December 5, 1990

NOTE TO: D. F. Ross, Deputy Director
Office of Analysis and Evaluation
and Operational Data

FROM: W. D. Beckner, Chief /s/
Risk Applications Branch, NRR

SUBJECT: ISLOCA ANALYSIS REPORT FOR DAVIS BESSE

The attached report on the assessment of ISLOCA risks for Davis Besse is in draft form. It contains preliminary information, some of which currently is being revised by INEL. Also, portions of the report are being contested by the licensee. In view of this, RES has denied its release to a recent FOIA request on the basis that the information is predecisional. The attached copy is for your personal use and should not be distributed in any way outside NRC. If you have any questions regarding this, please contact me.

cc w/o enclosure:
S. Diab, NRR
G. Burdick, RES

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Idaho National Engineering Laboratory

AN APPROACH TO IDENTIFYING AND QUANTIFYING HUMAN ERROR IN SUPPORT OF ISLOCA

HAROLD S. BLACKMAN

DAVID I. GERTMAN

DECEMBER 11TH AND 12TH, 1990

EG&G Idaho, Inc.

OBJECTIVE OF THE HRA WAS TO IDENTIFY THE SPECTRUM OF ERRORS ASSOCIATED WITH ISLOCA

FAILURE MODE DIMENSION

ACTIVITY DIMENSION	OMISSION	COMMISSION
LATENT		
ACTIVE		

AN INTEGRATED APPROACH TO HRA WAS USED

- Ensure all Types of Actions were considered for preliminary event trees
- Identify and Screen Human Interactions which May be Risk Significant
- Develop a Detailed Description of Important Human Actions
- Select and Apply Appropriate Modeling Techniques
- Develop new Models where Existing Techniques do not Adequately Represent Human Actions
- Quantify the Probabilities for the Various Human Actions
- Document the Information for Traceability

ERRORS OF COMMISSION ARE NOT USUALLY MODELED IN CONTEMPORARY PRA EFFORTS

- METHODS FOR IDENTIFYING AND QUANTIFYING ERRORS OF OMISSION FOR USE IN CONTEMPORARY PRA ARE WELL DEVELOPED

- METHODS FOR IDENTIFYING AND QUANTIFYING ERRORS OF COMMISSION ARE LESS WELL DEVELOPED

- PRESENT STUDY SOUGHT METHODS TO IDENTIFY, MODEL, AND QUANTIFY ERRORS OF COMMISSION

ERROR IDENTIFICATION BROADENED TO INCLUDE PROBABLE ERRORS OF COMMISSION

- ERRORS ARE NORMALLY IDENTIFIED THROUGH TASK ANALYSIS
- DATA COLLECTION IS KEYED TO HRA QUANTIFICATION TECHNIQUES
- STUDY APPLIED A VARIATION OF SNEAK ANALYSIS TO IDENTIFY POTENTIAL ERRORS

EXAMPLE FINDING FROM SNEAK ANALYSIS: THE POTENTIAL FOR EARLY ENTRY INTO DHR COOLDOWN

- o WE FOUND
  - ADMINISTRATIVE BARRIERS NOT IDENTIFIED
  - OPERATORS ROUTINELY BYPASS PHYSICAL BARRIERS BY JUMPERING INTERLOCKS
  - PROCEDURALLY SANCTIONED TO JUMPER ONE PIV

- o THIS SUGGESTED A SNEAK PATH FOR THE ERROR OF COMMISSION RELATED TO PREMATURELY OPENING VALVES

QUANTIFICATION OF INTENTIONAL ERRORS OF COMMISSION

- Insufficient Operational Data Exists to Support the Quantification of Errors of Commission Related to Erroneous Intent
- Errors of Intent are not Time Driven but are Conscious Decisions on the Part of the Operator
- Errors are Cognitive in Nature and are Influenced by Performance Shaping Factors Such as Quality of Procedures, Training, and More Nebulous Concepts such as ISLOCA Awareness
- Errors Occur in the Thinking as Much as in the Doing
- Therefore the Analyst Must Use Expert Judgement Techniques for Quantification

A SENSITIVITY ANALYSIS WAS CONDUCTED WHICH EVALUATED THE EFFECTS OF THE FOLLOWING POTENTIAL MODIFICATIONS:

- o Procedures
  - Cautions, Notes, and Warnings Added
  - Hypothesize a Procedure for ISLOCA
  - Preclude Jumpering of Interlocks
- o Instrumentation
  - Addition of Valve Status Board
  - Presentation of Information on Pressures, Temperatures, level, and Flow
- o Training
  - Formal Training on ISLOCA, Associated Alarms, New Procedures
- o Recovery
  - All Tasks Covered by Procedures, Checkoffs, and Independent Verification

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Idaho National Engineering Laboratory

RUPTURE PROBABILITY CALCULATIONS

W. J. GALYEAN

DECEMBER 12, 1990

EG&G Idaho, Inc.

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COMPREHENSIVE ISLOCA ANALYSIS REQUIRES ACCURATE ESTIMATION OF RUPTURES

ISLOCA EVALUATION REQUIRES PREDICTION AND UNDERSTANDING OF INTERFACING SYSTEM RESPONSE TO OVERPRESSURIZATION.

- O NEED TO IDENTIFY:
  - WHICH COMPONENTS ARE LIKELY TO RUPTURE
  - LIKELY RUPTURE LOCATION
  - SIZE OF RUPTURE

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OVERPRESSURE RUPTURES OF INTERFACING SYSTEMS ARE TREATED PROBABILISTICALLY

- O UNCERTAINTIES (BOTH TOLERANCE AND CONFIDENCE) IN SPECIFIC CONDITIONS PRECLUDES REALISTIC-DETERMINISTIC ANALYSIS:

  - COMPONENT PRESSURE CAPABILITIES (E.G. PRE-EXISTING FLAWS),

  - EXPECTED LOCAL SYSTEM PRESSURES (E.G. VARIATIONS IN SYSTEM CONFIGURATIONS AND OPERATIONS).

