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# Potential for Loss of NPSH Due to LOCA Debris Accumulation on PWR ECCS Sump Screens

## Analysis of Postulated Accidents

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# Analysis of Postulated Accidents - Overview

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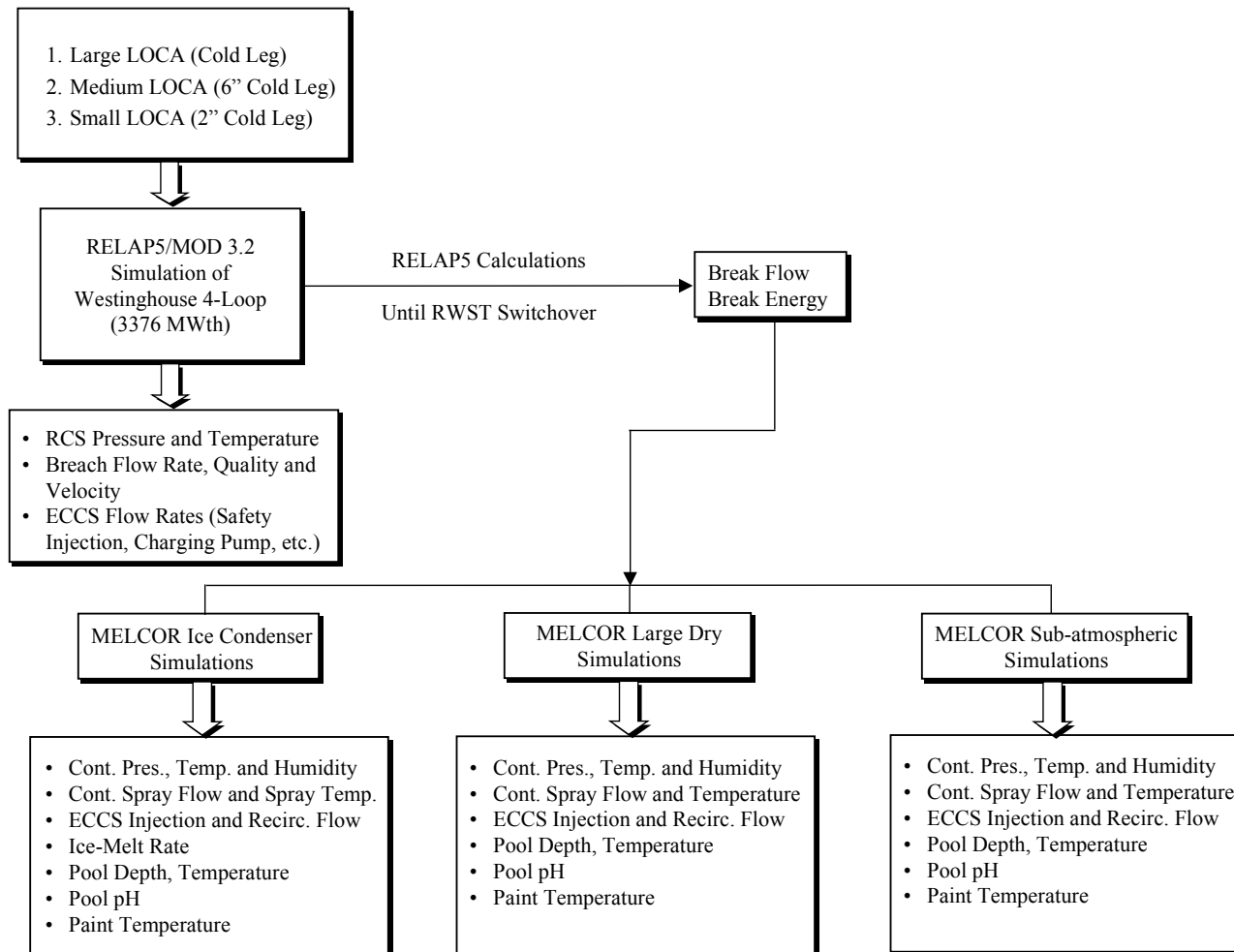
- ❖ Purpose of Accident Analysis
- ❖ Analysis Process
- ❖ RELAP5 / MELCOR Models
- ❖ Parameters Tracked
- ❖ LLOCA - Accident Progression & Results
- ❖ SLOCA - Accident Progression & Insights
- ❖ Key Accident Analysis Findings

