Central File

DEC 2 0 1979

Task Action Plan A-8

Docket Nos.: 50-358, 50-352/353, 50-367, 50-373/374, 50-387/388, 50-410, 50-322, 50-297

MEMORANDUM FOR: S. H. Hanauer, Director, Unresolved Safety Issues Program, NRR

FROM: C. J. Anderson, A-8 Task Manager, Containment Systems Branch, DSS

APPLICANT: Members of MARK II Owners Group

SUBJECT: MEETING WITH MARK II OWNERS TO DISCUSS LONG TERM PROGRAM STATUS

Background

The staff recently completed the review of alternate loads proposed by the MARK II owners as a part of the MARK II Lead Plant Program. With the completion of the review of these remaining Lead Plant Tasks, the staff has turned its attention to the review of the MARK II Long Term Program. The function of this meeting was to discuss the status of several of the Long Term Program tasks in advance of the final documentation of these tasks. These discussions were conducted to provide the staff and our consultants an opportunity to identify task problems prior to completion of the task.

The significant items discussed in the meeting included: the Creare multivent tests, the 4T condensation oscillation tests, the dynamics lateral load model, the improved chugging load, foreign tests and load combinations.

An attendance list and a copy of the meeting handouts are enclosed.

Summary

A summary of the discussions of the Long Term Program Tasks is provided below.

1. Generic Program Status Summary

Mr. Davis of General Electric provided an overview of the MARK II generic long term program. The total generic program, including the lead and Long Term Program (LTP), was approximately 85% complete at the end of October 1979. A detailed schedule was presented to show the status of milestones for several of the more important LTP tasks. A table of the LTP task documentation was also discussed. Documentation for the LTP LOCA related steam tests will not be available until the

OFFICE ▶					
SURNAME ▶					
DATE ▶					8001250121

third quarter of 1980. These late dates for task documentation jeopardize the staff's October 1979 schedule for completion of the LTP review.

Mr. Sobon of General Electric discussed the generic positions of the MARK II owners for the LTP. He identified those areas where the owner proposed deviating from the staff's lead plant acceptance criteria.

2. Creare Multivent Test Program - Task A.11

Mr. Patel of Creare discussed the status of the Creare multivent steam tests. The objective of this program is 1) to establish the trend of chugging wall loads with the number of vents to confirm that the lead plant approach utilizing single vent data is conservative and 2) to quantify the multivent effect in the LTP to allow refinement of the lead plant bounding load in the LTP. The first phase of this test program is complete. This includes multivent tests at 1/10 and 1/6 scale. The phase I test report will be submitted to the NRC in June 1980. The staff questioned the ability of the Creare tests to address phasing questions raised as a result of preliminary observations of related foreign tests.

3. Main Vent Lateral Loads - Task A.13

Mr. Davis of General Electric discussed the status of the A.13 vent lateral loads task. The lead plant criteria for lateral loads includes a very conservative static and dynamic load specification. The MARK II owners proposed a less conservative single vent dynamic lateral load for the LTP. The results of several large scale single and double vent tests were studied by the MARK II owners to confirm the MARK II owners' load specification. Preliminary results of the confirmatory study indicate that the proposed LTP dynamic lateral load is conservative.

In addition to the single vent dynamic lateral load studies, the MARK II owners have also conducted studies to extend the single vent dynamic lateral load for application to 28 in. downcomers and to multiple vents. A review of tests in different facilities with varying vent diameters (12 to 24 in.) indicates that the dynamic lateral load can be extrapolated to 28 in. vents. In addition, a statistical procedure similar to that utilized in the lead plant program was used to extend the single vent lateral load to a multivent dynamic lateral load specification.

A report documenting the results of the various dynamic lateral load subtasks is in preparation and will be submitted to the NRC in December 1979.

4. Generic Improved Chugging Load - A.16

The MARK II owners discussed the status of the milestones associated with completion of the generic improved chugging load task. The major task milestones have been completed. A final report documenting this task is currently scheduled to be submitted in February 1980. The staff stated that confirmation of the methodology, considering the results of the large scale multivent Japanese test, was important to resolve staff questions raised during previous meetings with the MARK II owners.

5. 4T CO Tests - A.17

The purpose of these additional 4T tests is to resolve questions raised by the staff in NUREG 0487 dealing with vent length effects in establishing the condensation oscillation load specification.

Modification of the original 4T test facility has been completed. The shakedown tests and 9 scheduled tests have been completed. The total test matrix includes 23 tests at varying conditions of vent submergence, initial drywell air, content pool temperature, break size, break submergence and break type (i.e., steam and liquid). In addition, tests will be conducted to investigate the effect of a vent riser. The testing program is scheduled to be completed in February 1980. The MARK II owners plan to discuss preliminary observations from these tests some time during the first quarter of 1980. Preliminary observations from other related test programs indicate that some vent length related modifications to the original CO load specifications may be appropriate. This modification would probably consist of a load specification at frequencies in the 7 to 20 HZ range. However, insufficient analyses have been performed related to the foreign tests to establish the necessity of a change in the original CO load.

6. GKSS Tests

The GKSS large scale multivent, steam tests were discussed with the MARK II owners. This included a description of the test facility, the test matrix, testing schedule and preliminary observations of the completed shakedown tests. The staff noted the close phasing of the chugging events and the similarity of chugging events occurring at the exit of each vent during gross pool chugging. The staff emphasized the need for a MARK II generic task to include a review of the foreign large scale multivent tests to confirm the lead plant loads and provide a basis for the proposed LTP reduced loads.

7. Load Combinations - SRSS

A draft copy of the Brookhaven studies on response combination methodologies was released by the staff for comment in October 1979. The MARK II owners' comments related to the BNL report were presented by Dr. Kennedy. A copy of the presentation slides is attached. Dr. Hou of NRC stated that additional BNL studies would be required before Criterion 2 of the Newmark-Kennedy criteria could be accepted. However, he was optimistic about the ultimate acceptability of criterion 2. He stated that further efforts to evaluate the modified criterion 2 would probably be included in a future review program.

The MARK II owners stated that February 1980 appeared to be the best time for the next generic MARK II owners/NRC staff meeting. This meeting would probably include most of the topics discussed in this meeting.

Clifford J. Anderson, A-8 Task Manager
Containment Systems Branch
Division of Systems Safety

Enclosure:
As stated

Distribution:
See attached pages

OFFICE					CSB:DSS
SURNAME					CAnderson;jpf
DATE					12/20/79

Meeting Notice Distribution

Distribution:

Docket Files
NRR Reading File
CSB Reading file
H. Denton
E. Case
R. Boyd
R. DeYoung
D. Skovholt
W. Haass
R. W. Houston
P. Collins
D. Vassallo
J. Stolz
R. Baer
S. Varga
W. Gammill
C. Heltemes
T. Speis
D. Eisenhut
D. Crutchfield
P. Check
G. Lainas
A. Schwencer
D. Ziemann
B. Grimes
G. Knighton
T. Ippolito
R. Reid
J. Miller
R. Clark
F. Pagano
R. Mattson
F. Schroeder
J. Knight
R. Bosnak
S. Pawlicki
F. Schauer

D. Ross
T. Novak
K. Kniel
Z. Rosztoczy
R. Tedesco
S. Hanauer
V. Benaroya
W. Butler
R. Satterfield
F. Rosa
D. Muller
R. Vollmer
W. Kreger
V. Moore
R. Ballard
W. Regan
M. Ernst
G. Lear
J. Youngblood
R. Denise
C. Stepp
J. Kudrick
J. Shapaker
NRC PDR
Local PDR
Receptionist
OELD
OSD
I&E (3)
R. Fraley, ACRS (3)
T. Su
C. Tan
C. Grimes
S. Fabic
R. Cudlin
M. Aycock
C. Anderson
A. Thadani

Mr. Earl A. Borgmann
Vice President - Engineering
The Cincinnati Gas and Electric Company
P. O. Box 960
Cincinnati, Ohio 45201

cc: Troy B. Conner, Jr., Esq.
Conner, Moore & Corber
1747 Pennsyania Avenue, N. W.
Washington, D. C. 20006

Mr. William J. Moran
General Counsel
The Cincinnati Gas and Electric
Company
P. O. Box 960
Cincinnait, Ohio 45201

Mr. William G. Porter, Jr.
Porter, Stanley, Arthur
and Platt
37 West Broad Street
Columbus, Ohio 43215

Mr. Peter H. Forster, Vice
President
Energy Resources
The Dayton Power and Light
Company
P. O. Box 1247
Dayton, Ohio 45401

J. Robert Newlin, Counsel
The Dayton Power and Light
Company
P. O. Box 1034
Dayton, Ohio 45401

Mr. James D. Flynn
Manager, Licensing
Environmental Affairs
The Cincinnati Gas and
Electric Company
P. O. Box 960
Cincinnati, Ohio 45201

Mr. J. P. Fenstermaker
Senior Vice President - Operations
Columbus and Southern Ohio
Electric Company
215 North Front Street
Coulubus, Ohio 43215

David B. Fankhauser, PhD
3569 Nine Mile Road
Cincinnati, Ohio 45230

Thomas A. Luebbers, Esq.
Cincinnati City Solicitor
Room 214, City Hall
Cincinnati, Ohio 45202

Mr. Stephen Schumacher
Miami Valley Power Project
P. O. Box 252
Dayton, Ohio 45401

Ms. Augusta Prince, Chairperson
601 Stanley Avenue
Cincinnati, Ohio 45226

Mr. Norman W. Curtis
Vice President - Engineering
and Construction
Pennsylvania Power and Light Company
2 North Ninth Street
Allentown, Pennsylvania 18101

Mr. Earle M. Mead
Project Engineering Manager
Pennsylvania Power & Light Company
2 North Ninth Street
Allentown, Pennsylvania 18101

Jay Silberg, Esq.
Shaw, Pittman, Potts &
Trowbridge
1800 M Street, N. W.
Washington, D. C. 20036

Mr. William E. Barberich,
Nuclear Licensing Group Supervisor
Pennsylvania Power & Light Company
2 North Ninth Street
Allentown, Pennsylvania 18101

Edward M. Nagel, Esquire
General Counsel and Secretary
Pennsylvania Power & Light Company
2 North Ninth Street
Allentown, Pennsylvania 18101

Bryan Snapp, Esq.
Pennsylvania Power & Light Company
901 Hamilton Street
Allentown, Pennsylvania 18101

Robert M. Gallo
Resident Inspector
P. O. Box 52
Shickshinny, Pennsylvania 18655

Susquehanna Environmental Advocates
c/o Gerald Schultz, Esq.
500 South River Street
Wilkes-Barre, PA 18702

John L. Anderson
Oak Ridge National Laboratory
Union Carbide Corporation
Bldg. 3500, P. O. Box X
Oak Ridge, Tennessee 37830

Mr. Robert J. Shovlin
Project Manager
Pennsylvania Power and Light Co.
2 North Ninth Street
Allentown, Pennsylvania 18101

Alan R. Yuspeh, Esq.
Shaw, Pittman, Potts &
Trowbridge
1800 M Street, N. W.
Washington, D. C. 20036

Dr. Judith H. Johnsrud
Co-Director
Environmental Coalition on
Nuclear Power
433 Orlando Avenue
State College, PA 16801

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

Ms. Colleen Marsh
Box 538A, RD#4
Mountain Top, PA 18707

Mrs. Irene Lemanowicz, Chairperso
The Citizens Against Nuclear
Dangers
P. O. Box 377
RD#1
Berwick, PA 18603

Mr. Byron Lee, Jr.
Vice President
Commonwealth Edison Company
P. O. Box 767
Chicago, Illinois 60690

cc: Richard E. Powell, Esq.
Isham, Lincoln & Beale
One First National Plaza
2400
Chicago, Illinois 60670

Niagara Mohawk Power Corporation

ccs:

Arvin E. Upton, Esq.
LeBoeuf, Lamb, Leiby & MacRae
1757 N Street, N. W.
Washington, D. C. 20036

Anthony Z. Roisman, Esq.
Natural Resources Defense Council
917 15th Street, N. W.
Washington, D. C. 20005

Mr. Richard Goldsmith
Syracuse University
College of Law
E. I. White Hall Campus
Syracuse, New York 13210

T. K. DeBoer, Director
Technological Development Programs
New York State Energy Office
Swan Street Building
Core 1 - 2nd Floor
Empire State Plaza
Albany, New York 12223

Niagara Mohawk Power Corporation
ATTN: Mr. Gerald K. Rhode, Vice President
System Project Management
300 Erie Boulevard West
Syracuse, New York 13202

Northern Indiana Public Service Company

ccs:

Meredith Hemphill, Jr. Esq.
Assistant General Counsel
Bethlehem Steel Corporation
701 East Third Street
Bethlehem, Pennsylvania 18016

Northern Indiana Public Service Company
ATTN: Mr. H. P. Lyle, Vice President
Electric Production & Engineering
5265 Hohm n Avenue
Hammond, Indiana 46325

William H. Eichhorn, Esq.
Eichhorn, Morrow & Eichhorn
5243 Hohman Avenue
Hammond, Indiana 46320

Edward W. Osann, Jr., Esq.
Wolfe, Hubbard, Leydid, Voit & Osann, Ltd.
Suite 4600
One IBM Plaza
Chicago, Illinois 60611

Robert J. Vollen, Esq.
109 North Dearborn Street
Chicago, Illinois 60602

Porter County, Izaak Walton
League of America, Inc.
Box 438
Chesterton, Illinois 46304

Michael I. Swygert, Esq.
25 East Jackson Boulevard
Chicago, Illinois 60604

Richard L. Robbins, Esq.
Lake Michigan Federation
53 West Jackson Boulevard
Chicago, Illinois 60604

Maurice Axelrad, Esq.
Lowenstein, Newman, Reis & Axelrad
1025 Connecticut Avenue, N. W.
Washington, D. C. 20036

James N. Cahan, Esq.
Russell Eggert, Esq.
Office of the Attorney General
188 Randolph Street
Chicago, Illinois 60602

Long Island Lighting Company

ccs:
Howard L. Blau, Esq.
Blau and Cohn, P.C.
217 Newbridge Road
Hicksville, New York 11801

Jeffrey Cohen, Esq.
Deputy Commissioner and Counsel
New York State Energy Office
Agency Building 2
Empire State Plaza
Albany, New York 12223

Energy Research Group, Inc.
400-1 Totten Pond Road
Waltham, Massachusetts 02154

Irving Like, Esq.
Reilly, Like and Schnieder
200 West Main Street
Babylong, New York 11702

J. P. Novarro
Project Manager
Shoreham Nuclear Power Station
P. O. Box 618
Wading River, New York 11792

W. Taylor Reveley, III, Esq.
Hunton & Williams
P. O. Box 1535
Richmond, Virginia 23212

Ralph Shapiro, Esq.
Cammer & Shapiro
No. 9 East 40th Street
New York, New York 10016

Edward J. Walsh, Esq.
General Attorney
Long Island Lighting Company
250 Old Country Road
Mineola, New York 11501

Mr. Edward G. Bauer, Jr.
Vice President & General Counsel
Philadelphia Electric Company
2301 Market Street
Philadelphia, Pennsylvania 19101

cc: Troy B. Conner, Jr., Esq.
Conner, Moore & Corber
1747 Pennsylvania Avenue, N. W.
Washington, D. C. 20006

W. William Anderson, Esq.
Deputy Attorney General
Room 512, Main Capitol Building
Harrisburg, Pennsylvania 17120

Frank R. Clokey, Esq.
Special Assistant Attorney General
Room 218, Towne House Apartments
P. O. Box 2063
Harrisburg, Pennsylvania 17105

Honorable Lawrence Coughlin
House of Representatives
Congress of the United States
Washington, D. C. 20515

Roger B. Reynolds, Jr., Esq.
324 Swede Street
Norristown, Pennsylvania 19401

Willard C. Hetzel, Esq.
312 Main Street
East Greenville, Pennsylvania 18041

Lawrence Sager, Esq.
Sager & Sager Associates
45 High Street
Pottstown, Pennsylvania 19464

Joseph A. Smyth
Assistant County Solicitor
County of Montgomery
Courthouse
Norristown, Pennsylvania 19404

Mr. Edward G. Bauer, Jr.

cc: Eugene J. Bradley
Philadelphia Electric Company
Associate General Counsel
2301 Market Street
Philadelphia, Pennsylvania 19101

Washington Public Power Supply System

cc:

Joseph B. Knotts, Jr., Esq.
Debevoise & Liberman
1200 Seventeenth Street, N. W.
Washington, D. C. 20036

Richard Q. Quigley, Esq.
Washington Public Power Supply System
3000 George Washington Way
P. O. Box 968
Richland, Washington 99352

Nicholas Lewis, Chairman
Energy Facility Site Evaluation Council
820 East Fifth Avenue
Olympia, Washington 98504

Mr. O. K. Earle
Licensing Engineer
P. O. Box 968
Richland, Washington 99352

Mr. Neil O. Strand
Washington Public Power Supply System
3000 George Washington Way
P. O. Box 968
Richland, Washington 99352

MARK II Meeting

MARK II Owners Group/NRC

November 14, 1979

Name	Organization
C. J. Anderson	NRC/DSS/CSB
W. M. Davis	GE
P. D. Hedgecock	WPPSS
J. A. Weyandt	Bechtel Power Corp.
D. F. Roth	Penna. Power & Light
D. L. Baker	Burns and Roe, Inc.
E. L. McFarland	Bechtel Power Corp.
D. M. O'Connor	Bechtel Power Corp.
H. W. Vollmer	Philadelphia Electric Co.
R. F. McClelland	GE
C. A. Malovrn	Stone & Webster
R. L. O'Mara	Stone & Webster
J. C. Black	GE
R. D. Hoagland	GE
C. Calderon	CNSNS
B. R. Patel	Creare, Inc.
C. Arredondo	CNSNS/Mexico
L. C. Ruth	NRC/DSS/CSB
J. A. Kudrick	NRC/DSS/CSB
W. R. Butler	NRC/DSS/CSB
R. Trevino	CNSNS/Mexico
L. V. Sobon	GE
M. R. Granback	NIPSCO
J. E. Metcalf	S&W
J. C. Herman	Cincinnati Gas & Elec. Co.
K. J. Green	Sargent and Lundh
R. J. Muzzy	GE
A. J. Bilanin	Continuum Dynamics
Ain A. Sonin	MIT (for BNL)
John R. Lehner	BNL
John E. Torbeck	GE
Harry R. Johnson	Ebasco
T. Zozueta	CFE
G. T. Kitz	S&L
F. C. Rally	GE
G. Avellone	Burns & Roe
T. Y. Chow	S&W
R. K. Mattu	NRC/DSS/MEB
T. Trocki	GE
J. Ogden	NMPC
C. V. Subramanian	GE
J. S. Abel	Commonwealth Edison
L. Memula	Bechtel Power Corp.
Dr. Kennedy	EDAC
R. Bosnak	NRC/DSS/MEB
Shou-nien Hou	NRC/DSS/MEB
H. Chau	Long Island Lighting Co.
L. C. S. Nien	Stone & Webster

MARK II OWNERS GROUP/NRC

MEETING AGENDA

DATE: NOVEMBER 14, 1979

TIME: 8:30 A.M. - 4:00 P.M.

PLACE: BETHESDA, MD. MARYLAND NATIONAL BANK BLDG. , ROOM 6110

TIME	TOPIC
8:30 AM	o GENERIC PROGRAM STATUS SUMMARY • FLOW CHARTS AND OVERALL SCHEDULE • NRC CRITERIA POSITIONS
10:00 AM	o A.11 CREARE MULTIVENT - STATUS • OVERVIEW • TEST DATA UPDATE
10:20 AM	o BREAK
10:30 AM	o A.13 MAIN VENT LATERAL LOADS • RESULTS OF DATA CORRELATION • MULTIVENT APPLICATION
12:00 NOON	o LUNCH
1:00 PM	o A.16 IMPROVED CHUG LOAD DEFINITION - STATUS
1:15 PM	o A.17 4T C.O. TEST - STATUS • OVERVIEW • RESULTS TO DATE
1:45 PM	o ATWS - "T" QUENCHER INFORMATION

WMD/DH 11/79

MK II OWNERS GROUP/NRC - MEETING AGENDA

NOVEMBER 14, 1979 - BETHESDA, MD.

TIME	TOPIC
2:00 PM	o BREAK
2:30 PM	o GKSS STAFF DISCUSSION
2:45 PM	o LOAD COMBINATIONS o SRSS
3:15 PM	o NRC POSITIONS ON MK II SUBMITTALS o NUREG 0487 UPDATE o USE OF "B" LIMITS FOR NSSS FATIGUE EVALUATION OF LOAD CASE 2 o FUNCTIONAL CAPABILITY O SRSS SCHEDULE FOR RESOLUTION

WMD/HD

11/79

MARK II CONTAINMENT PROGRAM

TASK STRUCTURE SUMMARY

TOTAL NUMBER OF TASKS __________ ~ 101

MARK II PLANT APPLICATION	% OF TOTAL TASKS
LEAD PLANT SER	8
NON-LEAD PLANT	32
COMBINATION OF PLANT CATEGORIES	34
CONFIRMATORY	12
INFORMATIONAL	14
TOTAL	100%

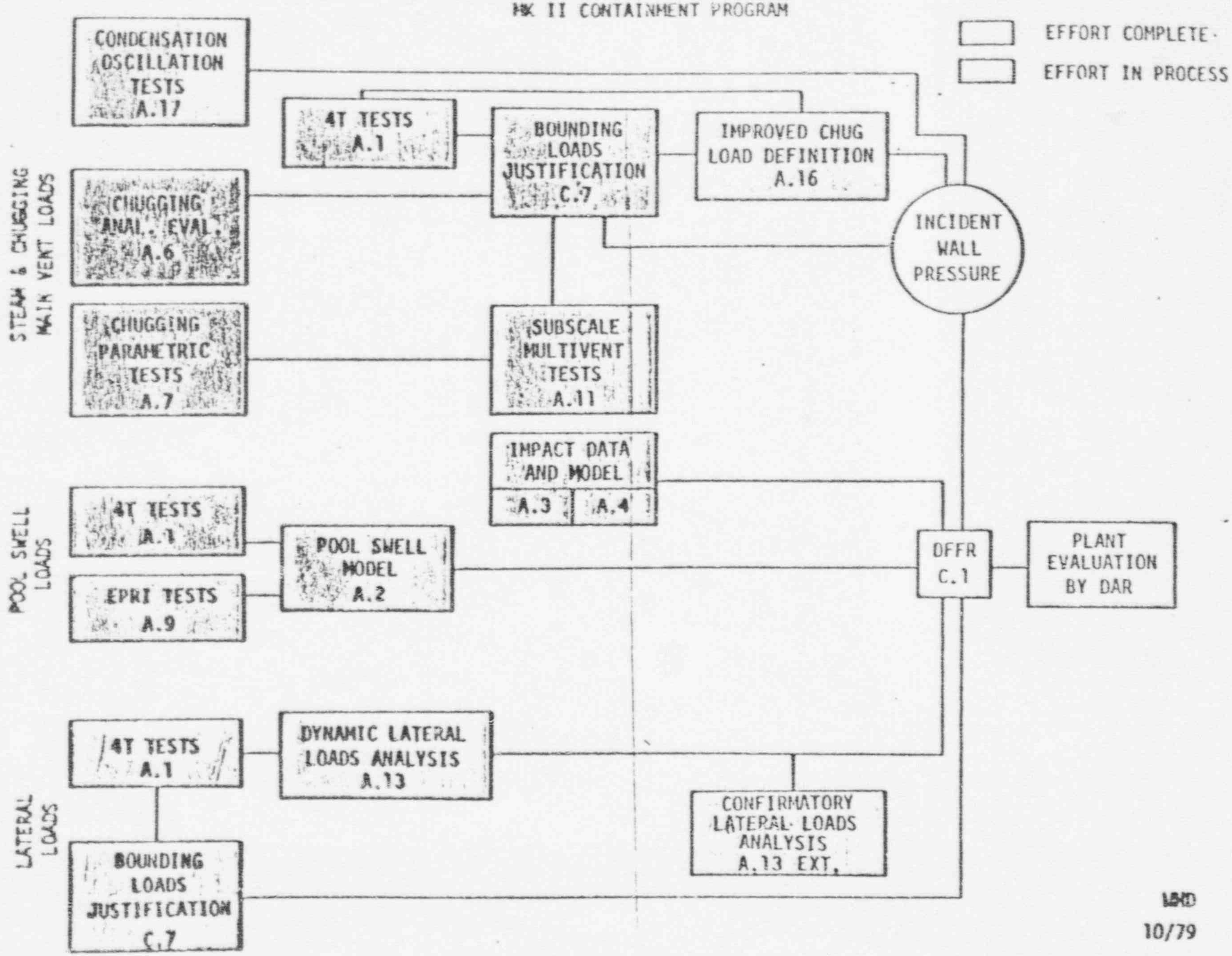
NOV 1979 COMPLETION STATUS:

