GENERAL ELECTRIC

NUCLEAR ENERGY DIVISION
BWR PROJECTS DEPARTMENT

GENERAL ELECTRIC COMPANY, 175 CURTNER AVENUE, SAN JOSE, CALIFORNIA 95125
Mail Code 682
Phone (408) 297-3000, TWX NO. 910-338-0116

March 10, 1975

Mr. R. L. Tedesco
Assistant Director For
Containment Safety
Directorate of Licensing
Office of Regulation
U.S. Nuclear Regulatory
Commission
Washington, D. C. 20555

Dear Mr. Tedesco:

Subject: HANDOUTS FOR GENERIC MARK III MEETING

Attached for your information are three copies of the visual aids used for presentations and discussions during the meeting on February 12 and 13 with you and Messrs. Lainas, Cudlin, Kudrick, Slegers, Shao, Mills and Slaughterbeck. During this meeting the following general topics were discussed:

1. Mark III Test Programs - status

2. Mark III Suppression Pool Dynamics - modeling and LOCA loads

3. Relief Valve Discharge Loads - modeling, testing, and loads

4. Containment Vacuum Breakers - sizing transient analysis

5. Miscellaneous - status of hydrogen control design
   - continuous purge of containment
   - secondary containment bypass leakage
   - subcompartment analysis

At the conclusion of the meeting, Mr. Cudlin summarized the comments and concerns that were expressed during the discussion of these topics and asked that GE provide a schedule by which information would be provided to resolve each item. The following is GE's interpretation of the expressed concerns or comments with an indication of when and how the information will be provided:

1. Provide additional information to explain and justify the applicability of the current one-third scale steam tests in combination with previous full scale air tests for defining pool swell loads for structures at or above the suppression pool surface.

Pool swell loads that GE has defined for structures above the suppression pool are based on the full scale PSTF air tests performed in February - March, 1974 and reported in the 7th Quarterly Progress Report, December, 1974. The purpose of the current one-third scale steam tests is to demonstrate that these loads are conservative. Defining reduced impact loads is not an immediate test objective. A discussion of the applicability of selecting ligament thickness and approach velocity as the key parameters for defining impact loads on all structures above the pool will be presented together with the scaling considerations used in selecting the test setup for the confirmatory tests. Included will be a discussion of the applicability of load definition to components and structures at various elevations from the suppression pool surface to the elevation at which bubble break through occurs. This information will be transmitted by April 11, 1975.

2. Provide a definition of all LOCA and relief valve discharge loads on the containment structure, the basis for each value, and justification for the magnitude given.

   A list of the phenomena that are either known or could potentially occur during the response of a Mark III contaiment system to a loss-of-coolant accident was presented in a letter to you dated January 27, 1975. This list will be the basis for identifying recommended applied loads for the various portions of the containment structure. The applicable phenomena will be identified and a resultant load together with a time history for application will be presented in the form of a bar chart. A separate chart will be prepared for each general area of the containment structure such as the drywell wall, bottom of pool, containment shell, structures above the pool, etc. A report will be prepared for the standard plant configuration with this information. The report will identify the load, indicate the basis for the load, and justify its adequacy. The report will be completed by July 1, 1975.

3. Provide a description of current modeling which is used for determining the magnitude of the loads on the suppression pool boundary due to the vent clearing associated with initial Safety/Relief valve discharge.

   A description of the preliminary model being used to predict safety/relief valve initial discharge loads on suppression pool boundary will be provided in a letter to you by May 9, 1975. This model utilizes the same basic principles as those originally presented in topical report NEDO-10859. In a letter from W. R. Butler to I. F. Stuart this topical report was indicated to be disapproved for reference on licensing applications, however, the attached evaluation stated that this "model generally represents a valid and sufficiently complete method of generating a pressure loading prediction for relief valve action" provided that this would be "supported by a larger data base." Therefore, GE is utilizing the basic principles for determining Mark III design loads and has established a small scale test program that will verify the adequacy of the technique for single as well as multiple valve discharge load prediction.

4. Provide a description of the current tests that are being performed to verify the analytical model being used to predict Safety/Relief valve discharge loads.

   A discussion of testing that is in progress for analytical model verification will be provided in a letter transmitted to you by April 11, 1975. The discussion will identify the purpose and objectives of the tests, a description of the test facility, and a discussion of the test program.

5. Provide a description of the current tests that are being performed to investigate seismic wave generation in the suppression pool.

   A discussion of the testing that GE has undertaken in an effort to confirm that the generation of waves from a seismic event are not of concern will be provided in a letter to you by April 18, 1975. The discussion will identify the purpose and objectives of the test, a description of the test facility, and a discussion of the test program. An identification of the seismic input which is used as the forcing function will be included. Current testing is scheduled for completion by June 27, 1975. A topical report on the test results will be prepared after the completion of the program. The report will be submitted four months after testing.

6. Provide a description of the nodal arrangement, area volumes, flow areas, loss coefficients, and the philosophy used in selecting these values in the subcompartment analysis for the RPV shield wall annulus.

   This information will be provided in a letter transmitted to you by April 4, 1975.

7. Revise the containment vacuum breaker sizing analysis to include mass transfer effects.

   The model information originally submitted by letter to you dated December 9, 1974 and commented on in your letter to I. F. Stuart dated January 15, 1975 will be revised and resubmitted by June 1, 1975. If model changes involve the use of a mass transfer rate rather than instantaneous transfer, information on details of the containment spray system design which determine this rate will be included. Analysis with the revised model will be performed at an initial temperature and relative humidity which are realistically worst case values that could be experienced in the containment.

GENERAL ELECTRIC

Mr. R. L. Tedesco
Page 4
March 10, 1975

In addition to the above items, you inquired as to the possibility of going to the Southwest Research Institute facility to observe a test run for the seismic wave generation investigation. Arrangements will be made and you will be notified of a good time to visit the facility with approximately two weeks prior notice. Testing is currently scheduled to run through June 27, 1975. If you have any comments or questions, please contact me or Mr. Bert Sobon (Ext. 3495).

Sincerely,

Geza Gyorey

Geza L. Gyorey, Manager
BWR Licensing
Mail Code 682, Ext. 2245

GLG:smk

Attachments

PSTF ONE-THIRD SCALE
POOL SWELL STRUCTURAL TESTING

DATA ON RESPONSE OF STRUCTURES TO DYNAMIC LOADS

- TO OBTAIN LOADING INFORMATION FROM TYPICAL STRUCTURES WHICH CAN BE APPLIED TO MARK III STRUCTURES
- TO CONFIRM CONSERVATISM OF 115 PSI FORCING FUNCTION BEING USED AS A DESIGN LOAD
- TO VERIFY BEAM RESPONSE STRESS ANALYSIS METHODS
- TO CORRELATE LOADING INFORMATION IN TERMS OF KNOWN POOL DYNAMICS
- TO CHECK ASSUMPTION THAT FLOOR GRATINGS ARE SUBJECT TO DRAG LOADS ONLY

STRUCTURAL TEST

TARGET CONFIGURATIONS

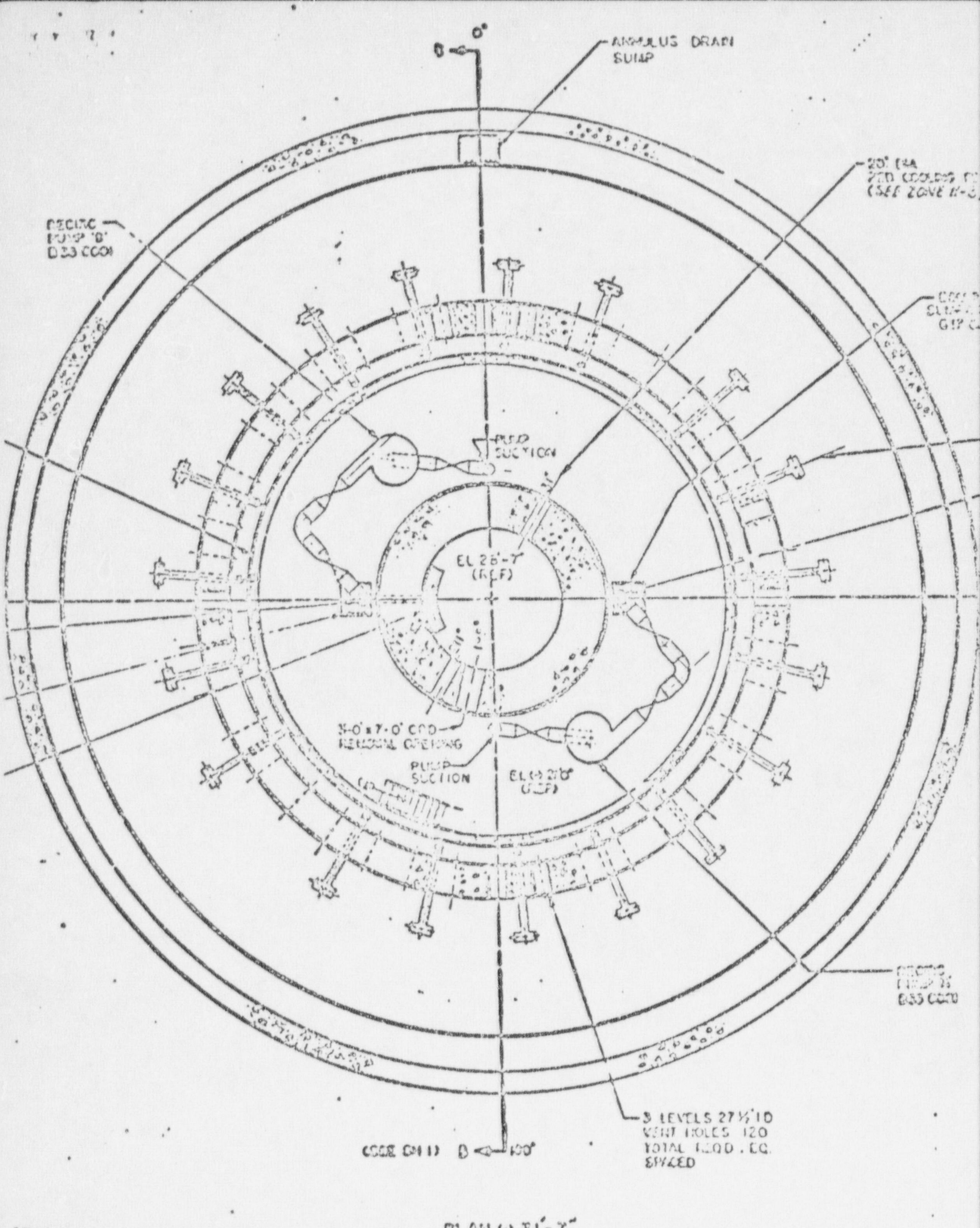
TARGET CONFIGURATION	TARGET ORIENTATION	
	RADIAL	TANGENTIAL
12-INCH DEEP BY 10-INCH WIDE BEAM	X	X
12-INCH DEEP BY 5-INCH WIDE BEAM	X	X
10-INCH SCHEDULE 20 PIPE	X	X
FLOOR GRATING		X
FLOOR GRATING ON BEAM		X

