March 18, 1986

Docket No.: 50-412

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J. Partlow
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P. Tam
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E. Jordan
B. Grimes
ACRS (10)
NRC Participants

APPLICANT: DUQUESNE LIGHT COMPANY

FACILITY: BEAVER VALLEY UNIT 2

SUBJECT: SUMMARY OF MEETING ON MARCH 4, 1986: FIRST PROGRESS REPORT MEETING ON WHIPJET

The subject meeting was held to discuss with Duquesne Light Company (DLC) its progress in the WHIPJET program. The program was described in some detail in DLC's submittal dated October 10, 1985. Prior to this progress report meeting, other meetings have been held with the applicant to address use of the leak-before-break assumption to balance-of-plant piping. On March 3, 1986, the staff issued a letter to the applicant, formally stating that the approach has merit, and describing the associated legal concerns.

Enclosure 1 is the meeting attendee list. Enclosure 2 is the agenda of the meeting.

Duquesne Light Company's presentation on the present status of WHIPJET is summarized in the viewgraphs (Enclosure 3). During the presentation and after a caucus, members of the NRC staff raised a number of questions; these are summarized in Enclosure 4. Duquesne Light personnel were requested to respond to these questions in the next meeting.

The next progress report meeting has been scheduled for March 13, 1986.

Peter S. Tam, Project Manager
PWR Project Directorate #2
Division of PWR Licensing-A
Office of Nuclear Reactor Regulation

cc: See next page

PM:PAD#2
PTam:hc PST
3/18/86

Mr. J. J. Carey
Duquesne Light Company

Beaver Valley 2 Power Station

cc:
Gerald Charnoff, Esq.
Jay E. Silberg, Esq.
Shaw, Pittman, Potts & Trowbridge
1800 M Street, N.W.
Washington, DC 20036

Mr. C. W. Ewing, Quality Assurance Manager
Quality Assurance Department
Duquesne Light Company
P.O. Box 186
Shippingport, Pennsylvania 15077

Mr. E. J. Woolever, Vice President
Special Nuclear Projects
Duquesne Light Company
P.O. Box 4
Shippingport, Pennsylvania 15077

Mr. T. J. Lex
Westinghouse Electric Corporation
Power Systems
P.O. Box 355
Pittsburgh, Pennsylvania 15230

Mr. P. RaySircar
Stone & Webster Engineering Corporation
P.O. Box 2325
Boston, Massachusetts 02107

Mr. Glenn Walton
U.S. NRC
P.O. Box 181
Shippingport, Pennsylvania 15077

Mr. Thomas E. Murley, Regional Admin.
U.S. NRC, Region I
631 Park Avenue
King of Prussia, Pennsylvania 15229

Mr. John P. Thomas, Manager Engineering
Beaver Valley Two Project
Duquesne Light Company
P.O. Box 328
Shippingport, Pennsylvania 15077

Mr. Roger Martin, Manager
Regulatory Affairs
Beaver Valley Two Project
Duquesne Light Company, P.O. Box 328
Shippingport, PA 15077

Director, Pennsylvania Emergency Management Agency
Room B-151
Transportation & Safety Building
Harrisburg, Pennsylvania 17120

Mr. Thomas Gerusky
Bureau of Radiation Protection
PA Department of Environmental Resources
P.O. Box 2063
Harrisburg, Pennsylvania 17120

BVPS-2 Records Management Supervisor
Duquesne Light Company
Post Office Box 4
Shippingport, Pennsylvania 15077

John A. Lee, Esq.
Duquesne Light Company
1 Oxford Centre
301 Grant Street
Pittsburgh, Pennsylvania 15279

Enclosure 1

Beaver Valley Unit 2 Meeting, 3/4/86

Attendee List

Name	Organization
Peter S. Tam	NRC Licensing Project Manager
Ron Gamble	NOVETECH
Walt Mikesell	Robert L Cloud Assoc
Douglas M. Norris	EPRI
ROBERT E. ROEMER	STONE & WEBSTER
WILLIAM L. SERVER	ROBERT L. CLOUD ASSOC.
ROGER E. MARTIN	DUQUESNE LIGHT
JOHN P. THOMAS	DUQUESNE LIGHT CO.
James Szyslowski	DUQUESNE LIGHT CO.
SANJIB K MUKHERJEE	DUQUESNE LIGHT CO.
Ted Sullivan	NRR/PWR-A/EB
AKRAM ZAHOOR	NOVETECH CORPORATION
KEITH WICHMAN	NRR/PWR-B/EB
Pei-Ying Chen	NRR/PWR-B/ISAPD
BARRY ELLIOT	NRR/PWR-A/EB
Sim S Lee	NRR/PWR-A/EB
GOUTAM BAGCHI	EB/PWR-A/NRR
BOB BOSNAK	NRR/DSRO/EIB
Frank Cherny	NRR/DSRO/EIB
H.L. BRAMMER	NRC/PWR-A/EB
Bill LoFave	NRR/PWR-A/PSB
J SHAPAKER	NRR/[illegible]
E. Rossi (Part time attend.)	NRR/PWR-A
C. Y. Cheng	NRR/PWR-B/EB
N A GOLDSTEIN	STONE & WEBSTER

Enclosure 2

BEAVER VALLEY UNIT 2

MEETING ON

WHIPJET PROGRESS

March 4, 1986

Part A

Opening Statements (P. Tam et al.)