(BASED ON COST WEIGHTING)

o OVERALL PROGRAM 85%

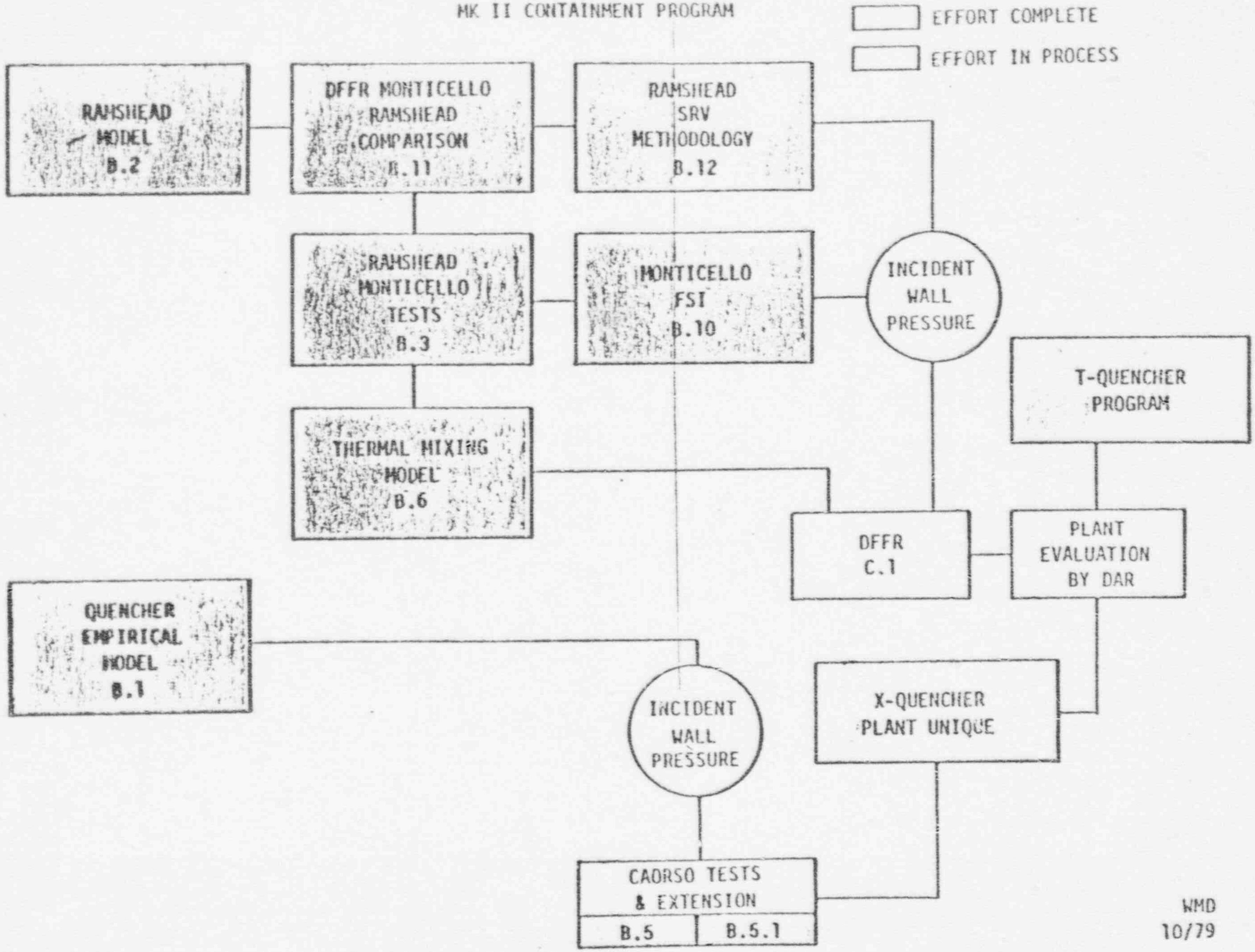
WMD:pes/837
10/26/79

MK II CONTAINMENT PROGRAM

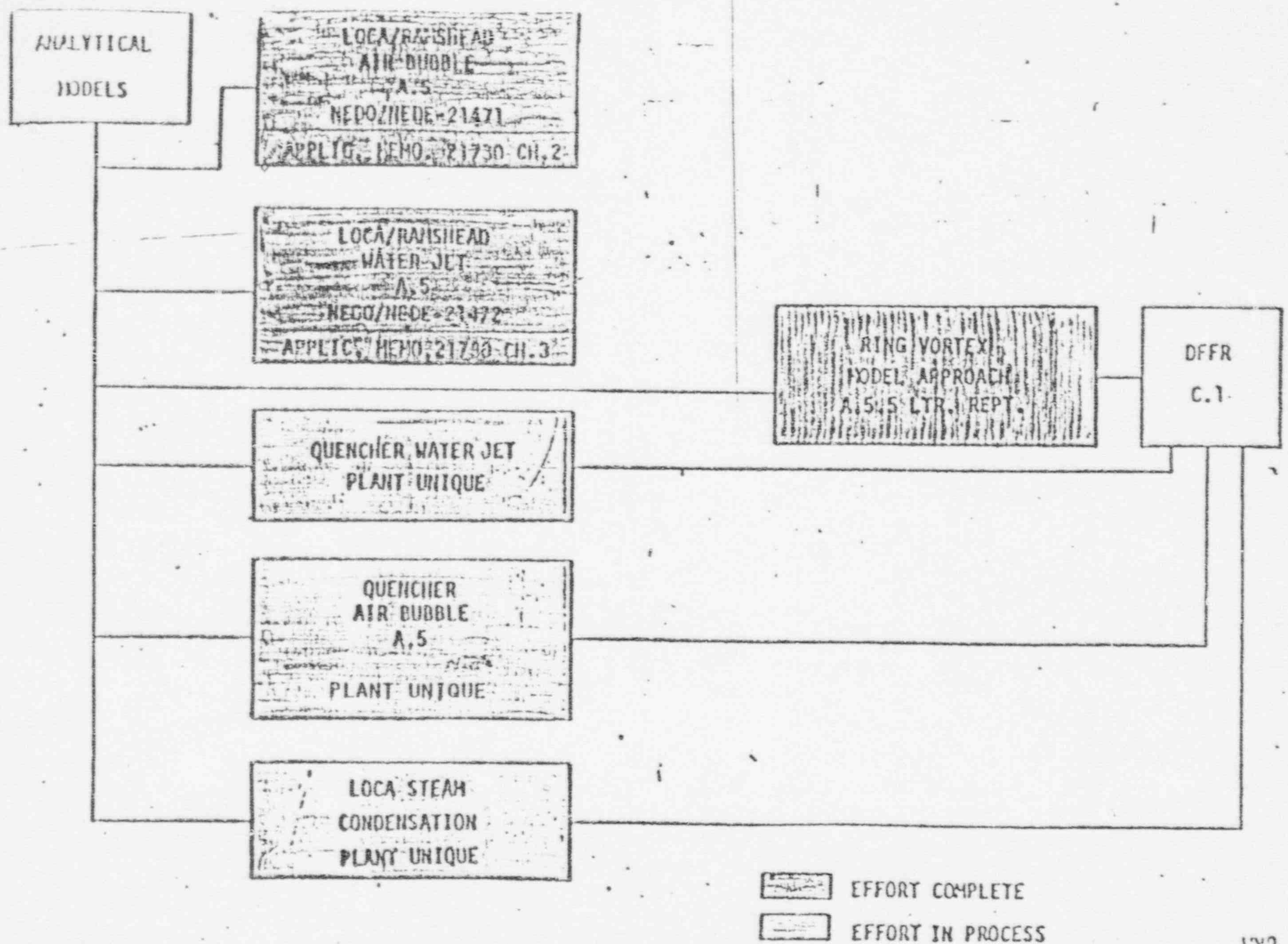


MMD
10/79

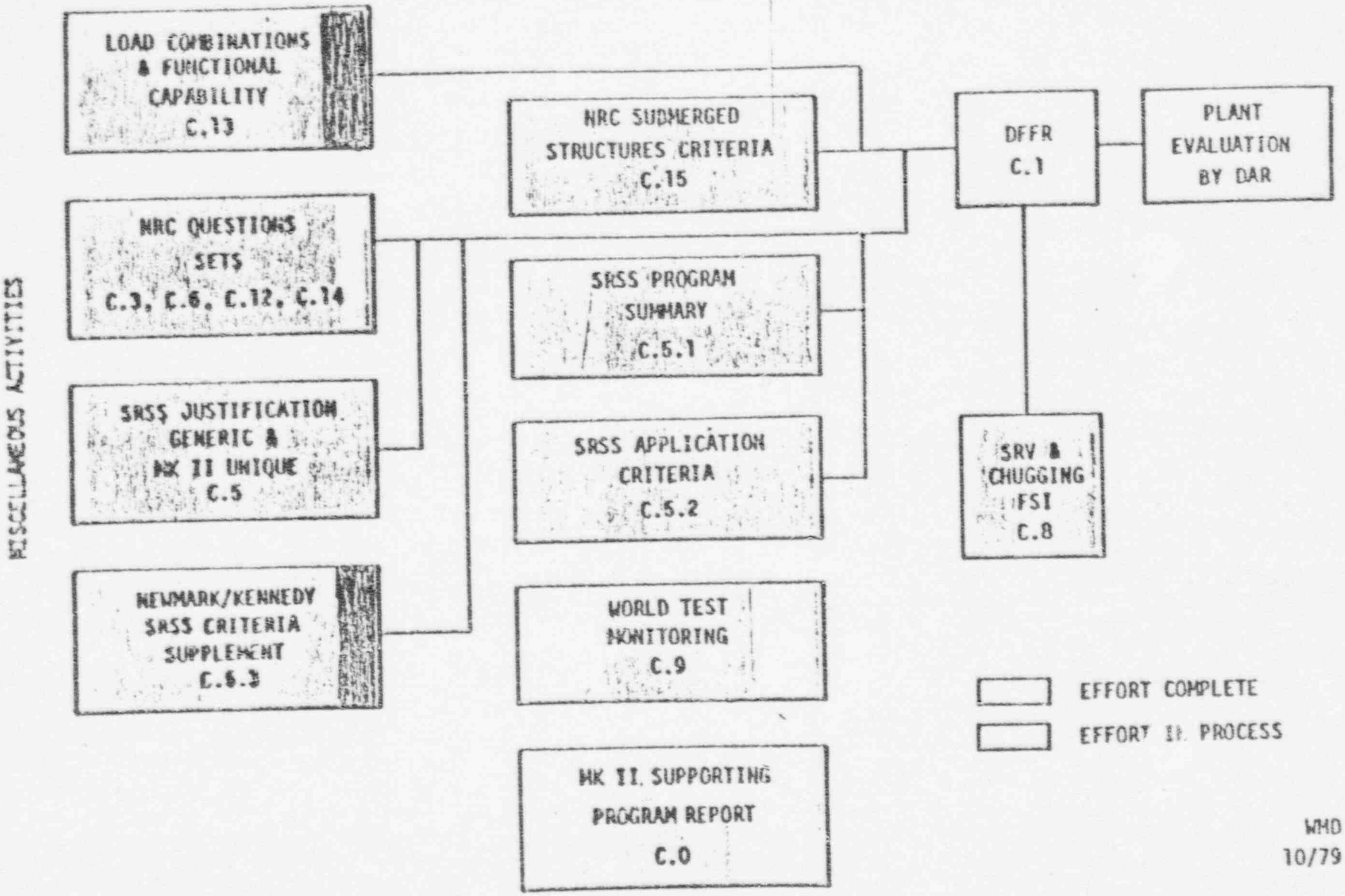
MK II CONTAINMENT PROGRAM



WMD
10/79

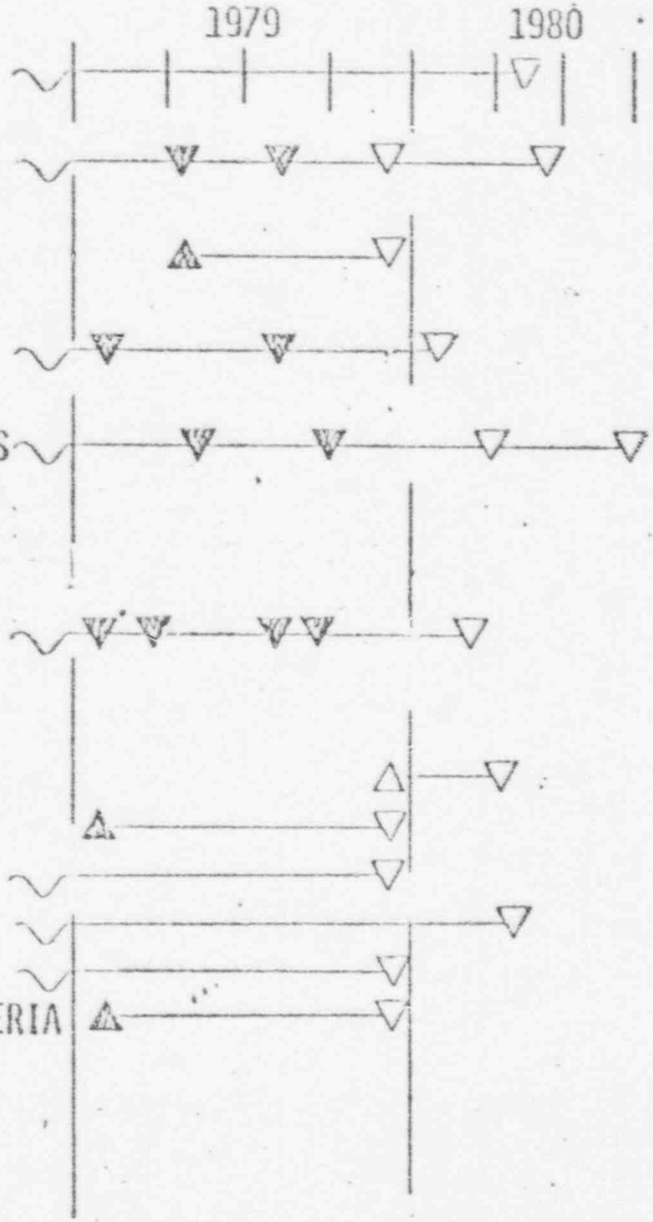

ANALYTICAL MODELS
LOCA/RAMSHEAD AIR BUBBLE A.5 NEDO/NEDE-21471
APPLIC. MEMO. 21730 CH.2
LOCA/RAMSHEAD WATER JET A.5 NEDO/NEDE-21472
APPLIC. MEMO. 21730 CH.3
QUENCHER WATER JET PLANT UNIQUE
QUENCHER AIR BUBBLE A.5 PLANT UNIQUE
LOCA STEAM CONDENSATION PLANT UNIQUE
RING VORTEX MODEL APPROACH A.5.5 LTR. REPT.
DFFR C.1
EFFORT COMPLETE
EFFORT IN PROCESS

KMD
10/79


MISCELLANEOUS ACTIVITIES
LOAD COMBINATIONS & FUNCTIONAL CAPABILITY C.13
NRC QUESTIONS SETS C.3, C.6, C.12, C.14
SRSS JUSTIFICATION GENERIC & MK II UNIQUE C.5
NEWMARK/KENNEDY SRSS CRITERIA SUPPLEMENT C.6.3
NRC SUBMERGED STRUCTURES CRITERIA C.15
SRSS PROGRAM SUMMARY C.5.1
SRSS APPLICATION CRITERIA C.5.2
WORLD TEST MONITORING C.9
MK II SUPPORTING PROGRAM REPORT C.0
DFFR C.1
PLANT EVALUATION BY DAR
SRV & CHUGGING FSI C.8
EFFORT COMPLETE
EFFORT IN PROCESS

WMD
10/79

MARK II GENERIC PROGRAM SCHEDULE



LOCA RELATED ACTIVITIES		
A.5.5	RING VORTEX MODEL	60% COMPLETE
A.11	SUBSCALE MULTIVENT TESTING	82% COMPLETE
A.13	EXTENSION-LATERAL LOADS ANAL.	90% COMPLETE
A.16	IMPROVED CHUG LOADS	90% COMPLETE
A.17	CONDENSATION OSCILLATION TESTS	55% COMPLETE
S/RV RELATED ACTIVITIES		
B.5	CAORSO QUENCHER TESTS	90% COMPLETE
MISCELLANEOUS ACTIVITIES		
C.0	PROGRAM ACTION PLAN UPDATE	
C.5.3	H/K SRSS SUPPLEMENT	100% COMPLETE
C.6	NRC ROUND 2 QUESTIONS	92% COMPLETE
C.9	WORLD TEST MONITORING	90% COMPLETE
C.12	NRC QUESTIONS 20.43/20.59	95% COMPLETE
C.15	NRC SUBMERGED STRUCTURES CRITERIA	97% COMPLETE

WMD:pes/CP-75, SH 5
10/26/79

MARK II CONTAINMENT - SUPPORTING PROGRAM
LOCA-RELATED TASKS

TASK NUMBER	ACTIVITY	ACTIVITY TYPE	TARGET COMPLETION	DOCUMENTATION	DATE DOC/SUBM	LEAD PLANT SER/ INTERMED PLANT
A.1	"4T" TEST PROGRAM	Phase I Test Report	Completed	NEDO/NEDE 13442-P-01	5/76 - 5/76	LP SER/IP
		Phase I Appl Memo	Completed	Application Memo	6/76 - 6/76	LP SER/IP
		Phase II & III Test Rpt	Completed	NEDO/NEDE 13468-P	12/76 - 1/77	LP SER/IP
		Application Memorandum	Completed	NEDO/NEDE 23678-P	1/77 - 2/77	LP SER/IP
A.2	POOL SWELL MODEL REPORT	Model Report	Completed	NEDO/NEDE 21544-P	12/76 - 2/77	LP SER/IP
A.3	IMPACT TESTS	PSTF 1/3 Scale Tests	Completed	NEDO/NEDE 13426-P	8/75 - 9/75	LP SER/IP
		Mark I 1/12 Scale Tests	Completed	NEDO/NEDC 20989-2P	9/75 - 11/75	LP SER/IP
A.4	IMPACT MODEL	PSTF 1/3 Scale Tests	Completed	NEDO/NEDE 13426P	8/75 - 9/75	LP SER/IP
		Mark I 1/12 Scale Tests	Completed	NEDO/NEDC 20989-2P	9/75 - 11/75	LP SER/IP
A.5	LOADS ON SUBMERGED STRUCTURES	LOCA/RH Air Bubble Model	Completed	NEDO/NEDE 21471-P	9/77 - 1/78	LP SER/IP
		LOCA/RH Water Jet Model	Completed	NEDO/NEDE 21472-P	9/77 - 1/78	LP SER/IP
		Ring Vortex Model	Completed	Letter Report	5/79 - 5/79	LP/IP
	→		2Q 80	Topical Report		IP
		Applications Methods	Completed	NEDO/NEDE 21730-P	12/77 - 1/78	LP SER/IP
	→					
	→					
		1/4 Scaling Tests	Complete	NEDE 23817-P	9/78 - 12/78	Info
	→	Steam Condensation Methods	-	Plant DAR's		LP SER/IP
A.6	CHUGGING ANALYSIS AND TESTING	Single Cell Report	Completed	NEDO/NEDE 23703-P	9/77 - 11/77	LP SER
		Multivent Model	Completed	NEDO/NEDE 21669-P	2/78 - 3/78	IP
		4T TSI Report	Completed	NEDO/NEDE 23710-P	4/78 - 3/78	LP SER
A.7	CHUGGING SINGLE VENT	CREARE Report	Completed	NEDO/NEDE 23851-P	6/78 - 7/78	Info.
A.9	EPRI TEST EVALUATION	EPRI-4T Comparison	Completed	NEDO 21667	8/77 - 9/77	LP SER*
-	EPRI 1/13 SCALE TESTS	3D Tests	Completed	EPRI NP-441	4/77 - --	LP SER*
-	EPRI SINGLE CELL TESTS →	Unit Cell Tests	4Q 79	EPRI Report		Info
A.11	MULTIVENT SUBSCALE TESTING AND ANALYSIS	Preliminary MV Prog Plan	Completed	NEDO 23697	12/77 - 1/78	LP SER/IP
		MV Test Program Plan & Proc. - Phase I	Completed	NEDO 23697 Rev 1	1/79 - 4/79	IP
	→	Phase I Test Report	4Q 79	Report		IP
		MV Test Prog Plan & Proc				IP
	→	- Phase II	4Q 79	NEDO 23697, Rev. 1, Supp. 1		
		Phase II Test Report	2Q 80	Report		IP
	→	CORMAP Tests	Completed	Report	6/79 - 8/79	Info.
		MRM Verification 1/10 Scale	Completed	NEDE 25116-P	5/79 - 7/79	Info.
A.13	SINGLE VENT LATERAL LOADS	Dynamic Analysis	Completed	NEDO 24106-P	3/78 - 7/78	IP
		Summary Report	Completed	NEDE 23806-P	10/78 - 11/78	IP
	→	Summary Report (Extension)	4Q 79	Report		
A.16	IMPROVED CHUGGING LOAD DEFINITION	Impulse Evaluation	Completed	Letter Report	6/78 - 7/78	LP SER*
	→	Improved Chug Load Defn.	1Q80	Report		IP
A.17	STEAM CONDENSATION OSCILL. →	4T C.O. Test	3Q80	Report		IP
	CO LOAD DEFINITION →	CO Data Evaluation	3Q80	Report		LP/IP

Ck.cas:at/30L2
5K1179

MARK II CONTAINMENT - SUPPORTING PROGRAM
SRV - RELATED TASKS

TASK NUMBER	ACTIVITY	ACTIVITY TYPE	TARGET COMPLETION	DOCUMENTATION	DATE DOC/SUBM	LEAD PLANT SER/ INTERMED PLANT
B.1	QUENCHER EMPIRICAL MODEL	DFFR Model	Completed	NEDO/NEDE 21061-P	9/76 - 9/76	IP
		Supporting Data	Completed	NEDO/NEDE 21078-P	5/75 - 7/75	IP
B.2	RAMSHEAD MODEL	DFFR Model	Completed	NEDO/NEDE 21061-P	9/76 - 9/76	LP SER
		Supporting Data	Completed	NEDO/NEDE 21062-P	7/75 - 10/75	LP SER
		Analysis	Completed	NEDO/NEDE 20942-P	5/75 - 7/75	LP SER
B.3	MONTICELLO IN-PLANT S/RV TESTS	Preliminary Test Rpt.	Completed	NEDO/NEDC 21465-P	12/76 - 1/77	LP SER
		Hydrodynamic Report	Completed	NEDO/NEDC 21581-P	8/77 - 8/77	LP SER
B.5	S/RV QUENCHER IN-PLANT CAORSO TESTS	Test Plan	Completed	NEDM 20988 Rev. 2	12/76 - 3/77	IP
		Test Plan Addendum 1	Completed	NEDM 20988 Rev. 2, Add 1	10/77 - 3/78	IP
		Test Plan Addendum 2	Completed	NEDM 20988 Rev. 2, Add 2	4/78 - 7/78	IP
		Test Summary	Completed	Letter Report	3/79 - 3/79	
	Phase I	Test Report	Completed	NEDO/NEDE-25100-P	5/79 - 6/79	IP
	Phase II	Test Report	1Q 80	Report		IP
B.6	THERMAL MIXING MODEL	Analytical Model	Completed	NEDO/NEDC 23689-P	3/78 - 3/78	Info.
B.10	MONTICELLO FSI	Analysis of FSI	Completed	NEDO 23834	6/78 - 7/78	LP SER
B.11	DFFR RAMSHEAD MODEL TO MONTICELLO DATA	Data/Model Comparison	Completed	NSC-GEN 0394	9/77 - 10/77	LP SER
B.12	RAMSHEAD SRV METHODOLOGY SUMMARY	Analytical Methods	Completed	NEDO 24070	10/77 - 11/77	LP SER