# Purpose of Accident Analysis

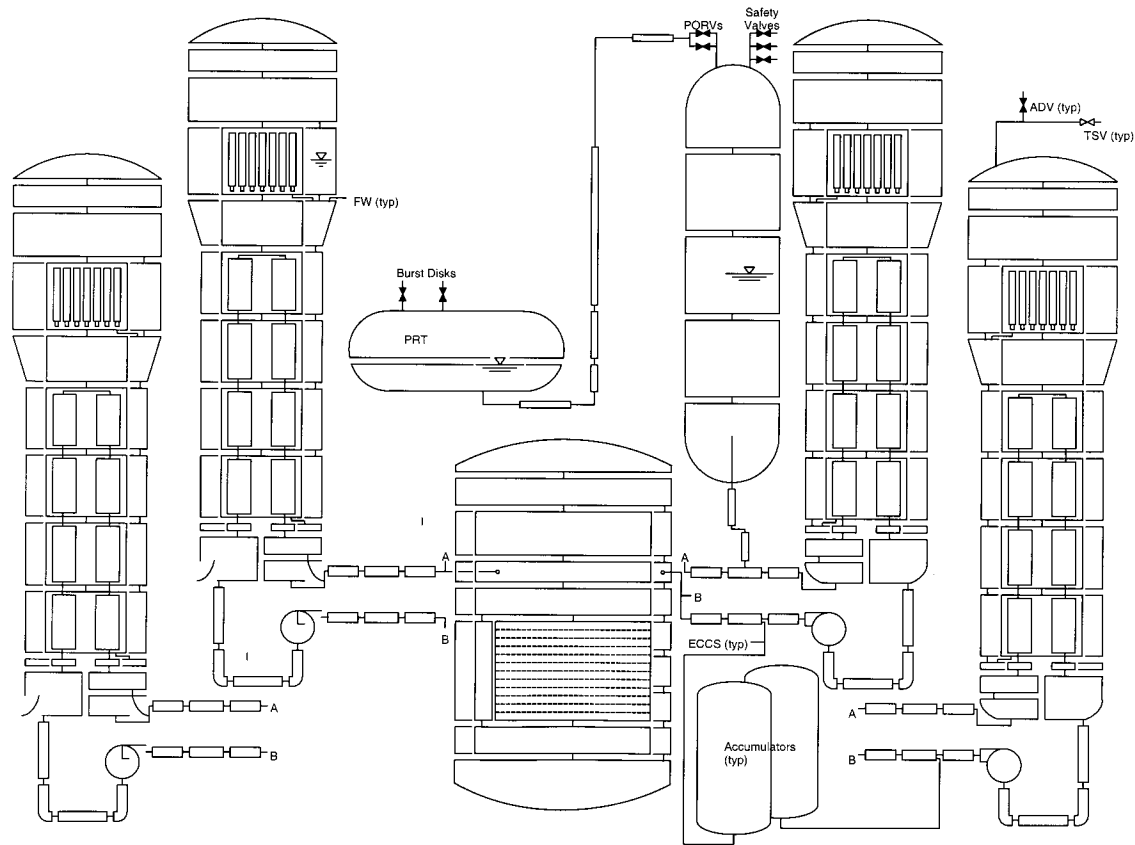
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- ❖ Identify Important RCS and Containment Thermal-Hydraulic Parameters that Influence PWR Debris Generation & Transport
- ❖ Perform Plant Simulations to Determine Value of Parameters as a Function of Time and System Response
- ❖ Construct Accident Progression Sequences to Form Basis for Strainer Blockage Vulnerability Assessment
- ❖ **Much Information Already Exists from LLOCA DBA Analyses - Virtually No Such Information Available for SLOCA/MLOCA**