Part B

Duquesne Light Company Presentation:

I. OVERVIEW (Roger Martin)

A. OBJECTIVE - ALTERNATE TO PIPE RUPTURE POSTULATION

1. REDUCE NUMBER OF PIPE BREAK POSTULATIONS
2. REDUCE HARDWARE
3. NO CHANGE IN NON-MECHANISTIC CONSIDERATION
4. IMPROVE CONSTRUCTION AND MAINTENANCE FACTORS

B. REGULATORY BACKGROUND/HISTORY

C. AFFECTED SYSTEMS

1. SYSTEM DESCRIPTION
2. PIPE SIZE RANGE AND MATERIALS

D. WHIPJET SCHEDULE

1. CONSTRUCTION/OPERATION SCHEDULE LINKAGE
2. FINAL SUBMITTAL TO NRC - DEC 86
3. REQUIRE SER RESPONSE - FEB 87
4. RESOLUTION OF 10CFR50.12[a]
5. IMPORTANCE OF NRC AGREEMENT AT THIS TIME

II. PROGRAM DESCRIPTION (Walt Mikesell)

A. FLOW CHART

1. SCREENING/FATIGUE ANALYSIS
2. FRACTURE ANALYSIS/TESTING

B. NRC REVIEW OF RESULTS

1. MEETINGS SCHEDULED AT FREQUENT INTERVALS

III. SCREENING PROCESS (N. A. Goldstein)

A. THERMAL TRANSIENTS

1. PROCESS
2. PROGRESS TO DATE

B. INITIAL SCREENING

1. METHODOLOGY
2. PROGRESS TO DATE
   a. PASSED SYSTEMS (CUF -0.1)
   b. FAILED SYSTEMS (CUF +0.1)

C. WATER HAMMER

1. METHODOLOGY
   a. NUREG 0582
   b. ARBITRARY INTERMEDIATE BREAK STUDY
   c. SYSTEM REVIEW
2. PROGRESS TO DATE

D. CORROSION

1. METHODOLOGY
   a. A.I.B. STUDY
   b. SITE SPECIFIC DATA
2. PROGRESS TO DATE
   a. PRIMARY SYSTEMS
   b. SECONDARY SYSTEMS

E. EQUIPMENT SUPPORTS

1. METHODOLOGY
   a. ASME III RECONCILIATION
   b. HAZARDS REVIEW
   c. CLASS 4 PIPE REVIEW
2. PROGRESS TO DATE

IV. FATIGUE ANALYSIS (W. Server)

A. METHODOLOGY

1. DEFINE GEOMETRY AT BREAK LOCATION
2. ASME III EQUATION II EVALUATION

B. PROGRESS TO DATE

V. FRACTURE ANALYSIS

A. METHODOLOGY

1. PIPE MATERIAL SELECTION (STAINLESS, CARBON STEEL)
2. ANALYSIS TECHNIQUES

B. PROGRESS TO DATE

1. TECHNICAL REPORT (LEAKAGE AND CRACK STABILITY)

VI. FRACTURE TESTING

A. METHODOLOGY

1. PIPE SELECTION (MATERIAL, SIZE)
2. TESTING TECHNIQUES

B. PROGRESS TO DATE

1. TEST PLAN
2. MATERIAL ALLOCATION

VII. LEAK DETECTION

Part C

NRC caucus

Part D

Summary

Enclosure 3

Most of these viewgraphs were also used in DLC's presentation to the ACRS, hence this designation.

PRESENTATION FOR FEBRUARY 27, 1986 MEETING WITH ACRS SUBCOMMITTEES ON STRUCTURAL ENGINEERING, SEISMIC DESIGN OF PIPING, AND METAL COMPONENTS

- INTRODUCTION (MARTIN)
- REVIEW OF WHIPJET (MIKESELL)
- SWEC PROGRESS (GOLDSTEIN)
- RLCA PROGRESS (SERVER)
- EPRI PROGRESS (NORRIS)
- SUMMARY (MIKESELL)

RLCA

EVENTS TO DATE

o MEETING WITH NRR: WHIPJET SCOPE	8/27/85
o SUBMITTAL TO NRR: WHIPJET PROGRAM DESCRIPTION	9/6/85
o MEETING WITH ACRS SUBCOMMITTEE: PROGRAM DESCRIPTION	9/24/85
o SUBMITTAL TO NRR: ACCEPTANCE CRITERIA DOCUMENT	10/10/85

EVENTS TO DATE (CONT)

- PRESENTATION TO ACRS SUBCOMMITTEE ON BVPS-2: PROGRAM DESCRIPTION 11/1/85

- PRESENTATION TO FULL ACRS COMMITTEE ON BVPS-2: PROGRAM DESCRIPTION 11/8/85

- CONVERSATIONS WITH NRR: TECHNICAL CONSIDERATIONS 12/85 – 1/86

- MEETING WITH NRR: PLAN FORMAL REVIEW 1/22/86

RLCA

UTILITY CONSIDERATIONS

- CONSTRUCTION AND LICENSING TIME CONSTRAINTS
- NRR REVIEW OF CRITERIA DOCUMENT
- BROAD SCOPE RULE RESOLUTION
- FREQUENT NRR MEETINGS DURING 1986
- WHIPJET FINAL REPORT: DEC 86
- REQUIRE SAFETY EVALUATION REPORT: FEB 87

REVIEW OF WHIPJET

- WHAT WHIPJET WILL DO
- WHIPJET PROCEDURE
- WHAT WHIPJET IS NOT INTENDED TO DO

RLCA

WHAT WHIPJET WILL DO

1. SATISFY DEGB POSTULATION WITH ENGINEERING ANALYSIS SHOWING A DETECTABLE LEAK BEFORE BREAK IS ASSURED.

2. REDUCE HARDWARE IN THE PLANT
   - MINIMIZE PLANT COST
   - FACILITATE ACCESS FOR INSERVICE INSPECTION
   - REDUCE TIME IN PERFORMING INSPECTIONS AND MAINTENANCE THUS ENHANCING ALARA POSITION

3. INCREASE PLANT SAFETY THROUGH MORE COMPLETE KNOWLEDGE OF PROPERTIES AND CAPABILITIES.

WHIPJET PROCEDURES

1. DEMONSTRATE APPLICABILITY
   - STRESS CORROSION
   - WATER HAMMER
   - FATIGUE CUMULATIVE USAGE FACTOR
   - EQUIPMENT SUPPORTS

