEMPERATURE IHTS PIPE LEAK



PEAK FLOOR TEMPERATURE FOR IHTS PIPE LEAK



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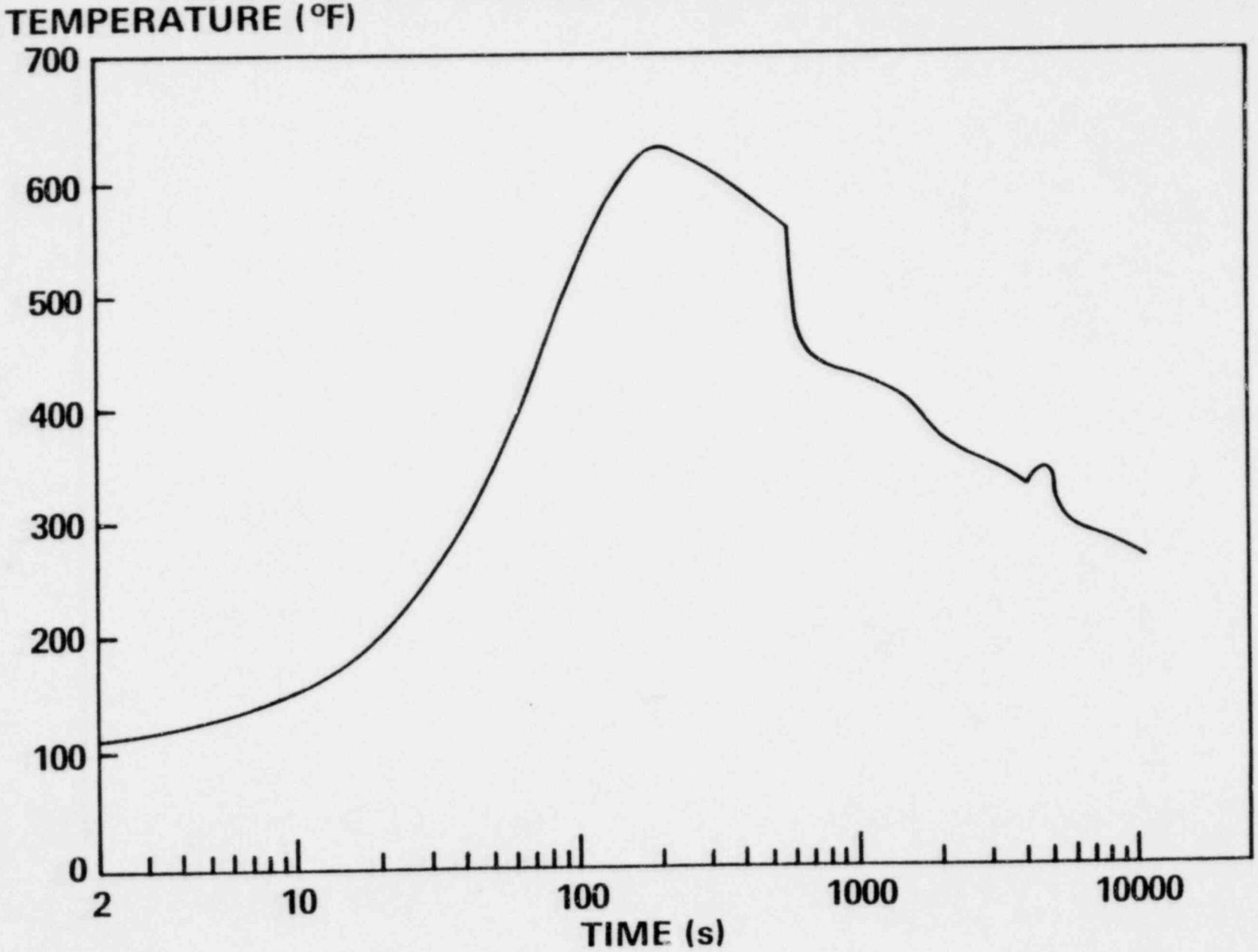
CELL ATMOSPHERE TEMPERATURE IHTS PIPE LEAK



POTENTIAL OFF-SITE DOSES

ORGAN	10CFR100	DOSE (REM) SB(0.42 MI) 2-HOUR	DOSE (REM) LPZ(2.5 MI) 30 DAYS
• WHOLE BODY**	25	0.65	2.0
• THYROID	300	0.55	1.61
• BONE	150 +	0.77	2.14
• LUNG	75 +	0.21	0.62

** INCLUDES BOTH INHALATION AND EXTERNAL GAMMA EXPOSURE

\+ NRC GUIDANCE PER MAY 6, 1976, LETTER.

10^{-6} gm/cc
Acceptance Criteria

FEATURES TO ACCOMMODATE

- CATCH/PAN FIRE SUPPRESSION DECK SYSTEM TO SUPPRESS LONG TERM SODIUM BURNING
- INSULATION UNDER CATCH PANS TO PROTECT STRUCTURAL CONCRETE
- AEROSOL RELEASE MITIGATION SYSTEM:
  - ENGINEERED SAFETY FEATURE AEROSOL DETECTORS
  - CONTROLLED 40 FT^2 VENT AREA
- ENGINEERED SAFETY FEATURE AEROSOL DETECTORS TO CLOSE AIR INLETS TO PACC UNITS

PSAR CHAPTER 15.6 ACCIDENTS

BRIEFING FOR

NUCLEAR REGULATORY COMMISSION

CRBRP PROGRAM OFFICE

EVST CAVITY & EX-CONTAINMENT PRIMARY STORAGE TANK ACCIDENTS

- CODES USED IN ANALYSES
- RESULTS
- FEATURES TO ACCOMMODATE

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ADVANCED REACTORS DIVISION

APRIL 5, 1982

FAILURE OF EX-VESSEL STORAGE TANK SODIUM COOLING SYSTEM

ACCIDENT SUMMARY

- BASED ON POSTULATED RUPTURE OF PUMP SUCTION LINE.
- MAXIMUM VOLUME OF SODIUM DISCHARGED TO CELL (7,500 GALLONS).
- ACCIDENT OCCURS DURING NORMAL OPERATION WITH SODIUM AT 475° F.
- ASSUMED THAT ACCIDENT OCCURS AT END OF PLANT LIFE & IMMEDIATELY FOLLOWING REFUELING WHEN EVST SODIUM ACTIVITY IS MAXIMUM.

FAILURE OF EX-VESSEL STORAGE TANK SODIUM COOLING SYSTEM (CONT.)

ACCIDENT SUMMARY

- ALL AEROSOL GENERATED DURING COMBUSTION RELEASED DIRECTLY TO EXTERNAL ATMOSPHERE
- RADIOACTIVE DECAY DURING ACCIDENT IS NEGLECTED
- FALLOUT OF AEROSOL DURING TRANSIT DOWNWIND IS NEGLECTED
- ACCIDENT ANALYZED AS POOL FIRE.
- PEAK TEMPERATURE OF 254° F AND PEAK PRESSURE OF 3.8 PSIG IN 3.6 HOURS

POTENTIAL OFF-SITE DOSES FOLLOWING FAILURE OF THE EVST COOLING SYSTEM

	DOSE (REM)		
ORGAN	10CFR100	SB (0.42 MI) 2-HOURS	LPZ (2.5 MI) 30 DAYS
• WHOLE BODY**	25	2.59 E-2*	5.31 E-3
• THYROID	300	2.20 E-2	4.52 E-3
• BONE	150 +	7.13 E-1	1.46 E-1
• LUNG	75 +	3.51 E-2	7.20 E-3

*2.59 E-2 = 2.59×10^{-2}

**INCLUDES BOTH INHALATION AND EXTERNAL GAMMA CLOUD EXPOSURE.

\+ NRC GUIDANCE PER MAY 6, 1976 LETTER.

FAILURE OF AN EX-CONTAINMENT PRIMARY SODIUM STORAGE TANK

ACCIDENT SUMMARY

- POSTULATED RUPTURE OF STORAGE TANK RESULTING IN SODIUM SPILL OF 45,000 GALLONS.
- INITIAL SODIUM TEMPERATURE OF 450° F.
- ACCIDENT OCCURS AT END OF PLANT LIFE.
- RADIOACTIVE DECAY DURING ACCIDENT IS NEGLECTED.
- RADIOLOGICAL ASSESSMENT ASSUMED INSTANTANEOUS RELEASE OF 90,000 GALLONS OF SODIUM TO CELL.
- ALL AEROSOL GENERATED DURING COMBUSTION IS RELEASED DIRECTLY TO THE EXTERNAL ATMOSPHERE.
- FALLOUT OF AEROSOL DURING TRANSIT DOWNWIND IS NEGLECTED.
- ACCIDENT ANALYZED AS POOL FIRE
- PEAK TEMPERATURE OF 260° F AND PEAK PRESSURE OF 3.5 PSIG AT 1.2 HOURS.