←→

CK:cas:at/30F2
SR1179

MARK II CONTAINMENT - SUPPORTING PROGRAM
MISCELLANEOUS TASKS

TASK NUMBER	ACTIVITY	ACTIVITY TYPE	TARGET COMPLETION	DOCUMENTATION	DATE DOC/SUBM	LEAD PLANT SER/ INTERMED PLANT
C.0	SUPPORTING PROGRAM	Supp Prog Rpt	Completed	NEDO 21297	5/76 - 6/76	-
		Supp Prog Rpt Rev. 1	Completed	NEDO 21297 - Rev. 1	4/78 - 4/78	-
		Supp Prog Rpt Rev. 2 →	2Q80	NEDO 21297 - Rev. 2		
C.1	DFFR REVISIONS	Revision 1	Completed	NEDO/NEDE 21061-P Rev. 1	9/75 - 4/76	-
		Revision 2	Completed	NEDO/NEDE 21061-P Rev. 2	9/76 - 9/76	-
		Revision 3	Completed	NEDO/NEDE 21061-P Rev. 3	6/78 - 6/78	-
C.3	NRC ROUND 1 QUESTIONS	DFFR Rev. 2	Completed	NEDO/NEDE 21061-P Rev. 2	9/75 - 9/76	LP SER*/IP
		DFFR Rev. 2 Amendment 1	Completed	NEDO/NEDE 21061-P Rev. 2 Amend. 1	12/76 - 2/77	LP SER*/IP
		DFFR Rev. 3, Appendix A	Completed	NEDO/NEDE 21061-P Rev. 3 Appendix A	6/78 - 5/79	LP SER*/IP
C.5	SRSS JUSTIFICATION	Interim Report	Completed	(NEDE 24010)	4/77 - 3/77	
		SRSS Report	Completed	NEDO/NEDE 24010-P	7/77 - 8/77	LP SER*/IP
		SRSS Exec. Report	Completed	Summary Report	4/78 - 5/78	LP SER*/IP
		SRSS Criteria Appl.	Completed	NEDO/NEDE 24010-P Suppl. 1	10/78 - 11/78	LP SER*/IP
		SRSS Bases	Completed	NEDO/NEDE 24010-P Suppl. 2	12/78 - 2/79	LP/IP
		SRSS Justification Suppl. →	4Q 79	Report		LP/IP
C.6	NRC ROUND 2 QUESTIONS	DFFR Amendment 2	Completed	NEDO/NEDE 21061-P Rev. 2 Amend. 2	6/77 - 7/77	LP SER*/IP
		DFFR Amend 2, Suppl 1	Completed	NEDO/NEDE 21061-P Rev.2 Amend.2 Supp.1	8/77 - 9/77	LP SER*/IP
		DFFR Amend 2, Suppl 2	Completed	NEDO/NEDE 21061-P Rev.2 Amend.2 Supp.2	9/77 - 11/77	LP SER*/IP
		DFFR Rev. 3, Appendix A →	4Q 79	NEDO/NEDE 21061-P, Rev. 3 Appendix A		LP SER*/IP
C.7	JUSTIFICATION OF "4T" BOUNDING LOADS	Chugging Loads Justification	Complete	NEDO/NEDE 23617-P	7/77 - 8/77	LP SER/IP
			Complete	NEDO/NEDE 24013-P	6/77 - 8/77	LP SER/IP
			Complete	NEDO/NEDE 24014-P	6/77 - 8/77	LP SER/IP
			Complete	NEDO/NEDE 24015-P	6/77 - 8/77	LP SER/IP
			Complete	NEDO/NEDE 24016-P	6/77 - 8/77	LP SER/IP
			Complete	NEDO/NEDE 24017-P	6/77 - 8/77	LP SER/IP
			Complete	NEDO/NEDE 23627-P	6/77 - 8/77	LP SER/IP
C.8	S/RV AND CHUGGING FSI	Prestressed Concrete Reinforced Concrete Steel	Completed	NEDO/NEDE 21936-P	7/78-7/78	LP SER/IP
C.9	MONITOR WORLD TESTS	Monitor Tests →	2Q80	None		
C.13	LOAD COMBINATIONS & FUNCTIONAL CAPABILITY CRITERIA	Criteria Justification	Completed	NEDO 21985	9/78 - 12/78	IP
C.14	NRC ROUND 3 QUESTIONS	Letter Report	Completed	Letter Report	6/78 - 6/78	LP SER*/IP
		DFFR, Rev. 3, Appendix A		NEDO/NEDE 21061-P Rev. 3 Appendix A	6/78 - 5/79	LP SER*/IP
C.15	SUBMERGED STRUCTURE CRITERIA	NRC Question Responses →	4Q 79	Letter Report		IP

* Submitted in response to NRC question.

LP SER: Zimmer, LaSalle, Shoreham
IP: All Other Plants

CF:cas:at/30E1
5K1179

NRC ACCEPTANCE CRITERIA MARK II POOL DYNAMIC LOADS (NUREG 0487, 10/78)	MARK II PROGRAM CLOSURE STATUS
I. LOCA RELATED HYDRODYNAMIC LOADS	
A. SUBMERGED BOUNDARY LOADS DURING VENT CLEARING 33 psi over-pressure added to local hydrostatic below vent exit (walls and basemat) - linear attenuation to pool surface.	I.A. 24 psi overpressure statically applied with hydrostatic pressure to surfaces below vent exit (attenuate to 0 psi at pool surface) for period of vent clearing per March 20, 1979 letter from GE.
B. POOL SWELL LOADS	
1. Pool Swell Analytical Model (PSAM)	
a. Air Bubble Pressure - Use PSAM described in NEDE-21544-P.	I.B.1.a. NUREG 0487 acceptable, no additional NRC review anticipated.
b. Pool Swell Elevation - Use PSAM described in NEDE-21544-P with polytropic exponent of 1.2 for wetwell air compression.	I.B.1.b. Use PSAM with polytropic exponent of 1.2 to a maximum swell height which is the greater of 1.5 vent submergence or the elevation corresponding to the drywell floor uplift ΔP used for design assessment per response to question 020.68 and February 16, 1979 letter from Shoreham.
c. Pool Swell Velocity - Use PSAM described in NEDE-21544-P multiplied by a factor of 1.1.	I.B.1.c. NUREG 0487 acceptable, no additional NRC review anticipated.
d. Pool Swell Acceleration - Use PSAM described in NEDE-21544-P.	I.B.1.d. NUREG 0487 acceptable, no additional NRC review anticipated.
e. Wetwell Air Compression - Use PSAM described in NEDE-21544-P.	I.B.1.e. NUREG 0487 acceptable, no additional NRC review anticipated.
f. Drywell Pressure History - Unique based on NEDM-10320 or equivalent model.	I.B.1.f. NUREG 0487 acceptable, no additional NRC review anticipated.

NRC ACCEPTANCE CRITERIA MARK II POOL DYNAMIC LOADS (NUREG 0487, 10/78)	MARK II PROGRAM CLOSURE STATUS
I.B POOL SWELL LOADS (cont.)	
2. Loads on Submerged Boundaries Maximum bubble pressure predicted by PSAM is to be added uniformly to local hydrostatic below vent exit (walls and basemat) and linear attenuation to pool surface. Apply to walls up to maximum pool swell elevation.	I.B.2 NUREG 0487 acceptable, no additional NRC review anticipated.
3. Impact Loads	
a. Small Structures - (For horizontal pipes, I-beams, and other similar structures having one dimension $\leq$ 20 in.) The loading function shall have the versed sine shape: $p(t) = 0.5\ P_{max}\ (1-\cos 2\pi \frac{t}{\tau})$ where: p = pressure acting on the projected area of the structure, psi $P_{max} = 1.35\ \frac{2\ I_p}{\tau}$, psi-sec where: $I_p = \frac{M_H}{A} \cdot \frac{V}{(32.2)(144)}$ psi-sec $\frac{M_H}{A}$ = hydrodynamic mass per unit area obtained from Figure 6-8 in NEDE-13426-P V = impact velocity from I.B.1.c.	I.B.3.a. NUREG 0487 acceptable, no additional NRC review anticipated. See Table 1 for plant unique information.

LS:caslat/89k2
11/14/79

I.B POOL SWELL LOADS (cont.)

$\tau = \frac{0.0463D}{V}$, for cylindrical targets

$\tau = \frac{0.011W}{V}$, for flat targets with > 7 ft/sec

$\tau = 0.016W$, for flat targets with < 7 ft/sec

D = diameter of cylindrical pipe, feet
W = width of flat structure, feet

NOTE: The masses of the impacted structures to be adjusted by adding the hydrodynamic masses of impact when performing the structural dynamic analysis with "rigid body" impact loads applied.

b. Large Structures - Plant unique calculation required where applicable.

c. Grating - The static drag load, F_{SS}, is to be calculated by forming the product of ΔP from Figure 4-40 of NEDO-21060, Rev. 2, and the total area of the grating. To account for the dynamic nature of the initial loading, the static drag load is increased by a multiplier given by:

$$\frac{F_{SE}}{D} = 1 + \sqrt{1 + (0.0064W\tau)^2}$$

I.B.3.b. NUREG 0487 criteria not applicable, no large structures in pool swell zone.

I.B.3.c. NUREG 0487 acceptable, no additional NRC review anticipated. See Table 1 for plant unique information.

I.B.3 Impact Loads (cont.)

where: F_{SE} = static equivalent load

W = width of grating bars, inches

f = natural frequency of lowest mode, Hz

D = static drag load

NOTE: Applies for grating with open area $\geq$ 60% and Wf < 2000 in/sec

4. Wetwell Air Compression

a. Wall Loads - Directly apply the PSAM calculated pressure due to wetwell compression.

I.B.4.a. NUREG 0487 acceptable, no additional NRC review anticipated.

b. Diaphragm Upward Load - Calculate ΔPUP using the correlation:

$\Delta PUP = 8.2 - 44F$, for $0 \leq F \leq 0.13$

$\Delta PUP = 2.5$ psi, for $F > 0.13$

where: $F = \frac{AB \cdot AP \cdot VS}{VD \cdot (AV)^2}$

AB = break area

AP = net pool area

AV = total vent area

VS = initial wetwell air space volume

VD = drywell volume

I.B.4.b. NUREG 0487 acceptable, no additional NRC review anticipated.

LS:cas:at:S9K4
11/14/79

I.B POOL SWELL LOADS (cont.)

5. Asymmetric Load

Apply the maximum air bubble pressure calculated from PSAM and a minimum air bubble pressure (zero increase) in a worst case distribution to the wetwell wall.

I.B.5 Use twice the 10% of maximum bubble pres. statically applied to 1/2 of the submerged boundary (with hydrostatic pressure) proposed in March 16, 1979 letter from GE.

I.C STEAM CONDENSATION AND CHUGGING LOADS

1. Downcomer Lateral Loads

a. Single Vent Loads

- A static equivalent load of 8.8 KIPs shall be used provided:
  (i) the downcomer is 24 inches in diameter
  (ii) the downcomer dominant natural frequency is $\leq$ 7 Hz, submerged
  (iii) the downcomer is unbraced or braced at or above approx. 8 ft. from the exit
- A static equivalent load of 8.8 KIPs multiplied by the ratio of the natural frequency and 7 Hz for dominant natural frequencies between 7 and 14 Hz. Other restrictions in (i) and (iii) apply.
- If the natural frequency of the downcomer is > 14 Hz or if bracing is closer than 8 ft. above the exit, a plant specific dynamic structural calculation shall be performed using a dynamic load defined by:

I.C.1.a. Task A. 13, "Single Vent Lateral Loads" for dynamic analysis. NEDE 24106-P has been submitted to NRC. Supplemental information is scheduled for submittal in 4Q79. See Table 1 for plant unique information.

NRC ACCEPTANCE CRITERIA MARK II POOL DYNAMIC LOADS (NUREG 0487, 10/78)	MARK II PROGRAM CLOSURE STATUS
I.C.1 Downcomer Lateral Loads (cont.) a. cont. $F(t) = F_0 \sin \frac{\pi t}{\tau}; 0 < t < \tau$ $= 0$; for $t < 0$ and $t > \tau$ where: 2 msec < τ < 10 msec, and the impulse $I = 2 F_0 (\tau/\pi)$ is 200 lbf-sec. Restriction (i) also applies.	
b. Multiple Vent Loads Use the load specified in Figure 4-10b of NEDE-21061-P, Rev. 2, multiplied by a factor of 1.26 for downcomers with natural frequencies that are ≤ 7 Hz. For natural frequencies > 7 Hz, apply an additional multiplier equal to the ratio of its frequency and 7 Hz.	I.C.1.b. Statistical distribution of loads, based on test observations, Task A.13, "Multi-vent Lateral Loads" to be used in a dynamic analysis. NEDE 24106-P has been submitted to NRC. Supplemental information is scheduled for submittal in 4Q79.
2. Submerged Boundary Loads a. High Steam Flux Loads Sinusoidal pressure fluctuation added to local hydrostatic. Amplitude uniform below vent exit, linear attenuation to pool surface. 4.4 psi peak to peak amplitude. 2-7 Hz frequencies. NEDE-21061-P, Rev. 2. b. Medium Steam Flux Loads Sinusoidal pressure fluctuation added to local hydrostatic. Amplitude uniform below vent exit, linear attenuation to pool surface. 7.5 psi peak to peak amplitude. 2-7 Hz frequencies. NEDE-21061-P, Rev. 2.	I.C.2.a. & b. NUREG 0487 criteria used as interim spec. pending completion of Task A.17 "Steam Condensation Oscillation Test." Additional frequency ranges also being evaluated. A 4T C.O. test report is scheduled for submittal in 3Q80 with data evaluation for load application scheduled for submittal in 3Q80. See Table 1 for plant unique information.

I.C.2 Submerged Boundary Loads (cont.)

c. Chugging

- Uniform Loading Condition - Maximum amplitude uniform below vent exit, linear attenuation to pool surface. +4.8 psi max overpressure, -4.0 psi max underpressure 20-30 Hz frequency. (Pending of FSI concerns) NEDE-21061-P, Rev. 2.

- Asymmetric Loading Condition - Maximum amplitude uniform below vent exit - linear attenuation to pool surface. +20 psi max overpressure, -14 psi max underpressure, 20-30 Hz frequency, peripheral variation of amplitude follows observed statistical distribution with maximum and minimum diametrically opposed. NEDE-21061-P, Rev. 2.

I.C.2.c. NUREG 0487 criteria used as interim spec. pending completion of Task A.16 "Improve Chugging Load Definition". A report is scheduled for submittal in 1Q80. See Table 1 for plant unique information.

II. SRV-RELATED HYDRODYNAMIC LOADS

A. POOL TEMPERATURE LIMITS

All Mark II facilities shall use quencher type devices. The suppression pool local temperature shall not exceed 200°F for all plant transients involving SRV operations. Measurements from temperature sensors located on the containment wall in the sector containing the discharge device at the same elevation as the device can be used as local indication.

II.A NUREG 0487 criteria regarding the use of a quencher device is acceptable. The plant temperature monitoring system will be described in separate plant unique documents.

Document will be prepared using additional PP&L test data to support no (Local) temperature limit for quenchers. Report to be submitted 1Q80.

NRC ACCEPTANCE CRITERIA MARK II POOL DYNAMIC LOADS (NUREG 0487, 10/78)	MARK II PROGRAM CLOSURE STATUS
II. SRV-RELATED HYDRODYNAMIC LOADS (cont.) B. AIR CLEARING LOADS	
(a) Methodology for Bubble Load Prediction T-Quencher - Use ramshead methodology described in Sec. 3.2 of NEDO-21061-P, Rev. 2. X-Quencher - Use Sec. 3.3 of NEDO-21061-P Rev. 2.	II.B(a) T-Quencher Load prediction methods presented in Susquehanna DAR, Sec. 4.1.3. See Table 1 for plant unique information.
(b) SRV Discharge Load Cases The following load cases shall be considered for design evaluation of containment structures and equipment inside the containment: 1. Single valve, first and subsequent actuation 2. ADS valve actuation 3. Two adjacent valve first actuation 4. All valves discharged sequentially by setpoint 5. All valves discharged simultaneously by assuming all bubbles are oscillating in phase.	II.B(b) Load Case 4 is not included for T-Quencher evaluation. It is bounded by Susquehanna DAR sections 4.1.3.1 and 4.1.3.2. See Table 1 for plant unique information.
(c) Bubble Frequency T-Quencher - a range of bubble frequency of 4-12 Hz is the minimum range that shall be evaluated. The range shall be increased if required to include the frequency predicted by the ramshead methodology together with ±50% margin.	II.B(c) Method for applying plant unique T-Quencher bubble frequency is presented in Susquehanna DAR, Section 4.1.3. See Table 1 for plant unique X-Quencher information.

5:cas:at/89K8
1/14/79

II.B AIR CLEARING LOADS (cont.)

X-Quencher - a range of bubble frequency of 4-12 Hz shall be evaluated.

C. QUENCHER ARM AND TIE DOWN LOADS

1. Quencher Arm Loads

Vertical and lateral arm loads are to be developed on the basis of bounding assumptions for air/water discharge from the quencher and conservative combinations of maximum/minimum bubble pressures acting on the quencher per NEDE-21061-P, Rev. 2.

II.C.1. T-Quencher arm loads are presented in Susquehanna DAR, Section 4.1.2.5.

NUREG 0487 criteria for X-Quencher arm loads acceptable, no additional NRC review anticipated.

2. Quencher Tie-down Loads

The vertical and lateral arm load transmitted to the basemat via the tie-down plus vertical transient wave and thrust loads calculated from a standard momentum balance are to be calculated based on conservative clearing assumptions per NEDE-21061-P, Rev. 2.

II.C.2. T-Quencher tie-down loads are presented in Susquehanna DAR Section 4.1.2.5.

NUREG 0487 criteria for X-Quencher tie down loads acceptable, no additional NRC review anticipated.

III. LOCA/SRV SUBMERGED STRUCTURE LOADS

A. LOCA/SRV JET LOADS

1. LOCA Downcomer Jet Load

Calculate based on methods described in NEDE-21730 and the following constraints and modifications:

III.A.1. Ring Vortex Model including potential function for induced flow being finalized. More appropriate acceleration drag consideration to be identifed. Basic model description has been submitted to NRC and final report is scheduled for submittal in 1Q80. See Table 1 for plant unique information.

III.A.1 LOCA Downcomer Jet Loads (cont.)

(a) Standard drag at the time the jet first encounters the structure must be multiplied by the factor:

$$1 + \frac{6 V_a}{C_D A_X R_i}$$

where: V_a = acceleration volume as defined in NEDE-21730
C_D = drag coefficient as defined in NEDE-21730
A_X = projected area as defined in NEDE-21730
R_i = vent exit radius

(b) Forces in the vicinity of the jet front shall be computed on the basis of Formula 2-12 and 2-13 of NEDE-21730. The local velocity, U_∞, and acceleration, $\dot{U}_\infty$, are to be conservatively calculated by the methods of NEDE-21471 from the potential function:

$$\phi = \frac{-3}{8\pi} \cdot U_j \cdot V_W \frac{\cos \theta}{r^2}$$

where: r & θ = spherical coordinates from jet front
U_j = jet velocity from NEDE-21730
V_W = initial volume of water in the vent

NRC ACCEPTANCE CRITERIA MARK II POOL DYNAMIC LOADS (NUREG 0487, 10/78)	MARK II PROGRAM CLOSURE STATUS
III.A.1 LOCA Downcomer Jet Load (cont.) (c) After the last fluid particle has reached the jet front a spherical vortex continues propagating. The drag on structures in its vicinity can be bounded by using the flow field from the formula for ϕ above with U_j as the jet front velocity from NEDE-21730 at time $t = t_f$.	
2. SRV Quencher Jet Loads This load may be neglected for those structures located outside a zone of influence which is a sphere circumscribed around the quencher arms. If there are holes in the end caps, the radius of the sphere should be increased by 10 hole diameters. (Confirmation during Long Term Program required.)	III.A.2. The P5.5 pressure transducer data from the T-Quencher test program presented in Section 8.0 of the Susquehanna DAR shows no water jet effect thus no loads are specified beyond a 5 ft. cylindrical zone of influence. NUREG 0487 criteria acceptable for X-Quenchers, no additional NRC review anticipated.
B. LOCA/SRV AIR BUBBLE DRAG LOADS 1. LOCA Air Bubble Loads	III.B.1 See Table 1 for plant unique information.
Calculate based on the analytical model of the bubble charging process and drag calculations of NEDE-21471 until the bubbles coalesce. After bubble contact, the pool swell analytical model, together with the drag computation procedure NEDE-21471 shall be used. Use of this methodology shall be subject to the following constraints and modifications:	
(a) A conservative estimate of bubble asymmetry shall be added by increasing accelerations and velocities computed	III.B.1(a) NUREG 0487 criteria acceptable, no additional NRC review anticipated.

LS:cas:at/89K11
11/14/79

NRC ACCEPTANCE CRITERIA MARK II POOL DYNAMIC LOADS (NUREG 0487, 10/78)	MARK II PROGRAM CLOSURE STATUS
III.B.1 LOCA Air Bubble Loads	
in step 12 of Section 2.2 of NEDE-21730 by 10%. If the alternate steps 5A, 12A, and 13A are used the acceleration drag shall be directly increased by 10% while the standard drag shall be increased by 20%.	
(b) Modified coefficients C_D' from accelerating flows as presented in Kenlegan & Carpenter and Sarpkaya references shall be used with transverse forces included, or an upper bound of a factor of three times the standard drag coefficients shall be used for structures with no sharp corners or with streamwise dimensions at least twice the width.	III.B.1(b) Drag coefficients have been presented in Appendix C.4 (Rev. G, 10/79) of the LaSalle DAR and in Attachment I.K of the Zimmer FSAR.
(c) The equivalent uniform flow velocity and acceleration for any structure or structural segment shall be taken as the maximum values "seen" by that structure not the value at the geometric center.	III.B.1(c) Justification for application of load at geometric center addressed in Appendix C.4 (Rev. 6, 10/79) of the LaSalle DAR and in Attachment I.K of the Zimmer FSAR.
(d) For structures that are closer together than three characteristic dimensions of the larger one, either a detailed analysis of the interference effects must be performed or a conservative multiplication of acceleration and drag forces by a factor of four must be performed.	III.B.1(d) Interference effects are addressed in Appendix C.4 (Rev. 6, 10/79) of the LaSalle DAR and in Attachment I.K of the Zimmer FSAR.
(e) If significant blockage from downcomer bracing exists relative to the net pool area, the standard drag coefficients shall be modified by conventional methods (Pankhurst & Holder reference).	III.B.1(e) Blockage effects will be evaluated and addressed in future documentation.

LS:cas:at/89K12
11/14/79

NRC ACCEPTANCE CRITERIA
MARK II POOL DYNAMIC LOADS
(NUREG 0487, 10/78)

III.B.1 LOCA Air Bubble Loads (cont.)

(f) Formula 2-23 of NEDE-21730 shall be modified by replacing M_H by $\rho_{FB} V_A$ where V_A is obtained from Tables 2-1 and 2-2.

2. SRV Ramshead Air Bubble Loads

Use the methodology described in NEDE-21471 subject to the following constraints and modifications:

(a) Standard drag shall not be neglected without first estimating its order of magnitude using the following equation:

$$\frac{F_{SM}}{F_{AM}} = f\left(\frac{P_{max}}{P_\infty}\right) \frac{C'_D}{\pi} \cdot \frac{Rmin}{d} \left(\frac{R_{min}}{r}\right)^2$$

where: F_{SM} = maximum standard drag
F_{AM} = maximum acceleration drag
C'_D = cycle-averaged effective drag coefficient
d = dia. of cylindrical structure
R_{min} = minimum bubble radius
r = distance from bubble center to the structure

and: $f\left(\frac{P_{max}}{P_\infty}\right) \simeq 8/3$ for $\frac{P_{max}}{P_\infty} \leq 30$

(b) Constraints of III.B.1 also apply.