- O PROBABILISTIC RUPTURE ANALYSES INCLUDES CONSIDERATION OF UNCERTAINTIES (EVEN WHEN POINT ESTIMATES ARE USED).

RUPTURE PROBABILITY CALCULATIONS REQUIRE BOTH STRESS AND STRENGTH INFORMATION

RUPTURE PROBABILITY DETERMINED BY TWO FACTORS:

- PRESSURE CAPACITY OF INTERFACING SYSTEM COMPONENTS
  - PERFORMED BY ABB-IMPELL.
- PRESSURES SEEN BY INTERFACING SYSTEM COMPONENTS
  - INCLUDES EFFECTS OF RELIEF VALVES AND FLOW RESTRICTIONS (ORIFICES, PIPE SIZE, CHOKE PLANES).

PRESSURE CAPACITY EVALUATION HAD THREE MAJOR OBJECTIVES

- DEVELOP A METHODOLOGY TO PROBABILISTICALLY ASSESS FLUID SYSTEM COMPONENTS WHEN SUBJECTED TO HIGHER THAN DESIGNED PRESSURES AND TEMPERATURES.
- DETERMINE MEDIAN FAILURE PRESSURE (LOGNORMAL) AND ASSOCIATED UNCERTAINTY FOR FLUID SYSTEM COMPONENTS.
- FOR POSTULATED FAILURES DETERMINE EXPECTED LEAK RATES OR LEAK AREAS.

ALL MAJOR COMPONENTS IN INTERFACING SYSTEMS WERE EVALUATED

DECAY HEAT REMOVAL - LOW PRESSURE INJECTION, HIGH PRESSURE INJECTION, AND MAKEUP & PURIFICATION SYSTEMS EXAMINED.

- PIPES (ALL STAINLESS STEEL)
- TANKS, VESSELS AND HEAT EXCHANGERS
- FLANGES
- VALVES
- PUMPS

ESTIMATING REALISTIC FAILURE PRESSURES WAS A PRIME CONSIDERATION

- O PRESSURE CAPACITIES BASED ON ACTUAL (RATHER THAN CODE OR DESIGN) MATERIAL PROPERTIES OR ACTUAL TEST DATA.

  STANDARD

- O PRESSURE CAPACITY ASSUMED TO BE A LOGNORMAL RANDOM VARIABLE.

- O QUASISTATIC PRESSURE AND TEMPERATURE CONDITIONS ASSUMED:

  - BASED ON RUNS OF SIMPLE RELAP5 MODELS OF INTERFACING SYSTEMS

    "QUICK" FAILURES HARD TO PREDICT ON BASIS OF OBSERVED EXPERIENCE.

MANY LOW PRESSURE RATED COMPONENTS NOT CAPABLE OF WITHSTANDING RCS PRESSURES

MEDIAN LARGE-RUPTURE FAILURE PRESSURES:

o 12" SCHEDULE-20 PIPE	1660 PSIG
o 18" SCHEDULE-10 PIPE	843 PSIG
o 12" 300-PSI FLANGE	2250 PSIG
o DHR HEAT EXCHANGER:	
- TUBE SHEET FLANGE	893 PSIG
- PLASTIC COLLAPSE HEAD BUCKLING	1030 PSIG
- CYLINDER RUPTURE	1630 PSIG

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LOCAL INTERFACING SYSTEM PRESSURES PREDICTED USING SIMPLE RELAP5 MODELS

RELAP5 MODEL OF INTERFACING SYSTEMS WERE BUILT AND RUN.

- O INTERFACING SYSTEMS NORMALLY KEPT FILLED
- O CALCULATIONS ASSUMED STEADY STATE RCS
  - JUSTIFIED (VERY SLIGHTLY CONSERVATIVE) BY RAPID PRESSURIZATION OF INTERFACING SYSTEM (I.E. 5-7 SECONDS)
- O PRESSURE EQUILIBRIUM ESTABLISHED VERY QUICKLY - DEAD ENDED (CLOSED) SYSTEMS PRESSURIZE VIRTUALLY INSTANTANEOUSLY.
- O SMALL RELIEF VALVES IN COMBINATION WITH FLOW RESTRICTIONS MAY PROTECT PORTIONS OF SYSTEMS.

INTERFACING SYSTEM EVENT TREE MODEL USED TO SIMULATE O.P. RESPONSE

- O EACH INTERFACING SYSTEM COMPONENT REPRESENTED BY AN EVENT ON THE EVENT TREE

- O INTERFACING SYSTEM LOCAL-PRESSURES ESTIMATED BY RELAP5 RUNS

  - OVERPRESSURE REPRESENTED AS "INITIATING EVENT"

- O PROBABILITY DISTRIBUTIONS ASSUMED FOR BOTH FAILURE PRESSURE AND LOCAL SYSTEM PRESSURE:

  - COMPONENT PRESSURE FRAGILITIES MODELED LOGNORMALLY,

  - LOCAL SYSTEM PRESSURES ARE A FUNCTION OF RCS PRESSURE, WHICH IS ASSUMED TO BE NORMALLY DISTRIBUTED.

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INTERFACING SYSTEM RUPTURE PROBABILITIES ESTIMATED BY MONTE CARLO SAMPLING EVENT TREE

EVNTRE-CODE DEVELOPED DURING NUREG-1150 PROGRAM UTILIZED FOR CALCULATION.

- O LOCAL SYSTEM PRESSURE SAMPLED FROM POSTULATED NORMAL DISTRIBUTION (E.G. MEAN 2100 PSIG, STD-DEV 50 PSI).