TEST CONDITION MATRIX

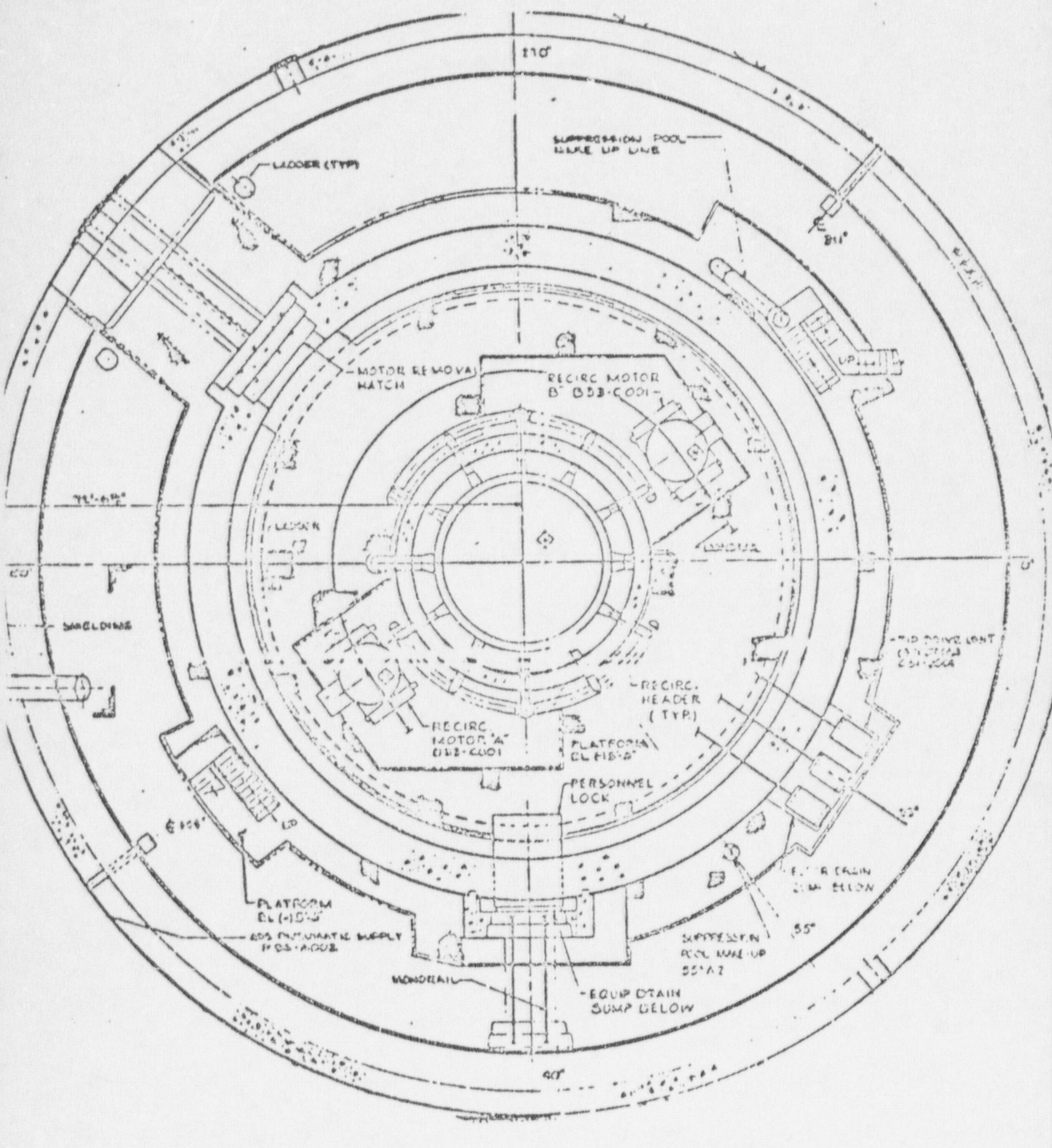
(SHOWING FLOW RESTRICTOR DIAMETER AND TOP VENT SUBMERGENCE NECESSARY TO PROVIDE THE SPECIFIED DYNAMIC CONDITIONS)

SURFACE VELOCITY \ SLUG THICKNESS	2 FT.	4 FT.	6 FT.
31 FT/SEC	2-1/2 IN/6-1/2 FT	3 IN/8-1/2 FT	-
27 FT/SEC	2-1/8 IN/6-1/2 FT	2-1/2 IN/8-1/2 FT	3 IN/10 FT
23 FT/SEC	-	2-1/8 IN/8-1/2 FT	2-1/2 IN/10 FT

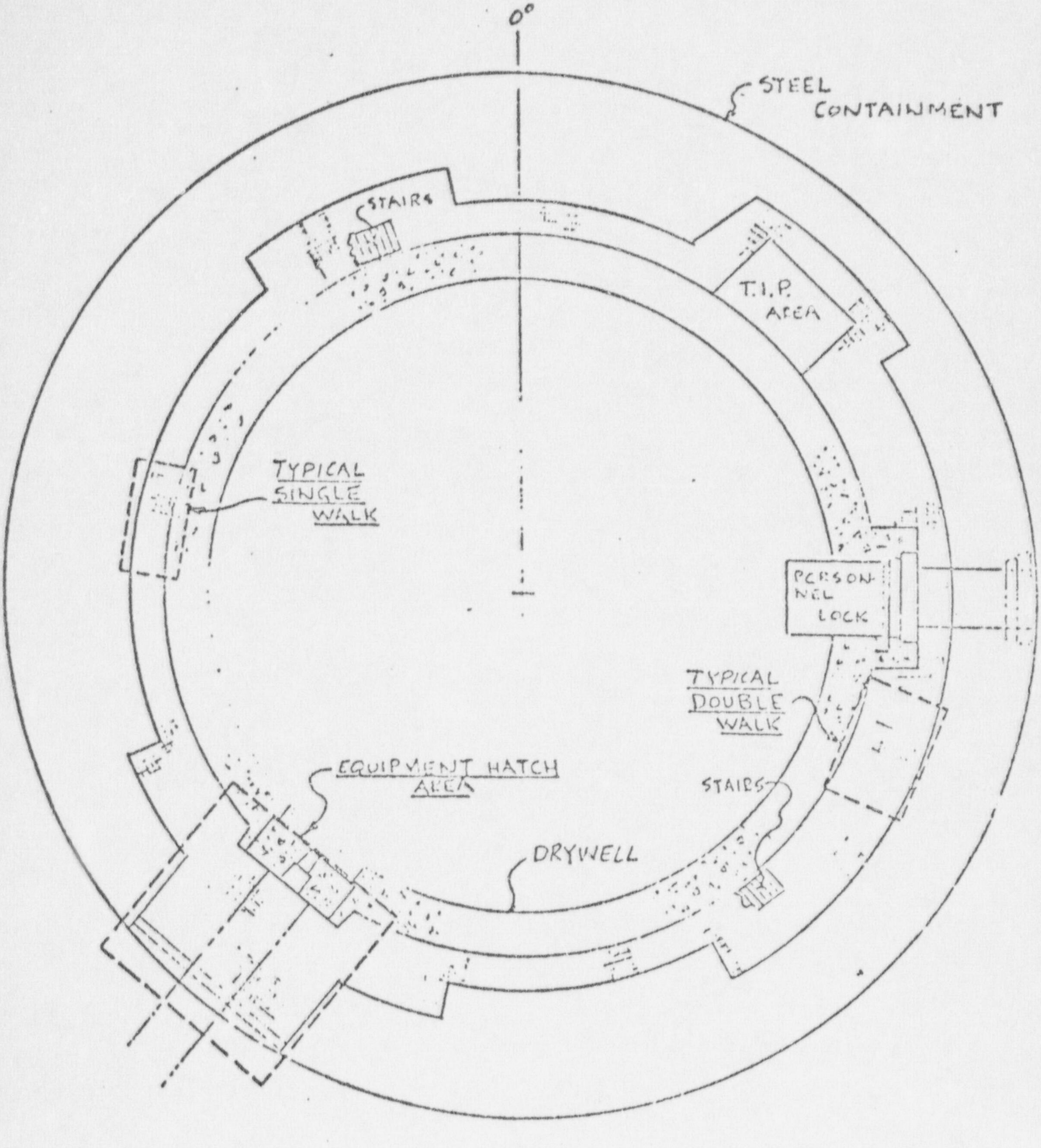
(MAY ADD 2-1/2 IN/ 5 FT CASE TO PROVIDE FROTH IMPINGEMENT ON GRATING)


0°
ANNULUS DRAIN SUMP
RECIRC PUMP 'B' B33 C001
PUMP SUCTION
EL 28'-7" (REF)
3'-0" x 7'-0" CRD REMOVAL OPENING
PUMP SUCTION
3 LEVELS 27½" ID VENT HOLES 120 TOTAL REQD. EQ. SPACED
180°

PLAN (-) 31'-7"