3. SRV Quencher Air Bubble Loads

(a) T-Quencher - Loads may be computed on the basis of the above ramshead methodology using 25% of the calculated ramshead bubble pressure and assuming the bubble to be located at the center of the quencher device having a bubble radius equal to the quencher radius.

MARK II PROGRAM CLOSURE STATUS

III.B.1(f) NUREG 0487 acceptable, no additional NRC review anticipated.

III.B.2.a & b NUREG 0487 criteria not applicable, ramshead devices not installed.

III.B.3.a T-Quencher bubble pressure prediction methodology is presented in Susquehanna DAR, Section 4.1.3. See Table 1 for plant unique information.

NRC ACCEPTANCE CRITERIA MARK II POOL DYNAMIC LOADS (NUREG 0487, 10/78)	MARK II PROGRAM CLOSURE STATUS
III.B.3 SRV Quencher Air Bubble Loads (cont.) (b) X-Quencher - Loads may be computed on the basis of the above ramshead methodology using bubble pressures calculated by the methods of NEDE-21061-P, Rev. 2, for the X-Quencher.	III.B.3.b Burns & Roe X-Quencher load definition to be based on a combination of resolution of certain aspects now being discussed with the NRC generically and plant unique methods given in WNP-2 DAR.
C. STEAM CONDENSATION DRAG LOADS Review will be conducted on a plant unique basis.	III.C See Table 1 for plant unique information.

LS:cas:at/8SK14
11/14/79

TABLE 1

NRC CRITERIA	PLANT UNIQUE CLOSURE
I.B.3.a & c (Pool Swell Impact Loads)	HANFORD - Burns & Roe has documented plant unique methods in WNP-2 DAR
I.C.1.a (Single Vent Lateral Loads)	SUSQUEHANNA - ~~Plant unique~~ generic lateral bracing loads will be confirmed by GKM-IIM test data.
I.C.2.a & b (C.O. Boundary Loads)	SUSQUEHANNA - Lead plant NRC criteria acceptable. Higher amplitude (3.5 & 10 psi) loads used. Confirmation of design loads to be based on plant unique GKM-IIM tests.
I.C.2.c (Chugging Boundary Load)	HANFORD - Burns and Roe chugging load definition has been documented in reports submitted April 13 and June 15, 1979.
II.B.a, b & c (SRV Air Clearing Load)	HANFORD - Burns and Roe is developing a unique X-Quencher load definition based largely on Caorso data. Loads will be presented in WNP-2 DAR.
III.A.1 (LOCA Water Jet Loads)	BAILLY - Methodology which meets the intent of NUREG-0487 criteria will be used. The method is documented in Appendix C.3 of the LaSalle DAR and in Attachment I.J.3 of the Zimmer FSAR. SUSQUEHANNA - Same as stated above for Bailly. LIMERICK - Same as stated above for Bailly.
III.B.1 (LOCA Air Bubble Loads)	SUSQUEHANNA - LOCA air bubble source term at the vent exit will be applied in a modified IWEGS/MARS Code to establish acceleration and velocity flow fields. Application of the flow fields will follow the Mark II Program Closure Status positions (a) through (f). Possible source term is being investigated using NEDE-21471 method to determine the bubble formation with the exception that time dependent drywell pressure history is used to determine bubble pressure. Report to be submitted April 1980. LIMERICK - Same as stated above for Susquehanna. HANFORD - Burns & Roe LOCA load definition to be based on a combination of resolution of certain aspects now being discussed with the NRC generically and plant unique methods given in WNP-2 DAR.

LJS
11/14/79

TABLE 1 (CONTINUED)

III.B.3 (SRV Air Bubble Loads)	BAILLY - Ramshead methodology (as modified by lead plants in response to NUREG-0487) is used with bubble location and radius defined appropriately for T-Quenchers. Bubbles are located near the arms. Bubble size is predicted from the discharge line air volume. Method is the same as for LaSalle and Zimmer.
III.C (Steam Condensation Loads)	BAILLY - The lead plant methods documented in the LaSalle and Zimmer closure reports will be used as an interim methodology pending results from Task A.16 or A.17 which would reduce source strengths. SUSQUEHANNA - C.O. and chugging source term defined from Task A.16 and A.17 at the vent exit will be applied in a modified IWEGS/MARS Code to establish acceleration and velocity flow fields. Application of flow fields will be made with appropriate drag coefficients. Report to be submitted April 1980. LIMERICK - Same as stated above for Susquehanna. HANFORD - Generic source as given in I.C.2 used as described in WNP-2 DAR. NINE MILE POINT - Load sources will be derived from generic tasks (A.16 and A.17). The flow field resulting from these sources along with appropriate drag coefficients as specified for LOCA air bubble drag loads will be used to determine the load.

LJS
11/14/79

A.11 MULTIVENT TEST PROGRAM

OVERALL OBJECTIVES

- OBTAIN A SINGLE-VENT/MULTIVENT CHUGGING DATA BASE TO ESTABLISH TRENDS IN POOL WALL LOADS WITH NUMBER OF VENTS

- DEMONSTRATE THAT THE MULTIVENT TRENDS OBSERVED IN SUBSCALE TESTS ARE VALID BY:

  - COMPARING SINGLE VENT DATA AT FOUR SUBSCALES

  - COMPARING MULTIVENT DATA AT TWO SUB-SCALES

TASK A.11

SCALED MULTIVENT TEST PROGRAM
PROGRAM STATUS/SCHEDULE

<u>PHASE 1</u>	
o TESTS, DATA REDUCTION, ANALYSIS	COMPLETE
o PHASE 1 REPORT TO NRC	DECEMBER
<u>PHASE 2</u>	
o PROGRAM PLAN	COMPLETE
o TESTS	
o 5/12, 1/4 SCALE	COMPLETE
o 1/10 SCALE, 19 VENTS	COMPLETE
o COMPLETE 1/6 SCALE, 7 VENTS	NOVEMBER
o COMPLETE PHASE 1 FROUDE SCALE	DECEMBER
o DATA REDUCTION	MARCH 80
o ANALYSIS	
o FSI	DECEMBER
o SCALING	APRIL 80
o FINAL RE[illegible] TO NRC	JUNE 80

TASK A.11

SCALED MULTIVENT TEST PROGRAM

OVERVIEW OF TEST PROGRAM

HIGHLIGHTS

	PHASE 1	PHASE 2
GEOMETRIES:	14	5
SCALE-VENTS:	1/10- 1, 3, 7 VENT	1/4 - 1 VENT
	1/6 - 1, 3 VENT	5/12 - 1 VENT
		1/10 - 19 VENT
		1/6 - 7 VENT
VESSEL DIA:	10, 18, 28, 30	28, 44
VARIABLES:	PRESSURE (4.5 TO 45 PSIA) STEAM MASS FLUX (.1 TO 16 LBM/FT^{2}SEC) TEMPERATURE (90° TO 200°) AIR CONTENT (.1 TO .5%)	
ADDITIONAL EFFECTS:	DRYWELL VOLUME	-
	OFFSET VENT	-
	LARGE DRYWELL	-
	POOL/VENT AREA RATIO	-
NUMBER OF RUNS	452	297
STATUS	COMPLETE	IN PROCESS
REPORT	DEC. '79	JUNE '80

11/14/79

TASK OBJECTIVE

- TO PERFORM STATISTICAL AND BOUNDING LOAD ANALYSIS OF INDEPENDENT DATA BASES TO CONFIRM OR MODIFY THE 4T LATERAL LOAD DEFINITION AS REQUIRED.

SUMMARY OF RESULTS

- GOOD CORRELATION WITH MAXIMUM OBSERVED VALUES IN OTHER DATA BASES.
- GOOD STATISTICAL CORRELATIN BETWEEN 4T AND THE RFERENCE DATA BASES.
- REFERENCE DATA #2 REPRESENTS THE MOST APPROPRIATE COMPARISON TESTS FOR 4T VERIFICATION.

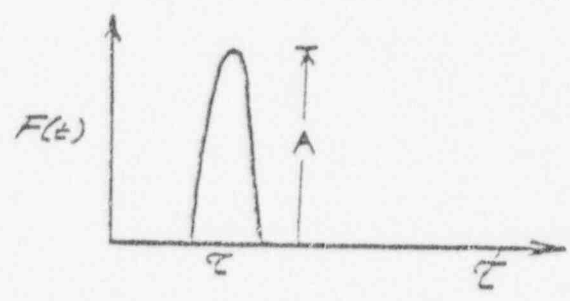
THE DYNAMIC LATERAL LOAD FUNCTION DEFINED IN NEDE 24106-P HAS BEEN CONFIRMED AS THE PROPER DESIGN LOAD CRITERION FOR MAIN VENT DOWNCOMER STRUCTURES.

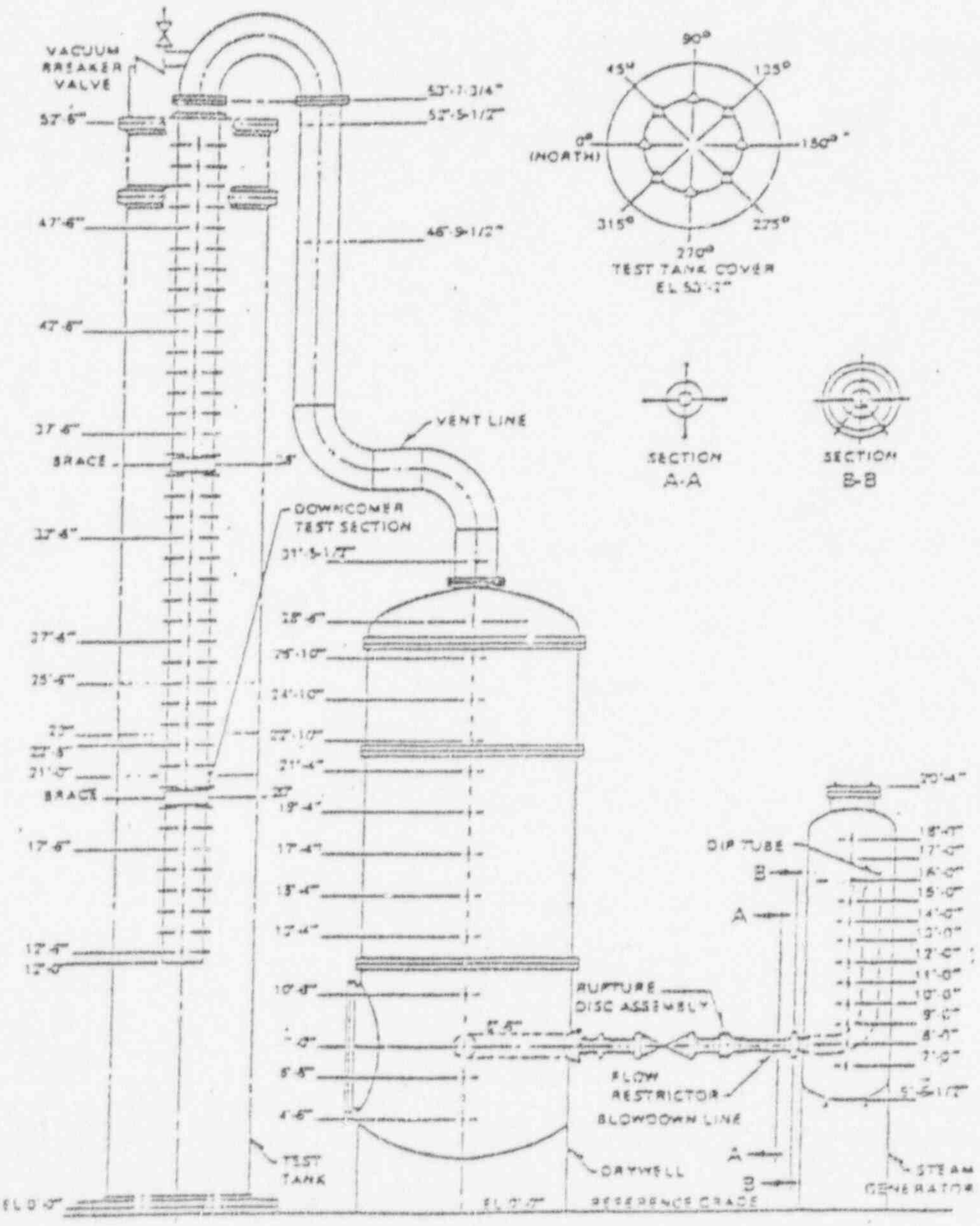
LATERAL LOAD FUNCTION

$F(T) = A \sin \frac{\pi t}{\tau}$, LATERAL LOAD ($LB_F$)

WHERE: $10^4 < A < 3 \times 10^4$, MAXIMUM AMPLITUDE (LB_F)

AND $3 < \tau < 6$, APPLICATION PERIOD (MSEC)

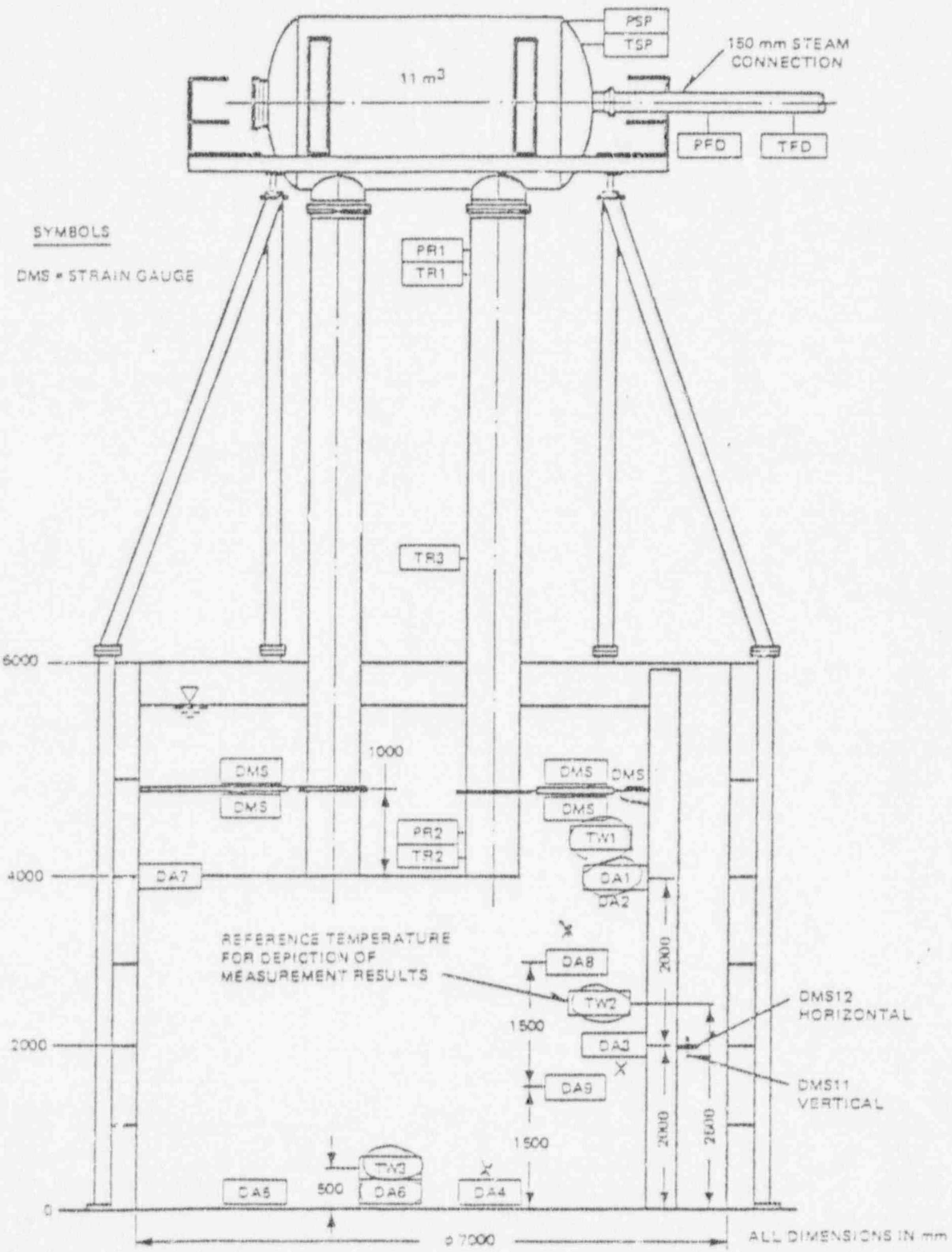




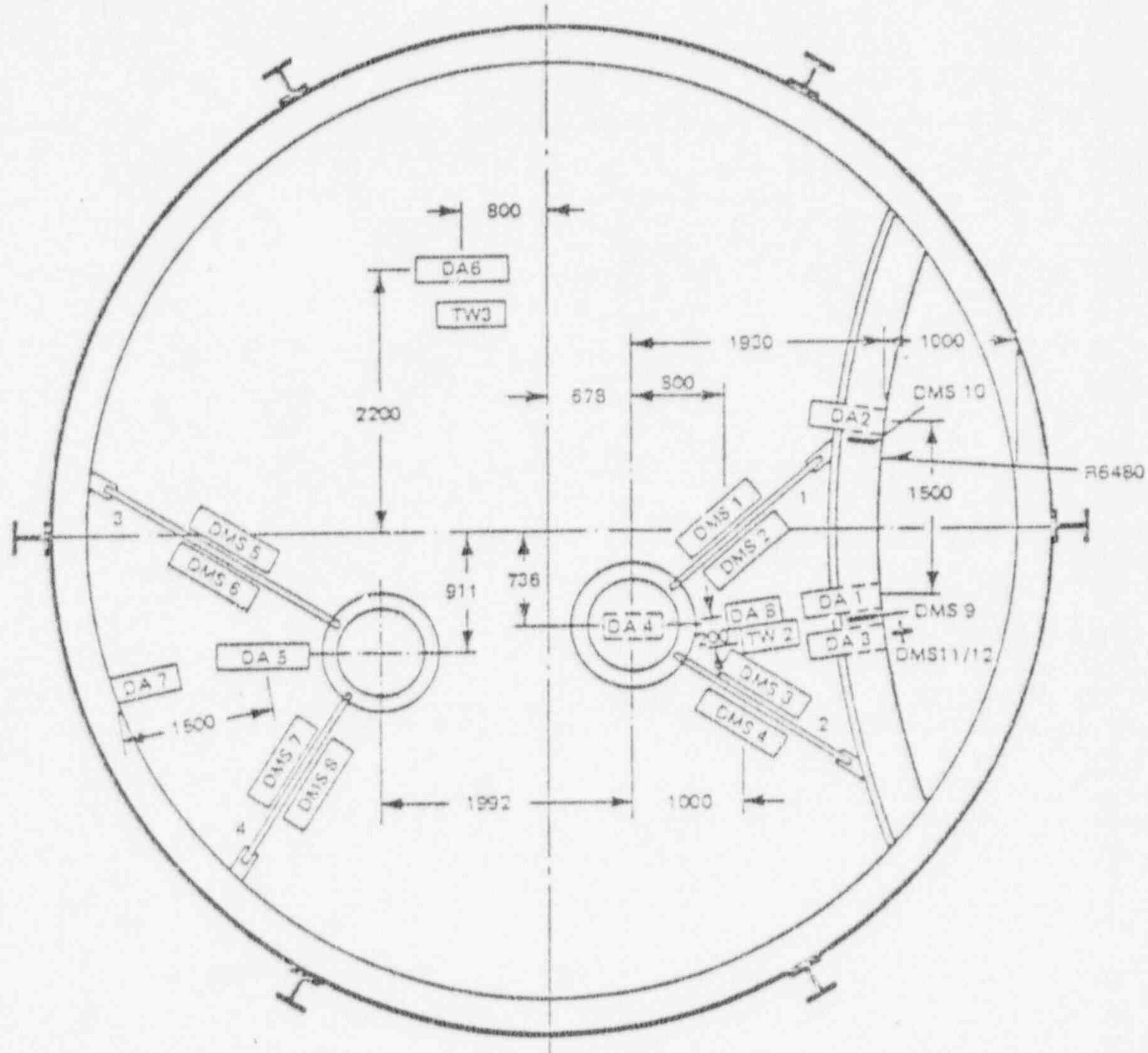
4T TEST FACILITY

DYNAMIC LATERAL LOAD DEFINITION

- COMPARISON BETWEEN 4T DATA AND TEST RESULTS REPORTED BY TWO INDEPENDENT REFERENCE TESTS.
- REFERENCE TEST #1. LARGE TANK, STEADY STATE MASS FLUX.
- REFERENCE TEST #2. SINGLE CELL, TRANSIENT BLOWDOWN.