- O COMPONENT FAILURE PRESSURE SAMPLED FROM POSTULATED LOGNORMAL DISTRIBUTION, E.G. 12-INCH SCH20 PIPE: MEDIAN 1660 PSIG, LOG-STD-DEV 0.36.

INTERFACING SYSTEM RUPTURES ESTIMATED BY MONTE CARLO SAMPLING EVENT TREE (CONTINUED)

FOR EACH COMPONENT IN THE INTERFACING SYSTEM, MONTE CARLO ROUTINE SAMPLES A LOCAL SYSTEM PRESSURE, A FAILURE PRESSURE AND COMPARES THE TWO, IF:

- O $P_L > P_F$, THEN COMPONENT RUPTURES,
- O $P_L < P_F$, THEN COMPONENT DOES NOT RUPTURE.
- O RUPTURE PROBABILITY IS FRACTION OF MONTE CARLO OBSERVATIONS RESULTING IN RUPTURES.

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COMPONENT FAILURE PROBABILITIES CAN BE CALCULATED UTILIZING SEISMIC FAILURE EQUATION

- O PROBABILITY OF FAILURE AT 2100 PSIG FOR A 12-INCH SCH20 PIPE (MEDIAN = 1660 PSIG, LOG-STD-DEV = 0.36)

PROB(FAIL PRESS < 2100 PSIG) = PHI((LN(2100)-LN(1660))/0.36)
= PHI(0.65)
PROBABILITY OF RUPTURE = 0.742

- O (REF: R. P. KENNEDY ET AL, NUCLEAR ENGINEERING AND DESIGN, VOL.59, NO.2, AUGUST 1980.)