POTENTIAL OFF-SITE DOSES FOLLOWING FAILURE OF EX-CONTAINMENT Na STORAGE TANK

ORGAN	10CFR100	DOSE (REM) SB (0.42 MI) 2-HOUR	DOSE (REM) LPZ (2.5 MI) 30 DAYS
• WHOLE BODY**	25	2.38 E-1*	3.83 E-2
• THYROID	300	8.85 E-1	1.42 E-1
• BONE	150 +	3.19 E+0	5.11 E-1
• LUNG	75 +	1.77 E-1	2.84 E-2

*2.38 E-1 = 2.38×10^{-1}

**INCLUDES BOTH INHALATION AND EXTERNAL GAMMA CLOUD EXPOSURE.

+ NRC GUIDANCE PER MAY 6, 1976 LETTER.

3-82-2800-26

SUMMARY

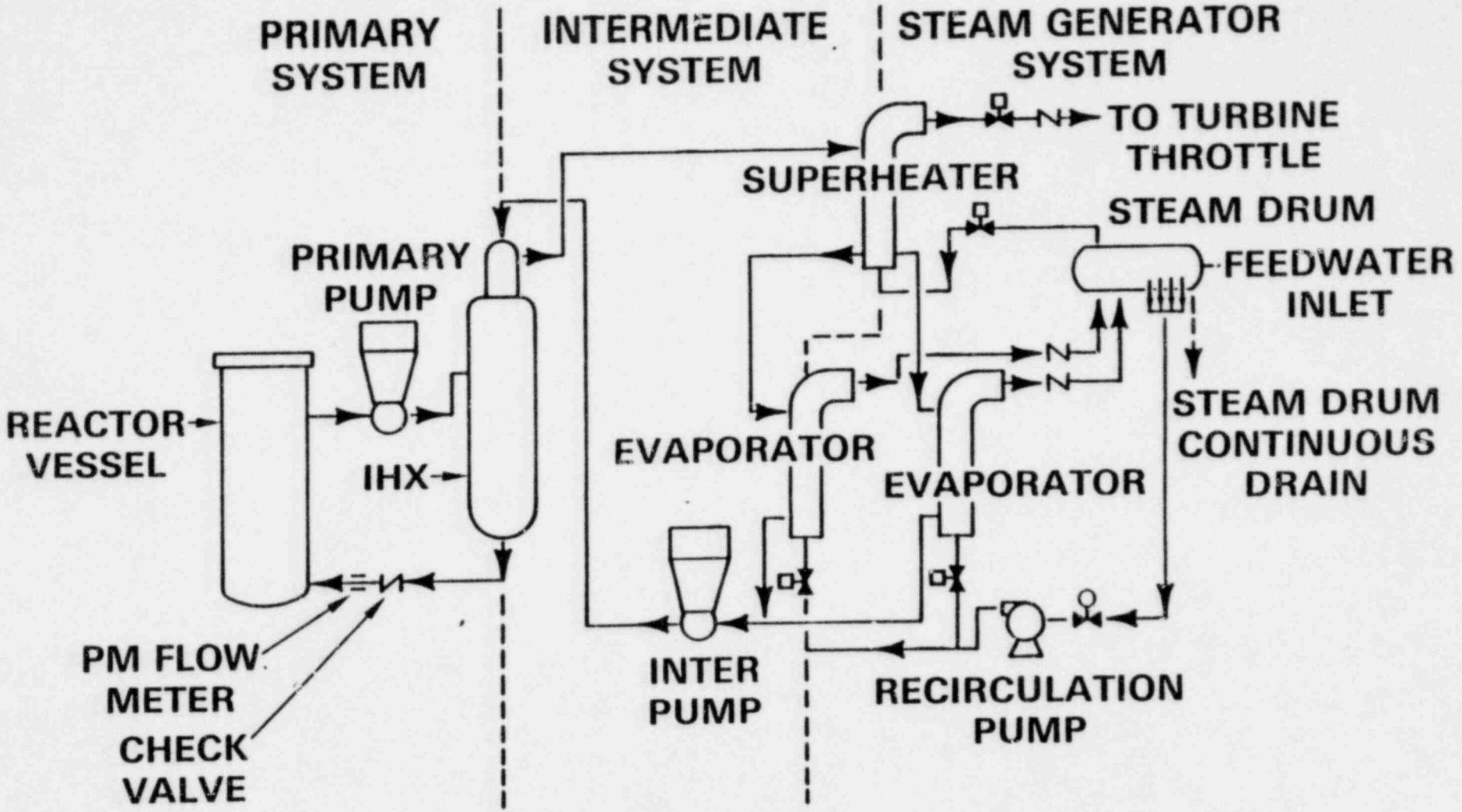
THE DESIGN BASIS ACCIDENTS ADDRESSED IN PSAR SECTION 15.6 ARE ACCOMMODATED BY THE CRBRP DESIGN

- THE CONTAINMENT AND CELL STRUCTURES ARE DESIGNED TO ACCOMMODATE THE RESULTANT TEMPERATURES AND PRESSURES
- OFF-SITE DOSES ARE MAINTAINED WITHIN ACCEPTABLE LIMITS
- ESSENTIAL PLANT EQUIPMENT WILL OPERATE AS REQUIRED

PSAR 15.7.1.3—IHX LEAK

A LEAK IS ASSUMED TO OCCUR IN AN IHX TUBE AND SODIUM LEAKS FROM THE INTERMEDIATE HEAT TRANSPORT SYSTEM TO THE PRIMARY HEAT TRANSPORT SYSTEM

CRBRP HTS SCHEMATIC



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THE FOLLOWING DESIGN FEATURES AND OPERATOR ACTIONS ACCOMMODATE THIS EVENT:

- PRESSURE DIFFERENTIAL MAINTAINS LEAKAGE PATH FROM INTERMEDIATE TO PRIMARY
- TEMPERATURE-COMPENSATED LEVEL SENSORS DETECT THE LEAKAGE
- OPERATOR SHUTS DOWN THE PLANT AND CORRECTIVE MAINTENANCE IS PERFORMED.

PSAR 15.7.3.5—FUEL ROD LEAKAGE COMBINED WITH IHX AND STEAM GENERATOR LEAKAGE

THIS EVENT DETERMINES THE POTEN AL FOR FISSION GASES FROM LEAKING FUEL ODS TO PASS FROM THE PRIMARY SYSTEM TO THE STEAM GENERATOR SYSTEM IF LEAKS WERE TO OCCUR IN BOTH THE IHX AND STEAM GENERATOR TUBES