2. IMPLEMENT LBB PROGRAM

   A. MATERIALS TESTING
   - ACTUAL PLANT MATERIALS
     - o BASE MATERIALS (TYPES 304, 316, AND A106 GR B)
     - o WELDMENTS MADE FROM PLANT MATERIALS
   - TENSILE TESTS
   - FULL SECTION FRACTURE TOUGHNESS TESTS

WHIPJET PROCEDURES (CONT)

B. CUMULATIVE USAGE FACTOR AND CRACK PROPAGATION ANALYSIS

C. LEAK-BEFORE-BREAK ANALYSIS

3. LEAK DETECTION PROGRAM

A. LEAK RATE CALCULATION

B. LEAK DETECTION METHODS

WHAT WHIPJET IS <u>NOT</u>

INTENDED TO DO

(BASED ON Q & A AT 1/22/86 MTG)

1. AFFIRM OR AUGMENT OTHER'S QA.

2. CHANGE THE USE OF DEGB FOR ESTABLISHING DESIGN CRITERIA FOR ECCS AND CONTAINMENT.

3. CHANGE REQUIREMENTS FOR EQUIPMENT QUALIFICATION

4. ADDRESS THE FAILURE MODE ENCOUNTERED AT MOHAVE AND MONROE.

WHIPJET-An Alternative to Pipe Rupture Postulation

The following table is a summary of the scope of the WHIPJET program. It will list the piping systems(all high energy) involved, their building location, the total number of breaks to be considered, and the expected number of protective devices(either restraints or jet shields) required should WHIPJET not be implemented.

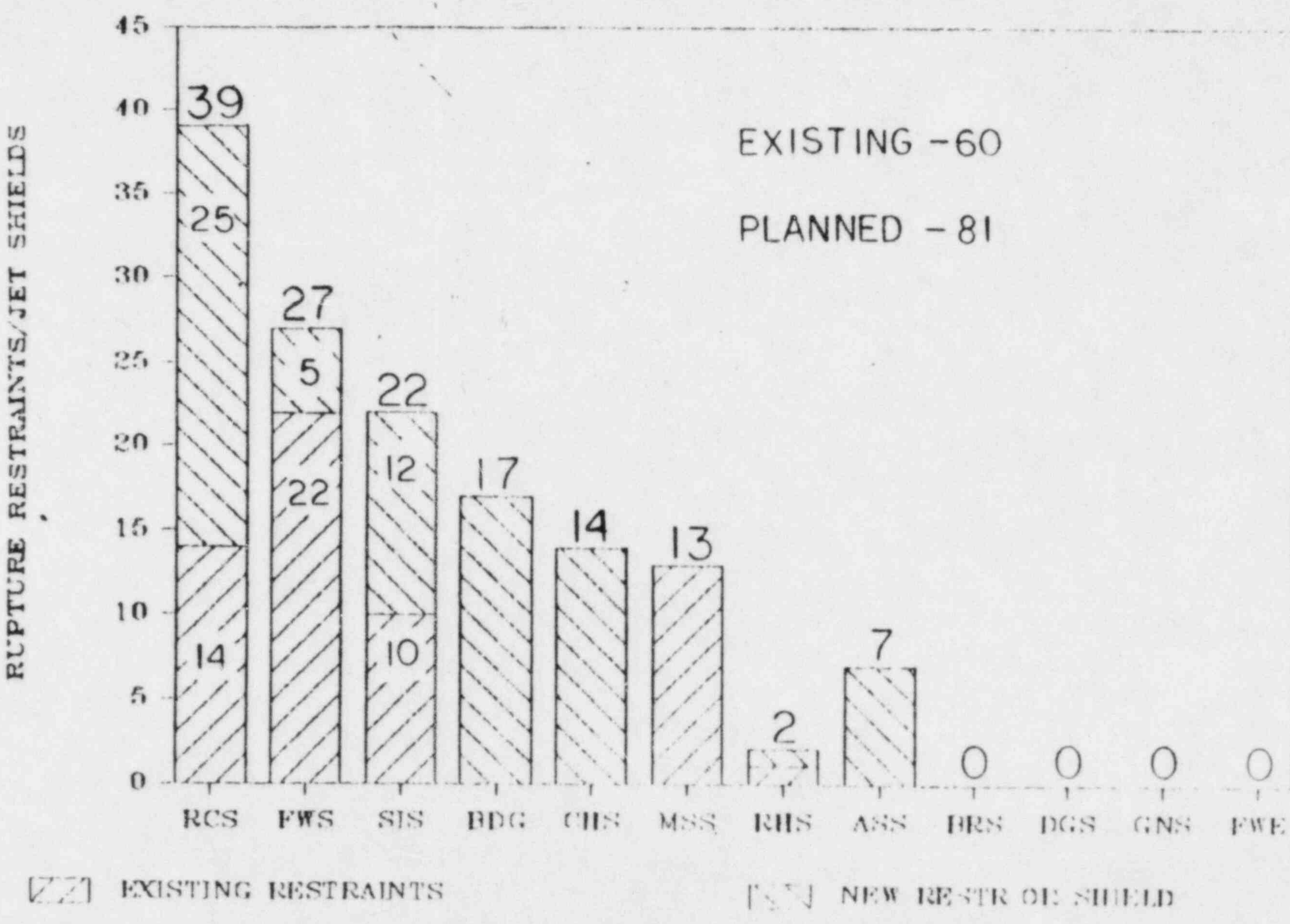
SYSTEM	BREAKS IC	BREAKS OC	PROTECTIVE DEVICES EXISTING	PROTECTIVE DEVICES PLANNED
AUXILIARY STEAM(ASS)	0	54	0	7
STM GEN. BLOWDOWN(BDG)	12	46	0	17
BORON RECOVERY(BRS)	0	51	0	0
CHEM/VOL CONTROL(CHS)	92	48	0	14
HYDROGENATED DRAIN(DGS)	42	0	0	0
AUX. FEEDWATER(FWE)	6	0	0	0
GASEOUS NITROGEN(GNS)	0	9	0	0
MAIN STEAM(MSS)	6	3	13	0
REACTOR COOLANT(RCS)	272	0	14	25
FEEDWATER(FWS)	6	27	22	5
RESIDUAL HEAT RMVL(RHS)	7	0	1	1
SAFETY INJECTION(SIS)	104	25	10	12
	547	263	60	81
	810			

The above table does not include the LOOP breaks and restraints nor the A.I.B. breaks and restraints.