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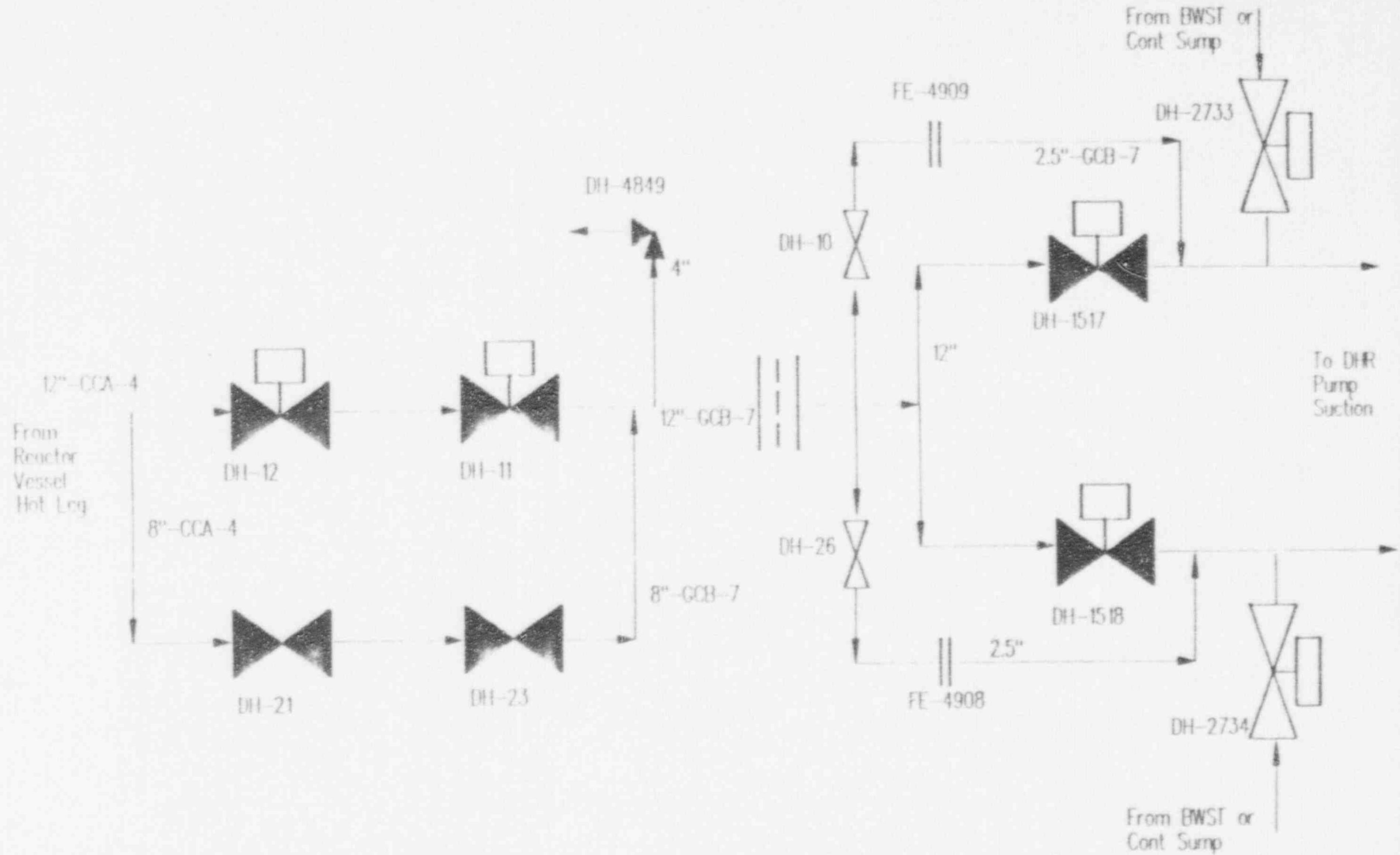
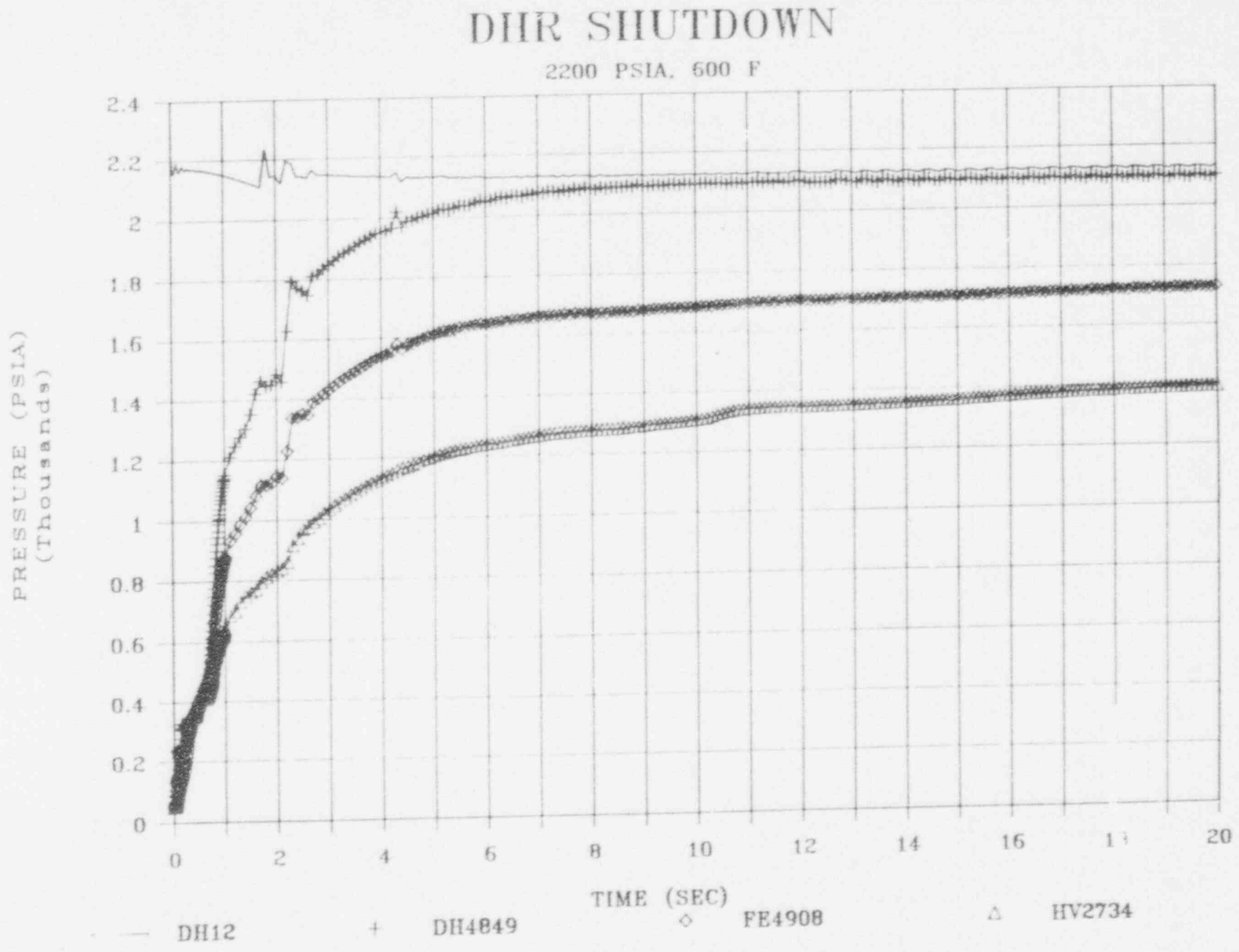
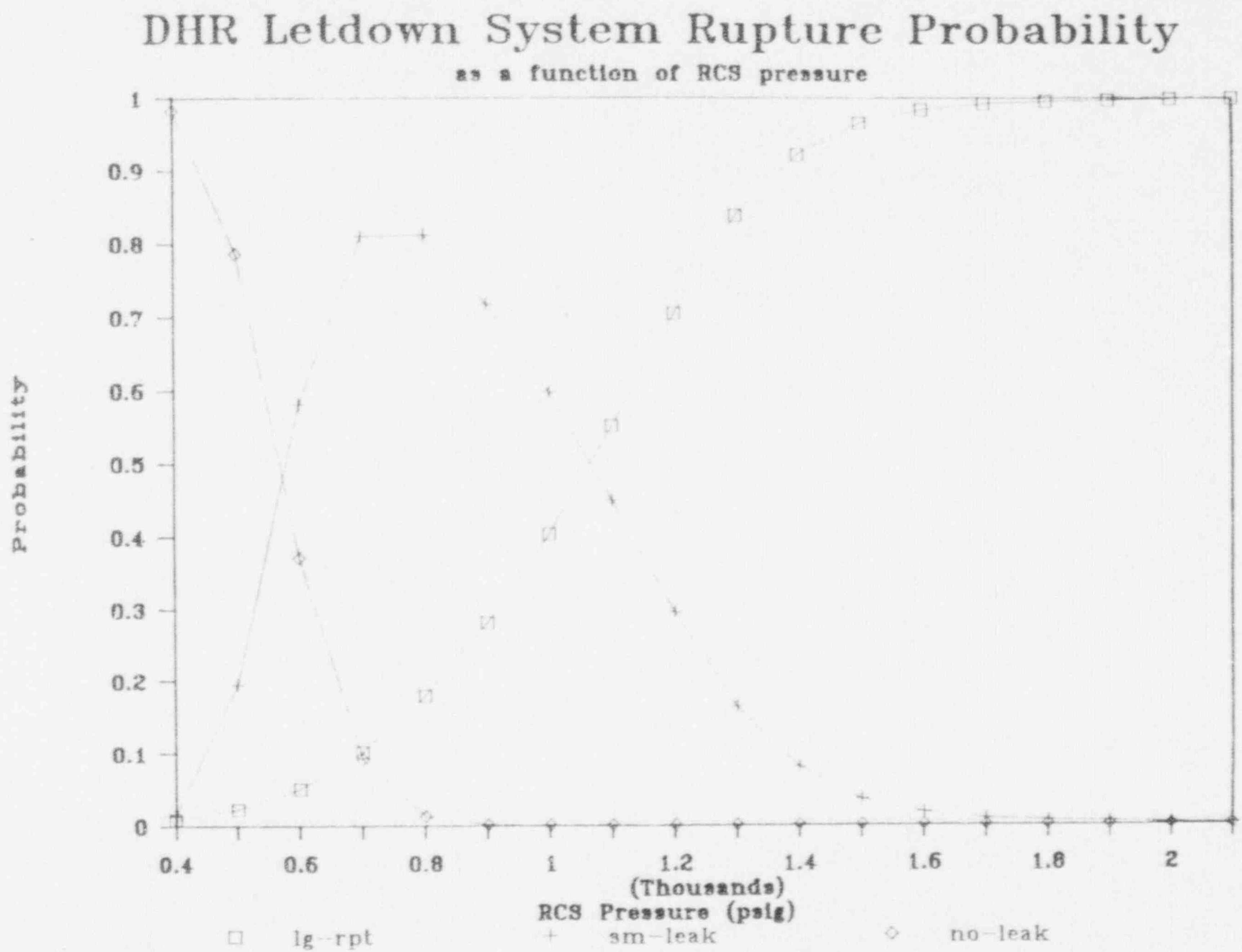