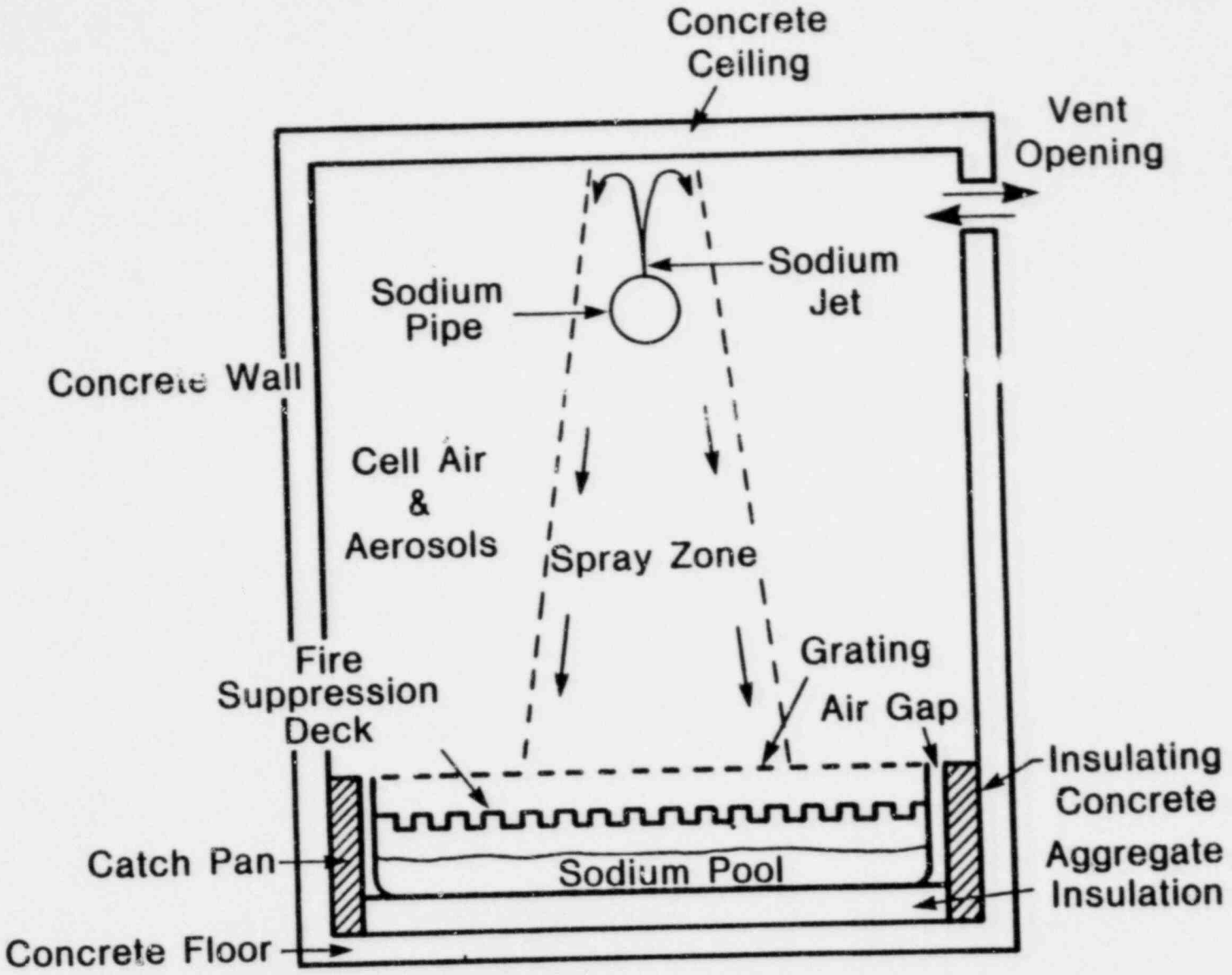
THE FOLLOWING DESIGN FEATURES AND OPERATOR ACTIONS ACCOMMODATE THIS EVENT:

- PRESSURE DIFFERENTIAL MAINTAIN LEAKAGE FROM STEAM GENERATORS TO INTERMEDIATE AND FROM INTERMEDIATE TO PRIMARY.
- TEMPERATURE-COMPENSATED LEVEL SENSORS DETECT INTERMEDIATE TO PRIMARY LEAKAGE
- IHTS LEAK DETECTORS DETECT LEAKAGE FROM STEAM GENERATOR SYSTEM
- OPERATOR SHUTS DOWN THE PLANT AND CORRECTIVE MAINTENANCE IS PERFORMED

PURPOSE OF SPCA CODE

- Model combined spray & pool fires for air filled cells
- Fire suppression deck included
- Cell venting
- Significant effects determined
  - Cell temperature & pressure
  - Structural temperatures
  - Sodium burning rate
  - Venting rate

SPCA CODE MODEL



7017-1

SPCA CODE ASSUMPTIONS

- 1-D heat transfer structures
- Sodium burning takes place at top of grating, fire suppression deck, and below the deck
- Heat input from spray burning based on spray code calculation and oxygen concentration
- Venting area of 40 $ft.^2$

CRBRP PSAR
CHAPTER 15.5, 15.6, 15.7

NUCLEAR REGULATORY COMMISSION
CRBRP PROGRAM OFFICE

OTHER EVENTS—15.7

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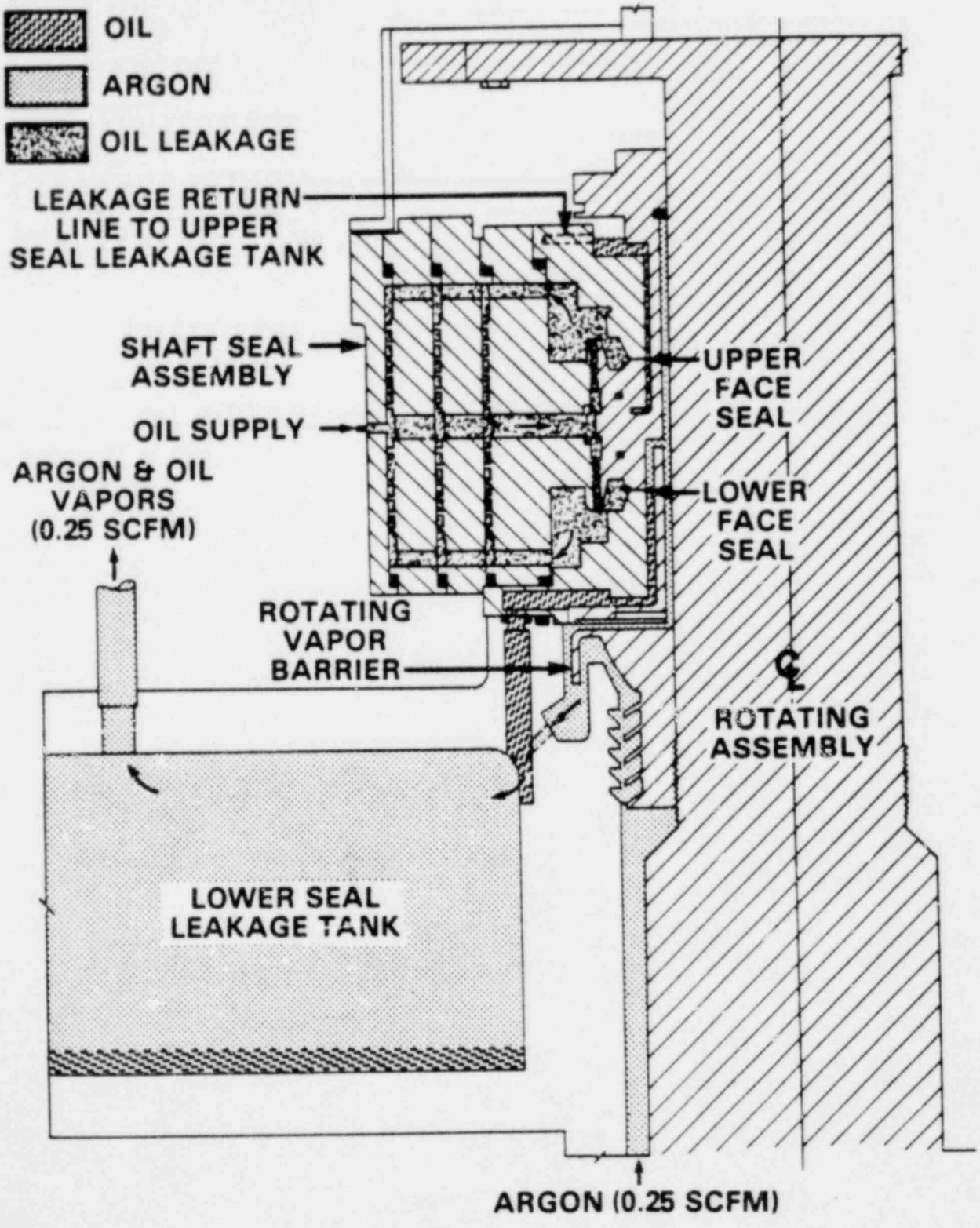
APRIL 5, 1982

15.7.2.1 AND 15.7.2.2 INADVERTENT RELEASE OF OIL THROUGH THE PHTS AND IHTS PUMP SEALS

- DESIGN OF THE PHTS AND IHTS PUMPS INCORPORATES FEATURES TO PROTECT OIL FROM LEAKING INTO REGIONS CONTAINING LIQUID SODIUM.
- OIL TO SODIUM LEAK IN THE PUMPS IS EXTREMELY UNLIKELY. HOWEVER, ANALYSES HAVE SHOWN THIS EVENT RESULTS IN INSIGNIFICANT EFFECTS.
  - PLUGGING EFFECT
  - REACTIVITY EFFECTS