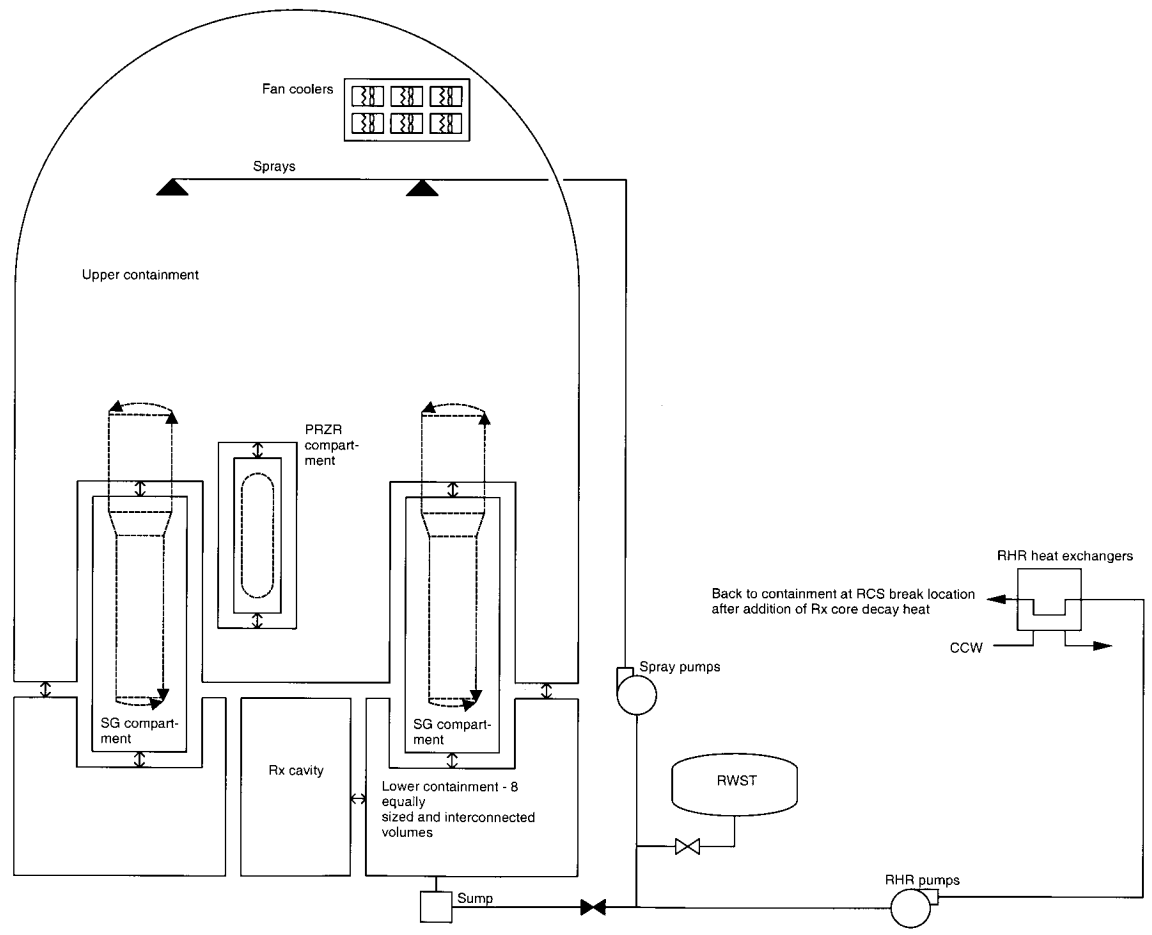
# Accident Analysis Process



# RELAP5 RCS Model Nodalization



# MELCOR Large-Dry Containment Nodalization

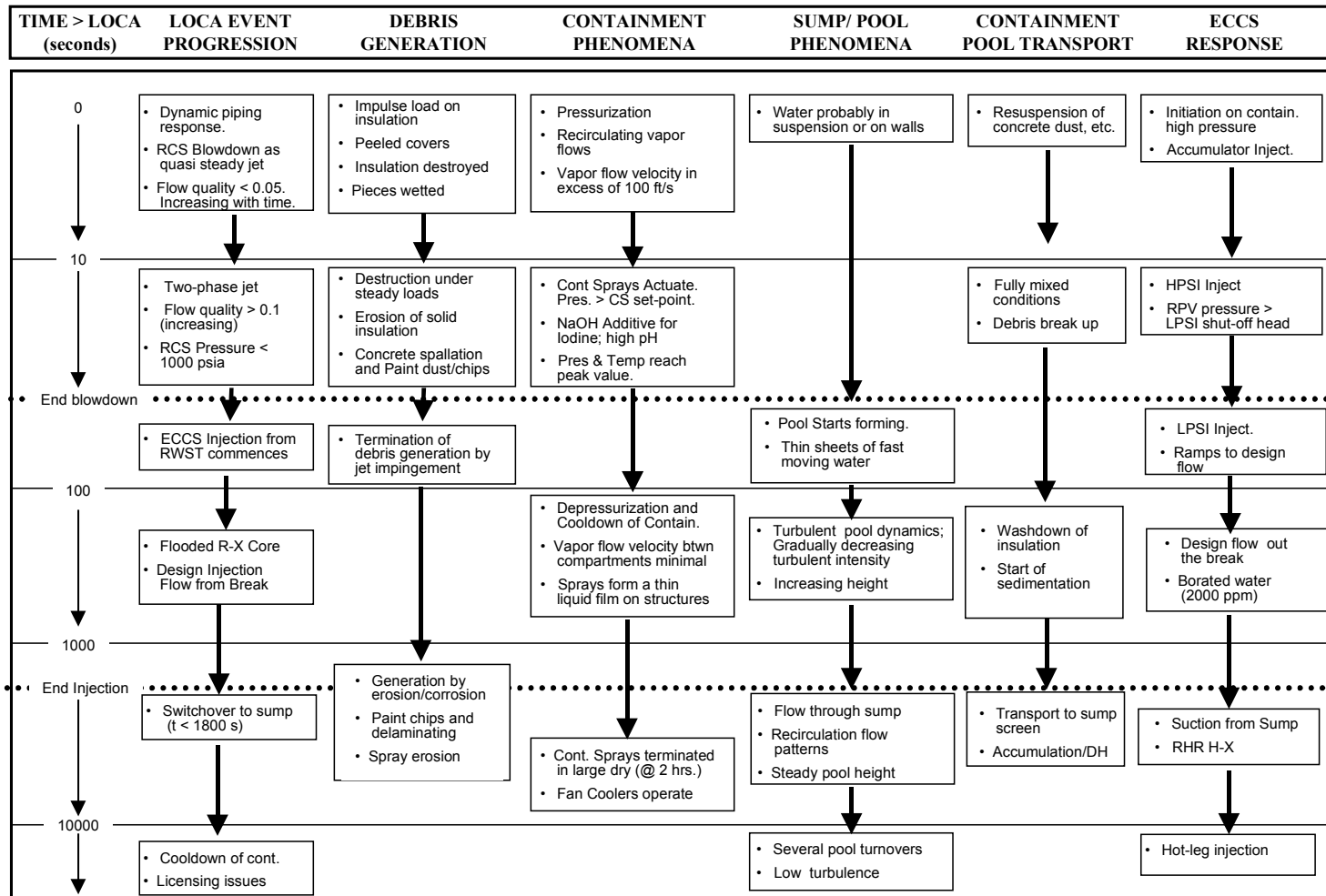


# Accident Analysis - Parameters Tracked

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- ❖ RCS Pressure & Temperature
- ❖ Breach Flow Conditions (Flow Rate, Velocity, Quality)
- ❖ ECCS Safety Injection Flow
- ❖ ECCS Recirculation Flow
- ❖ Containment Spray Flow
- ❖ Containment Spray Temperature
- ❖ Containment Water Pool Depth & Temperature
- ❖ Containment Water Pool pH
- ❖ Containment Atmospheric Velocity
- ❖ Temperature of Containment Coatings