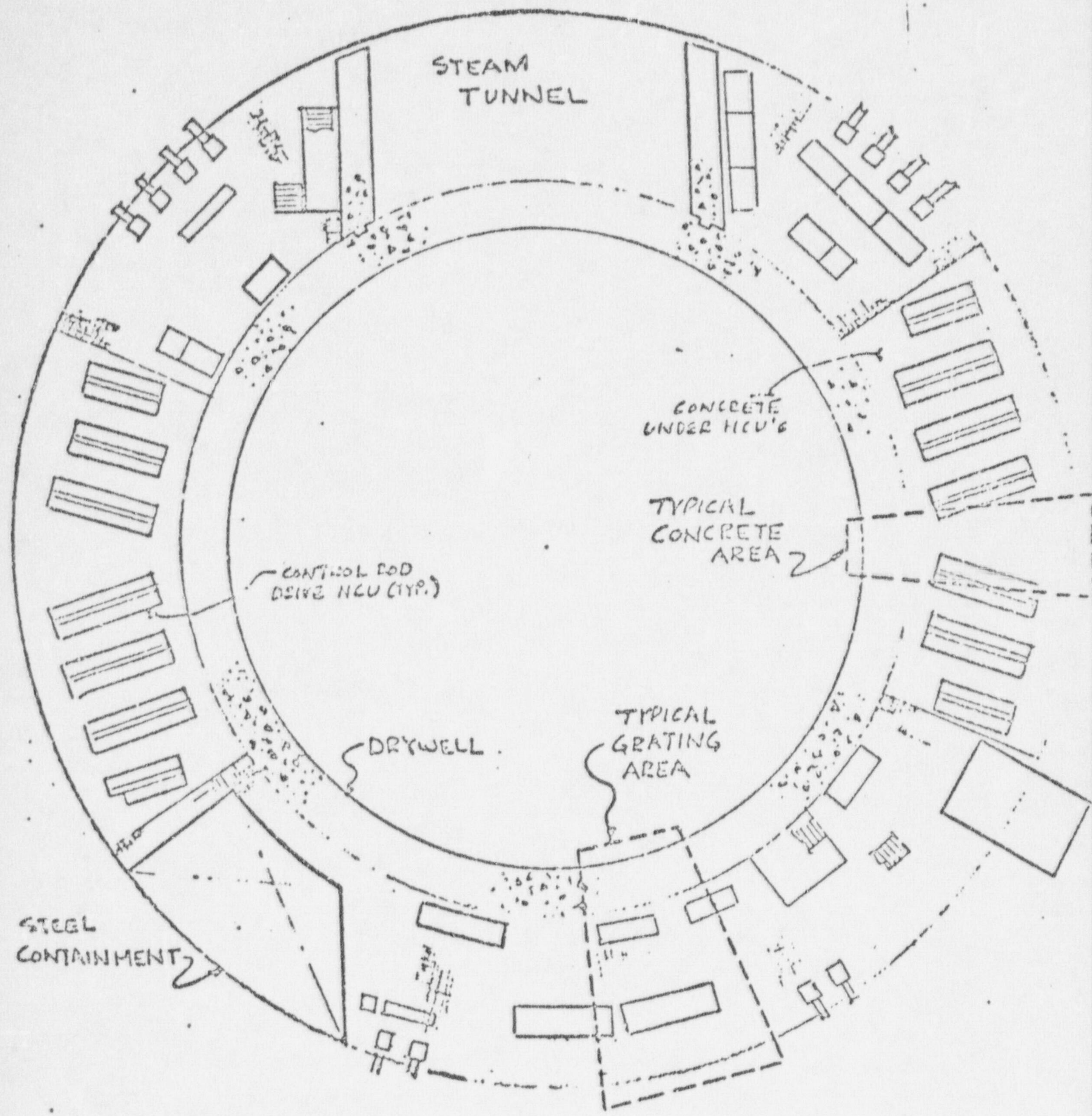


LADDER (TYP)
MOTOR REMOVAL HATCH
RECIRC MOTOR B" B33-C001
SHIELDING
RECIRC. MOTOR "A" B33-C001
RECIRC. HEADER (TYP)
PERSONNEL LOCK
PLATFORM
EQUIP DRAIN SUMP BELOW
MONORAIL
0°



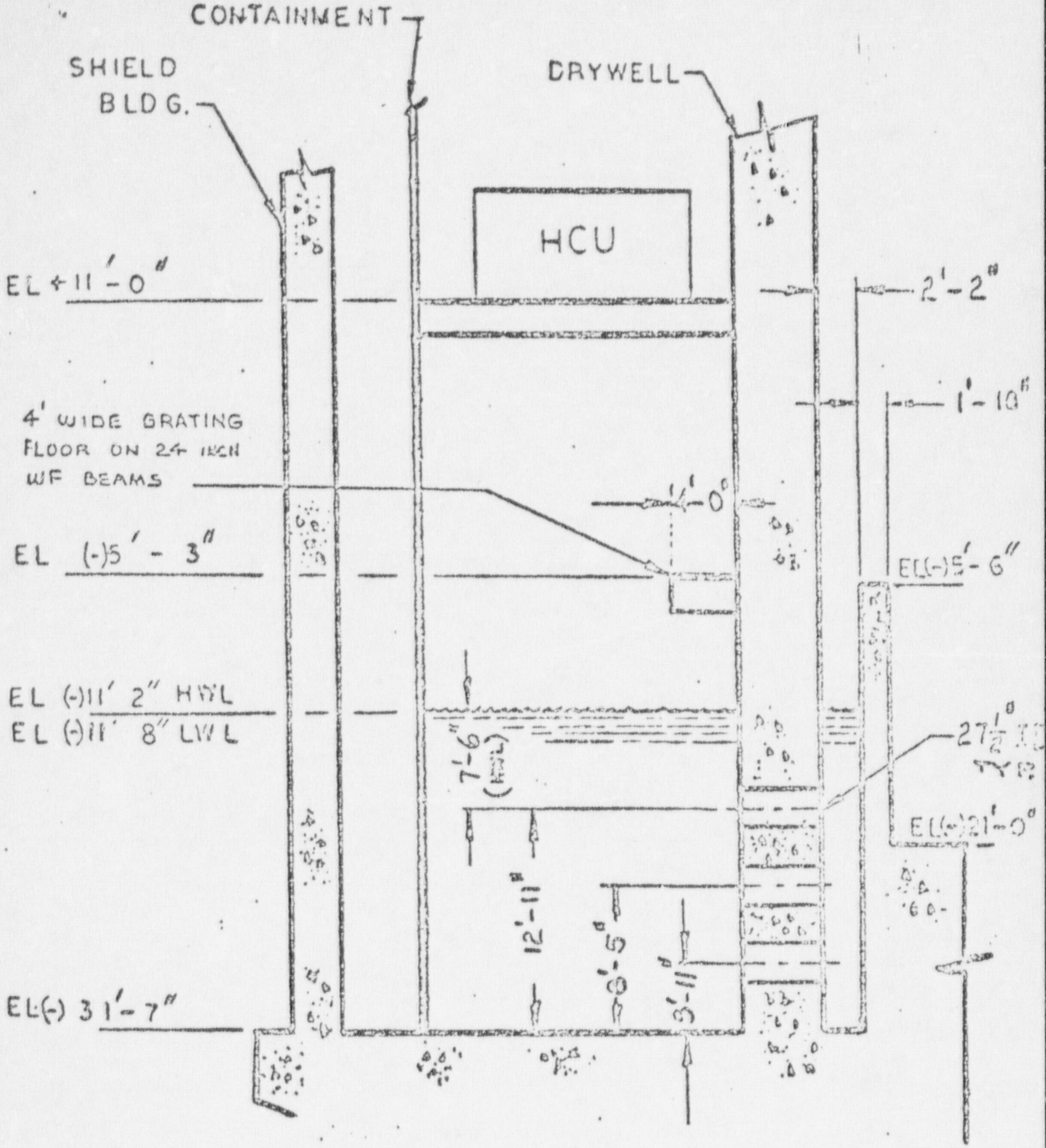
FLOOR AT ELEVATION -5'3"

FIGURE 2.1



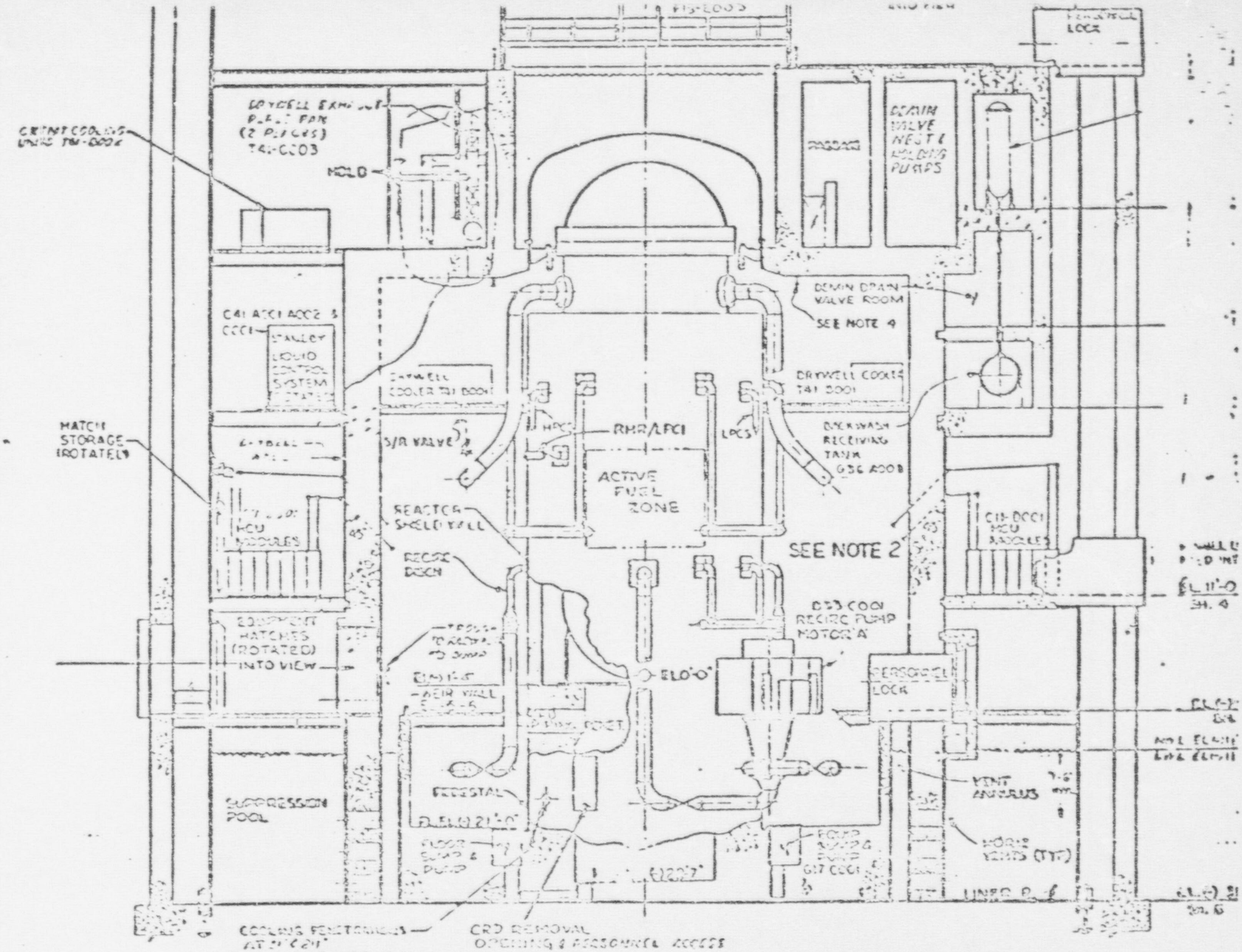
FLOOR AT ELEVATION 11'-0"