IC=inside containment OC=outside containment

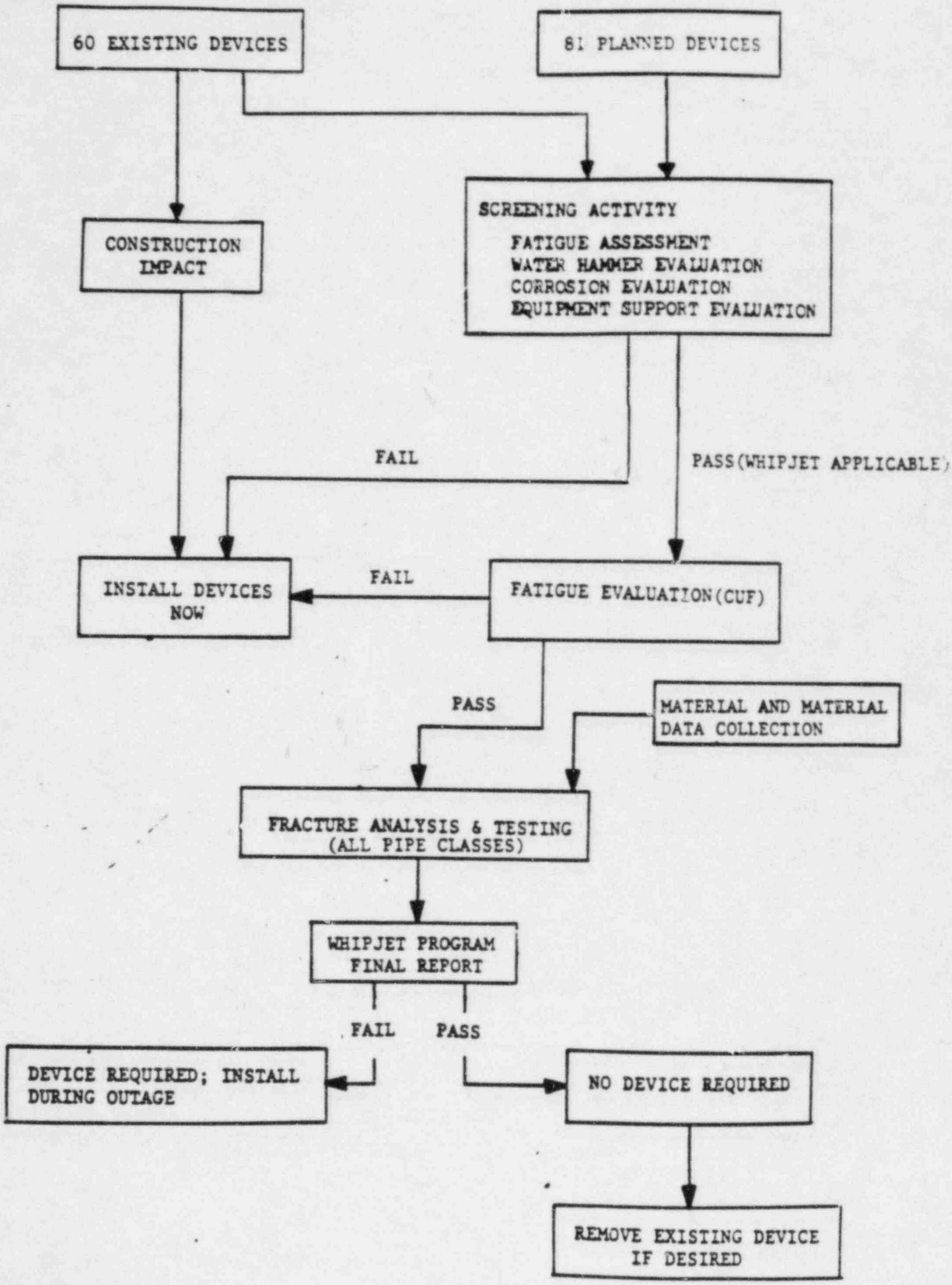
IC/OC | 39/21 | 55/36

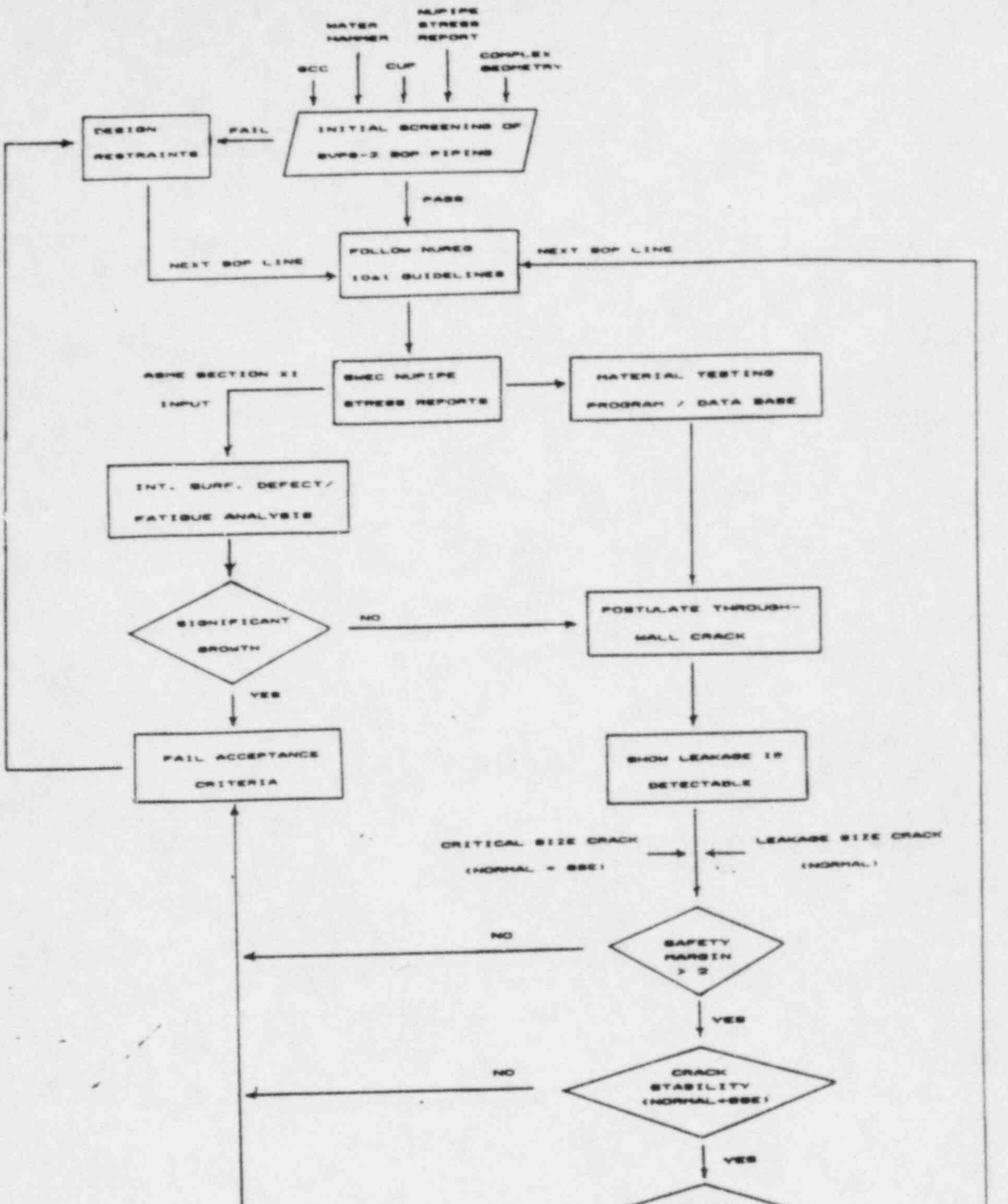
WHIPJET - SCOPE OF HARDWARE REDUCTION



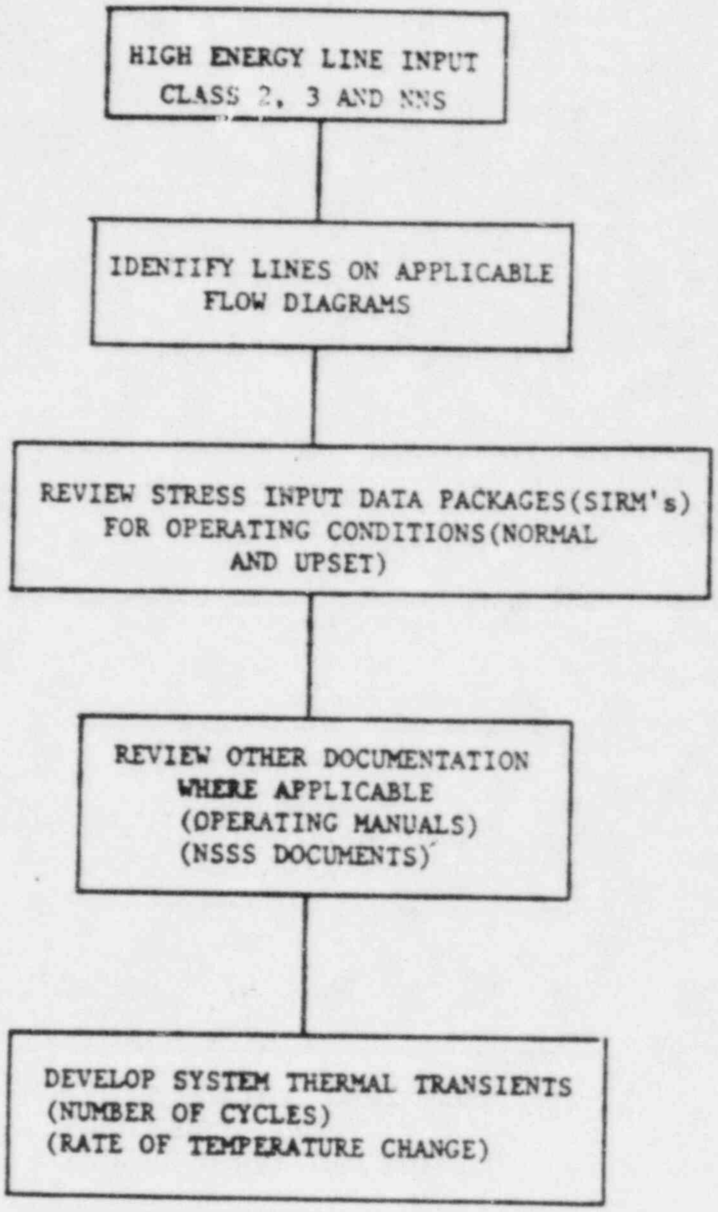
SYSTEM	PIPE SIZE RANGE INCHES	PIPE MATERIAL SS	PIPE MATERIAL CS
AUXILIARY STEAM(ASS)	1.5, 2, 3, 4, 8		A106B
STM GEN. BLOWDOWN(BDG)	1.5, 2, 2.5, 3	TP316	A106B
BORON RECOVERY(BRS	1.5, 3, 4, 8	TP304	
CHEM/VOL CONTROL(CHS)	1.5, 2, 3, 4	TP316/304	
HYDROGENATED DRAIN(DGS)	2	TP316	
AUX. FEEDWATER(FWE)	4		A106B
GASEOUS NITROGEN(GNS)	1.5		A106B
MAIN STEAM(MSS)	32		A106C/A155
REACTOR COOLANT(RCS)	1.5, 2, 3, 4, 6, 8, 14	TP316	
FEEDWATER(FWS)	6, 16		A106B
RESIDUAL HEAT RMVL(RHS)	10, 12	TP316	
SAFETY INJECTION(SIS)	2, 3, 4, 6, 12	TP316/304	