CRBRP HTS SODIUM PUMP SHAFT SEAL OIL SYSTEM



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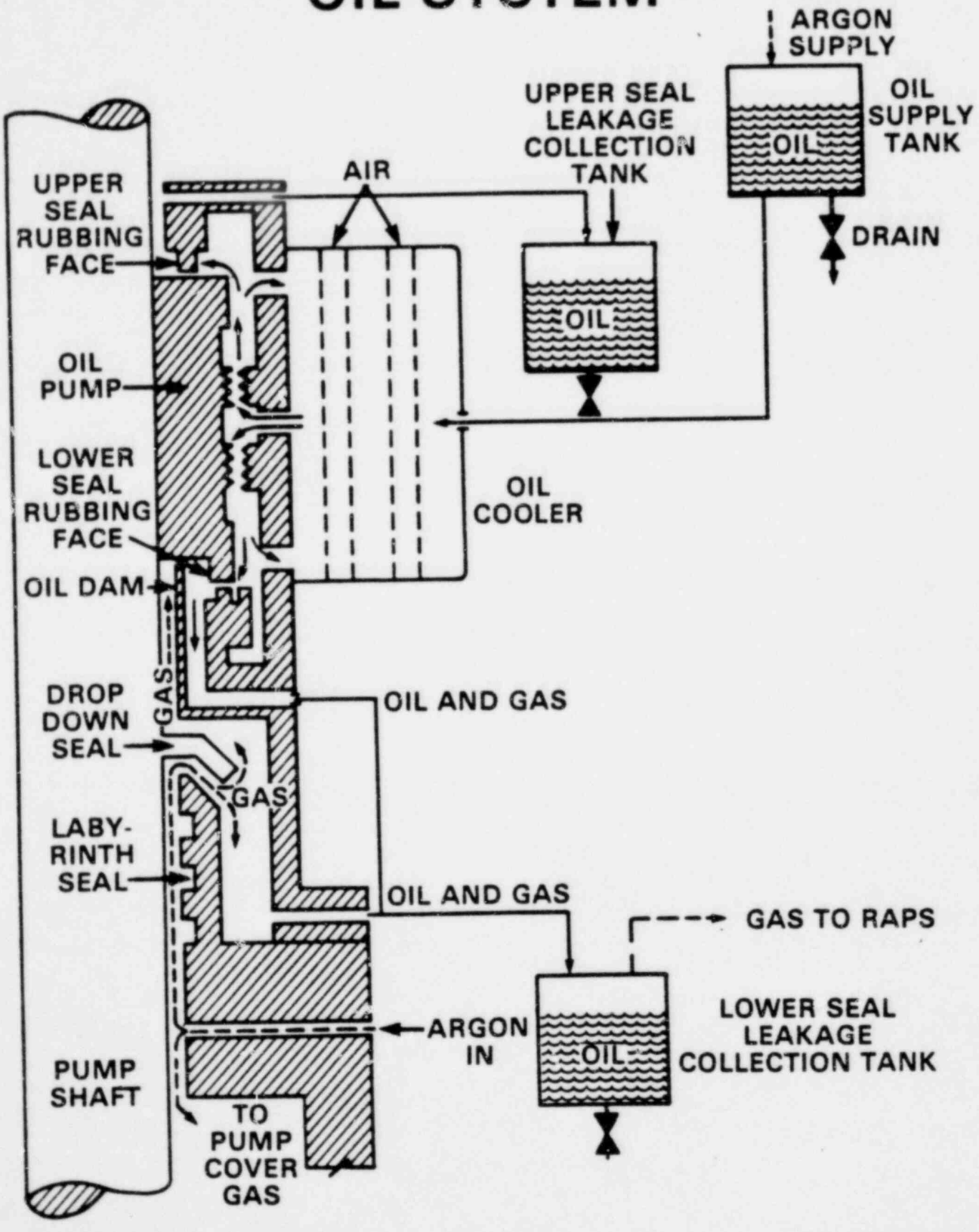
SCHEMATIC OF TYPICAL SEAL OIL SYSTEM



EVALUATION OF SODIUM/OIL REACTION CONSEQUENCES

ASSUMPTIONS

- OIL LEAKS INTO PUMP TANK AT A RATE WHICH MAINTAINS 1000°F SODIUM SATURATED WITH H_2
- SATURATED MIXTURE IS DRAWN INTO HYDRAULICS REGION AT A RATE OF 700 GPM (WITH 34000 GPM TOTAL PUMP FLOW)
- NO H_2 ENTERS COVER GAS SYSTEM
- NO COLD TRAPPING
- 6 GALLONS OF OIL ENTERS SYSTEM

EVALUATION OF SODIUM/OIL REACTION CONSEQUENCES

RESULTS

- PLUGGING EFFECTS
  - FOR NORMAL OPERATION (AVERAGE SODIUM TEMPERATURE = 860°F)
    - HYDROGEN CONCENTRATION: 2 PPM
    - PLUGGING TEMPERATURE: 440°F
  - FOR HOT STANDBY/REFUELING CONDITIONS (AVERAGE SODIUM TEMPERATURE = 400°F)
    - HYDROGEN CONCENTRATION: $<$ .74 PPM
    - PLUGGING TEMPERATURE: $<$ 377°F
- REACTIVITY EFFECTS
  - 100 PPM HYDROGEN IN CORE WILL INCREASE REACTIVITY APPROXIMATELY 0.5 ¢

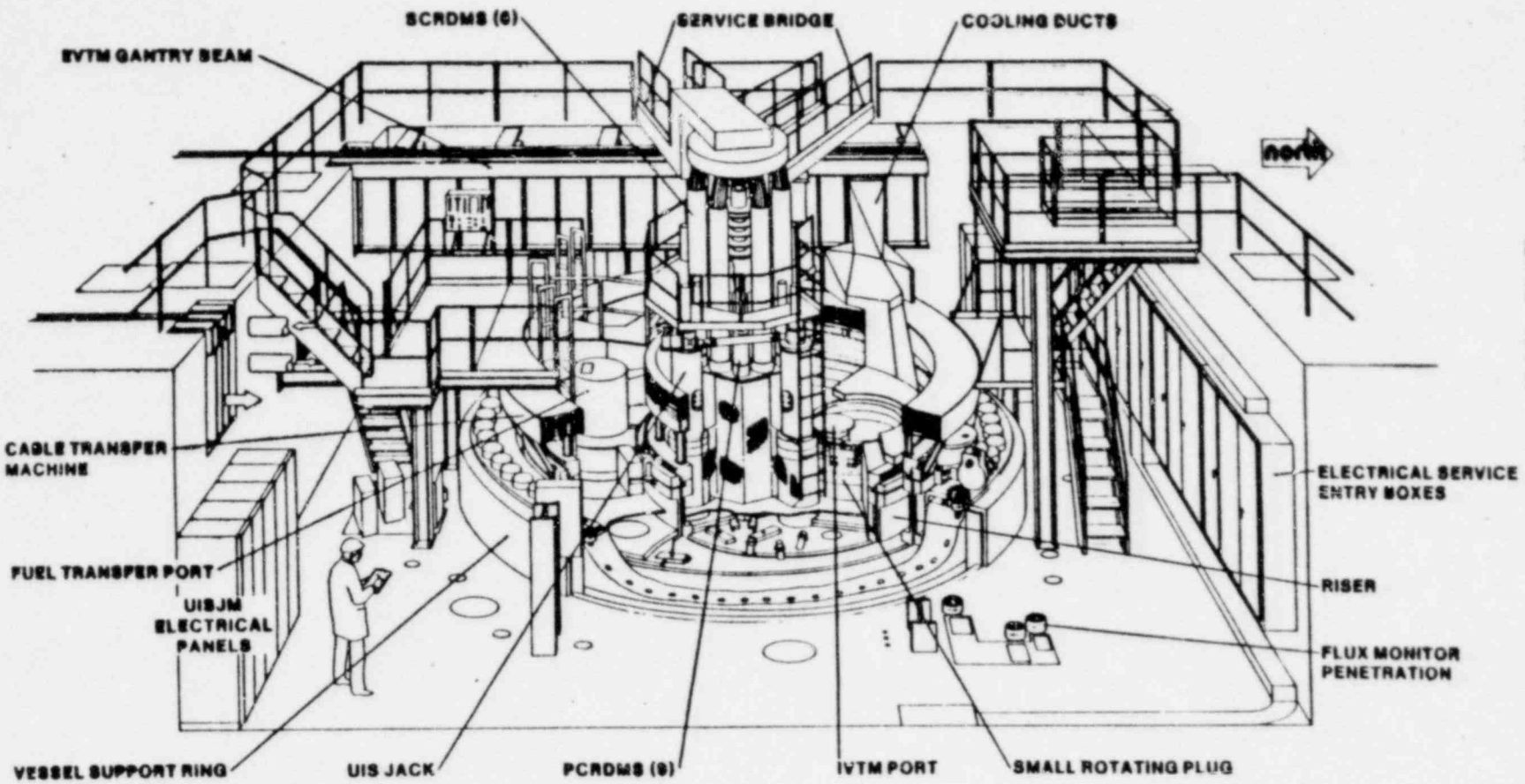
CONCLUSIONS

- PLUGGING TEMPERATURES ARE WELL BELOW PHTS AND IHTS TEMPERATURE FOR NORMAL OPERATIONAL CONDITIONS.
- REACTIVITY EFFECTS ARE INCONSEQUENTIAL