FIGURE 3.1

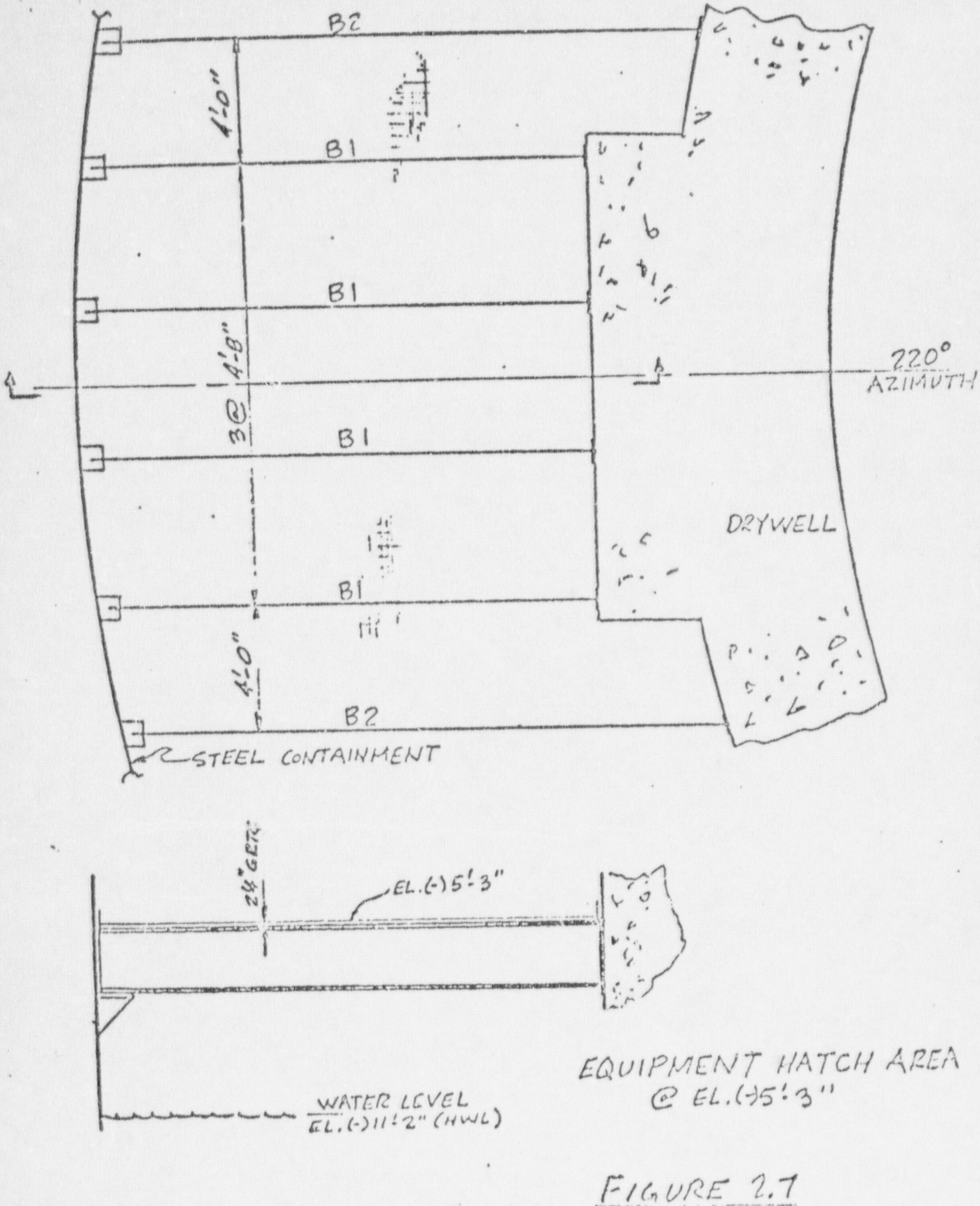


CONTAINMENT
SHIELD BLDG.
DRYWELL
HCU
EL +11'-0"
2'-2"
1'-10"
4' WIDE GRATING FLOOR ON 24 INCH WF BEAMS
1'-0"
EL (-)5'-3"
EL(-)5'-6"
EL (-)11' 2" HWL
EL (-)11' 8" LWL
7'-6" (HWL)
27½" ID TYP.
EL(-)21'-0"
12'-11"
8'-5"
3'-11"
EL(-) 31'-7"

238 PLANT



ELEVATION A A



EQUIPMENT HATCH AREA
@ EL.(-)5'-3"

FIGURE 2.7

DRYWELL PENETRATIONS
BELOW 11'-0" FLOOR

PENE NO.	QTY.	DESCRIPTION	LINE SIZE	ELEV.
2D	1	EQUIP HATCH	12'	(-)5'-3"
3D	1	PERSONNEL LOCK	9'-7"	(-)1'-11"
74D	1	DRYWELL VENT	4"	—
107D	52	ELECTRICAL CONDUIT	2½"	(-)5'-0"
103D	8	ELECTRICAL CONDUIT	2½"	—
110D	20	INSTRUMENT	8"	—
114D	1	EQUIPMENT SUMP	4"	—
115D	1	FLOOR SUMP	4"	—
139D	4	TIP	2"	(-)1'-9"
140D	4	TIP	2"	(-)1'-9"
—	-	WATER	4"	—
-	-	AIR	4"	—

CONTAINMENT PENETRATIONS
BELOW 11'-0" FLOOR
24" MAX LINE SIZE

PENE. NO.	QTY.	DESCRIPTION	LINE SIZE IN.	ELEVATION
33C	1	RHR A TO POOL	16	(-)3'-3"
34C	1	RHR B TO POOL	16	(-)3'-3"
35C	1	RHR C TO POOL	16	(-)3'-3"
50C	1	RCIC TO POOL	16	(-)3'-3"
81C	1	ELECTRICAL	18	7'-0"
82C	1	ELECTRICAL	18	7'-0"
30C	1	LPCI A SUCTION	24	(-)26'-0"
31C	1	LPCI B SUCTION	24	(-)26'-0"
32C	1	LPCI C SUCTION	24	(-)26'-0"
54C	1	LPCS SUCTION	24	(-)26'-0"
59C	1	HPCS SUCTION	24	(-)26'-0"

MARK III PRESSURE SUPPRESSION SYSTEM

Significant LOCA Phenomena	Is Applicable Test Data Available		Type of Information Being Used For Design Purposes	Where Information Documented	Does Ref. Contain Model/Test Data Comparison	Comments
	Now	Future				
1. RPV Blowdown and Break Flow Rate	Yes	Yes	Model Prediction	NEDO-20533	Yes	Pipe inventory effect is included in evaluation model.
2. Drywell Pressurization	Yes	Yes	Model Prediction	NEDO-20533	Yes	
3. Vent Clearing	Yes	Yes	Model Prediction	NEDO-20533	Yes	
4. Vent Clearing Jet Load	Yes	Yes	Test Data	Not reported (see comment)[1]	--	Load is very small and n[illegible] controlling.
5. Vent Flow	Yes	Yes	Model Prediction	NEDO-20533	Yes	Further data/Model comparisons, supp. to NEDO-20533 scheduled 4/1/75. Present predictions are accurate.
6. Vent Interaction/Vertical	Yes	Yes	Model Prediction	NEDO-20533	Yes	
7. Vent Interaction/Horizontal	No	Yes	(See comment)	(See comment)	--	No mechanism identified for generating significant horizontal vent interaction. 1/9 scale test series will confirm.[2]
8. Bubble Formation Loads/Bulk	Yes	Yes	Test Data	Not reported (See comment)[1]	--	Based on Mark III representative PSTF air tests. Not a controlling load.

[1] No significant impact on Mark III; at this time documentation date has not been established.

[2] Ongoing Quarterly Progress Reports will document modeling development.

MARK III PRESSURE SUPPRESSION SYSTEM

Significant LOCA Phenomena	Is Applicable Test Data Available		Type of Information Being Used For Design Purposes	Where Information Documented	Does Ref. Contain Model/Test Data Comparison	Comments
	Now	Future				
9. Bubble Formation Loads/Asymmetric	No	Yes	(See comment)	--	--	No mechanism identified for generating significant asymmetric bubble formation loads. 1/9 scale test series will confirm.[2]
10. Bulk Pool Swell	Yes	Yes	Test Data (See comment)	NEDO-20732[2]	Preliminary	Model development is underway to demonstrate understanding of phenomenon. Not required for containment loading specifications.
11. Bulk Swell Impact Loads	Yes	Yes	Test Data (See comment)	NEDO-20732[2]	Preliminary	Same as comment for item #10
12. Pool Swell Drag Loads	Yes	Yes	Model Prediction	Not reported (See comment)	--	Uses well established methods coupled with empirical drag coefficients.
13. Bubble Break Through	Yes	Yes	Test Data (See comment)	Not reported[2]	--	Same as comment for item #10.
14. Froth Density/Velocity	Yes	Yes	Test Data (See comment)	Not reported[2]	--	Same as comment for item #10.
15. HCU Floor Froth Impingement Load	Yes	Yes	Test Data (See comment)	NEDO-20732[2]	Preliminary	Same as comment for item #10.

[1] No significant impact on Mark III; at this time documentation date has not been established.

[2] Ongoing Quarterly Progress Reports will document modeling development.