WHIPJET PROGRAM FLOWCHART

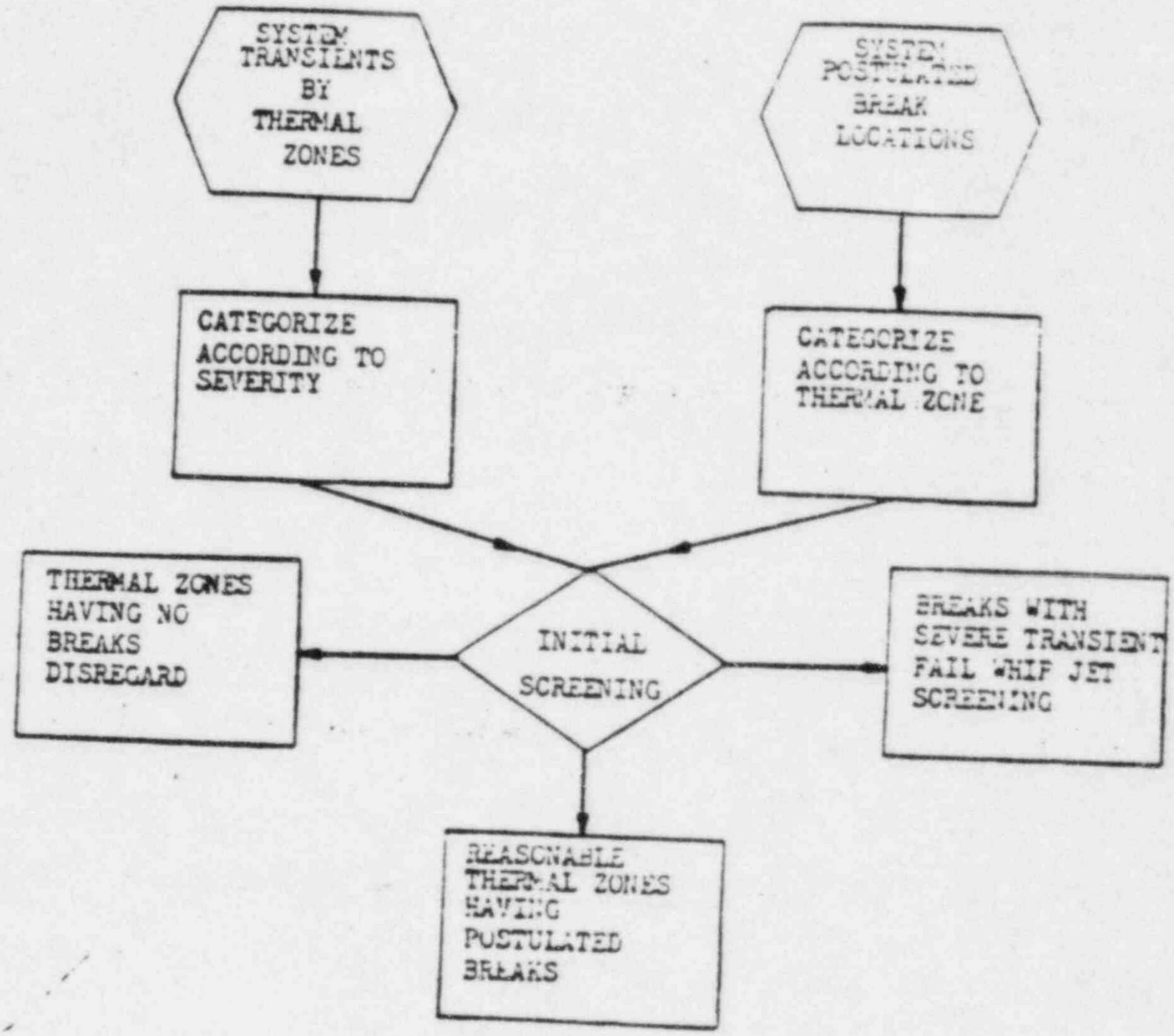



WATER HAMMER
NUPIPE STRESS REPORT
SCC
CUF
COMPLEX GEOMETRY
DESIGN RESTRAINTS
FAIL
INITIAL SCREENING OF BVPS-2 BOP PIPING
PASS
NEXT BOP LINE
FOLLOW NUREG 1061 GUIDELINES
NEXT BOP LINE
ASME SECTION XI INPUT
SWEC NUPIPE STRESS REPORTS
MATERIAL TESTING PROGRAM / DATA BASE
INT. SURF. DEFECT/ FATIGUE ANALYSIS
SIGNIFICANT GROWTH
NO
POSTULATE THROUGH-WALL CRACK
YES
FAIL ACCEPTANCE CRITERIA
SHOW LEAKAGE IS DETECTABLE
CRITICAL SIZE CRACK (NORMAL + SSE)
LEAKAGE SIZE CRACK (NORMAL)
NO
SAFETY MARGIN > 2
YES
NO
CRACK STABILITY (NORMAL+SSE)
YES
NO
CRACK STABILITY 1.41(NORMAL+SSE)
YES
PASS ACCEPTANCE CRITERIA
NO RESTRAINTS