From BWST or
Cont Sump
FE-4909
DH-2733
2.5"-GCB-7
DH-4849
DH-10
4"
DH-1517
12"
To DHR
Pump
Suction
12"-CCA-4
12"-GCB-7
From
Reactor
Vessel
Hot Leg
DH-12
DH-11
8"-CCA-4
DH-26
DH-1518
8"-GCB-7
2.5"
DH-21
DH-23
FE-4908
DH-2734
From BWST or
Cont Sump


DHR SHUTDOWN
2200 PSIA, 600 F
PRESSURE (PSIA)
(Thousands)
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
14
16
20
TIME (SEC)
— DH12
+ DH4849
◇ FE4908
△ HV2734


DHR Letdown System Rupture Probability
as a function of RCS pressure
Probability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
(Thousands)
RCS Pressure (psig)
lg-rpt
sm-leak
no-leak

DHR LETDOWN SYSTEM COMPONENT RUPTURE DATA

MEDIAN RCS PRESS = 1250 (UNIFORM BETWEEN 300 AND 2200 PSI).
MEDIAN SYSTEM PRESSURE AT DH-4849 = 1188. PSIA.
MEDIAN SYSTEM PRESSURE AT DH-2734 = 818. PSIA.

COMPONENT	DESCRIPTION	MED. FAIL PRESS	FAILURE PROB.
DH-4849			
12"-GCB-7	PIPE, SCH. 20	1660	* 0.2553
DH-2734			
DH-1517	12" MOGV, 300 PSI	1704	0.013 SM
18"-GCB-8	PIPE, SCH. 20	1488	* 0.1072
DH-2733	18" MOGV, 300 PSI	2277	5.0E-4 SM
18"-HCB-1	PIPE, SCH. 10S	843	* 0.447
14"-HCB-1	PIPE, SCH. 10S	1090	* 0.2695
DH-81	14" SWCV, 150 PSI	1445	0.0675 SM
12"-GCB-8	PIPE, SCH. 20	1660	0.0712
12GCBA	FLANGE, 300 PSI	2250	0
12GCBB	FLANGE, 300 PSI	2250	0
12GCBC	FLANGE, 300 PSI	2250	0
P42-1	DHR PUMP 1-1	2250	3.0E-4 SM
10"-GCB-1	PIPE, SCH. 20	1984	0.0315
10GCB1A	10" FLANGE, 300 PSI	2485	0
DH-43	10" SWCV, 300 PSI	2016	2.5E-3 SM
DH-45	10" HWGV, 300 PSI	2170	9.0E-4 SM
E271T	DHR HX TUBE SHT	432	* 0.8546 (50% SM)
E271P	DHR HX PLASTIC COL	1030	0.05988
E271C	DHR HX CYL. RUPT.	1630	0.0448
E271A	DHR HX ASYM HD. BKL	2030	9.2E-4 SM
E271A	10" OUT-F, 300 PSI	2485	0
E271B	10" IN-F, 300 PSI	2485	0
6"-GCB-10	PIPE, SCH. 10S	1585	0.0822
10"-GCB-10	PIPE, SCH. 20	1984	0.0295
8"-GCB-10	PIPE, SCH. 20	2503	7.3E-3
DH-128	8" SWCV, 300 PSI	1242	0.142 SM
4"-GCB-2	PIPE, SCH. 10S	2075	0.022
FE-DH2B	10" FE, 300 PSI	2485	0