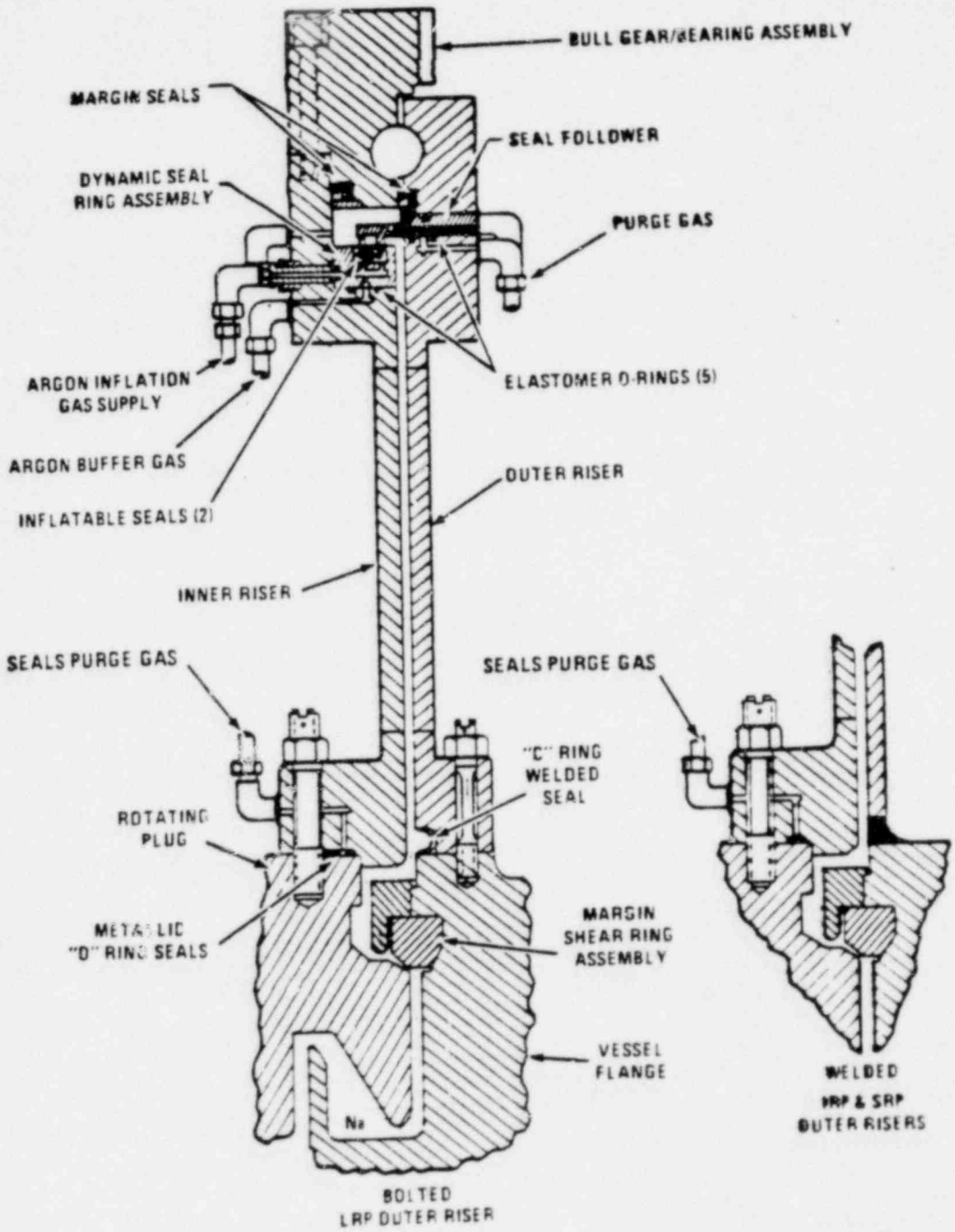
15.7.3.4
FAILURE OF PLUG SEALS AND ANNULI

THIS EVENT IS EXTREMELY UNLIKELY

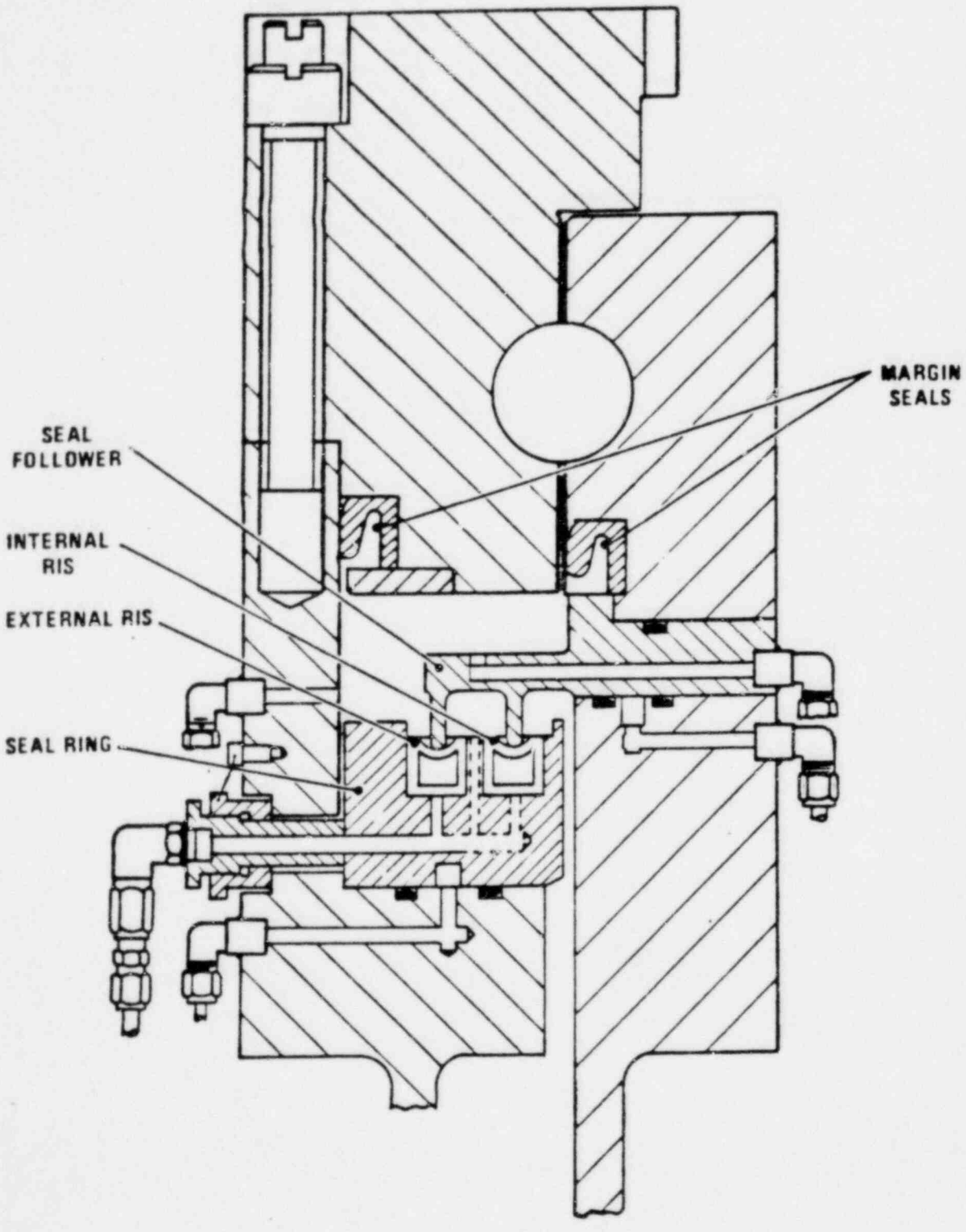
- ASSUMES MASSIVE FAILURES OF VESSEL HEAD PLUG SEALS AND THE INFLATABLE SEALS.