MARK III PRESSURE SUPPRESSION SYSTEM

Significant LOCA Phenomena	Is Applicable Test Data Available		Type of Information Being Used For Design Purposes	Where Information Documented	Does Ref. Contain Model/Test Data Comparison	Comments
	Now	Future				
16. HCU Floor Froth Flow ΔP (Bulk)	Yes	No	Model Prediction	Supp. to NEDO-20533 (4/1/75)	Yes	Preliminary model predictions/test data comparisons show model conservative. Asymmetry addressed by bounding calcs. and show no significance.
17. Fall Back Loads	Yes	Yes	Bounding Calcs.	Not reported[1]	--	Loads not significant, confirmed by representative PSTF air tests.
18. Drywell Pressure Undershoot at Vent Clearing	Yes	Yes	Test Data	Not reported[1]	No	Phenomena observed in some large scale PSTF tests but are not applicable to Mark III because of scaling considerations. Properly scaled tests indicate that this will not be present in Mark III.
19. Condensation Process	Yes	Yes	Test Data	Not reported[1]	--	Large scale PSTF testing with elevated pool temperature scheduled for 1975-76.

[1] No significant impact on Mark III; at this time documentation date has not been established.

MARK III PRESSURE SUPPRESSION SYSTEM

Significant LOCA Phenomena	Is Applicable Test Data Available		Type of Information Being Used For Design Purposes	Where Information Documented	Does Ref. Contain Model/Test Data Comparison	Comments
	Now	Future				
20. Pressure Oscillations During Condensation Process	Yes	Yes	Test Data	Not reported[1]	--	Loading condition not significant.
21. Vent Recovery	Yes	Yes	Model Prediction	GESSAR, Sect. 6	No	Model and data agree closely.
22. Chugging	Yes	Yes	Test Data	Not reported[1]	--	Present test results indicate vent chugging induces good pool mixing; no significant containment loads have been observed.
23. Containment Free Space P and T	Yes	Yes	Model Prediction	NEDO-20533	Yes	
24. Stratification	Yes	Yes	Test Data	Not reported[1]	--	Test data indicate sufficient pool mixing.
25. Post LOCA Waves on Pool Surface	Yes	Yes	Bounding Calcs.	Grand Gulf ACRS - bounding calculation	--	No significant radial waves have been observed in any PSTF test. The 1/9 scale test series will confirm no significant circumferential waves.

[1] No significant impact on Mark III; at this time documentation data has not been established.

MARK III PRESSURE SUPPRESSION SYSTEM

Significant LOCA Phenomena	Is Applicable Test Data Available		Type of Information Being Used For Design Purposes	Where Information Documented	Does Ref. Contain Model/Test Data Comparison	Comments
	Now	Future				
26. Seismic Waves on Pool Surface	Yes	Yes	(See comment)	Not reported	--	Presently the GE Company is developing a model to predict wave amplitudes for a random earthquake spectrum. Presently tests results are not directly applicable to the Mark III system. Steam bypass to vent uncovery resulting from a seismic event is not anticipated. See Grand Gulf ACRS bounding discussion. Mark III pool swell related structural impact loads are based on an essentially flat impacting pool surface. Any seismic waves generated prior to LOCA would therefore tend to decrease the magnitude of this impact load.
27. Long Term Model (ECCS Networks, Two Pools, Etc.)	No	No	Model Prediction	GESSAR, Sect. 6	No	Simple model. Complete description planned for NEDO-20533 4/1/75 supp.

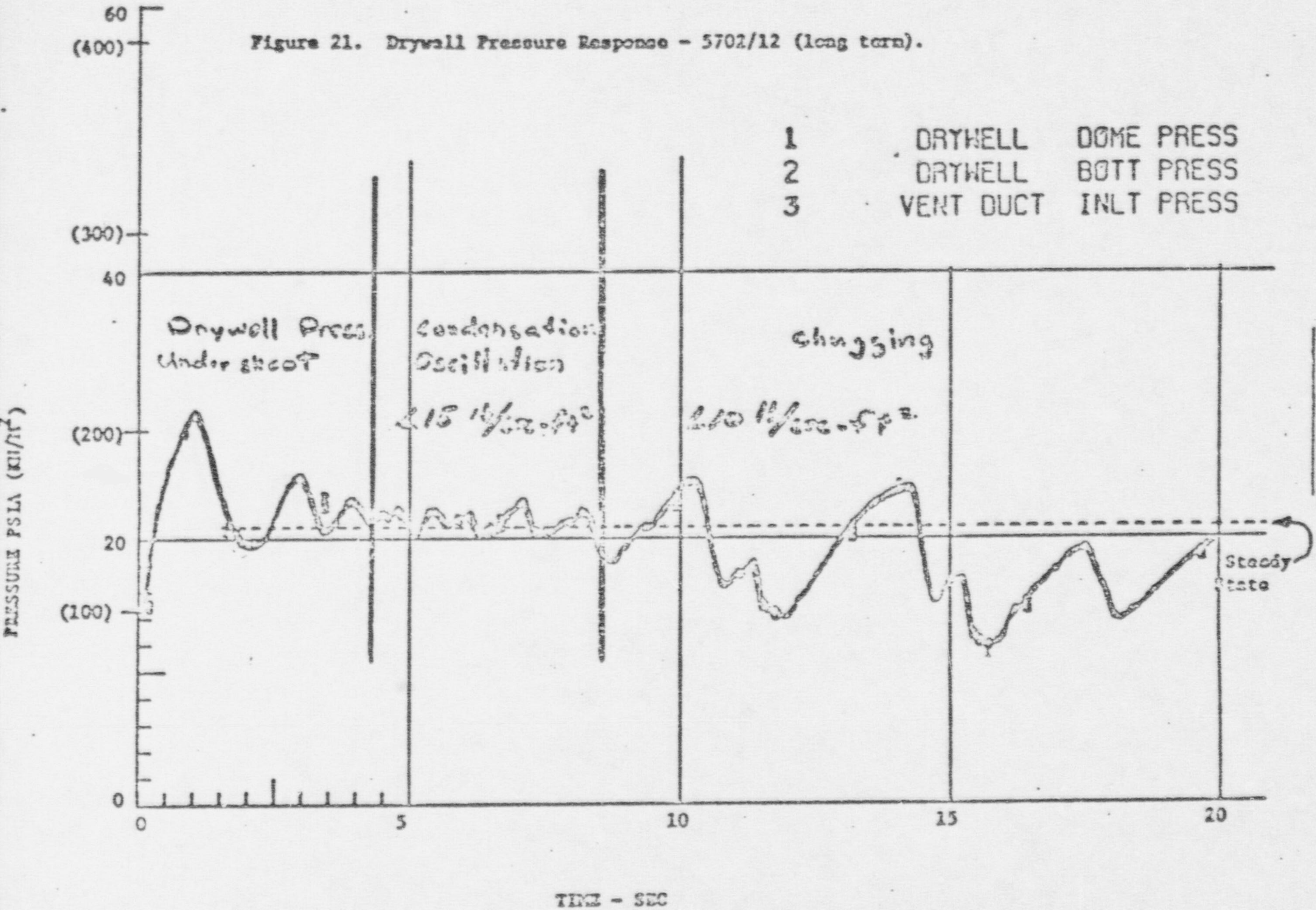
PRESSURE OSCILLATIONS OBSERVED DURING PSTF TESTING

- IDENTIFICATION OF OSCILLATIONS
- DETAILED DISCUSSION OF IDENTIFIED OSCILLATIONS
  - PHENOMENA
  - STATUS OF G.E. INVESTIGATION (INCLUDING SCALING EFFECTS)
  - RELATIONSHIP OF PHENOMENA TO MARK III
  - FUTURE WORK
- SUMMARY

W.J.B. 2/13/75

COMPANY PRIVATE

Figure 21. Drywall Pressure Response - 5702/12 (long term).