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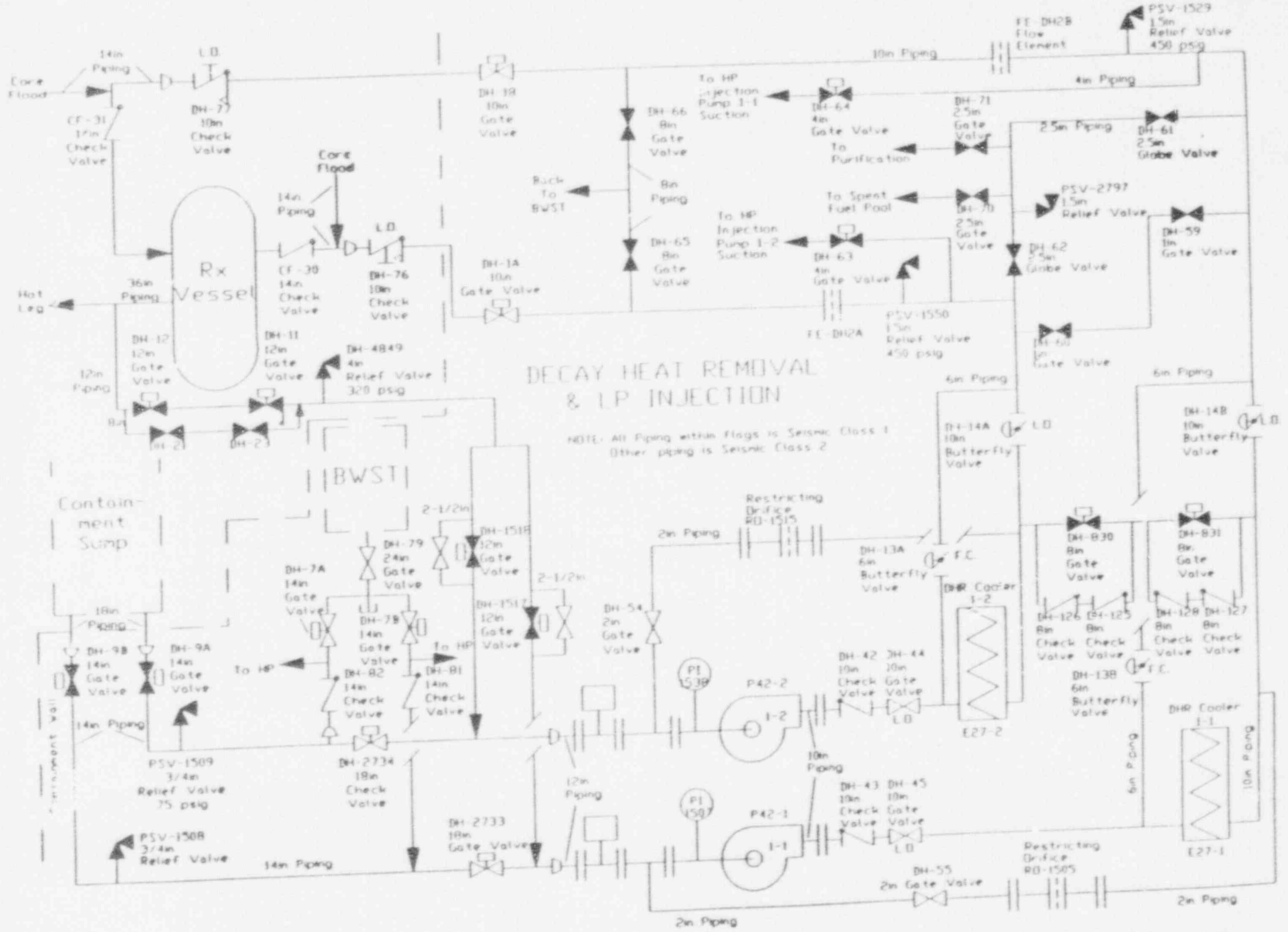

DECAY HEAT REMOVAL
& LP INJECTION
NOTE: All Piping within flags is Seismic Class 1
Other piping is Seismic Class 2
Core Flood
14in Piping
CF-31 14in Check Valve
L.O.
DH-77 10in Check Valve
Rx Vessel
36in Piping
Hot Leg
Core Flood
14in Piping
CF-30 14in Check Valve
DH-76 10in Check Valve
DH-12 12in Gate Valve
DH-11 12in Gate Valve
12in Piping
DH-4849 4in Relief Valve 320 psig
DH-2
DH-23
BWST
Contain-ment Sump
DH-19 10in Gate Valve
DH-1A 10in Gate Valve
DH-66 8in Gate Valve
Back To BWST
8in Piping
DH-65 8in Gate Valve
To HP Injection Pump 1-1 Suction
DH-64 4in Gate Valve
To HP Injection Pump 1-2 Suction
DH-63 4in Gate Valve
FE-DH2A
PSV-1550 1.5in Relief Valve 450 psig
To Purification
To Spent Fuel Pool
DH-71 2.5in Gate Valve
DH-70 2.5in Gate Valve
DH-62 2.5in Globe Valve
DH-60 1in Gate Valve
10in Piping
FE-DH2B Flow Element
PSV-1529 1.5in Relief Valve 450 psig
4in Piping
2.5in Piping
DH-61 2.5in Globe Valve
PSV-2797 1.5in Relief Valve
DH-59 1in Gate Valve
6in Piping
DH-14A 10in Butterfly Valve
DH-14B 10in Butterfly Valve
Restricting Orifice RO-1515
2in Piping
DH-13A 6in Butterfly Valve
F.C.
DH-830 8in Gate Valve
DH-831 8in Gate Valve
DH-126 8in Check Valve
DH-125 8in Check Valve
DH-128 8in Check Valve
DH-127 8in Check Valve
DH-13B 6in Butterfly Valve
DHR Cooler 1-2
E27-2
DHR Cooler 1-1
E27-1
6in Piping
10in Piping
2-1/2in
DH-1518 12in Gate Valve
DH-1517 12in Gate Valve
DH-79 24in Gate Valve
DH-7A 14in Gate Valve
DH-7B 14in Gate Valve
To HP
DH-82 14in Check Valve
DH-81 14in Check Valve
18in Piping
DH-9B 14in Gate Valve
DH-9A 14in Gate Valve
14in Piping
PSV-1509 3/4in Relief Valve 75 psig
DH-2734 18in Check Valve
DH-2733 18in Gate Valve
PSV-1508 3/4in Relief Valve
12in Piping
DH-54 2in Gate Valve
PI 1538
PI 1537
P42-2
P42-1
1-2
1-1
DH-42 10in Check Valve
DH-44 10in Gate Valve
DH-43 10in Check Valve
DH-45 10in Gate Valve
Restricting Orifice RO-1505
DH-55 2in Gate Valve