# LLOCA Analysis - Accident Progression





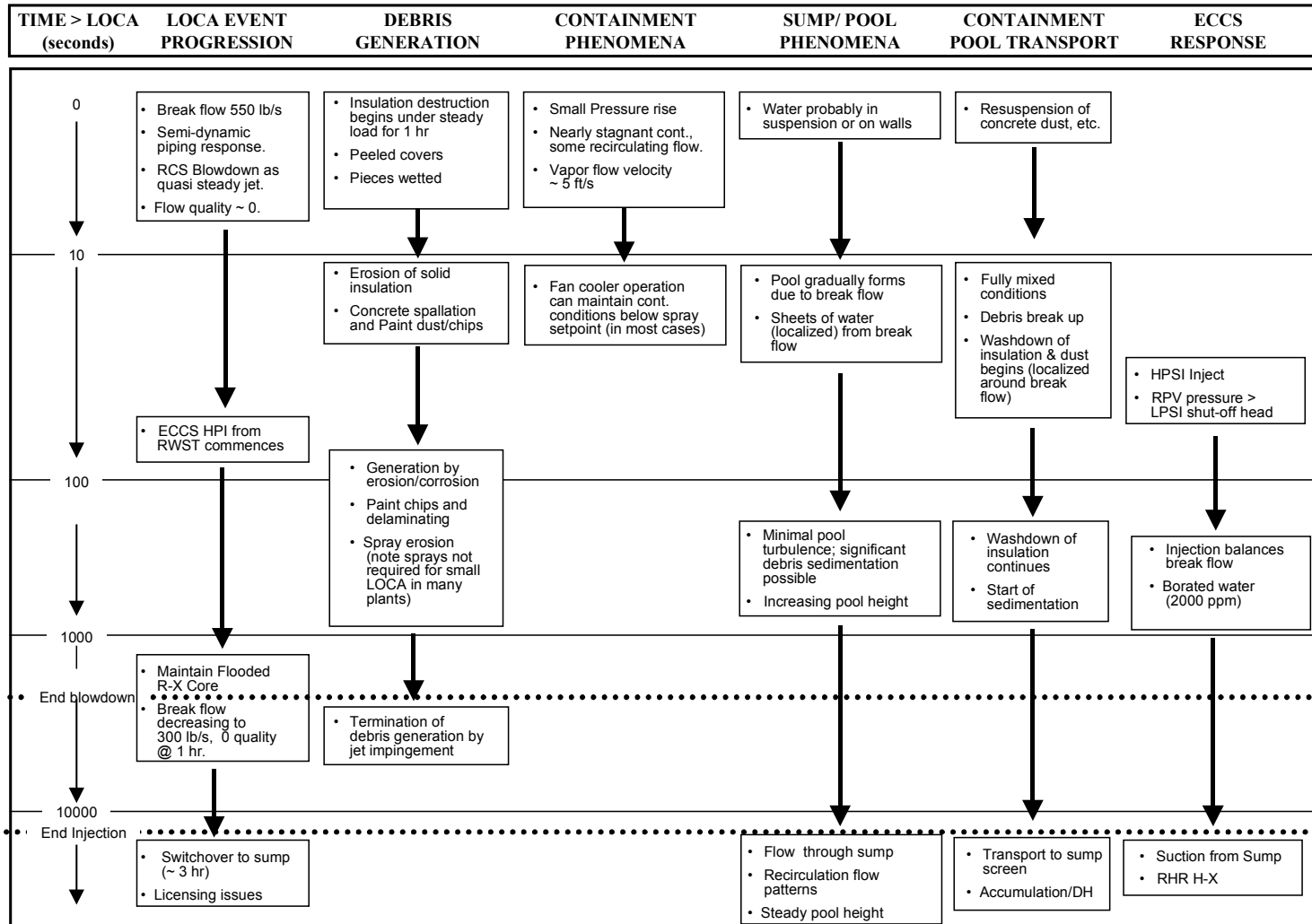
# LLOCA Results for Large-Dry Containment

Parameter	Blowdown Phase			Injection Phase			Recirculation Phase		
	0+	20 s	45 s	45 s	15 min	27 min	27 min	2 h	24 h
RCS pressure at break (psia)	2250	393	55						
RCS temperature at break (°F)	531	291	250	250	173	144	144		
Break flow (lbm/s)	7.97e4	1.28e4	4.89e3						
Break flow velocity (ft/s)	296	930	100						
Break flow quality	0	0.25	0.3	0.3	0				
Safety injection (gal/min)				11500	11500	11500			
Recirculation flow (gal/min)							17500	11800	11800
Spray flow (gal/min)				0	5700	5700	5700	0	
Spray temperature (°F)					105	190	190		
Containment pressure (psig)	0	36	33	33	11.5	7	7	1.5	0
Containment temperature (°F)	110	305	250	250	190	163	163	115	95
Pool depth (ft)					2	3.5	3.5	3.5	3.5
Pool temperature (°F)					212	187	187	125	100
Pool pH									
Containment atmosphere velocity (ft/s)	282		7						
Containment relative humidity (%)	50	100	100	100	100	90	90	100	100
Paint temperature (°F)	100			215	240	220	220	145	112

Peak break flow: 7.97e4 lbm/s at 0+ s  
 Quality at peak break flow: 0  
 Peak containment pressure: 36 psig at 20 sec