OSCILLATION AT VENT CLEARING

- PHENOMENA

- STATUS OF G.E. INVESTIGATION

  - SCALING EFFECTS

  OBSERVED - 2, 3-VENT LARGE SCALE TESTS

  NOT OBSERVED - 1-VENT LARGE SCALE TESTS
  3-VENT 1/3RD SCALE TESTS
  1, 3-VENT SMALL SCALE TESTS

- RELATIONSHIP OF PHENOMENA TO MARK III

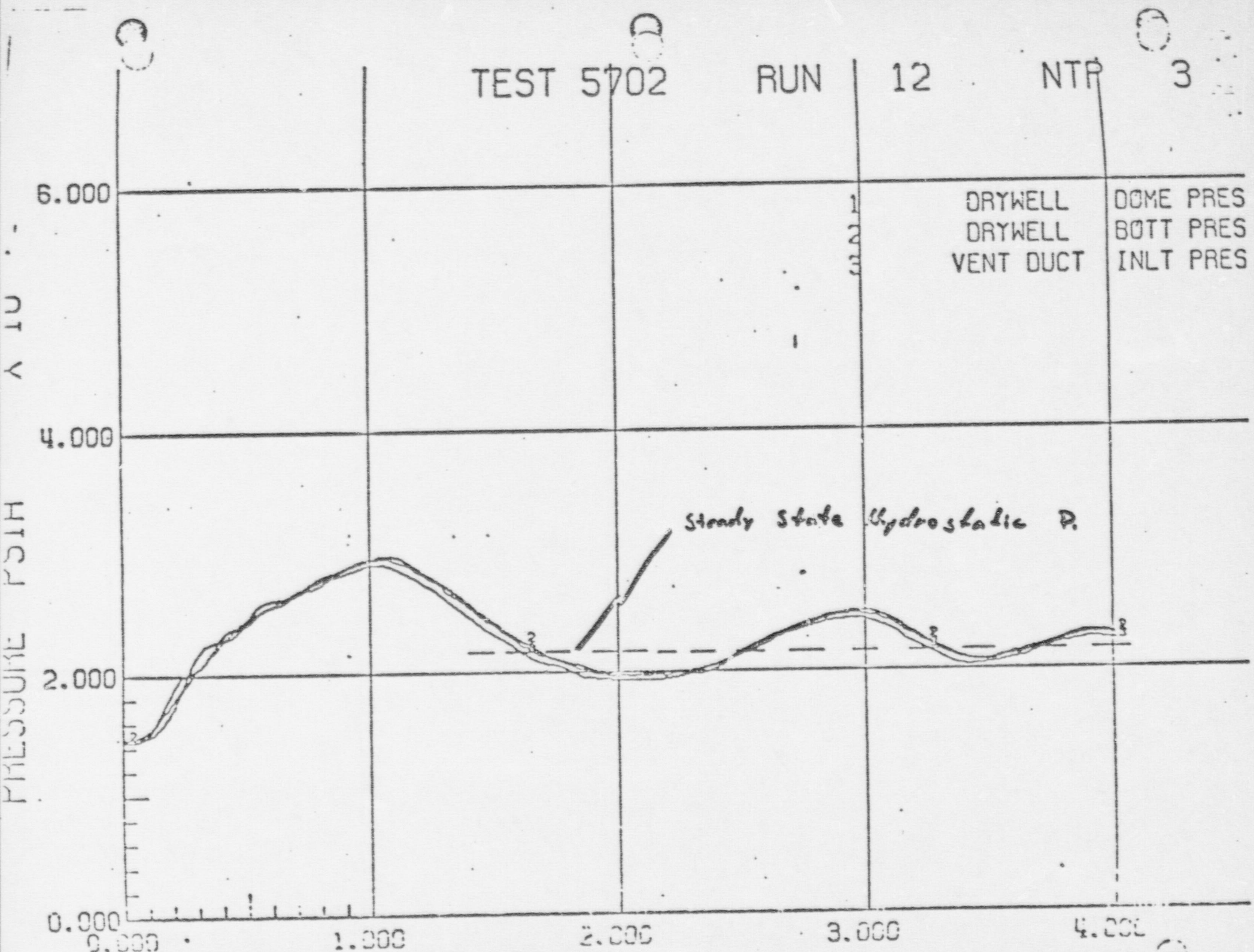
  - NOT EXPECTED TO OCCUR IN THE MARK III SYSTEM

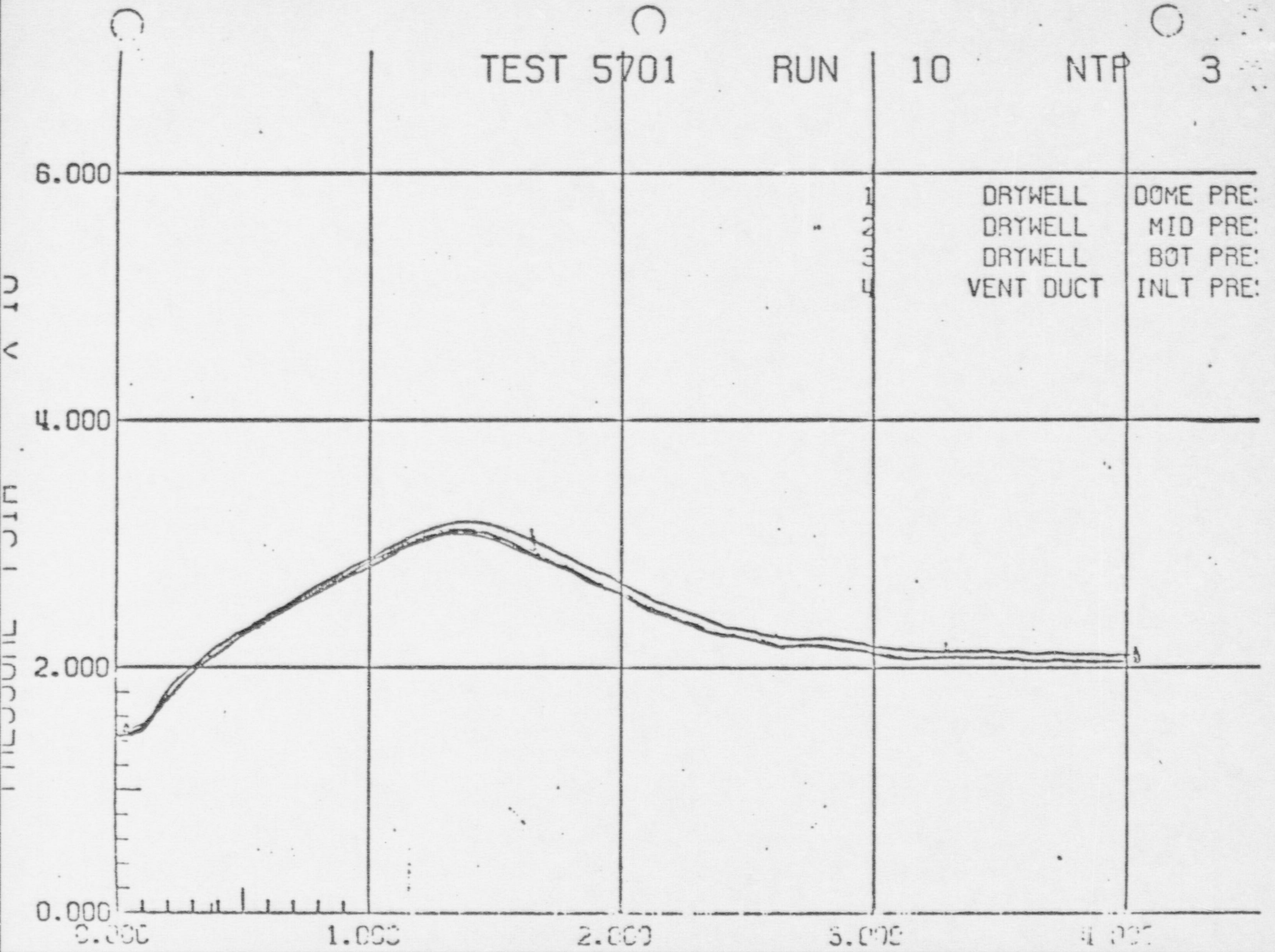
  - POSTULATED OCCURANCE HAS NO IMPACT ON DESIGN

- FUTURE WORK

  - ATTEMPT TO SIMULATE PHENOMENA WITH OVERALL MARK III MODEL

W.J.B. 2/11/75


TEST 5702 RUN 12 NTR 3
1 DRYWELL DOME PRES
2 DRYWELL BOTT PRES
3 VENT DUCT INLT PRES
Steady State Hydrostatic P.
PRESSURE PSIA
6.000
4.000
2.000
0.000
0.000
1.000
2.000
3.000
4.000



TEST 5701 RUN 10 NTP 3
1 DRYWELL DOME PRE:
2 DRYWELL MID PRE:
3 DRYWELL BOT PRE:
4 VENT DUCT INLT PRE:
6.000
4.000
2.000
0.000
1.000
2.000