Head Access Area


BULL GEAR/BEARING ASSEMBLY
MARGIN SEALS
SEAL FOLLOWER
DYNAMIC SEAL RING ASSEMBLY
PURGE GAS
ARGON INFLATION GAS SUPPLY
ELASTOMER O-RINGS (5)
ARGON BUFFER GAS
OUTER RISER
INFLATABLE SEALS (2)
INNER RISER
SEALS PURGE GAS
SEALS PURGE GAS
"C" RING WELDED SEAL
ROTATING PLUG
METALLIC "O" RING SEALS
MARGIN SHEAR RING ASSEMBLY
VESSEL FLANGE
WELDED
LRP & SRP OUTER RISERS
BOLTED
LRP OUTER RISER

Riser Seals



Typical Upper Riser Seals

Seal Pressure Margin

Pressure Tests of Riser Elastomer Seals

Seal	Failure Pressire (psi)
Margin Seals	400
O-Rings	1,050

Maximum Imposed Pressure

Overpressure Relief Setting For Reactor Cover Gas Space Is 15 Psig.

ATTACHMENT 7

CRBRP OVERVIEW BRIEFING

FOR

NUCLEAR REGULATORY COMMISSION

CRBRP PROGRAM OFFICE

CHAPTER 15.7

PRESENTED BY

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EI&C SECTION

A. D. BURKHART/W. LORENZ
LICENSING SECTION

BURNS AND ROE, INC.

EVENT

- LOSS OF ONE CLASS IE DC DIVISION

CAUSES

- FAULTED MAIN DC BUS
- FAULTED BRANCH CIRCUIT

EFFECTS & CONSEQUENCES

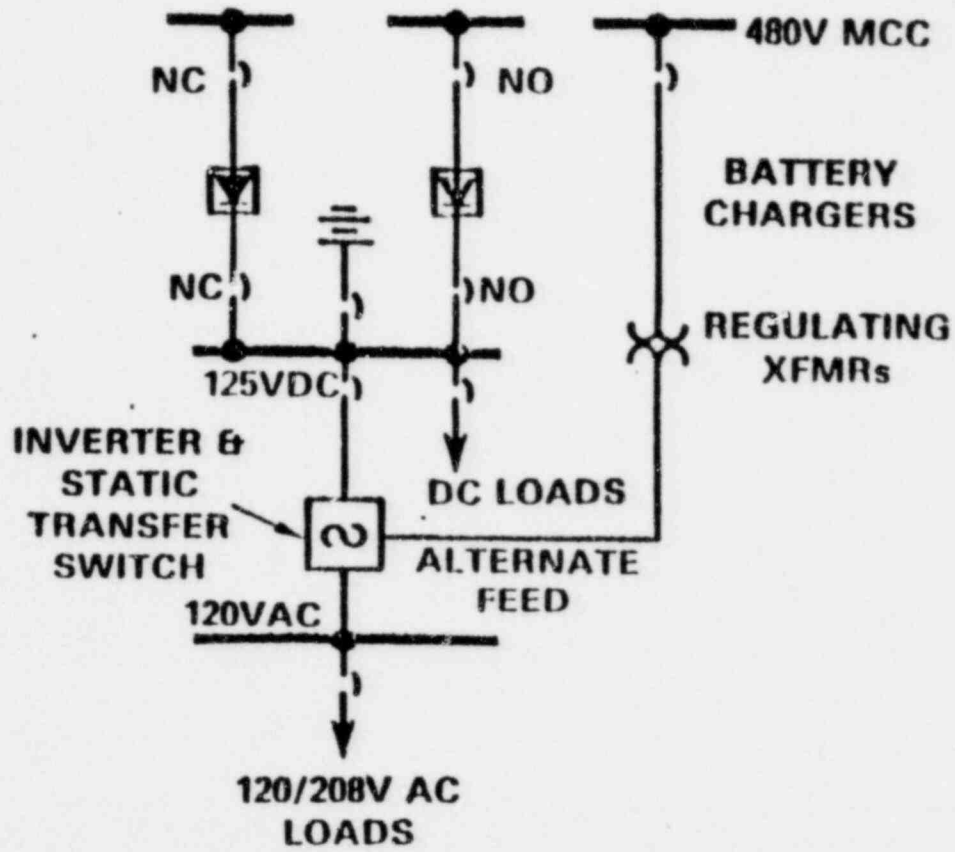
- LOSS OF VOLTAGE ON THE DC BUS WILL BE ANNUNCIATED IN THE CONTROL ROOM
- LOSS OF CONTROL POWER FOR ASSOCIATED CLASS IE AC CIRCUIT BREAKERS. BREAKERS WILL REMAIN CLOSED
- THE 4.16KV BREAKERS FOR THE SODIUM PUMP DRIVES WILL REMAIN CLOSED
- SODIUM PUMP DRIVE MOTORS ARE PROVIDED WITH TWO 4.16KV CIRCUIT BREAKERS IN SERIES POWERED FROM 2 INDEPENDENT DC POWER SOURCES, AS SUCH, THEIR OPERATION WILL NOT BE AFFECTED BY LOSS OF ONE DC DIVISION
- LOSS OF DC LOADS INCLUDING THE ASSOCIATED DIESEL GENERATOR
- POWER SUPPLY TO THE CLASS 1E INVERTER WILL BE AUTOMATICALLY TRANSFERRED TO THE 480V AC BUS BY THE STATIC TRANSFER SWITCH. AS SUCH, UPS LOADS WILL NOT SEE LOSS OF POWER
- IF THE AFFECTED DC SUPPLY IS NOT RESTORED WITHIN 2 HOURS, PLANT SHUTDOWN WILL BE REQUIRED AS PER REG. GUIDE 1.93

CONCLUSION

- COMPLETE LOSS OF ONE CLASS 1E DC DIVISION WILL NOT AFFECT SAFE SHUTDOWN CAPABILITY OF THE PLANT
- PLANT WILL REQUIRE SHUTDOWN WITHIN 2 HOURS OF DC POWER LOSS