REFERENCE TEST #1
TEST SET_UP AND INSTRUMENTATOIN



SYMBOL

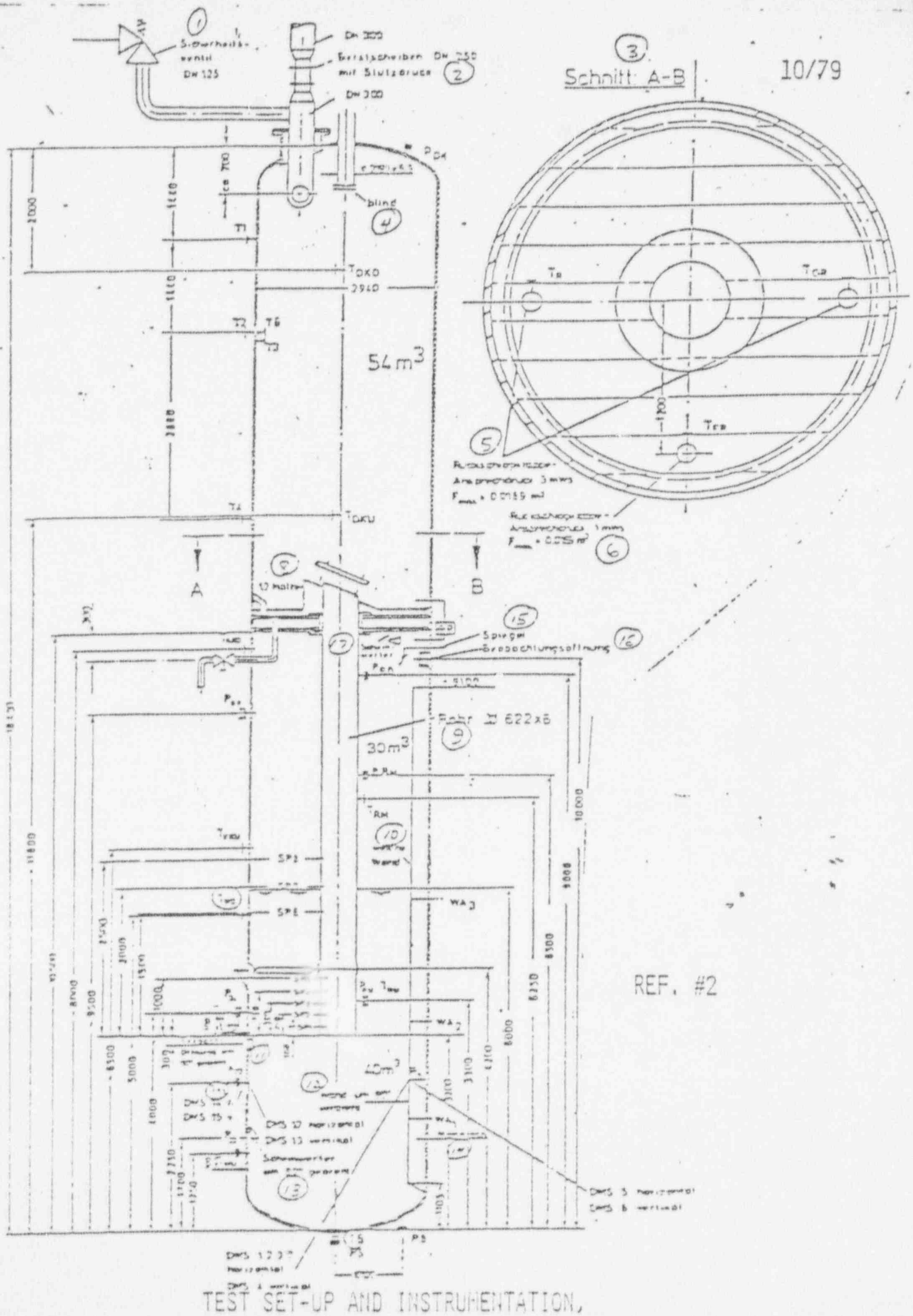
DMS = STRAIN GAUGE

DMS 9/10 VERTICALLY ABOVE DA1 AND DA2

ALL DIMENSIONS IN mm

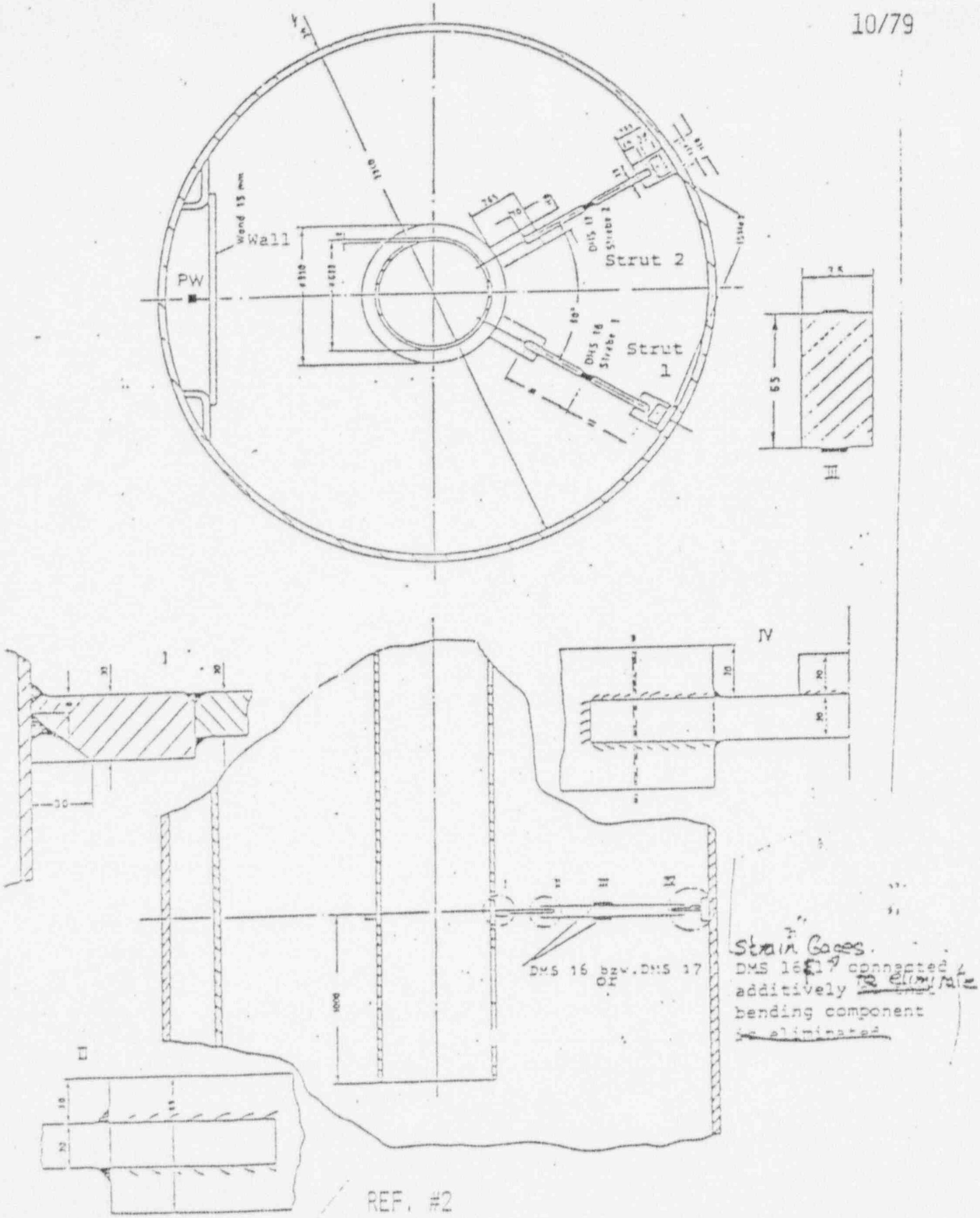
REF. TEST #1

10/79



REF. #2

TEST SET-UP AND INSTRUMENTATION.



REF. #2

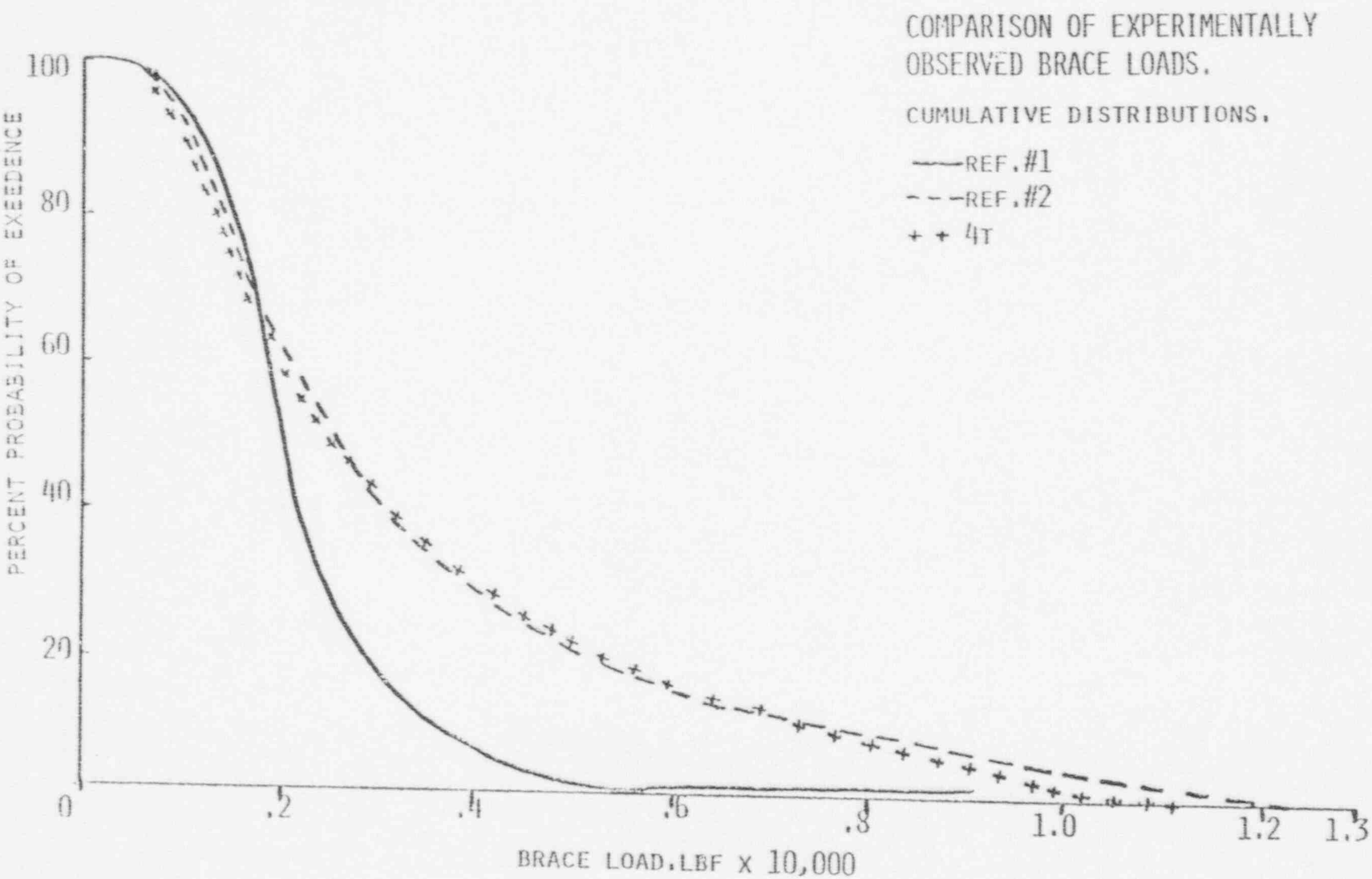
TEST SET-UP AND INSTRUMENTATION,
600 MM VENTS, HORIZONTAL SECTION

EVALUATION OF REFERENCE DATA

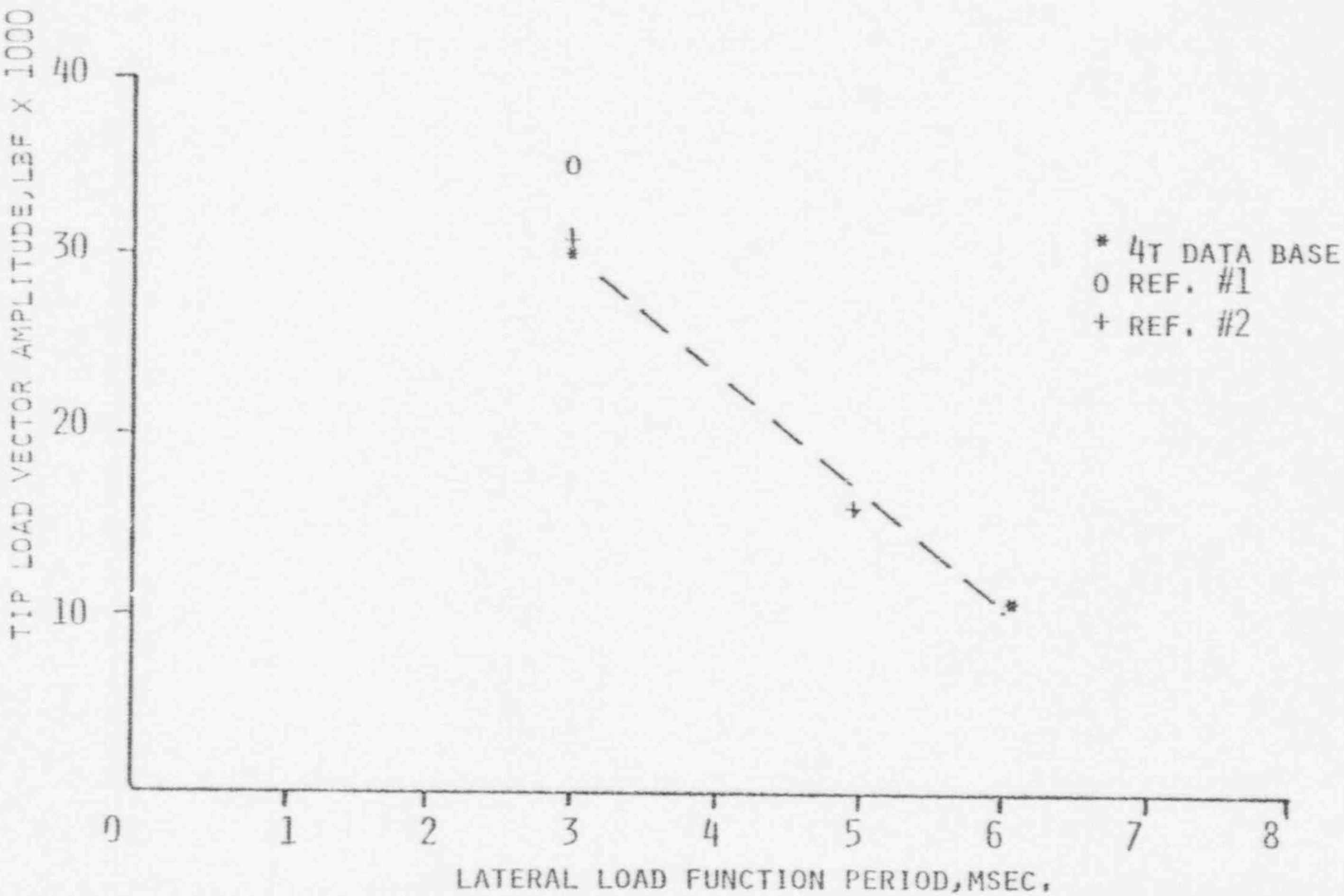
- o APPROACH
  - . NUMERICAL SIMULATION OF SUBJECT TEST FACILITY
  - . DETERMINATION OF BRACE LOAD AMPLITUDE AND RESPONSE PERIOD AS FUNCTION OF:
    - _ APPLIED LOAD PERIOD
    - _ POOL TEMPERATURE
    - _ MASS FLUX
  - . STATISTICAL ANALYSIS OF RESPONSE DATA ON 4T EQUIVALENT BASIS.
  - . COMPARISON OF REFERENCE DATA RESULTS WITH 4T

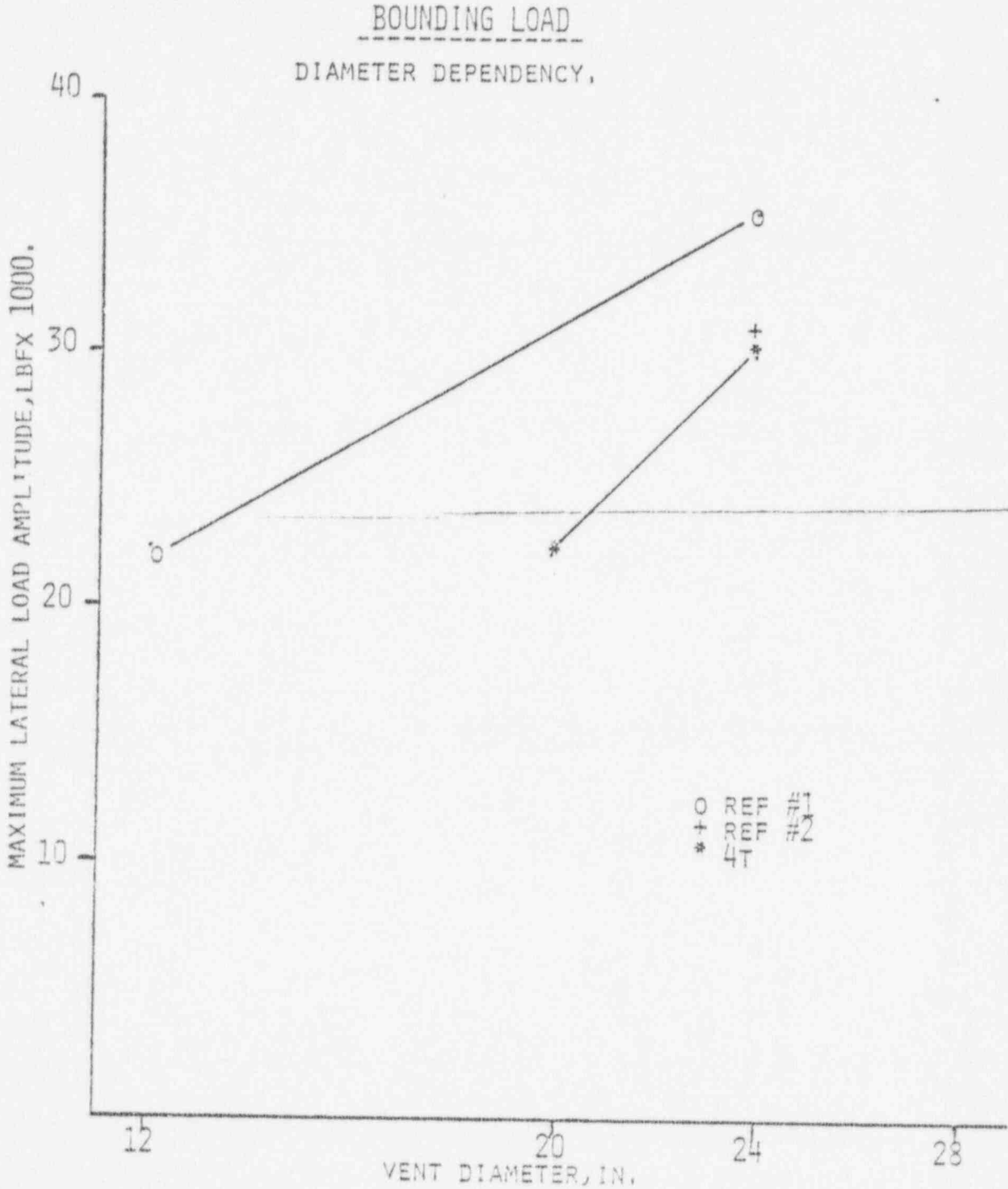
SPECIFIC CORRELATION PROCEDURE

- o SIMULATE DYNAMIC LATERAL RESPONSE OF REFERENCE FACILITY TO FORCING FUNCTION DEFINED BY 4T DATA.
- o CALCULATE RESULTING BRACE LOADS AND ACCELERATION RESPONSES AS MEASURED IN THE SUBJECT TESTS.
- o Compare ~~CORRELATE~~ SIMULATED AND EXPERIMENTAL BRACE STRESS AND/OR ACCELERATION TIME HISTORIES TO DETERMINE AMPLITUDE AND HALF PERIOD OF THE LATERAL LOAD FUNCTION WHICH REPRODUCES THE MEASURED RESPONSE DATA.


COMPARISON OF EXPERIMENTALLY OBSERVED BRACE LOADS.
CUMULATIVE DISTRIBUTIONS.
——REF.#1
- - -REF.#2
+ + 4T
PERCENT PROBABILITY OF EXEEDENCE
100
80
60
40
20
0
.2
.4
.6
.8
1.0
1.2
1.3
BRACE LOAD,LBF X 10,000

LATERAL BOUNDING LOAD FOR ALL TESTS.




BOUNDING LOAD
DIAMETER DEPENDENCY.
MAXIMUM LATERAL LOAD AMPLITUDE,LBFX 1000.
40
30
20
10
12
20
24
28
VENT DIAMETER,IN.
O REF #1
+ REF #2
* 4T

DIAMETER DEPENDENCY

- 4T AND REFERENCE #1 SUGGEST THAT THE FOLLOWING GENERAL EXPRESSION DEFINES THE DEPENDENCY OF LATERAL LOAD UPON DIAMETER:

$$F = F_O [D/D_O]^N$$

WHERE: F IS TIP LOAD AT ANY DIAMETER D
F_O BOUNDING LOAD AMPLITUDE AT D_O
N, EXPERIMENTAL COEFF.

- 4T DATA SHOWS VALUES OF N RANGING FROM .5 TO 1.7, BUT HAS LIMITED PARAMETRIC ACCURACY DUE TO THE SMALL DIFFERENCES IN TEST DIAMETERS. 20 TO 24 IN.
- REFERENCE #1 DATA SHOWS A VALUE OF N=.7. GOOD PARAMETRIC ACCURACY WAS OBTAINED FROM THESE TESTS. 12 AND 24 IN.

THE USE OF EITHER OF THE TWO MAXIMUM EXPONENT VALUES WITH THE CORRESPONDING REFERENCE BOUNDING LOAD YIELDS A DYNAMIC DESIGN LOAD OF 40,000 LBF. FOR 28 INCH DOWNCOMERS.

STATUS OF MULTIVENT LATERAL LOAD METHODOLOGY

OBJECT - DEVELOP A CONSERVATIVE MULTIVENT LATERAL LOAD SPECIFICATION

APPROACH - USE STATISTICS OF 4-T CHUGGING LATERAL LOADS (AS ANALYZED BY PRETECH) TO DETERMINE THE TIP IMPULSE AS A FUNCTION OF NUMBER OF DOWNCOMERS

C.D.I.
11/14/79

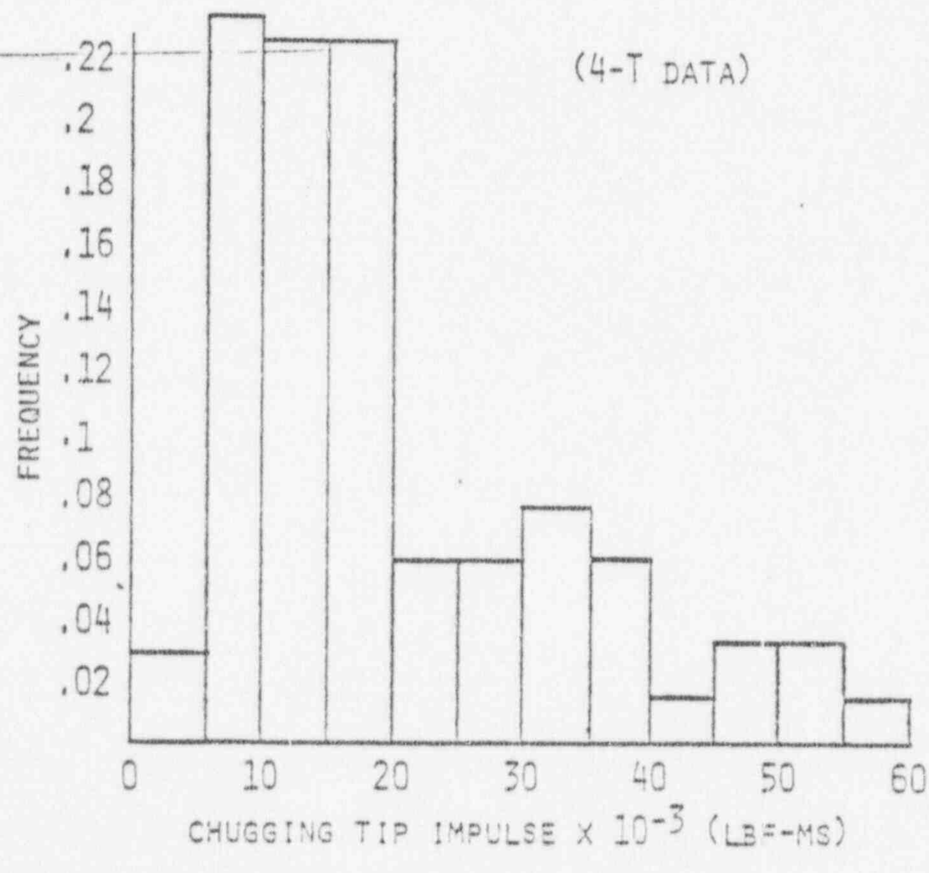
- PRETECH BOUNDING DYNAMIC LOAD

$$F(t) = A(\tau)\sin\frac{t\pi}{\tau} \quad \text{for} \quad 0 < t < \tau$$

$$A(\tau) = -20\text{klbf}\left(\frac{\tau}{3\text{ms}}\right) + 50\text{klbf} \quad \text{for} \quad 3\text{ms} < \tau < 6\text{ms}$$

$$I = \int_0^\tau A(\tau)\sin\frac{t\pi}{\tau}\,dt$$

- CHUGGING TIP IMPULSE PROBABILITY DENSITY

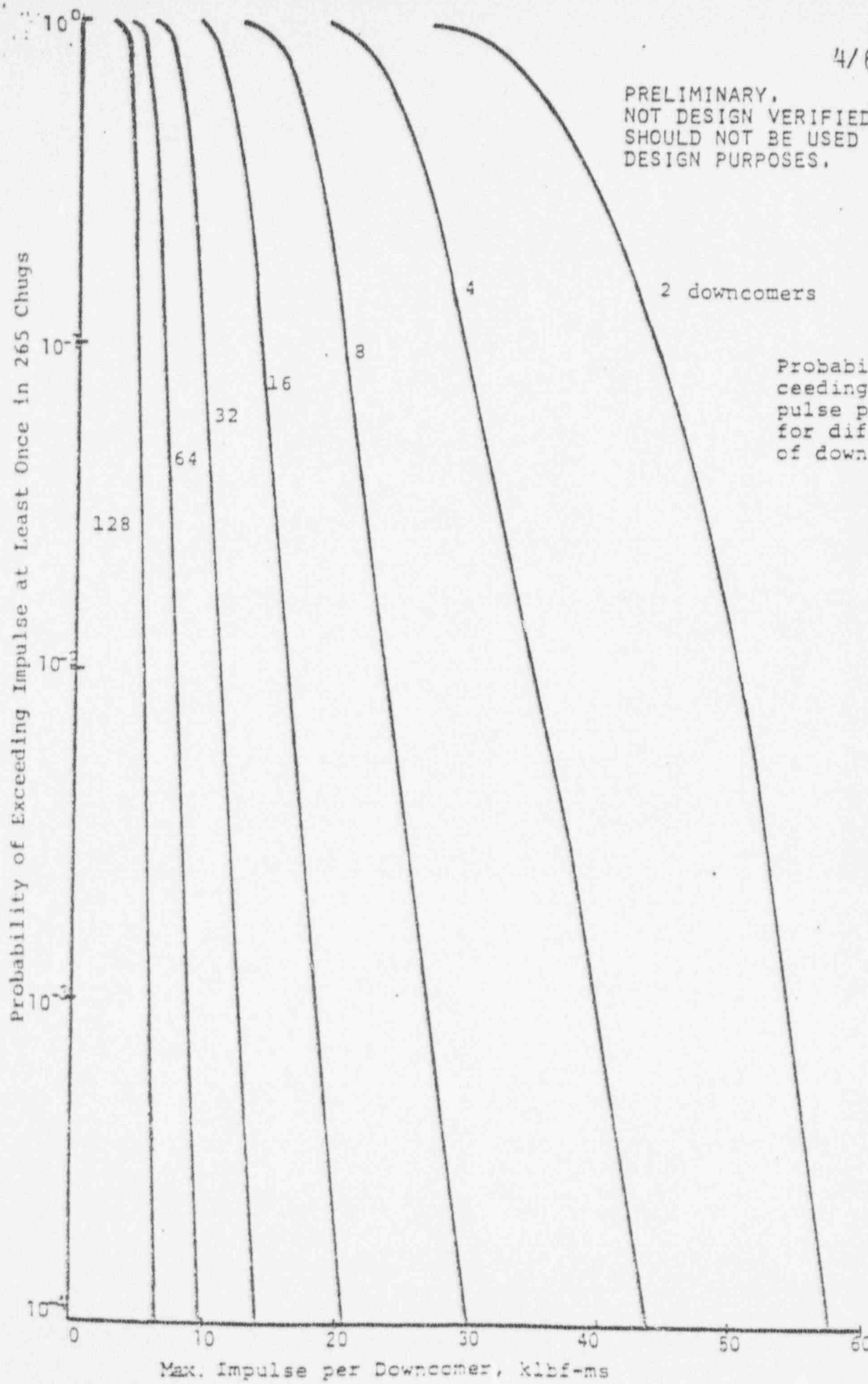


- THE ANGLE OF THE CHUGGING TIP IMPULSE HAS A DENSITY FUNCTION UNIFORMLY DISTRIBUTED OVER 2π RADIANS IN THE HORIZONTAL PLANE.