LARGE RUPTURES OF INTERFACING SYSTEMS ARE LIKELY FOR MOST ISLOCA SEQUENCES

WHEN EXPOSED TO FULL RCS PRESSURE AND TEMPERATURE RUPTURES ARE EXPECTED TO OCCUR VERY RAPIDLY

- O INTERFACING SYSTEMS WILL REACH MAXIMUM PRESSURE WITHIN 5 TO 7 SECONDS
  - THIS WILL NEGATE MOST BENEFIT EXPECTED FROM RCS DEPRESSURIZATION
- O FLANGE AND SEAL LEAKS ARE POSSIBLE BUT ARE NOT EXPECTED TO BE LARGE ENOUGH TO PROTECT OTHER EQUIPMENT
- O PIPE RUPTURES AND FAILURES OF HEAT EXCHANGERS ARE MOST LIKELY

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Idaho National Engineering Laboratory

BACKGROUND AND APPROACH FOR ISLOCA EVALUATIONS

DUANE J. HANSON

DECEMBER 11, 12 1990

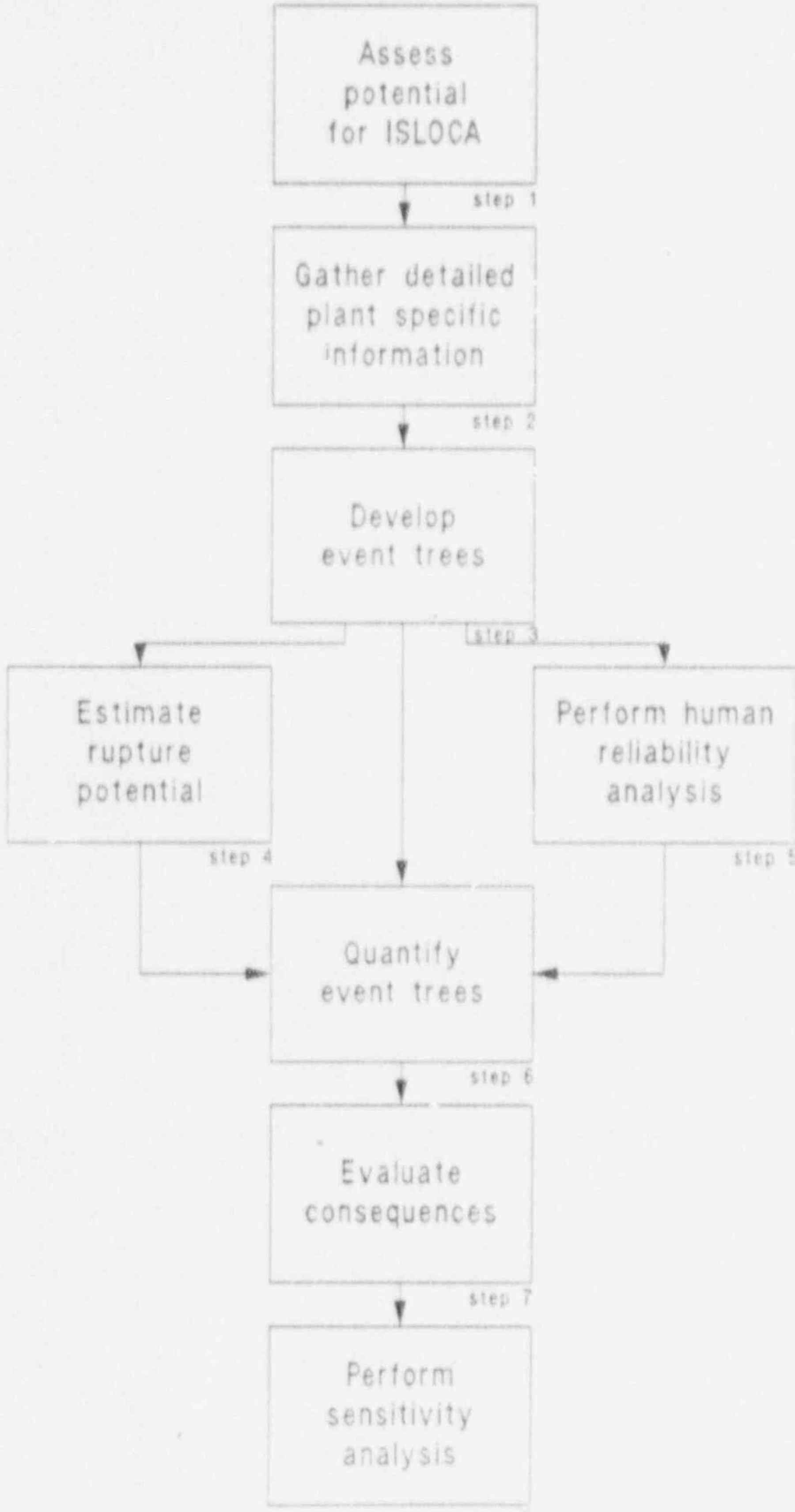
EG&G Idaho, Inc.

SKIP

ISLOCA PROGRAM OBJECTIVES (CONT.)