CLASS 1E DC/UNINTERRUPTIBLE AC DISTRIBUTION SYSTEM

CLASS 1E



EVENT

- GENERATOR BREAKER FAILURE TO OPEN AT TURBINE TRIP

CAUSES

- BREAKER FAILURE CAN OCCUR DUE TO ELECTRICAL OR MECHANICAL FAILURE OF THE TRIPPING MECHANISM

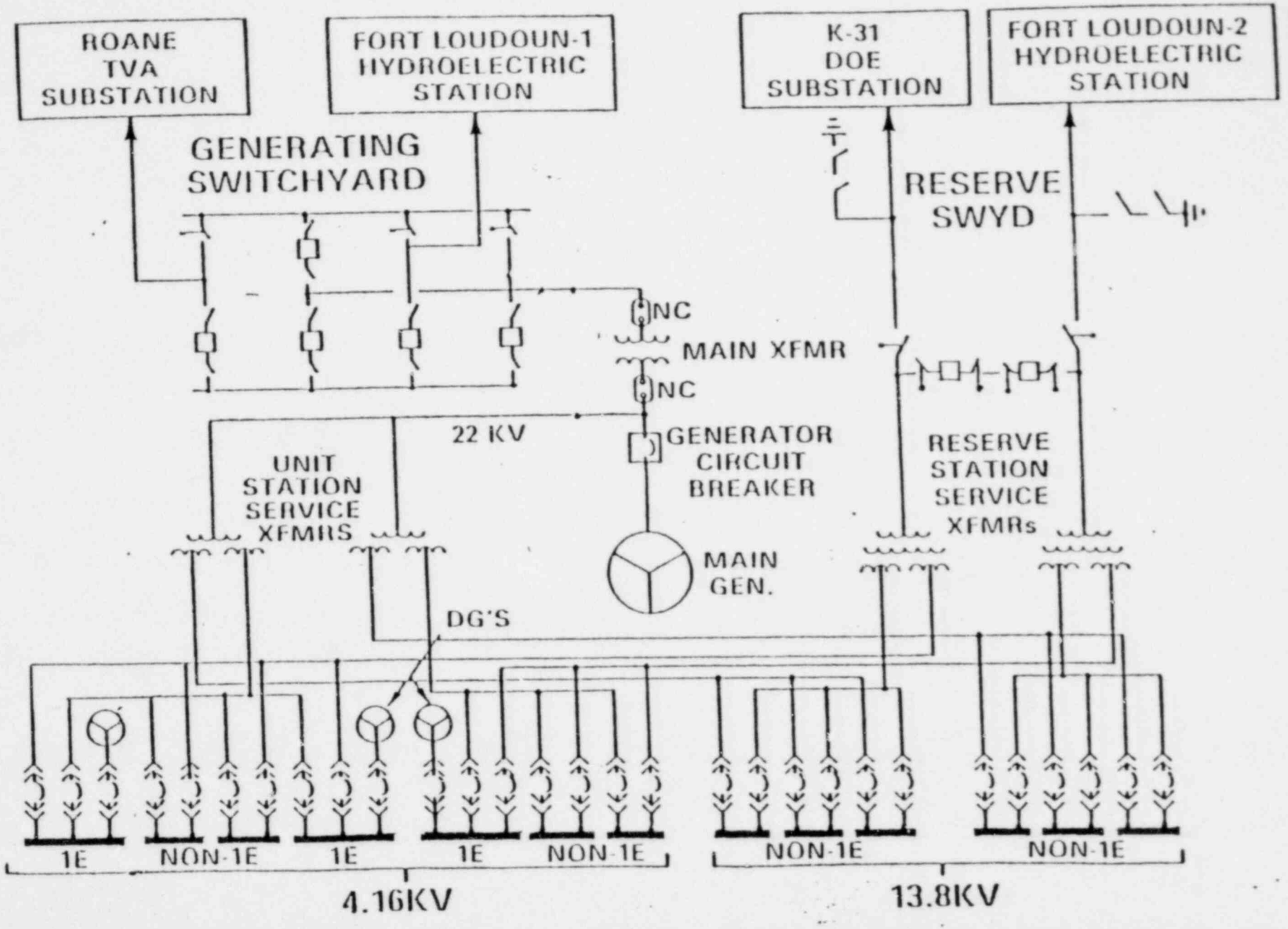
FEATURES

- FAILURE OF GENERATOR CIRCUIT BREAKER TO OPEN AFTER TURBINE TRIP WILL INITIATE TRIPPING OF SWITCHYARD 161KV BREAKERS
- LOSS OF OFFSITE POWER FROM THE GENERATING SWITCHYARD WILL RESULT IN A FAST AUTOMATIC TRANSFER OF POWER CONNECTIONS TO THE RESERVE SWITCHYARDS
- THE RESERVE SWITCHYARD IS KEPT ENERGIZED CONTINUOUSLY
- THE POWER TRANSFER WILL BE ACHIEVED IN APPROXIMATELY 6 CYCLES
- THE REACTOR CAN BE SAFELY SHUTDOWN AS DESCRIBED IN PSAR SECTION 15.3.1.5

CONSEQUENCES

- ONE OFFSITE POWER SUPPLY REMAINS AVAILABLE
- THE EFFECT OF THE BREAKER FAILURE TO OPEN ON THE PLANT REMAINS NEGLIGIBLE

KEY ONE LINE DIAGRAM



EVENT

- LOSS OF SAFETY RELATED INSTRUMENTS OR VALVES

CAUSES

- MULTIPLE SYSTEM FAILURE
- SINGLE FAILURE DURING A DBA

EFFECT

- IF THE NON-SAFETY RELATED SYSTEM FAILS, THE SAFETY RELATED FUNCTIONS ARE MAINTAINED.

RESULTS

- ACTIVE SAFETY RELATED AIR OPERATED VALVES ARE DESIGNED TO FAIL IN THEIR SAFE POSITIONS UPON LOSS OF AIR SUPPLY
- DESCRIPTION OF THE FAILURE EFFECTS ON SAFETY RELATED INSTRUMENTATION AIR WILL BE PROVIDED IN THE FSAR.

FEATURES

- EXCESS CAPACITY DESIGNED INTO SYSTEM
- THREE COMPRESSORS, REDUNDANT RECEIVERS, DRYERS, ETC.

CONCLUSION

- SYSTEM DESIGNED TO HIGH QUALITY AND RELIABILITY
- LOSS OF SYSTEM WILL NOT RESULT IN LOSS OF SAFETY RELATED VALVES AND SAFETY RELATED INSTRUMENT AIR FUNCTIONS

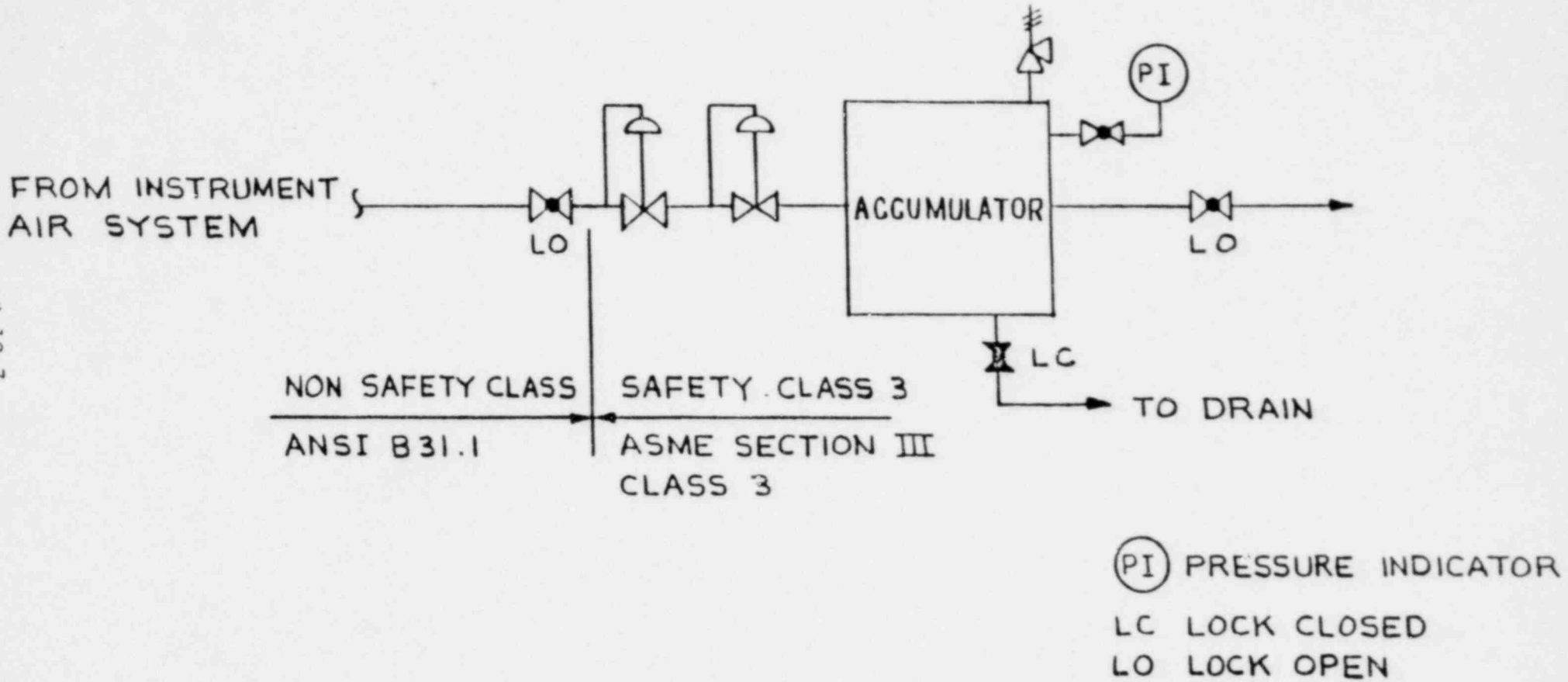


Figure 9.10-2 Compressed Air System Typical Safety Class 3 Instrument Air Supply

Amend. 47
Nov. 1978

EVENT

- MAXIMUM POSSIBLE CONVENTIONAL FIRE
  FLOOD
  STORM
  MINIMUM RIVER LEVEL

CAUSES	EFFECTS
• CONVENTIONAL FIRE SPECTRUM OF EVENTS ACTS OF NATURE	NIL
• FLOOD ACT OF NATURE SABOTAGE OF DAM	NONE
• STORM ACT OF NATURE	ACCOMMODATED
• MINIMUM RIVER LEVEL ACT OF NATURE	ACCOMMODATED

ANALYSIS

CONVENTIONAL FIRE:

- UTILIZES - WATER, HALON, OTHER AGENTS (9.13.1)
- FACILITY ISOLATED FROM FOREST BY MINIMUM 300 FT.
- YARD FIRE PROTECTION LOOP

ANALYSIS (CONT'D.)