FOR A GROUP OF N DOWNCOMERS, COMPUTE THE PROBABILITY P THAT THE RESULTANT TIP IMPULSE ON THE GROUP OF DOWNCOMERS WILL FALL WITHIN A GIVEN TIP IMPULSE INTERVAL.

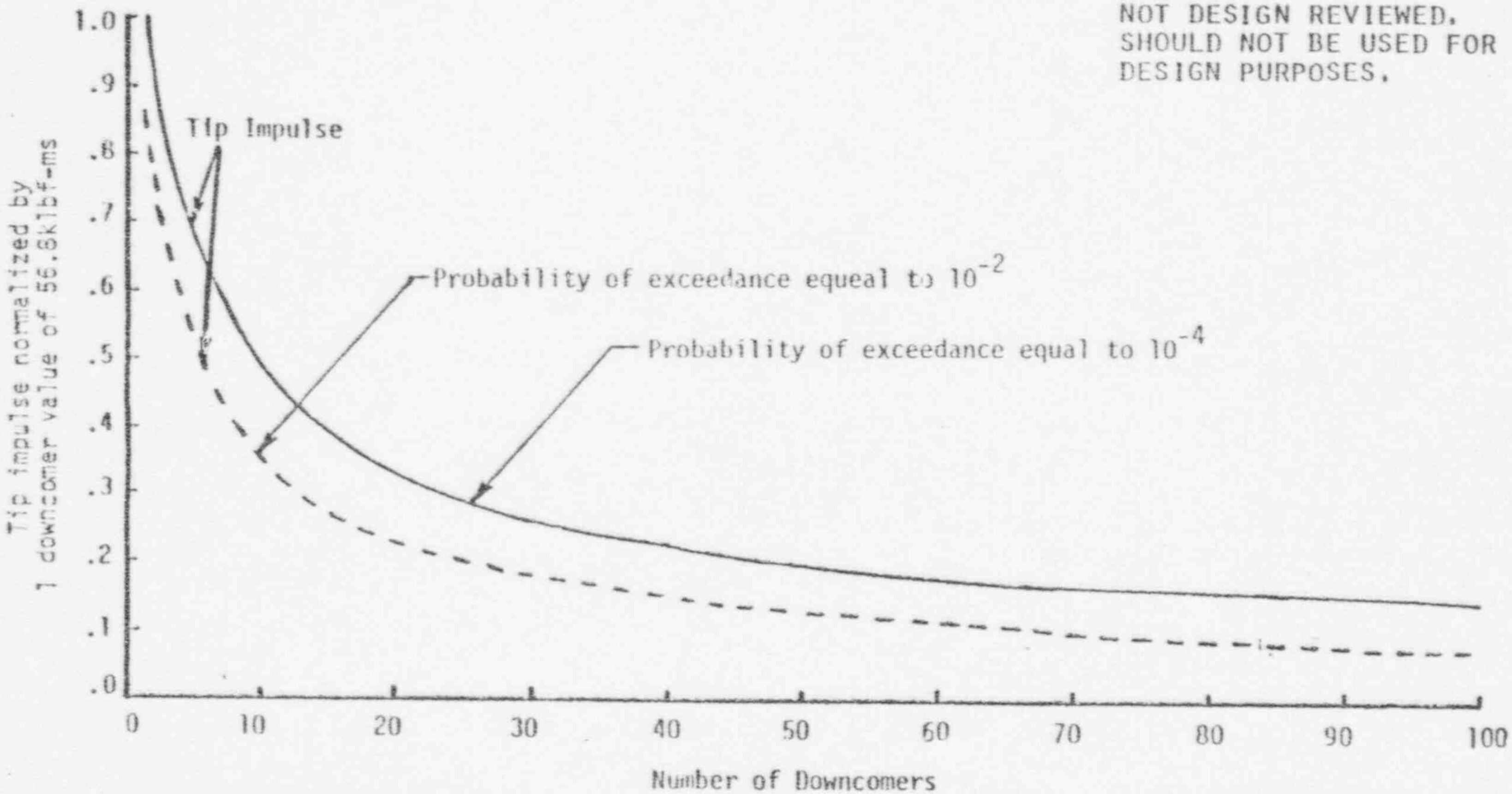
THEN, IF P_1 IS THE CUMULATIVE PROBABILITY THAT THE RESULTANT TIP IMPULSE WILL NOT EXCEED THE IMPULSE VALUE AT THE UPPER BOUNDARY OF THE INTERVAL IN ONE CHUG, $1 - (P_1)^M$ IS THE PROBABILITY OF EXCEEDING THE GIVEN TIP IMPULSE MAGNITUDE AFTER M CHUGS.

PRELIMINARY.
NOT DESIGN VERIFIED.
SHOULD NOT BE USED FOR
DESIGN PURPOSES.



Probability of exceeding a given impulse per downcome for different numbe of downcomers

PRELIMINARY.
NOT DESIGN REVIEWED.
SHOULD NOT BE USED FOR
DESIGN PURPOSES.



Tip impulse normalized by the one downcomer value of 56.8klbf-ms vs number of downcomers for a probability level of exceedance.

5/6

PRELIMINARY CONCLUSIONS

A MULTIVENT DYNAMIC LATERAL LOAD SPECIFICATION HAS BEEN DEVELOPED WHICH USES STATISTICS OF 4-T CHUGGING LATERAL LOADS TO DETERMINE THE TIP IMPULSE.

CONSERVATISMS EXIST IN THE SPEC

- THE IMPULSE FUNCTION COMPUTED FROM PRETECH'S LOADING FUNCTION BOUNDS ALL 4-T DATA.
- NO CREDIT IS TAKEN FOR LACK OF SYNCHRONIZATION BETWEEN VENTS.

A.16 PHASE II CHUGGING STATUS

- PROGRAM OBJECTIVES

  - CONFIRM DFFR LOAD IS CONSERVATIVE FOR LEAD PLANT APPLICATION

  - JUSTIFY IMPROVED LOAD FOR NON-LEAD PLANT APPLICATION

A.16 PHASE II CHUGGING STATUS

	COMPLETED SCHEDULE ITEMS
• KEY MILESTONES	
• ANALYZED 137 CHUGS FROM 4T	--
• DEVELOPED ACOUSTIC MODEL TO SIMULATE TYPICAL CHUGS	--
• AVERAGED PSD OF 137 CHUGS	--
• DEVELOPED CRITERIA FOR ENVELOPING PSD	--
• USED ACOUSTIC MODEL TO INFER VENT SOURCE THAT ENVELOPED PSD	--
• DEFINED SYMMETRIC AND ASYMMETRIC LOAD CASES	--
• COMPUTED MK II RIGID WALL RESPONSES USING DESIGN SOURCE	--
• COMPUTED MK II RESPONSES USING TYPICAL MK II STRUCTURAL MODEL AND COMPARED TO DFFR	--
• NRC TECHNICAL MEETING IN HA ER	JULY '79

A.16 PHASE II CHUGGING STATUS

	TARGET SCHEDULE
• **KEY MILESTONES**	
• VERIFY TREATMENT OF FSI BY NASTRAN MODEL OF 4T	NOV. '79
• VERIFY USE OF TYPICAL MK II STRUCTURAL MODEL USING NASTRAN MODEL OF MK II	NOV. '79
• FINAL REPORT MODIFIED AND EXPANDED BASED ON NRC JULY INPUT	FEB. '80

4T CO TEST PROGRAM

OBJECTIVES

- RESOLVE VENT LENGTH EFFECT
- COMPARE DATA TO EXISTING DFFR C.O. SPECIFICATION
  - MODIFIED 4T FACILITY
  - PROTOTYPICAL CONFIGURATION
  - VARYING TEST CONDITIONS

4TCO TEST PROGRAM

SCHEDULE & MILESTONES

MILESTONE	COMPLETION DATE
FACILITY DESIGN	COMPLETE
TEST PLAN	COMPLETE
TEST FREEZE	COMPLETE
FACILITY MODIFICATION	COMPLETE
SHAKEDOWN TESTING	COMPLETE
MATRIX TESTS - 23 TOTAL	
• 9 TESTS	COMPLETE
• COMPLETE TESTING	FEBRUARY '80
DATA REDUCTION	MAY ' 80
FINAL TEST REPORT	3Q80

4TCO TEST MATRIX

RUN NO.	BREAK TYPE	BREAK SIZE (IN)	POOL TEMP. (°F)	VENT SUBMER. (FT.)	VENT RISER	INITIAL DRYWELL AIR (%)
16	STEAM	3.00	70	11	YES	100
2	LIQUID	3.00	70	11	NO	100
3	LIQUID	3.82	70	11	NO	100
4	LIQUID	3.82	70	11	YES	100
5	LIQUID	-- *	80	11	NO	100
6	LIQUID	3.82	70	11	NO	∼ 50
7	LIQUID	-- *	90	11	NO	100
8	LIQUID	3.82	110	11	NO	100
9	LIQUID	3.00	110	11	NO	100
10	LIQUID	-- *	70	9	NO	100
11	LIQUID	-- *	70	13.5	NO	100
12	LIQUID	2.50	110	11	NO	100
13	LIQUID	2.125	110	11	NO	100
14	LIQUID	2.125	70	11	NO	100
15	LIQUID	2.125	70	11	YES	100
1	STEAM	3.00	70	11	NO	100
17	STEAM	3.00	70	9	NO	100
18	STEAM	3.00	70	13.5	NO	100
19	STEAM	3.00	70	13.5	NO	100
20	STEAM	2.50	70	11	NO	100
21	STEAM	2.50	70	11	NO	100
22	REPEAT	(LATER)				
23	REPEAT	(LATER)				

* Break sizes for these tests to be specified after evaluation of initial results.

TEST MATRIX OBJECTIVES

- DUPLICATE PREVIOUS 4T TEST CONDITIONS
  - TESTS 17, 1, 18, 20
- OBTAIN DATA AT C.O. CONDITIONS FOR RANGE OF MARK II FLOW RATE/POOL TEMPERATURES
  - TESTS 3, 5, 7, 8, 2, 9, 12, 14, 13
- PARAMETER RANGE FOR MARK II
  - AIR CONTENT AND POOL TEMPERATURE
    - TESTS 3, 5, 7, 8, 6
  - VENT SUBMERGENCE
    - TESTS 17, 1, 18, 10, 2, 11
  - VENT RISER
    - TESTS 4, 3, 15, 14, 16, 1
- REPEATABILITY
  - TESTS 18, 19, 20, 21, 22, 23

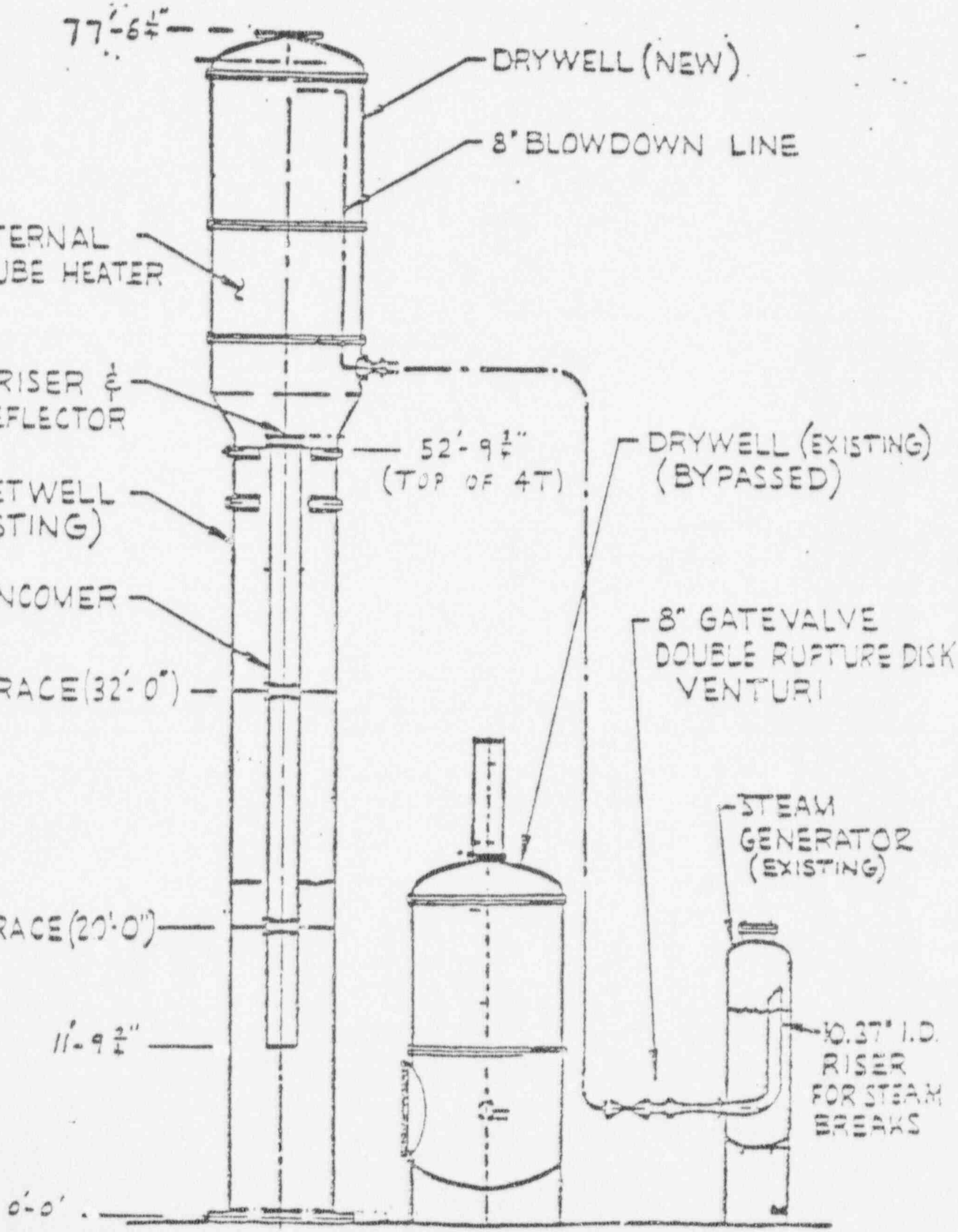
4T CO INSTRUMENTATION

LOCATION	INSTRUMENT TYPE	MEASUREMENT	NO.
Wetwell & Suppression Pool	Flush Mount Press. xdcr	Pool Boundary Press.	11
		Wetwell airspace press.	1
	Accelerometers	Fac. Response	6
	Strain gages	Fac. Comp. Response	3
	Thermocouples	Pool temperature	11
		Freespace temperature	1
	Cavity Press. xdcr	Liquid Level	1
Downcomer	Flush Mount Press. xdcr	Vent acoustics	5
	Cavity ΔP xdcr	Vent flow	1
	Cavity press. xdcr	Vent flow	1
	Level probe	Chug initiation	1
	Accelerometers	Chug initiation	2
	Thermocouples	Vent flow & temp.	1
Drywell	Flush Mount Press. xdcr	Acoustics	1
	Cavity press. xdcr	Static press.	1
	Capacitance Probe	Liquid retention	1
	Thermocouples	Drywell temperature	1
Blowdown Line	Cavity press. xdcr	Blowdown flow	1
	Thermocouples	Blowdown line exit temp.	1
Steam Vessel	Cavity ΔP xdcr	Liquid blowdown flow	8
	Cavity press. xdcr	Vessel pressure	1
Vacuum Breaker	Potentiometer	Valve opening	1

Other Instrumentation

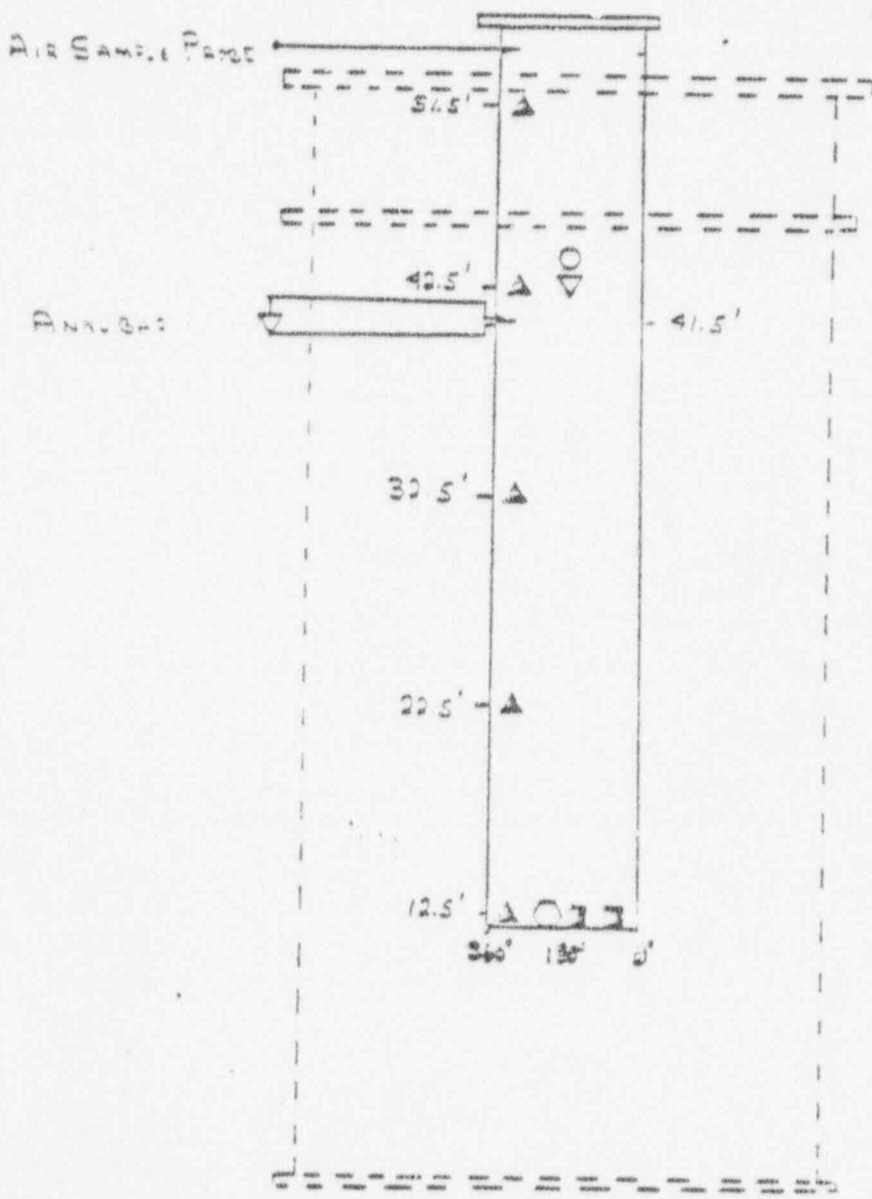
- Air Content (grab sample and continous air monitoring)

TEST CONFIGURATION FOR MARK II 4T CONDENSATION OSCILLATION (4TCO) TESTS



△ FLUSH MOUNT PRESSURE TRANSDUCER
▽ CAVITY PRESSURE TRANSDUCER
○ THERMOCOUPLE
□ ACCELEROMETER
○ CONDUCTIVITY PROBE

REPLAY (1000 SAMPLES/SEC)
REAL TIME (100 SAMPLES/SEC)



ORIENTATION

ACCELEROMETER

HORIZONTAL TANGENT
TO DOWNCOMER

NOTE: PRESSURE TRANSDUCER AND CONDUCTIVITY PROBE ON BOTTOM OF DOWNCOMER ARE LOCATED AS CLOSE TOGETHER AS POSSIBLE.