Peak break flow velocity: 930 ft/s at 21 s  
 Quality at peak break flow velocity: 0.25  
 Peak containment atmosphere velocity: 282 ft/s at 0+ s

# SLOCA Analysis - Accident Progression



# SLOCA - Containment Spray Operation

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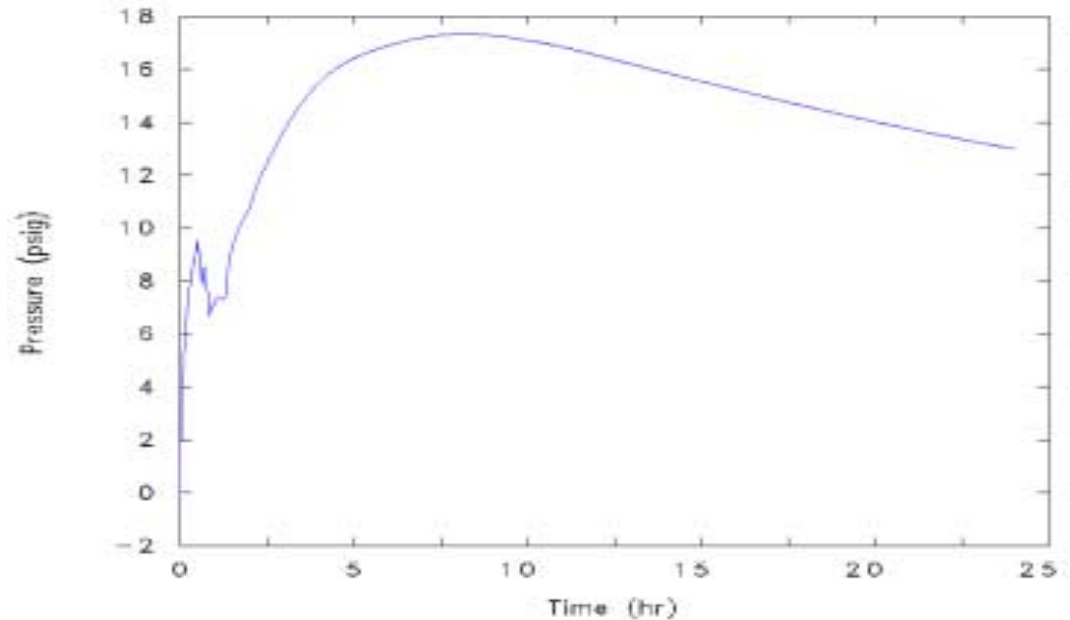
- ❖ Sprays Affect Vulnerability Assessment for SLOCA
  - ⊗ Spray Operation Increases Recirculation Flow Rate (Assumed Spray Flow of 6400 gpm)
  - ⊗ Large-Dry Accident Analysis for 2" Break (w/o Fan Coolers) Estimated Containment Pressure In Excess of 18 psi
  - ⊗ Parametric Evaluation Assumed Spray Operation for:
    - » All Ice-Condenser and Sub-Atmospheric Units
    - » Large-Dry Units with Setpoints of 10 psig or Greater

Setpoint (psig)	No. Units	Containment Type
0 to 3	9	Ice-Condenser
	1	Large-Dry
4 to 10	15	Large-Dry
	3	Sub-Atmospheric
> 10	32	Large-Dry
	4	Sub-Atmospheric
No Data	5	Large-Dry

# SLOCA - Containment Pressure Response

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- ❖ Large-Dry Containment
- ❖ 2" Break
- ❖ No Fan Coolers



# Key Accident Analysis Findings

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- ❖ Blowdown Timing & Duration Highly Dependent on Break Size
  - ⊗ Affects Debris Generation
  - ⊗ Affects Containment Atmosphere Velocities (Debris Transport)
  - ⊗ Affects Time to Recirculation (Debris Settling)
  - ⊗ Duration Varies from LLOCA = 30 sec to SLOCA = 3600 sec
- ❖ Magnitude of ECCS Recirculation Flow Varies with Break Size
  - ⊗ LLOCA Recirculation Approaches Design Flows
  - ⊗ Survey of Plant Data Suggests SLOCA Recirculation of 1800-4800 gpm, with Median Value of 2500 gpm
- ❖ Containment Spray Actuation Expected for All LLOCA, MLOCA Sequences - Actuation for SLOCA Varies by Unit