FLOOD:

- PLANT GRADE BY DESIGN - 815 FT. MAXIMUM POSSIBLE FLOOD INCLUDING WAVE RUNUP - 809.2 FT.
  WATER LEVEL & FLOOD DESIGN - SECTION 3.4
  FLOODS - SECTION 2.4.2

STORMS:

- MAXIMUM RAINFALL (24 HRS.) - 7.75 INCHES
- SITE DRAINAGE - 3.5 IN. IN 1 HR. WITH 50% RUNOFF COEFF.

MINIMUM RIVER LEVEL

- TVA CONTROLLED MINIMUM LEVEL - 735 FT.
- CRBRP INTAKE STRUCTURE AT - 729.5 FT.

CONCLUSION

NONE OF THE ABOVE EVENTS POSE ANY DELITERIOUS EFFECTS ON THE PLANT.

EVENT

- SODIUM INTERACTION WITH CHILLED WATER

CAUSE

- TWO PIPE FAILURES AND EITHER: STRUCTURE FAILURE
  OR VALVE FAILURE
  OR REDUNDANT LEAK DETECTION FAILURE

EFFECTS

SYSTEM ALARMS AND AUTOMATIC SYSTEM ACTIONS:

- WATER LEAK DETECTED
- VALVE FAILURE DETECTED
- UNIT COOLER ISOLATES
- DRAIN SUMPS OPEN
- SODIUM LEAK DETECTED

ANALYSIS

- COOLING COIL LEAKAGE AND NITROGEN VALVE FAILURE DETECTED BY REDUNDANT MOISTURE DETECTORS. FAILURE OF ABOVE CAUSES FAN-COOLER UNITS TO ISOLATE AND DRAIN. FAILURE OF ABOVE RESULTS IN TWO HOURS TIME DELAY TO MANUALLY RESPOND.

- HVAC COOLERS SERVING AREAS CONTAINING SODIUM PIPING OR EQUIPMENT ARE PROTECTED IN LIKE MANNER.

ANALYSIS (CONT'D.)

- CHILLED WATER PIPING LEAKAGE TO FLOOR DRAINS ACTUATES LEAK DETECTION SYSTEM RESULTING IN ISOLATION OF FAULTY SYSTEM.

- SODIUM SYSTEMS EQUIPPED WITH LEAK DETECTION DEVICES SO AS TO ALARM

CONCLUSION

- SINCE THESE THREE BARRIER SYSTEMS ARE SAFEGUARDED FROM THE WATER SIDE AND SAFEGUARDED FROM THE SODIUM SIDE, THE OCCURRENCE OF A SODIUM WATER REACTION IS CONSIDERED NEGLIGIBLE.

EVENTS

- LIQUID RADWASTE SYSTEM FAILURE

SOURCE

- FAILURE OF 20,000 GAL. INTERMEDIATE ACTIVITY LEVEL TANK CONTAINING THE ACTIVITY SHOWN IN TABLE 11.2-2.

CAUSE

- TANK FAILURE
- MALFUNCTION
- OPERATOR ERROR

ANALYSIS

GASEOUS RELEASE:

.4 Ci HTO IN WATER

100% RELEASED TO ATMOSPHERE IN 2 HRS.

CONSERVATISM:

- ALL SAFETY SYSTEMS FAIL
- MAX. ACT. POSSIBLE IN TANK
- SUMP SYSTEM FAILS

LIQUID RELEASE:

- 80% OF ACTIVITY RELEASED TO GROUND IN 2 HRS.
- .05 DILUTION FACTOR 60 FT. FROM DISCHARGE POINT
  CONSERVATISM:
  - NO FLOOR DRAINS OPERATE
  - NO OPERATOR ACTION TAKEN
  - NO RADIOACTIVE DECAY FROM GROUND ENTRY TO RIVER ENTRY
  - NO ION EXCHANGE FROM GROUND ENTRY TO RIVER ENTRY
  - NO CREDIT TAKEN FOR BUILDING RETENTION PLATEOUT OR WALL CONDENSATION
  - NEAREST WATER INTAKE 1.5 MI. DOWNSTREAM OF CRBRP DISCHARGE
  - SOIL CHARACTERISTICS IN SECTION 2.4.13

NOTE: ABOVE ANALYSIS IS CONSISTENT WITH SRP 15.7.

CONCLUSION

DOSES RESULTING FROM EXPOSURE TO GASEOUS RELEASES

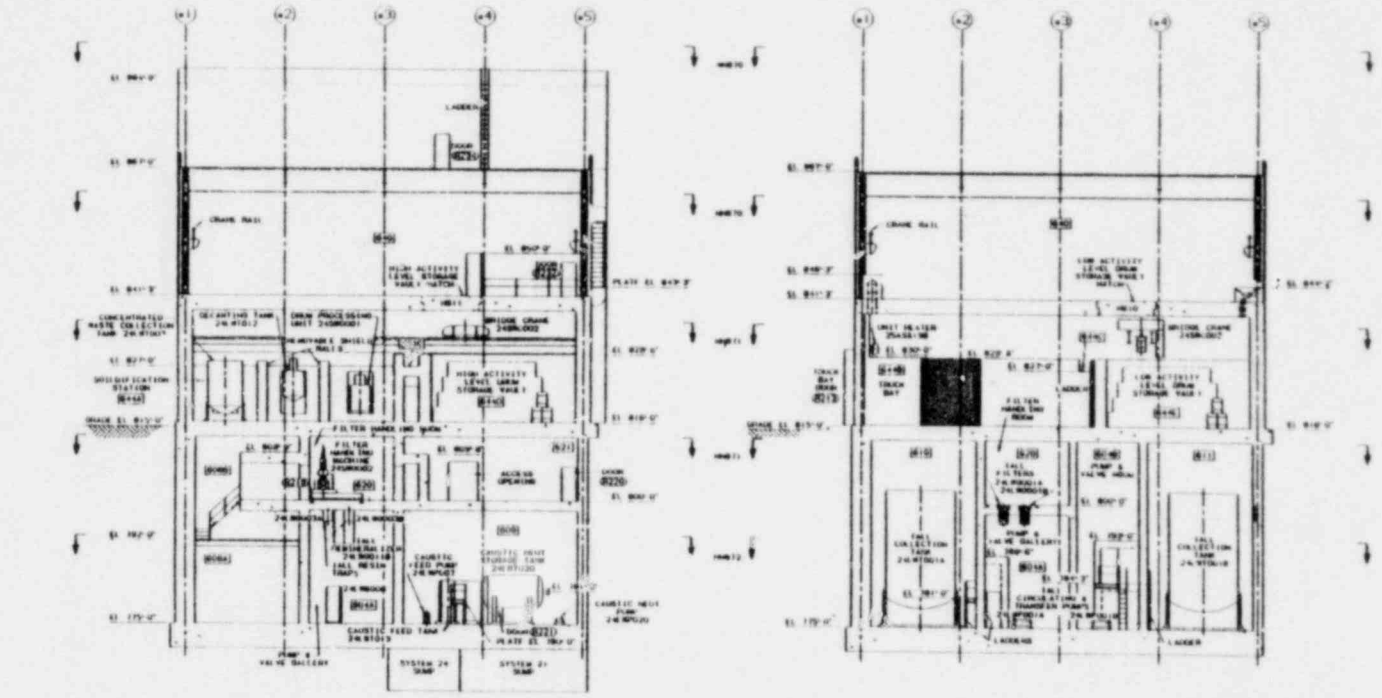
		DOSE (REM)	
ORGAN	10CFR100 LIMIT	S.B. (2 HR.) (.42 MI)	LPZ (30 DAY) (2.5 MI.)
BONE	150	0.0	0.0
LUNG	75	6.56-5*	2.46-5
THYROID	300	6.56-5	2.46-5
WHOLE BODY	25	6.56-5	2.46-5

*6.56-5=6.56×10^{-5}

MAXIMUM EXPOSURE FOR AN INDIVIDUAL
FOLLOWING POSTULATED FAILURE OF THE
LIQUID RADWASTE TANK

ORGAN	DOSE (REM)+	PERMISSIBLE 10CFR20 EXPOSURE (REM)
WHOLE BODY	0.039	0.500
THYROID	0.078	1.500
BONE	0.054	3.000
G.I. TRACT	0.039	1.500

+INDIVIDUAL ASSUMED TO REMAIN AT SITE BOUNDARY AND EXPOSED TO LIQUID (INCLUDING DRINKING) ENVIRONMENTS.



SECTION G-G

SECTION H-H

GENERAL NOTES

REFERENCE DRAWINGS

KEY PLAN

GRAPHIC SCALE

Figure 1.2-47
General Arrangement
Reactor Service Building
Radwaste Area
Section G-G and H-H