DOWNCOMER INSTRUMENTATION

▽ CAVITY PRESSURE TRANSDUCER

△ FLUSH MOUNT PRESSURE TRANSDUCER

□ ACCELEROMETER

◢ UNIAXIAL STRAIN GAGE

⊕ REPLAY (1000 SAMPLES/SEC)

○ REAL TIME (100 SAMPLES/SEC)

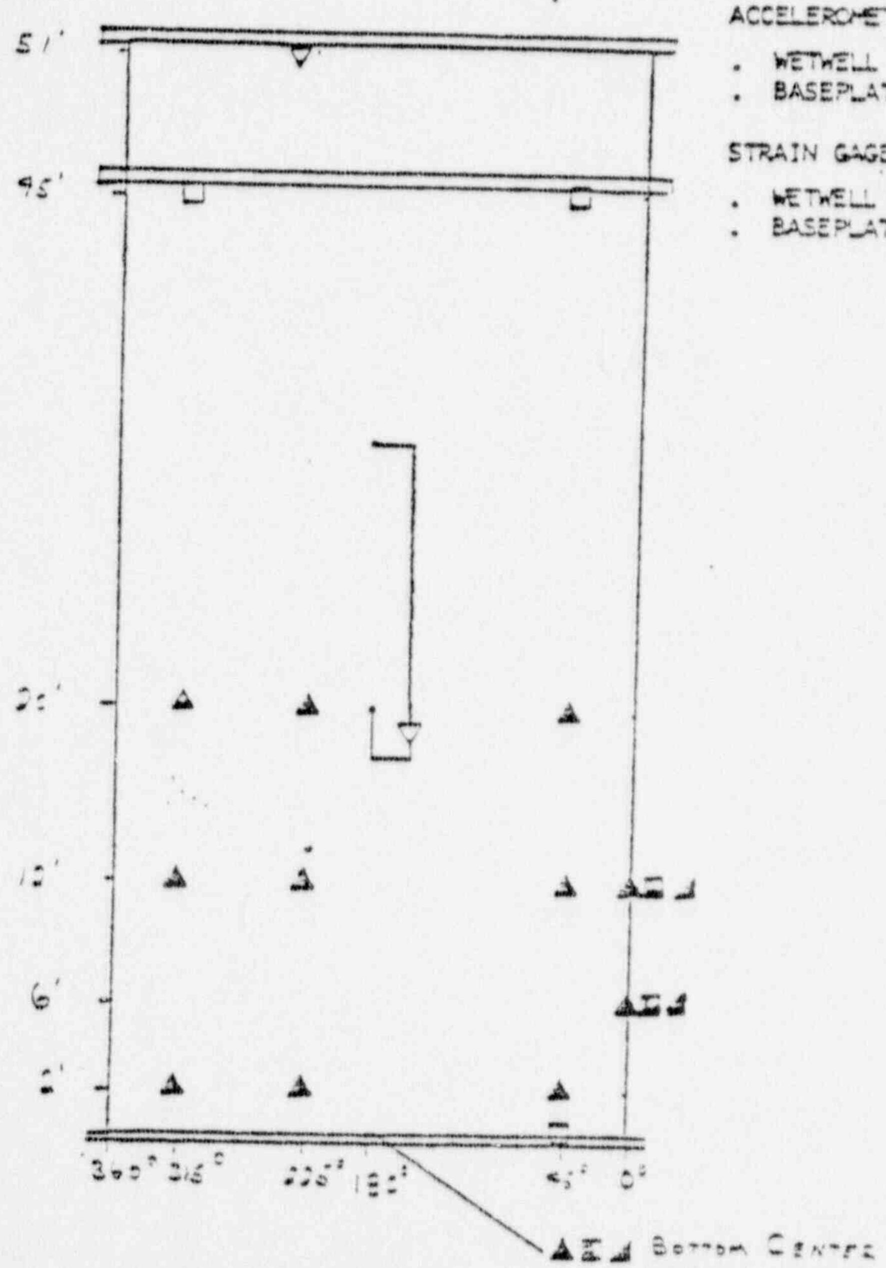
ORIENTATION

ACCELEROMETERS

. WETWELL O.D. - RADIAL
. BASEPLATE - VERTICAL

STRAIN GAGES

. WETWELL O.D. - HOOP
. BASEPLATE - RADIAL



WETWELL AND SUPPRESSION POOL INSTRUMENTATION
PRESSURE, ACCELERATION, AND STRAIN

4T CO DATA INTERPRETATION

ELEMENTS	USAGE
• VENT PRESSURE HISTORIES	- DETERMINATION OF STANDING WAVE PRESENCE
• POOL WALL PRESSURES	- ESTABLISH CO AMPLITUDE vs FREQUENCY CONTENT
	- INTERPRETATION FOR MARK II APPLICATION
	- COMPARE TO DFFR

RJM 11/79

TESTS CONDUCTED

NO.	BREAK TYPE	BREAK SIZE (IN)	POOL TEMP. (^{o}F)	SPECIAL FEATURES	
				VENT RISER	INITIAL DRYWELL AIR
16	STEAM	3.0	70	YES	100%
2	LIQUID	3.0	70	NO	100%
3	LIQUID	3.82	70	NO	100%
4	LIQUID	3.82	70	YES	100%
6	LIQUID	3.82	70	NO	~50%
8	LIQUID	3.82	110	NO	100%
9	LIQUID	3.0	110	NO	100%
12	LIQUID	2.5	110	NO	100%
13	LIQUID	2.125	110	NO	100%

11/79

BROOKHAVEN THEORETICAL STUDIES

(CHAPTER 2 AND 3)

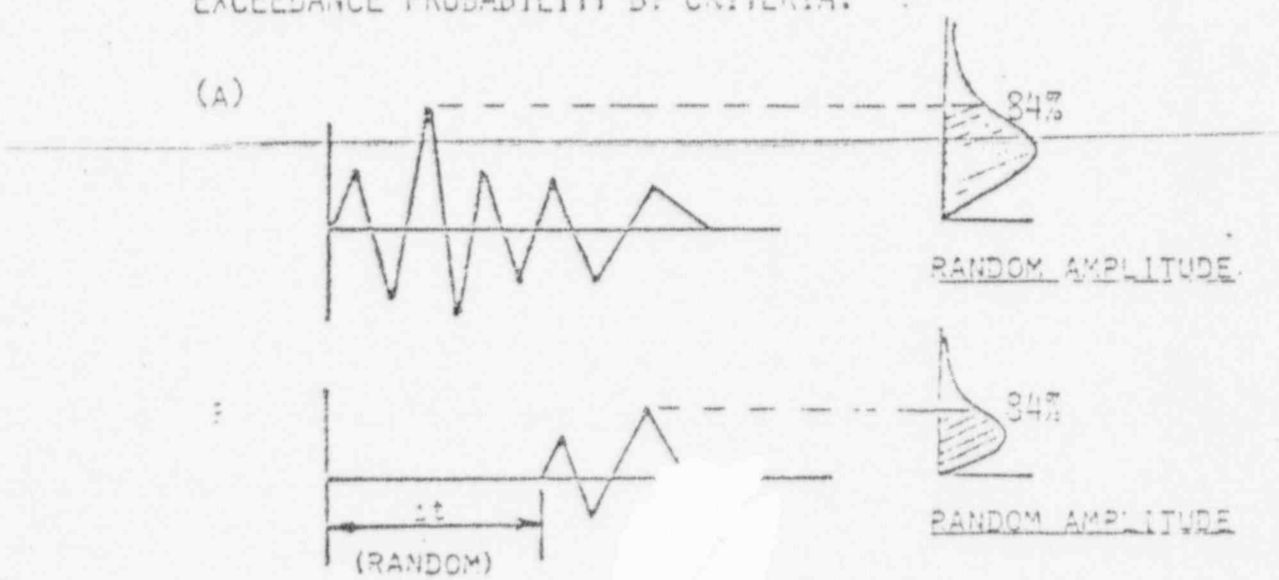
- STUDIED LIGHTLY DAMPED & UNDAMPED SINE WAVES
- CONCLUDED THAT WHEN YOU COMBINE TWO WAVES OF SIGNIFICANTLY DIFFERENT FREQUENCIES, THE NEP OF SRSS CAN BE LOW
- NOT RELEVANT TO TRANSIENT RESPONSE
  - LIGHTLY DAMPED SINE WAVES ONLY REPRESENT RESPONSE DURING FREE VIBRATION AFTER TERMINATION OF INPUT
  - FOR NUCLEAR PLANT TYPE STRUCTURES SUBJECT TO REAL INPUT, PEAK RESPONSE NEARLY ALWAYS OCCURS DURING TRANSIENT RESPONSE STAGE
- IF CONCLUSION WERE TRUE, WE WOULD BE UNABLE TO COMBINE EARTHQUAKE RESPONSES BY SRSS. EXPERIENCE HAS INDICATED THAT FOR EARTHQUAKE-LIKE INPUT, WIDE FREQUENCY VARIATION DOES NOT LEAD TO LOW NEP FOR SRSS.

MULTIPLE RESPONSE TIME HISTORIES

1. TIME HISTORIES HAVE RANDOM RELATIVE START TIMES. (UNCORRELATED)

2. TIME HISTORIES ALSO HAVE RANDOM AMPLITUDES.

3. DESIGN AMPLITUDES ARE DEFINED TO BE AT THE 84% NON-EXCEEDANCE PROBABILITY BY CRITERIA.



4. HOW SHOULD PEAK INDIVIDUAL RESPONSE BE COMBINED?

BASIC ASSUMPTION BEHIND CRITERIA FOR SRSS COMBINATION OF RESPONSES

- MANY SOURCES OF CONSERVATISM EXIST IN DESIGN AND EVALUATION PROCESS.
- ADDITIONAL CONSERVATISM DOES NOT HAVE TO BE INCORPORATED WITHIN THE RESPONSE COMBINATION PROCESS.
- IT IS NOT NECESSARY FOR THE COMBINED RESPONSE TO HAVE A LOWER PROBABILITY OF EXCEEDANCE THAN THE INDIVIDUAL RESPONSES.

CRITERION 2

$R_{SRSS_{84}}$ = SRSS COMBINED RESPONSE WHERE EACH INDIVIDUAL RESPONSE HAS BEEN DEFINED CONSERVATIVELY AT 84TH PERCENTILE OR F•MEDIAN.

$R_{T_{84}}$ = RANDOM TIME PHASE COMBINED RESPONSE WHERE ALL AMPLITUDES DEFINED AT 84TH PERCENTILE.

R = COMBINED RESPONSE CONSIDERING BOTH RANDOM AMPLITUDE AND TIME PHASING.

GOAL OF SRSS COMBINATION

$$P\left[R \le R_{SRSS_{84}}\right] \ge 84\% \qquad (1)$$

CRITERION 2 REQUIREMENT

$$P\left[R_{T_{84}} \le R_{SRSS_{84}}\right] \ge 50\% \qquad (2)$$

&

$$P\left[R_{T_{84}} \le 1.2\, R_{SRSS_{84}}\right] \ge 85\% \qquad (3)$$

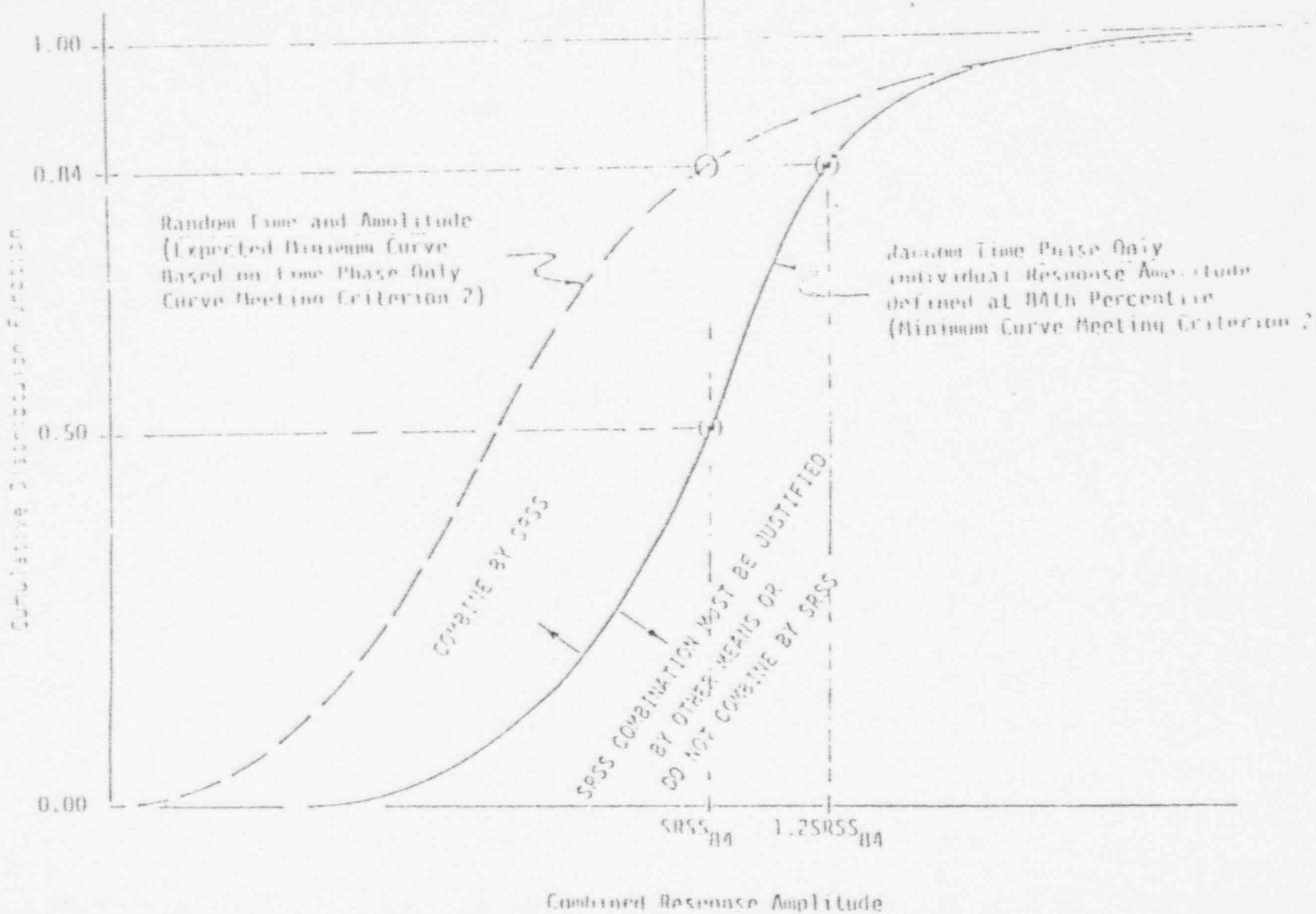


FIGURE 2-1. COMPARISON OF RANDOM TIME PHASE ONLY CDF CURVES WITH RANDOM TIME PHASE AND AMPLITUDE CDF CURVES

CUMULATIVE DISTRIBUTION FUNCTION

P(R<R₀)

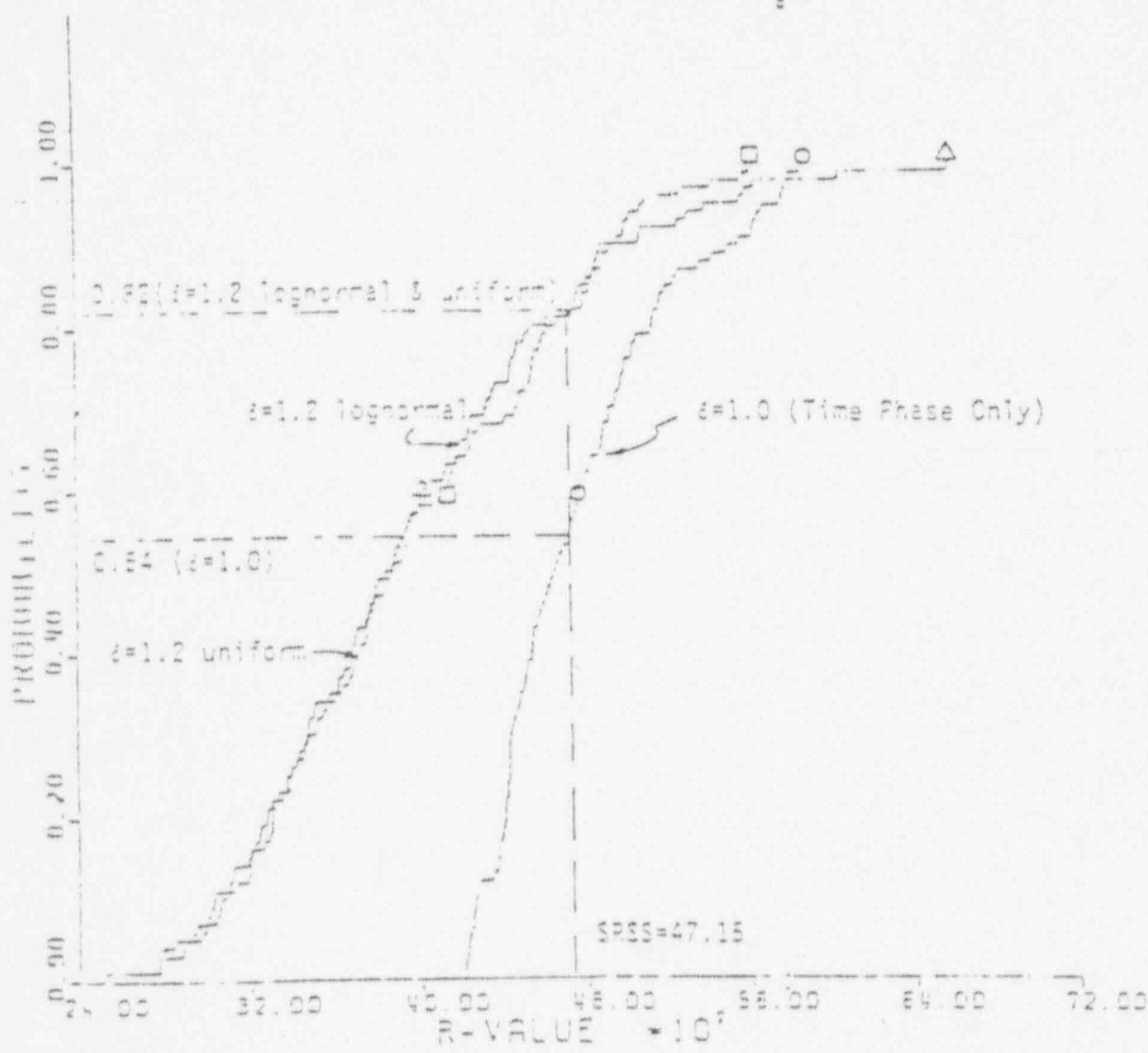


FIGURE 2-66 CASE 3: RHR-WETWELL OBE + SRVBUB M_a (POSITIVE)

INFLUENCE OF SHAPE OF AMPLITUDE

CONCLUSION OF STUDY OF CRITERION 2

- IN MOST CASES, CRITERION 2 LEADS TO A NEP FOR SRSS COMBINED RESPONSES OF APPROXIMATELY 84%
- IN SOME CASES, CRITERION MORE CONSERVATIVE THAN NECESSARY
- IN NO CASE CAN THE 84% NEP PEAK COMBINED RESPONSE EXCEED THE SRSS COMBINED RESPONSE BY MORE THAN 9%
- THUS, CRITERION 2 IS AN ADEQUATE, SLIGHTLY CONSERVATIVELY BIASED CRITERION

CORNELL STUDIES

- DR. CORNELL HAS BEEN INDEPENDENTLY ENGAGED TO EVALUATE ADEQUACY OF CRITERION 2
- HE HAS CONCLUDED THAT CDF CURVES CAN BE ACCURATELY GENERATED FROM A KNOWLEDGE OF THE FOLLOWING RESPONSE CHARACTERISTICS
  - UPCROSSING RATES (NUMBER OF PEAKS)
  - MARGINALS (TOTAL DURATION OF PEAKS)
- IMPLICATIONS ARE:
  - WE WILL BE ABLE TO DIRECTLY GENERATE CDF FROM SIMPLE CHARACTERISTICS OF RESPONSES
  - WE MAY EVENTUALLY BE ABLE TO DIRECTLY GENERATE CDF FROM SIMPLE CHARACTERISTICS OF INPUT
- HE HAS MADE MANY ADDED STUDIES OF CRITERION 2 AND REINFORCES OUR CONCLUSION THAT IT ACHIEVES ITS GOAL IN EVERY CASE !

BROOKHAVEN STUDY CRITERION 2

- THEY STATE THEIR RESULTS DO NOT AGREE WITH GE BUT DO NOT PRESENT BASIS FOR THIS CONCLUSION

- IN THEIR EXAMPLES, EVERY CASE WHICH MEETS CRITERION 2 ALSO MEETS ITS INTENT

- THEY CLAIM LACK OF UNIQUENESS. HOWEVER, WHEN COMBINED WITH ASME CODE, APPENDIX N PROCEDURE FOR GENERATING CDF, CRITERION IS UNIQUE.

- WE BELIEVE THAT IT IS EXTREMELY IMPORTANT TO HAVE A CRITERION LIKE CRITERION 2 AND WISH TO WORK WITH THE NRL TO RESOLVE ANY BROOKHAVEN CONCERNS ON THIS CRITERION

CRITERIA 1 REQUIREMENTS:

- RESPONSE COMPONENTS FROM INDEPENDENT EVENTS OR RANDOM PHASING

- LIMITED NUMBER OF NEAR PEAK EXCURSION

  NO MORE THAN 5 EXCEEDING 75% OF THE MAXIMUM, OR
  NO MORE THAN 10 EXCEEDING 60% OF THE MAXIMUM

- LIMITED DURATION

  10 SECONDS OR LESS

- APPROXIMATELY ZERO MEAN

JUSTIFICATION OF CRITERION 1

- CRITERION 1 IS INTENDED TO ASSURE THAT RESPONSE IS EARTHQUAKE-LIKE

- FOR CERTAIN STATIONARY STOCHASTIC PROCESSES THE PROBABILITY OF EXCEEDANCE OF SRSS COMBINED RESPONSE CAN BE SHOWN TO BE EQUAL TO THE PROBABILITY OF EXCEEDANCE OF THE INDIVIDUAL RESPONSES

$$P\left[R \leq R_{SRSS_{84}}\right] = 84\%$$

- EARTHQUAKE-LIKE RESPONSES HAVE BEEN SHOWN TO BE REASONABLY APPROXIMATED AS STATIONARY STOCHASTIC PROCESSES AND CAN BE EVEN BETTER APPROXIMATED AS NON-STATIONARY PROCESSES

- FOR NON-STATIONARY PROCESSES:

$$P\left[R \leq R_{SRSS_{84}}\right] \geq 84\% \qquad (1)$$

- EARTHQUAKE-LIKE RESPONSE EXPECTED TO MEET EQUATION 1

- EARTHQUAKE-LIKE RESPONSE REQUIRES <u>LESS</u> NEAR-MAX. PEAKS (MORE NON-STATIONARY) THAN FOR EARTHQUAKE RESPONSE, APPROXIMATELY ZERO MEAN, AND RANDOM PHASING

- RANDOM PHASING AUTOMATICALLY ACHIEVED BY RANDOM START TIME. TO BE CONSIDERED RANDOM, RELATIVE START TIMES MUST BE CONSIDERED UNKNOWN WITHIN A TIME INTERVAL GREATER THAN ABOUT 2 TO 5 TIMES THE NATURAL PERIOD OF THE STRUCTURE

JUSTIFICATION OF CRITERION 1 (CON'T.)

- JUSTIFICATION OF CRITERION 1 CONSIDERABLY BOLSTERED BY FACT THAT OUT OF 235 MARK II RESPONSE COMBINATIONS WHICH MEET CRITERION 1, 100% OF CASES (ALL 235) ALSO MET CRITERION 2

  ∴ MEETING CRITERION 1 PROVIDES HIGH CONFIDENCE THAT CRITERION 2 WOULD BE MET

RESPONSES TO QUESTIONS ON CRITERION 1

1. HOW TO ASSURE SUFFICIENTLY RAPID VARIATION OF TIME HISTORIES.

- RAPID VARIATION IS ASSURED BY:

  A) LIMITING THE NUMBER OF NEAR MAXIMUM PEAKS

  AND

  B) ASSURING A NEAR ZERO RATIO OF MEAN TO MAXIMUM RESPONSE OVER A TIME DURATION LESS THAN THE UNCERTAINTY IN THE LAG TIME.

- A RATIO OF MEAN TO MAXIMUM LESS THAN ABOUT 0.1 TO 0.2 MEETS REQUIREMENT OF NEAR ZERO MEAN.

2. WHY CAN LOADING TIME HISTORY BE USED IN LIEU OF RESPONSE TIME HISTORY.

- IF LOADING TIME-HISTORY IS EARTHQUAKE-LIKE THEN RESPONSE TIME-HISTORY WILL AUTOMATICALLY BE EARTHQUAKE-LIKE FOR LINEAR ELASTIC STRUCTURES (I.E.) IF LOADING HAS LESS NEAR PEAK EXCURSIONS THAN FOR EARTHQUAKE, THE RESPONSE TO LOADING WILL AUTOMATICALLY HAVE LESS NEAR PEAK EXCURSION THAN IT WOULD HAVE FROM EARTHQUAKE TIME HISTORY.

- IF LOADING HAS NEAR-ZERO MEAN, RESPONSE AUTOMATICALLY HAS NEAR-ZERO MEAN FOR LINEAR ELASTIC SYSTEMS.

- NOT PRACTICAL TO LIMIT CRITERIA TO RESPONSE. FOR MANY CASES, RESPONSE TIME HISTORIES ARE NOT GENERATED. NEED A CRITERIA WHICH CAN BE APPLIED AT THE LOADING LEVEL.