- IDENTIFY AND DESCRIBE POTENTIAL ISLOCA SEQUENCES
  - TIMING
  - ACCIDENT MANAGEMENT STRATEGIES
  - EFFECT ON OTHER EQUIPMENT
- ESTIMATE CONSEQUENCES OF POTENTIAL ISLOCA SEQUENCES
  - CORE MELT FREQUENCY
  - OFFSITE CONSEQUENCES
  - RECOMMEND CONSEQUENCE REDUCTION ACTIONS

Approach for Evaluation of ISLOCA



STEP 2 - GATHER DETAILED PLANT SPECIFIC INFORMATION

- INFORMATION ON CAPABILITIES AND LIMITATIONS OF HARDWARE THAT COULD BE INVOLVED IN AN ISLOCA
- INFORMATION ON PROCEDURES AND GUIDELINES DURING STARTUP, POWER OPERATION, SHUTDOWN, AND EMERGENCY OPERATING PROCEDURES THAT MAY EFFECT ISLOCA
- INFORMATION ON MAINTENANCE AND IN-SERVICE TEST PRACTICES
- INFORMATION ON FACTORS THAT COULD INFLUENCE HUMAN PERFORMANCE FOR DETECTION, PREVENTION, AND MITIGATION

STEP 4 - ESTIMATE RUPTURE POTENTIAL

- ESTIMATE THE MEDIAN FAILURE PRESSURE, ITS EXPECTED DISTRIBUTION AND VARIANCE, AND THE POTENTIAL LEAK RATE FOR EACH COMPONENT (IMPELL RESULTS)

- ESTIMATE THE PRESSURE EACH COMPONENT WILL BE EXPOSED TO BASED ON THE POTENTIAL INITIATING EVENTS AND PRIMARY SYSTEM CONDITIONS

- DEVELOP AN EVENT TREE FOR EACH SYSTEM TO COMPARE THE EXPECTED LOCAL PRESSURE AND ESTIMATED FAILURE PRESSURE FOR THE IMPORTANT COMPONENTS

- ESTIMATE THE RELATIVE FREQUENCY OF EQUIPMENT FAILURES USING A MONTE CARLO SIMULATION TO RANDOMLY SELECT A SYSTEM PRESSURE AND COMPARE IT TO A RANDOMLY SELECTED COMPONENT FAILURE PRESSURE

STEP 6 - QUANTIFY EVENT TREES

- SEQUENCE INITIATORS
  - GENERIC HARDWARE FAILURE DATA
  - HRA RESULTS
- RUPTURE PROBABILITIES
  - ESTIMATES OF EQUIPMENT FAILURE FREQUENCIES
- DETECTION, DIAGNOSIS, ISOLATION, AND MITIGATION
  - HRA RESULTS
  - VALVE CAPABILITIES
  - CAPABILITY OF SYSTEMS TO SCRUB FISSION PRODUCTS

STEP 8 - SENSITIVITY STUDIES

- EVALUATE THE SENSITIVITY TO PARAMETERS THAT HAVE A RELATIVE LARGE UNCERTAINTY IN THEIR VALUES

- ESTIMATE THE CHANGE IN CORE DAMAGE FREQUENCY FROM PROPOSED CHANGES TO PLANT HARDWARE AND OPERATIONS

- EXAMINE ALTERNATIVE METHODS OF ESTABLISHING PROBABILITIES

IMPORTANT RESULTS TO CONSIDER DURING THE FOLLOWING PRESENTATIONS

- EFFECT OF HUMAN ACTIONS AS INITIATORS FOR ISLOCA
- RELATIVE CONTRIBUTION OF HUMAN ERRORS AND HARDWARE FAILURES TO ISLOCA CDF AND RISK
- COMPONENTS THAT WOULD FAIL WHEN EXPOSED TO OVERPRESSURE
- IMPORTANCE OF DETECTION, DIAGNOSIS, ISOLATION, AND MITIGATION IN REDUCING RISK
- CAPABILITY OF VALVES TO INITIATE AND TERMINATE AN ISLOCA
- INFLUENCE OF PROCEDURES, INSTRUMENTATION, AND TRAINING ON THE CAPABILITIES OF PLANT PERSONNEL TO REDUCE ISLOCA RISK

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QUICKCHECK™

Data Collection

A. Portable, Data Acquisition Box, consisting of the following components:

- TEAC RD101T Digital Audio Tape Recorder
- Sophisticated digital signal processing circuitry
- Rugged field carrying case

B. QUICKCHECK™ Dual Sensors

- Combined accelerometer and Hall Effect sensor
- Permanent-mounting option
- Hermetically-sealed in stainless steel housing
- Can be utilized in high radiation / high temperature environments
- Standard (-40°F / -40°C to 300°F / 149°C) and high temperature (to 550°F / 288°C) designs

C. Internal Magnets

- High strength, high temperature Samarium Cobalt magnet
- Magnet housing either welded or ~~bonded~~ brazed to the check valve hinge arm or disk

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LIBERTY TECHNOLOGY CENTER

QUICKCHECK™

Advanced Digital Signal Processing

A. Pre-conditioning circuitry for: power supply, zeroing, gain, and filtering

B. Post-conditioning circuitry which allows:

- Striking diagnostics due to the detailed display of data sampled at 20 KHz
- Detection of metal-to-metal contact (such as hinge pin / arm wear) through a 4 KHz filter 1.8
- Qualification of flow and low frequency flutter through a 200 Hz filter

C. Four primary data acquisition channels:

- 2 dedicated acoustic channels displayed in raw, high pass filtered, and low pass filtered formats
- 2 universal channels available for magnetic, acoustic, or alternative transducers (pressure, temperature, or flow)

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QUICKCHECK™

Analysis Hardware and Software

A. Hardware

- COMPAQ 386 desktop computer with such features as: 1 MB RAM, 100 MB hard disk, VGA color graphics, 44 MB Bernoulli drive, 80387 math coprocessor, A/D Card, ...
- HP Paintjet color inkjet printer

B. Advanced menu-driven software

- Zoom, vertical expansion, and scrolling
- Pull-down menus with pop-up windows
- Displays any 2 channels of data at one time
- FFT and RMS calculation capability
- Event labeling
- Display of 20 seconds of data (sampled at 20KHz)
- Data transfer to Lotus 1-2-3 or DBASE
- Automated report generation

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TECHNOLOGY CENTER

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BENEFITS

I. Fast, accurate, and reliable

II. Minimizes disassemblies and inspections

III. Works on all common check valve sizes, types, and materials

IV. Reduces radiation exposure levels for check valve diagnostics

V. Satisfies SOER 86-03 and GL 89-04 concerns