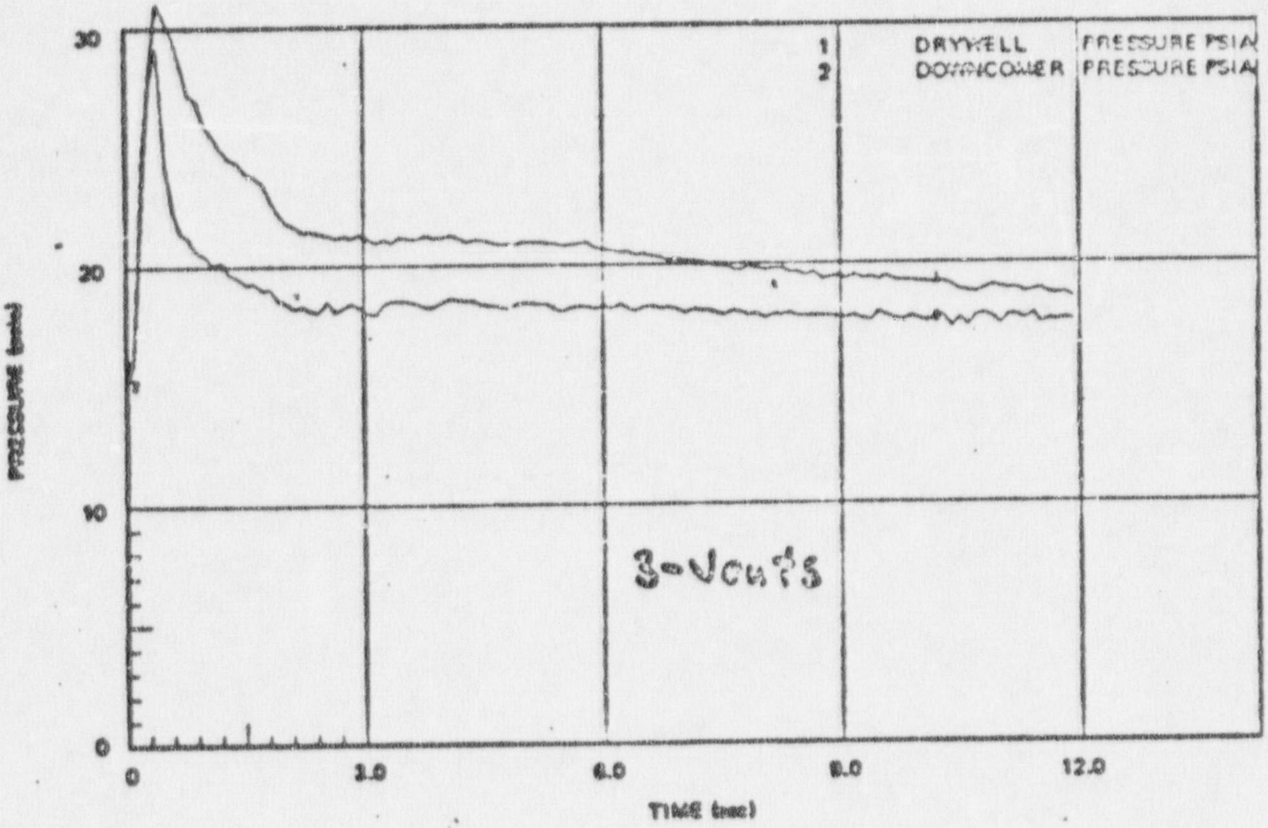


Figure 4-2. Drywell Pressure Transient — Test 5008 Run 17

CONDENSATION OSCILLATIONS

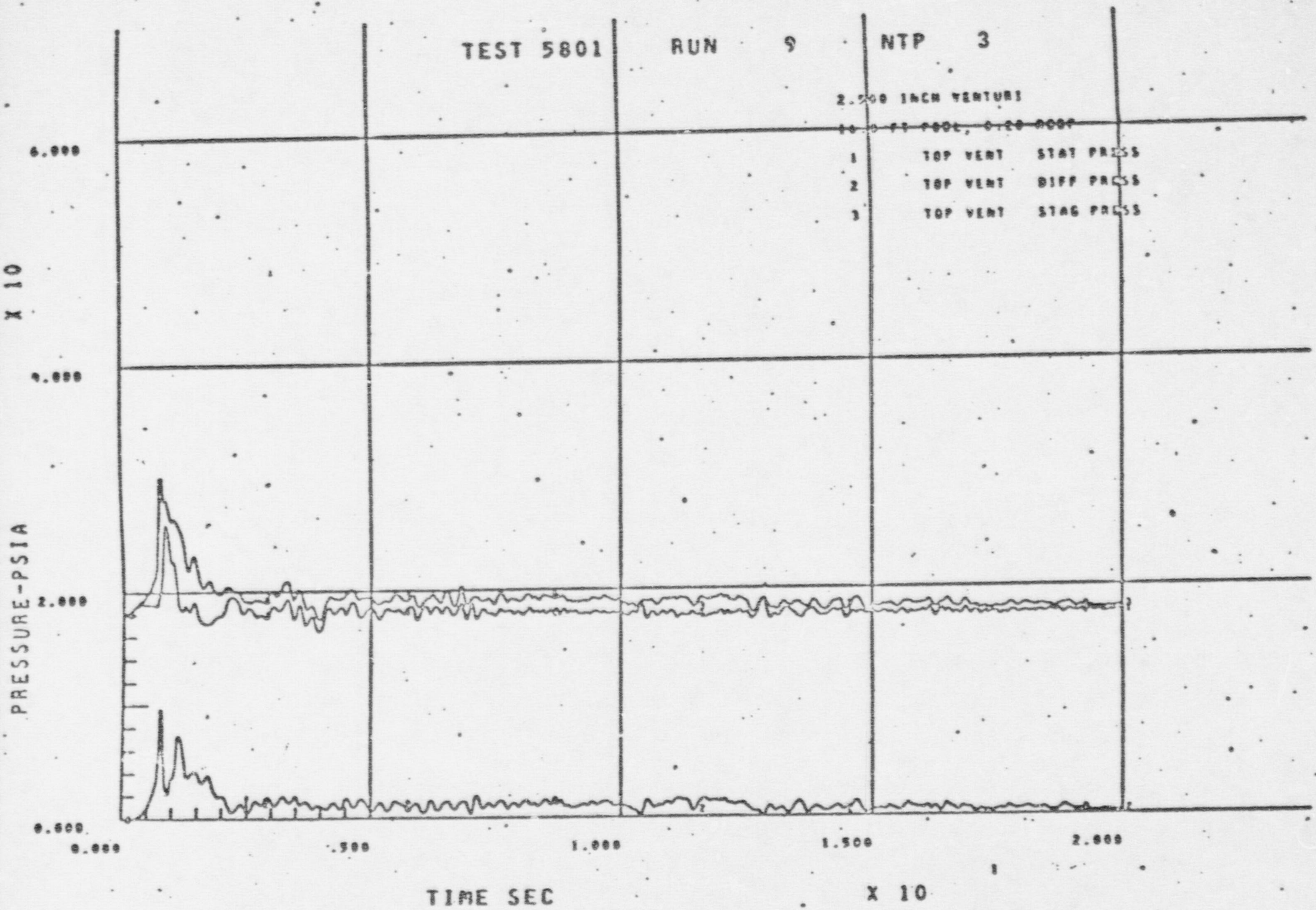
- PHENOMENA

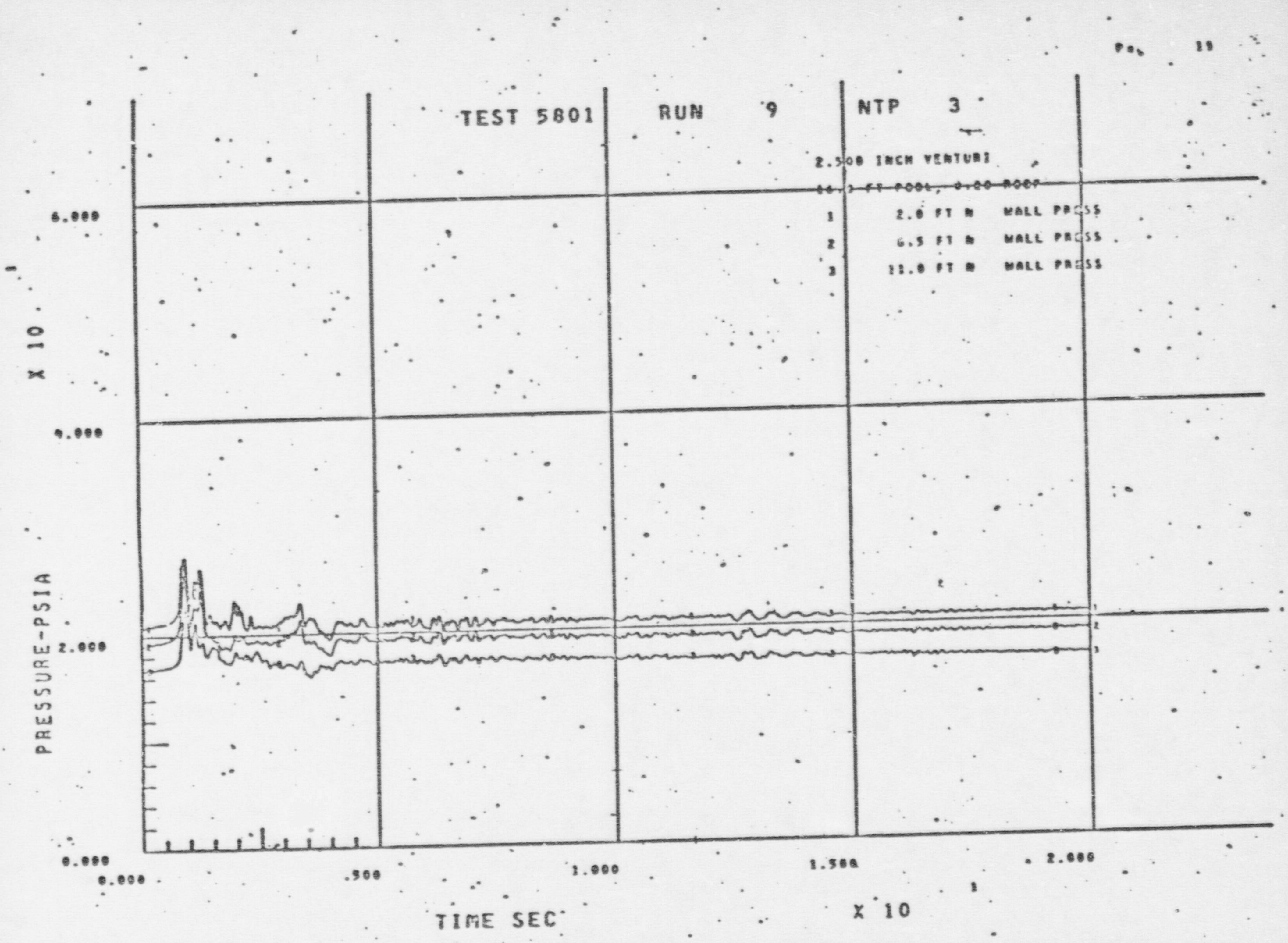
- STATUS OF G.E. INVESTIGATION
  - SCALING EFFECTS
    NONE
    COMMON TO CONDENSATION PROCESS
  - DIFFICULT TO MODEL

- RELATIONSHIP OF PHENOMENA TO MARK III
  - DIRECT
  - RESULTING CONTAINMENT WALL LOADS LESS THAN ± 2 PSI AT 3 - 5 CPS
  - MAGNITUDE OF LOADS ARE WELL WITHIN DESIGN

- FUTURE WORK
  - ONGOING INVESTIGATION OF AVAILABLE AND FUTURE TEST DATA

W.J.B. 2/12/75


TEST 5801 RUN 9 NTP 3
2.500 INCH VENTURI
1 TOP VENT STAT PRESS
2 TOP VENT DIFF PRESS
3 TOP VENT STAG PRESS
PRESSURE-PSIA
X 10
6.000
4.000
2.000
0.000
0.000
.500
1.000
1.500
2.000
TIME SEC
X 10



Pg. 19
TEST 5801
RUN 9
NTP 3
2.500 INCH VENTURI
1 2.0 FT W WALL PRESS
2 6.5 FT W WALL PRESS
3 11.0 FT W WALL PRESS
PRESSURE-PSIA
X 10
6.000
4.000
2.000
0.000
0.000
.500
1.000
1.500
2.000
TIME SEC
X 10