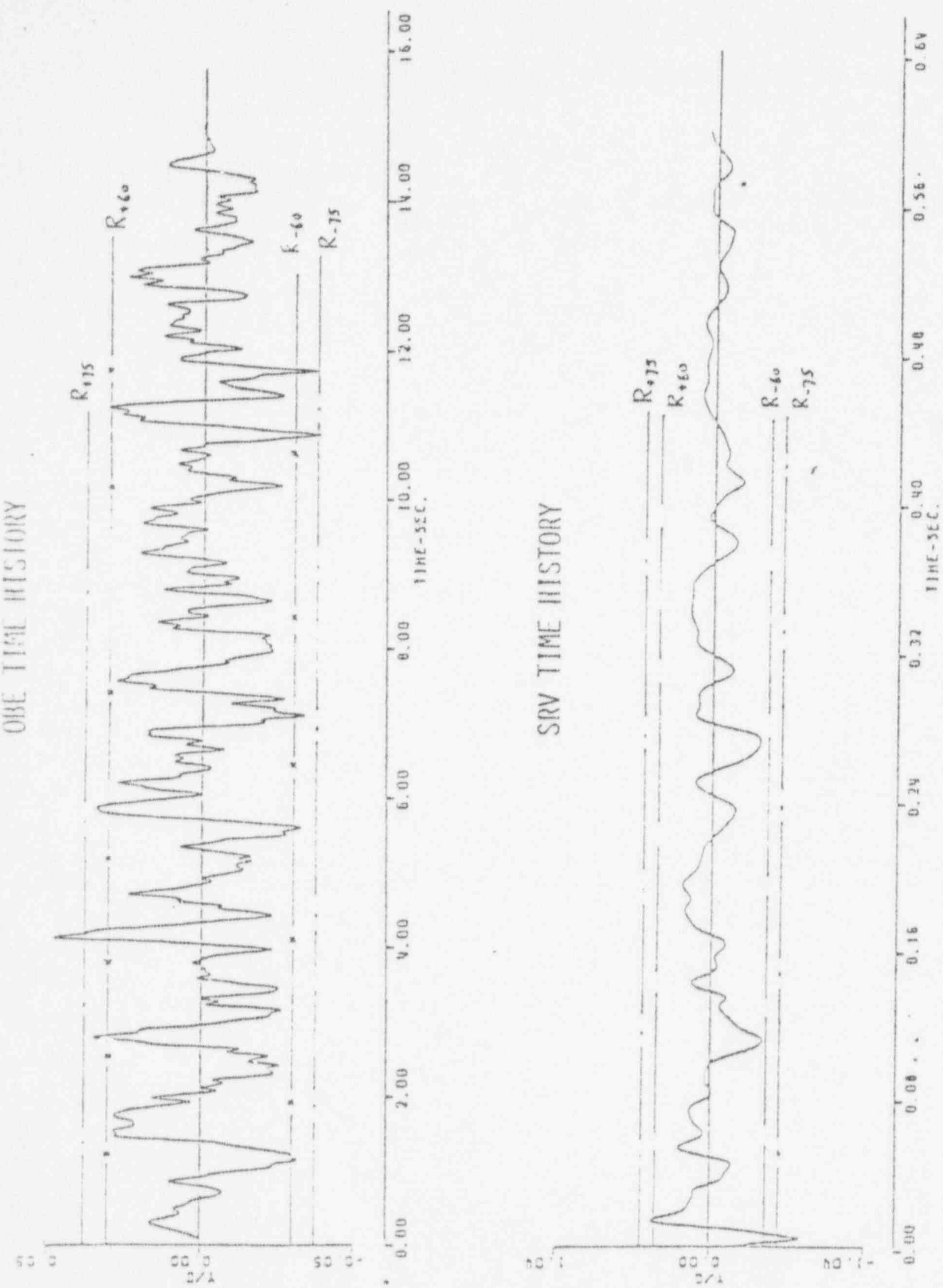


FIGURE 1-1. DYNAMIC EVENT LOADING FUNCTIONS

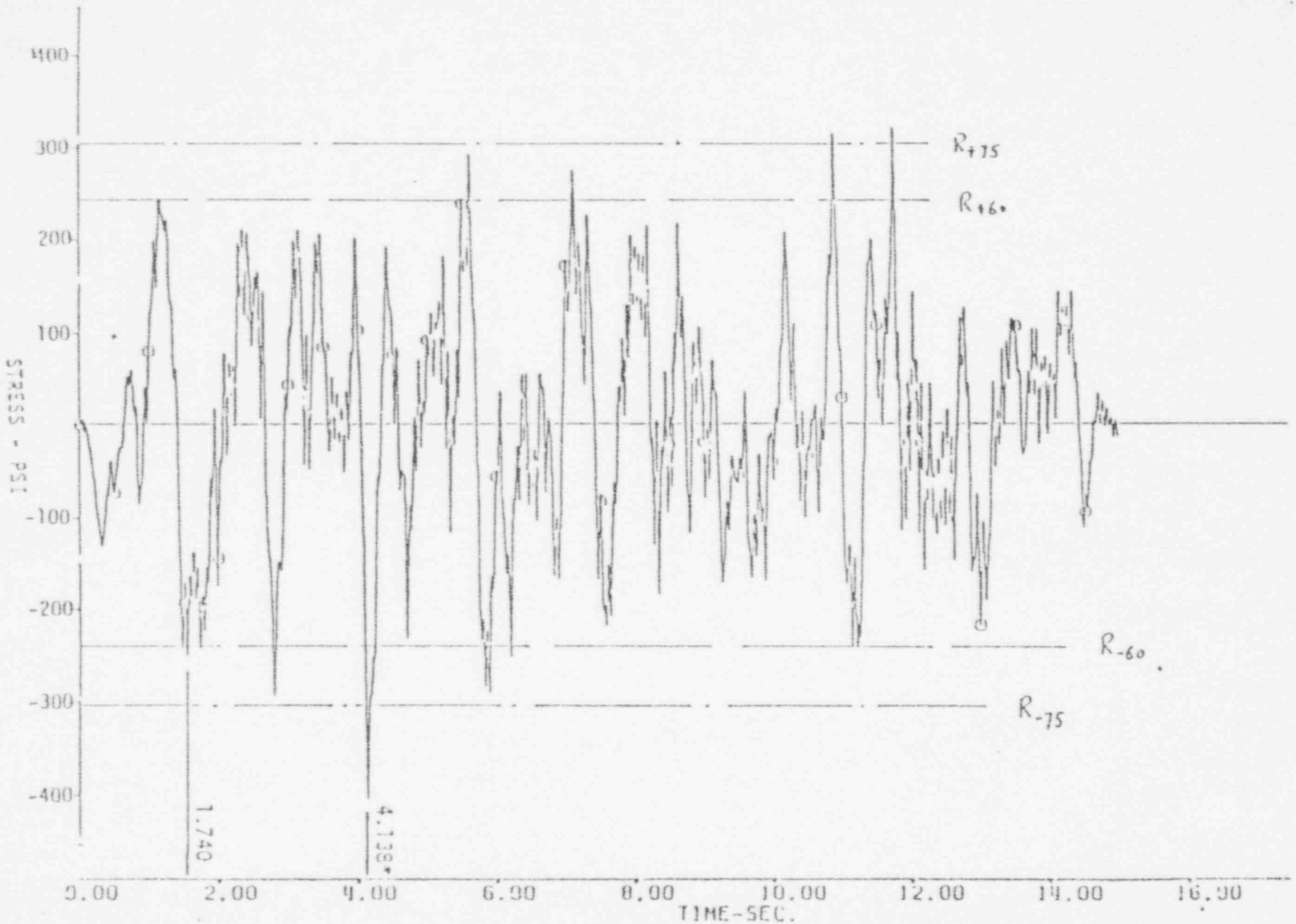


FIGURE 3-8. ELASTIC RESPONSE TO UNSCALED OBE, 16 Hz MODEL, 2 PERCENT DAMPING

* Time for peak elastic response.

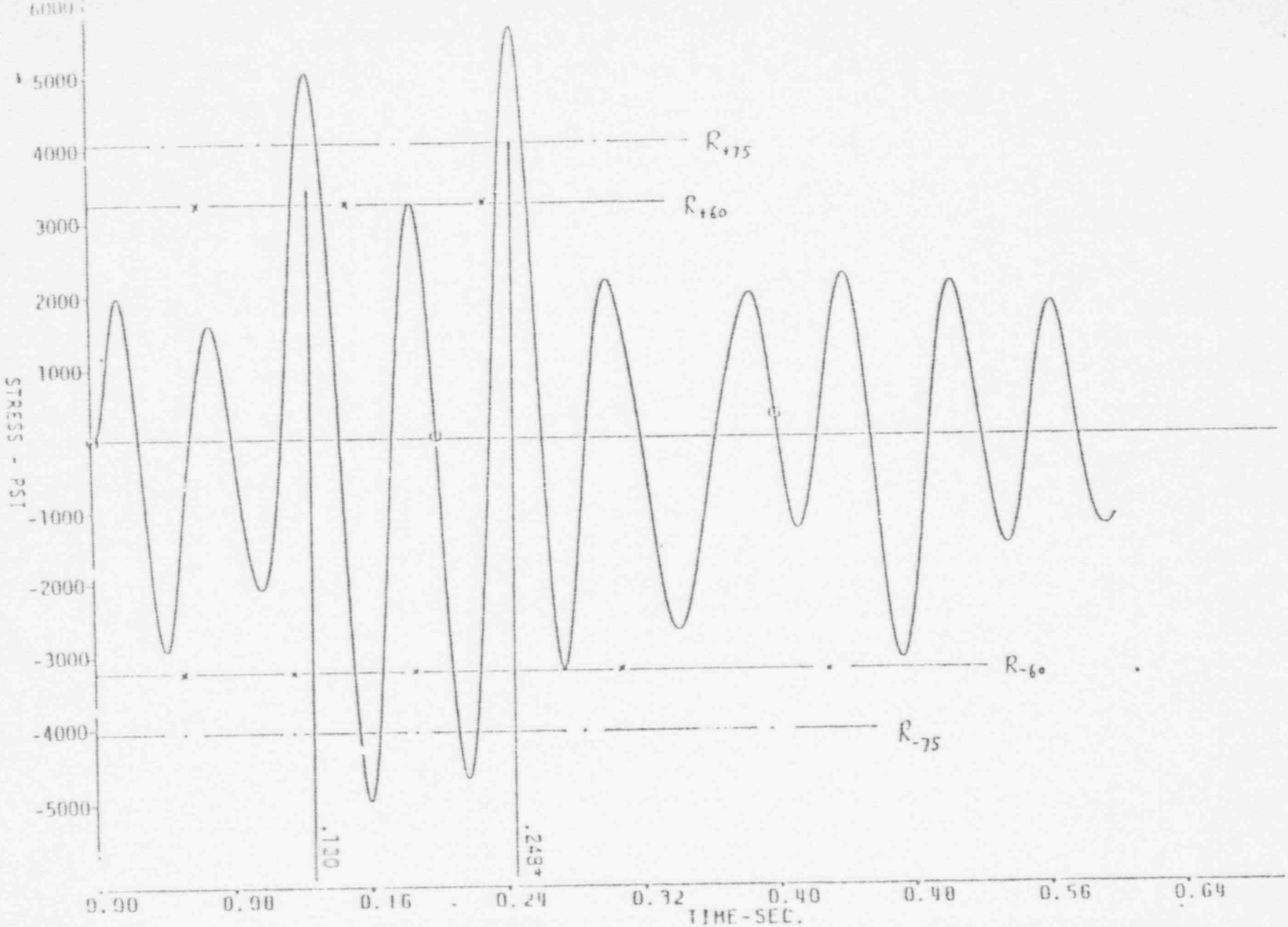


FIGURE 3-9. ELASTIC RESPONSE TO UNSCALED SRV, 16 Hz MODEL, 2 PERCENT DAMPING

* Time for peak elastic response.

BROOKHAVEN STUDY - CRITERION 2

LOAD VERSUS RESPONSE TIME HISTORIES

- BROOKHAVEN CLAIMS THAT OUR BASIS FOR RECOMMENDING THAT CRITERION 1 CAN BE USED AT THE LOAD LEVEL IS BASED ON OUR BELIEF THAT THERE ARE LESS PEAKS TO THE RESPONSE THAN THERE ARE FOR THE INPUT.
- WE HAVE NEVER MADE SUCH A CLAIM. IN FACT, ON TWO PREVIOUS OCCASIONS WE HAVE EXPLAINED TO BROOKHAVEN OUR BASIS FOR CRITERION 1, BUT THEY HAVE BEEN UNWILLING TO REVISE THEIR STATEMENT.
- BROOKHAVEN HAS ERECTED A "STRAWMAN" SO THEY COULD TEAR IT DOWN AND THEN HAS USED THIS AS THEIR BASIS FOR REJECTING A VALID CRITERION.
- OUR CRITERION 1 IS BASED ON THE CHARACTERISTICS OF EARTHQUAKE INPUT AND OUR KNOWLEDGE THAT WHEN THE INPUT HAS LESS PEAKS THAN FOR EARTHQUAKE INPUT, THE RESPONSES WILL HAVE LESS PEAKS THAN EARTHQUAKE RESPONSE.
- THUS, IF EARTHQUAKE RESPONSES CAN BE COMBINED SRSS, THESE OTHER RESPONSES SHOULD ALSO BE ABLE TO BE COMBINED SRSS.

BROOKHAVEN STUDY - CRITERION 1

NUMBER OF PEAKS VERSUS TOTAL DURATION OF PEAKS

- BROOKHAVEN HAS DEMONSTRATED THAT THE TOTAL DURATION OF PEAKS IS MORE SIGNIFICANT THAN NUMBER OF PEAKS FOR DETERMINING THE NEP OF SRSS COMBINED RESPONSE. WE AGREE.

- WE HAVE PREVIOUSLY PRESENTED A PROPOSED MODIFICATION TO CRITERION 1 TO CORRECT FOR THIS POTENTIAL DEFICIENCY IN CRITERION 1 AND ASKED BROOKHAVEN TO CONSIDER ITS GENERIC APPLICABILITY. THEY APPEAR TO HAVE NOT DONE SO.

- FOR MARK II APPLICATIONS, WE HAVE DEMONSTRATED THAT THE UNMODIFIED CRITERION 1 IS MORE STRINGENT THAN CRITERION 2 AND DOES NOT HAVE TO BE MODIFIED. HOWEVER, FOR GENERIC APPLICATION WE RECOMMEND CRITERION 1 BE MODIFIED TO CORRECT FOR THIS POTENTIAL DEFICIENCY.

REVISED CRITERION 1

Dynamic or transient responses of structures, components, and equipment arising from combinations of dynamic loading or motions may be combined by SRSS provided that each of the dynamic inputs or responses has characteristics similar to those of earthquake ground motions, and that the individual component inputs can be considered to be relatively uncorrelated. This similarity involves a limited number of peaks of force or acceleration, with approximately zero mean.

- UNCORRELATED <u>OR</u> RANDOM START TIME
- NEAR ZERO MEAN
- ANY OF THE FOLLOWING:

1) RESPONSES

ALL $\frac{T_{50}}{\Delta T} \leq 0.08$ AND $\frac{T_{75}}{\Delta T} \leq 0.02$

2) INPUT (LOAD)

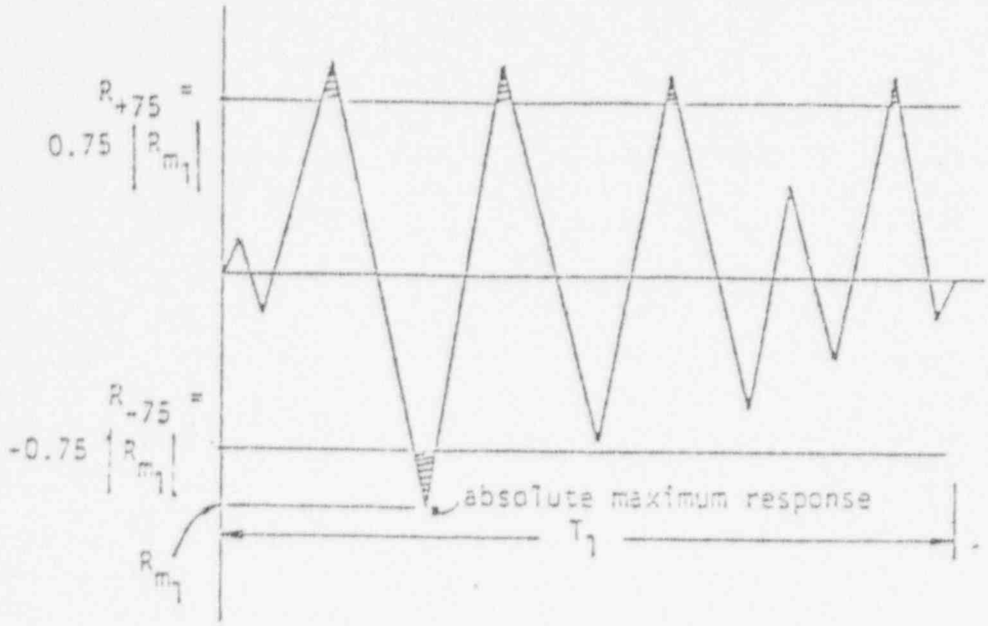
ALL $\frac{T_{50}}{\Delta T} \leq 0.04$ AND $\frac{T_{75}}{\Delta T} \leq 0.01$

3) RESPONSES

$$\left(\frac{T_{50}}{\Delta T}\right)_e \leq 0.08 , \quad \left(\frac{T_{75}}{\Delta T}\right)_e \leq 0.02$$

WHERE

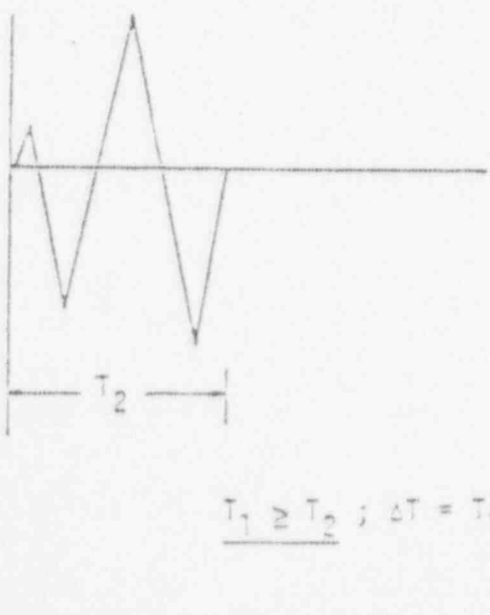
$$\left(\frac{T_{75}}{\Delta T}\right)_e = \sqrt{\frac{\sum_{i=1}^{N} \left(R_m T_{75}/\Delta T\right)_i^2}{\sum_{i=1}^{N} \left(R_m\right)_i^2}}$$



$T_{+75} = \sum$ time that response exceeds R_{+75}

$T_{-75} = \sum$ time that response less than R_{-75}

$T_{75} = \sum$ larger of T_{+75} or T_{-75}



$\underline{T_1 \geq T_2}$; $\Delta T = T_1$

FIGURE 1: Definition of Notation

FROM BROOKHAVEN

$$\frac{\sigma}{R_{max}} \lesssim 0.36 \quad \text{FOR SRSS COMBINATION}$$

REQUIREMENT OF CRITERION 1

- RESPONSE HAS MEAN ZERO CENTERED

IF NORMALLY DISTRIBUTED :

$$R_x = f_x \cdot \sigma$$

IF $\sigma = 0.36\, R_{max}$

$$f_x = \frac{R_x}{\sigma} = \left(\frac{R_x}{R_{max}}\right)\frac{1}{0.36} = \left(\frac{R_x}{R_{max}}\right)(2.78)$$

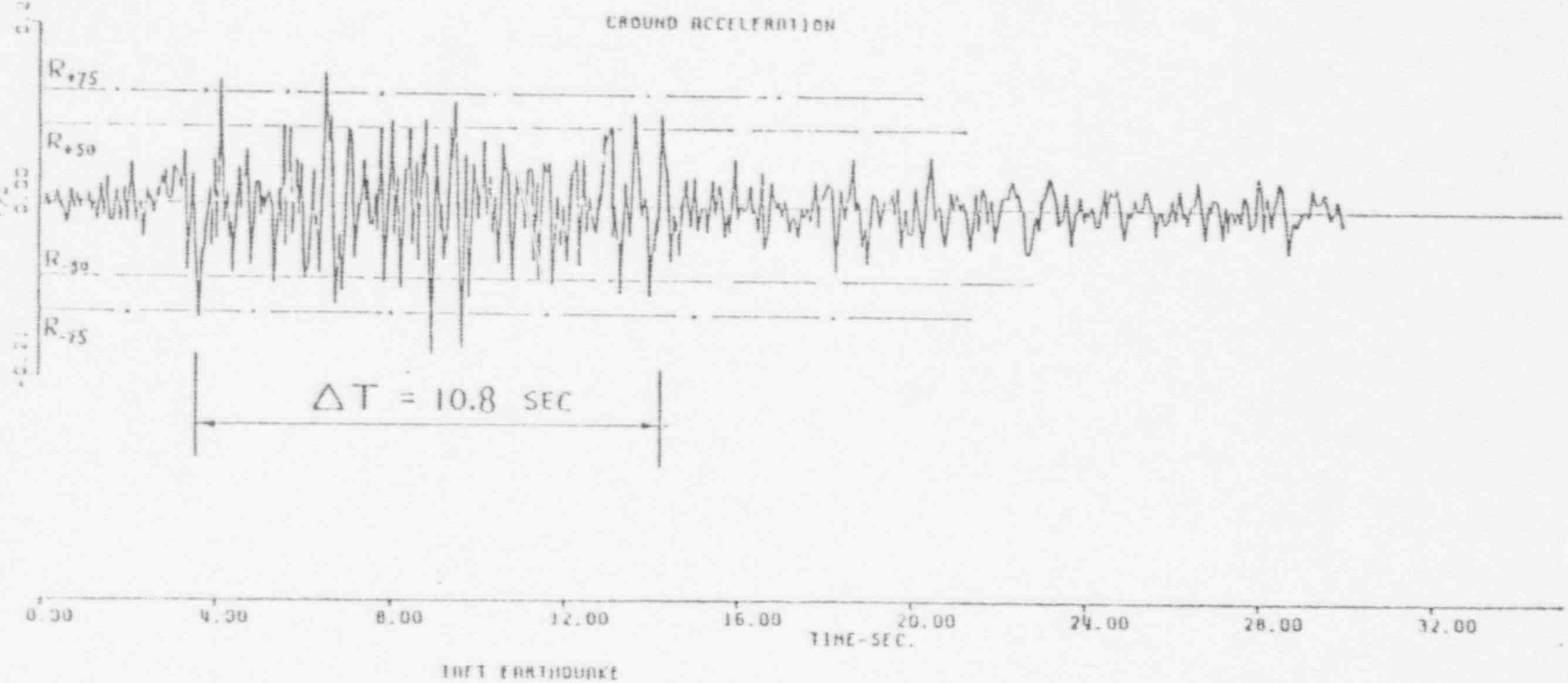
$\therefore$ FOR $R_{50}/R_{max} = .50 \longrightarrow f_{50} = 1.39 \longrightarrow P\left[\frac{R_{50}}{R_{max}} > 0.50\right] = 0.082$

$$\longrightarrow \boxed{\frac{T_{50}}{\Delta T} \leq 0.08}$$

FOR $R_{75}/R_{max} = 0.75 \longrightarrow f_{75} = 2.08 \longrightarrow P\left[\frac{R_{75}}{R_{max}} > 0.75\right] = 0.019$

$$\longrightarrow \boxed{\frac{T_{75}}{\Delta T} \leq 0.02}$$

DERIVATION OF NEW CRITERION 1



$$\left\{ \begin{array}{l} \dfrac{T_{75}}{\Delta T} = 0.0083 \\[2ex] \dfrac{T_{50}}{\Delta T} = 0.0420 \end{array} \right.$$

CONCLUSIONS

- RECENT SUPPORTIVE MK II/G.E. EFFORTS HAVE CONFIRMED THAT NEWMARK/KENNEDY CRITERION 2 REPRESENTS A CONSERVATIVE BASIS FOR JUDGING THE ACCEPTABILITY FOR THE SRSS COMBINATION OF RESPONSES.

- PREVIOUS STUDIES USING REAL MK II RESPONSE TIME HISTORIES HAVE DEMONSTRATED THAT THE NEWMARK/KENNEDY CRITERION 1 IS MORE CONSERVATIVE THAN CRITERION 2. MEETING CRITERION 1 PROVIDES GOOD ASSURANCE OF MEETING CRITERION 2 FOR THE TYPES OF DYNAMIC LOADS EVALUATED IN THE MK II SRSS STUDY.

- RECENT FINDINGS HAVE INDICATED SOME POTENTIAL AMBIGUTIES IN CRITERION 1 IF THE NEWMARK/KENNEDY CRITERIA IS TO BE APPLIED AS A GENERIC STANDARD. HOWEVER, N/K CRITERION 1 STILL REMAINS A CONSERVATIVE JUSTIFIABLE BASIS FOR JUDGING THE ACCEPTABILITY OF SRSS FOR THE TYPES OF LOADING COMBINATIONS CONSIDERED IN THE MK II SRSS STUDY.