THERMAL TRANSIENTS



WHIPJET FATIGUE ASSESSMENT ASME CLASS 2, 3, AND NNS



FATIGUE SCREENING RESULTS TO DATE

- SYSTEM	-	BREAKS EVALUATED PASS	FAIL	HARDWARE REQ'MTS EXISTING	PLANNED	-
- AUXILIARY STEAM(ASS)	-	29	25	0/0	3/7	-
- STM GEN BLOWDOWN(BDG)	-	9	49	0/0	17/17	
- BORON RECOVERY(BRS)	-	*	*	0/0	0/0	-
- CHEM/VOL CONTROL(CHS)	-	103	37	0/0	9/12	-
- HYDROGENATED DRAIN(DGS)	-	42	0	0/0	0/0	-
- AUX. FEEDWATER(FWE)	-	*	*	0/0	0/0	-
- GASEOUS NITROGEN(GNS)	-	*	*	0/0	0/0	-
- MAIN STEAM(MSS)	-	9	0	0/13	0/0	-
- REACTOR COOLANT(RCS)	-	272	0	0/14	0/25	-
- FEEDWATER(FWS)	-	0	33	22/22	5/5	-
- RESIDUAL HEAT RMVL(RHS)	-	7	0	0/1	0/1	-
- SAFETY INJECTION(SIS)	-	129	0	0/10	0/12	-
		600	144	22/60	34/81	

TOTAL CLASS 2, 3, AND NNS BREAK LOCATIONS TO BE EVALUATED - 325
TOTAL CLASS 1 BREAKS LOCATIONS(ALL PASS 1.0 CUF CRITERIA) - 485

HARDWARE REQUIREMENTS = ACTUAL REQUIRED/ESTIMATED REQUIRED.

CUF = CUMULATIVE USAGE FACTOR AS DEFINED IN ASME 3

56 PROTECTIVE DEVICES REQUIRED BY WHIPJET

85 PROTECTIVE DEVICES ELIMINATED BY WHIPJET

OF THE 85 DEVICES ELIMINATED, 61 ARE ASSOCIATED WITH CLASS 1 BREAKS

		IC/OC
EXISTING		
FWS	22	4/18
PLANNED		
ASS	3	0/3
BDG	17	5/12
CHS	9	9/0
FWS	5	0/5
		14/20
TOTAL		18/38

FATIGUE CRACK GROWTH

(EXTRA SCREENING)

- POSTULATE PTC GREATER THAN SECTION XI ACCEPTANCE STANDARDS
- EVALUATE FOR SIGNIFICANT GROWTH
- CLASS 2/3 -- EVALUATE TYPICAL LINE(S) WITH CUF > 0.1
- CLASS 1 -- EVALUATE CASE-BY-CASE

MATERIALS TESTING PROGRAM

- o STAINLESS STEEL DATA BASE IS ADEQUATE
  - TYPE 304
  - TYPE 316
  - SMAW
- o FERRITIC STEEL TESTS PLANNED
  - ONE HEAT OF A106C (4" PIPE) OR A106B (3" PIPE)
  - TWO HEATS OF A106B (6" & 8" PIPE)
  - THREE HEATS OF SMAW (3" OR 4", 6", AND 8" PIPE).

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FERRITIC STEEL TEST MATRIX

(3 HEATS BASE & 3 HEATS WELD)

- J-R CURVE 2 @ 550 F

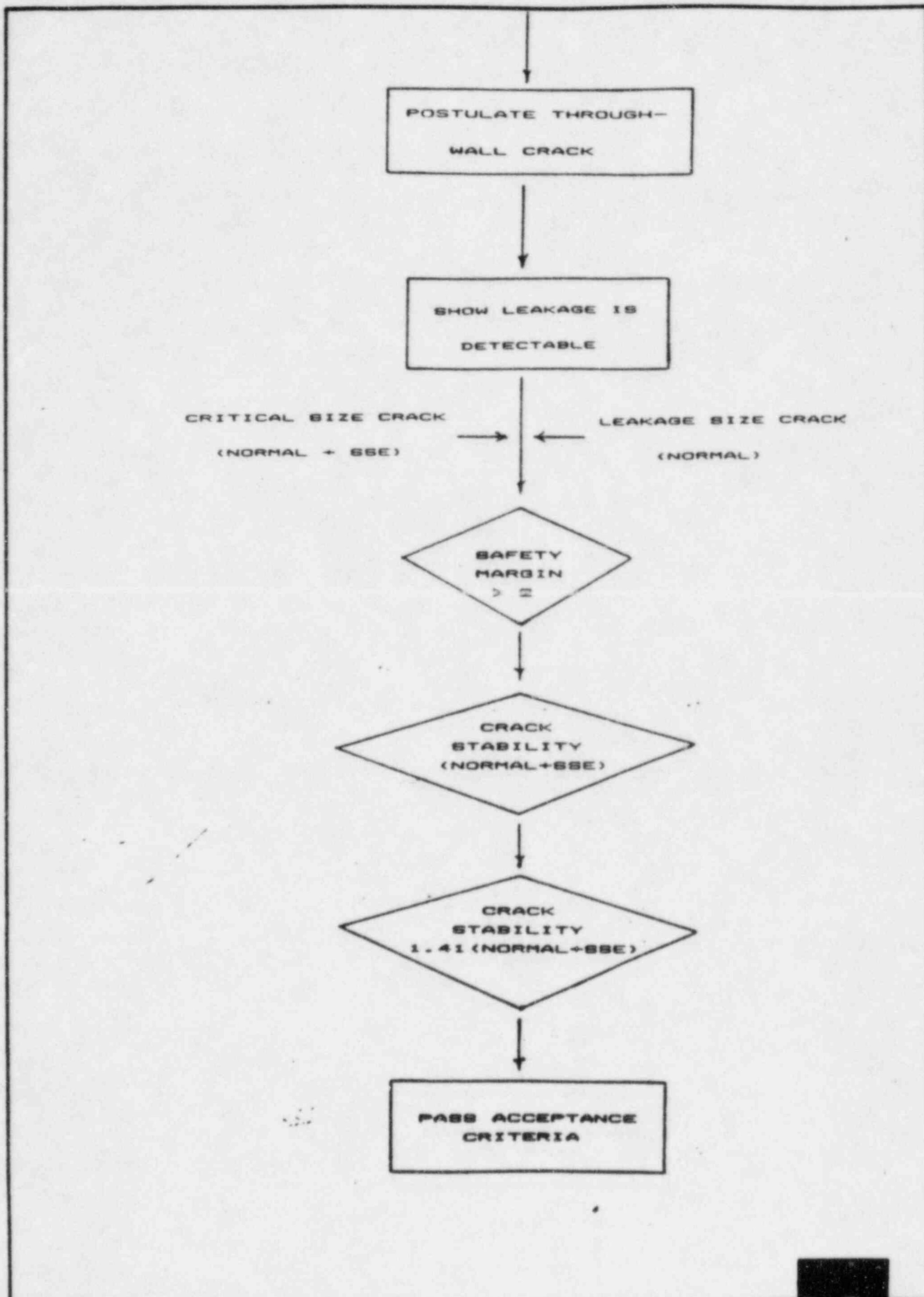
  PIPE BEND 1 @ 200-300 F

  18 TESTS TOTAL

- TENSILE 3 @ 550 F

  STRESS-STRAIN 1 @ 200-300 F

  24 TESTS TOTAL


POSTULATE THROUGH-WALL CRACK
SHOW LEAKAGE IS DETECTABLE
CRITICAL SIZE CRACK (NORMAL + SSE)
LEAKAGE SIZE CRACK (NORMAL)
SAFETY MARGIN > 2
CRACK STABILITY (NORMAL+SSE)
CRACK STABILITY 1.41(NORMAL+SSE)
PASS ACCEPTANCE CRITERIA

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LEAKAGE SIZE CRACKS

(NORMAL OPERATING LOADS)

- o USE EPRI PICEP COMPUTER CODE
- o PRESSURIZER SPRAY LINE (TYPE 316SS, 6" DIA)
  - CIRCUM TWC: 4.9" = 5 GPM
- o LEAK DETECTION CAPABILITY IS AT LEAST 1 GPM

LEAK DETECTION SAFETY MARGIN

(INSTABILITY FOR NORMAL

+ SSE LOADS)

- REQUIRE RATIO OF
  INSTABILITY CRACK SIZE TO
  LEAKAGE CRACK SIZE > 2

- PRESSURIZER SPRAY LINE
  - CIRCUM TWC @ 5 GPM: 2.04

STABILITY CHECKS

- LEAKAGE SIZE CRACKS STABLE AT NORMAL + SSE LOADS
  - MARGIN ON J_{Ic} (FOR NO CRACK GROWTH) IS > 2
- LEAKAGE SIZE CRACKS STABLE AT EXCESSIVELY HIGH LOADS
  - -- 1.41 X (NORMAL + SSE)
  - MARGIN ON INSTABILITY > 1.9

Enclosure 4

QUESTIONS TO BE ADDRESSED BY DLC ON WHIPJET

1. Tests on pipes to determine J-R curves may turn out to have significantly higher results than from compact specimens, depending upon the computational techniques. Differences arise from the crack associated displacements. DLC should discuss the techniques they intend to use.

2. The staff would like to have a presentation on a step by step example of fatigue crack growth analysis methods and results.

3. The staff would like to have a presentation on the methodology followed by DLC to determine the susceptibility of each high energy piping system to waterhammer. This presentation should reflect the findings in NUREG-0927, Rev. 1, since NUREG-0582, which was referenced by DLC, is outdated.

4. The staff would like to hear a presentation describing the procedures DLC will use to detect leakage from a cracked pipe. These procedures should be illustrated by discussion of a typical scenario. The discussion should also include licensee action upon detection of leakage.

5. The staff would like to review a verification package for the PICEP code as pertains to leakage calculations. This information should show both analytical and experimental verification to the extent possible.

6. The staff would like to have a presentation on the methodology followed by DLC to determine the susceptibility of each high energy line to stress corrosion cracking. This presentation should address both ferritic and stainless steel piping.

7. The staff would like to have DLC present the justification for the flaw size used for fatigue crack growth studies and for using their material data for the tearing stability analyses for the non-nuclear high energy piping. This question is asked in view of the differences between nuclear and non-nuclear piping with respect to fabrication, examination, and design.

8. DLC should confirm whether there are any cast fittings in the BOP piping.

9. DLC should discuss whether the Section III Fatigue calculations accounted for flow stratifications. Specifically did any of the calculations resulting in CUF <0.1 involve piping with flow stratification.

10. The testing program for J-R curves is for ferritic piping. DLC is planning to rely on stainless steel data base rather than testing. DLC should provide the NRC with austenitic weld data for our review prior to beginning their testing program.

Questions 11 – 16 were discussed with the applicant in a phone conversation -3- after the meeting (These were not questions asked in the meeting):

11. The austenitic weld data base and ferritic weld tests should represent the weld metal with the limiting fracture properties. To justify this conclusion for each weld joint for which a break will no longer be postulated indicate:

    a) Type of weld: full penetration, socket, etc.
    b) Weld process
    c) Electrode type and size
    d) Weld procedure
    e) Post weld heat treatment
    f) Inspection required following fabrication

    Based on these parameters, DLC should justify the conclusion that the austenitic weld data base and ferritic weld tests represent the limiting fracture properties for each weld joint for which a break will no longer be postulated.

12. Will J-R tests be performed under static or dynamic conditions? Why?

13. Which lines have positive displacement pumps? How do you account for vibration fatigue from positive displacement pumps?

14. What is the fracture properties of ferritic heat affected zone (HAZ) material that has not been post weld heat treated (PWHT)? How does your leak-before-break evaluation consider post welded HAZ cracks?

15. How does your leak-before-break evaluation account for residual weld stresses in welds, which have not been PWHT? (Resolved with our consultant)

16. What is the minimum fluid temperature in each line when the line is performing its normal operation and its failure could result in a safety concern? What are the fracture properties for the ferritic materials at the minimum fluid temperature? Will tests confirm this?