CHUGGING

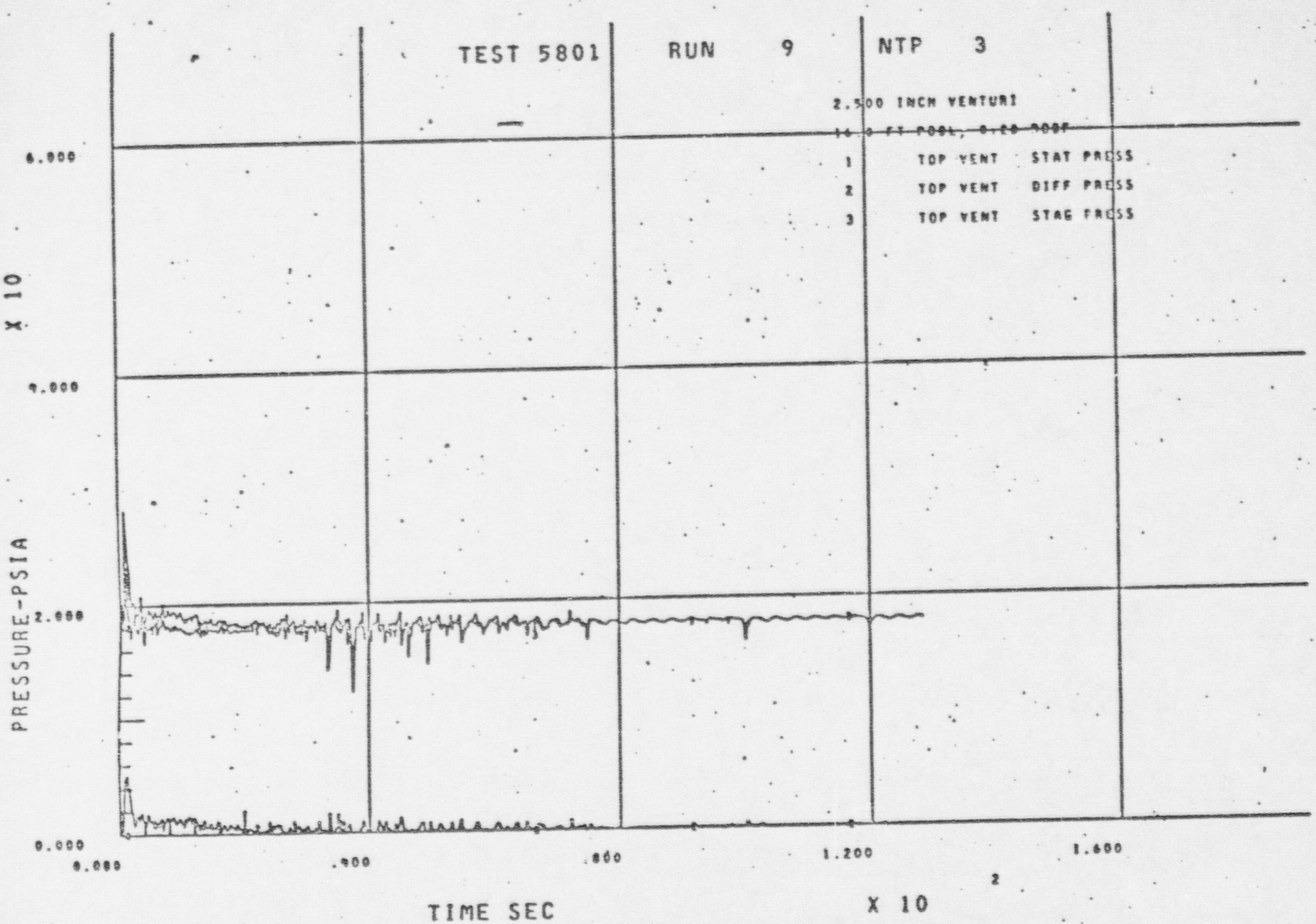
- PHENOMENA

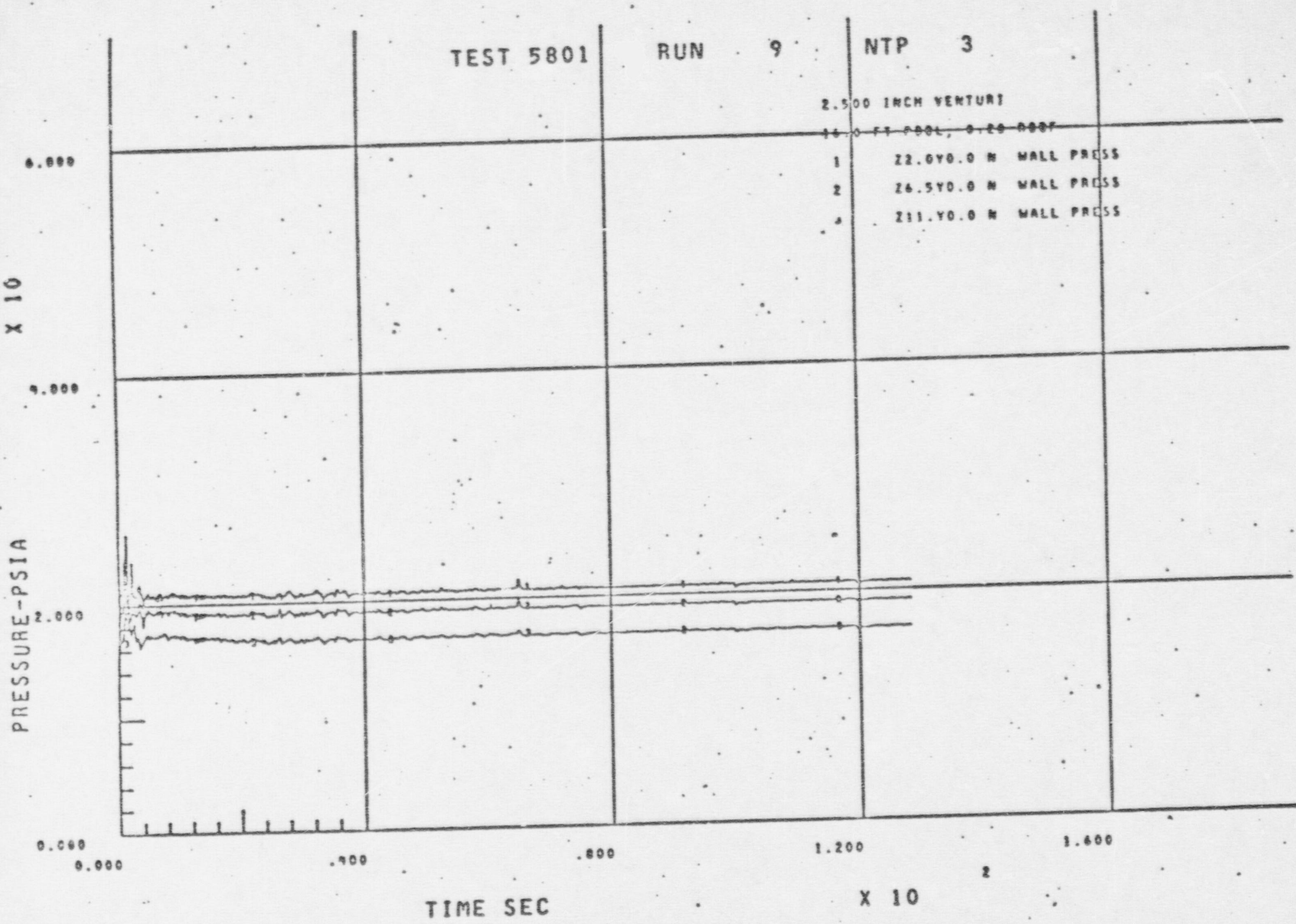
- STATUS OF G.E. INVESTIGATION
  - SCALING EFFECTS
    SMALL
  - DIFFICULT TO MODEL

- RELATIONSHIP OF PHENOMENA TO MARK III
  - RESULTING CONTAINMENT WALL LOADS INSIGNIFICANT
  - RESULTING DRYWELL WALL LOADS NOT CONTROLLING
  - RANDOM CHUGGING BETWEEN VENT STACKS WOULD TEND TO DECREASE DRYWELL PRESSURE OSCILLATIONS

- FUTURE WORK
  - 1/9TH SCALE TESTS (RANDOM CHUGGING BETWEEN VENT STACKS)

W.J.B. 2/12/75


TEST 5801
RUN 9
NTP 3
2.500 INCH VENTURI
14.0 FT POOL, 0.28 ROOF
1 TOP VENT STAT PRESS
2 TOP VENT DIFF PRESS
3 TOP VENT STAG PRESS
6.000
4.000
2.000
0.000
0.000
.400
.800
1.200
1.600
TIME SEC
X 10
2
PRESSURE-PSIA
X 10


TEST 5801
RUN 9
NTP 3
2.500 INCH VENTURI
1 Z2.6Y0.0 N WALL PRESS
2 Z6.5Y0.0 N WALL PRESS
3 Z11.Y0.0 N WALL PRESS
6.000
4.000
2.000
0.000
PRESSURE-PSIA
X 10
0.000
.400
.800
1.200
1.600
TIME SEC
X 10
2

SUMMARY

- G.E. Position Identified
- Documentation (8th Quarterly Progress Report)
- Ongoing Evaluation Of PSTF Data
  - Staff Will Be Kept Informed
- Observed Oscillations Have No Impact On The Mark III Design

W.J.B. 2/12/75

MARK III SEISMIC POOL SLOSHING

	EVENT	COMMENT
1973	SEISMIC SLOSHING QUESTIONS DURING GRAND GULF ACRS/STAFF REVIEW.	
1974	G.E. INITIATED MODEL DEVELOPMENT AND TESTING EFFORT.	
	G.E. PREDICTED MARK III ANNULUS POOL RESONANCE FREQUENCIES (LINEAR MODEL).	MODEL ADEQUACY WAS CONFIRMED WITH G.E. TEST DATA.
	G.E. INITIATED DEVELOPMENT OF NON LINEAR MODEL TO PREDICT WAVE AMPLITUDES.	OUTSTANDING COMMITMENTS DID NOT PERMIT MODEL COMPLETION.
	G.E. CONTRACTED SWRI TO INVESTIGATE MARK III SEISMIC POOL SLOSH.	
	SWRI CONDUCTED SCALING STUDIES AND ADDITIONAL TESTS.	RESULTS CONFIRMED SCALED TEST CAN BE USED TO SIMULATE MARK III
	SWRI PERFORMED 3-AXIS TESTS WITH G.E. RANDOM SEISMIC INPUT	VENT UNCOVERY DID NOT OCCUR (0 —.3G)
1975	SWRI TO PERFORM 3-AXIS RANDOM SEISMIC INPUT TESTS WITH LOWER FLOORS IN PLACE	WILL ENABLE EVALUATION OF POOL SLOSH EFFECT ON CONTAINMENT AND STRUCTURES

W.J.B. 2/11/75

RELIEF VALVE AIR CLEARING MODEL

- ORIGINAL QUAD CITIES MODEL
- REVISED ANALYTICAL MODEL
  - BUBBLE OSCILLATION FREQUENCY
  - BUBBLE LOCATION
  - BUBBLE VERTICAL MOTION
  - BUBBLE INDUCED PRESSURE DISTRIBUTION
- STRUCTURE WALLS AND FREE SURFACE EFFECTS
- PRESSURE DISTRIBUTION ON STRUCTURE
- MODEL VERIFICATION TEST PROGRAM OBJECTIVES

T.Y.F. 2/12/75

ORIGINAL QUAD CITIES TEST MODEL

- CONSISTS OF TWO MODELS
  (1) ONE DIMENSIONAL PIPE DYNAMICS
  (2) AIR BUBBLE RESPONSE IN INFINITE POOL
- NO FREE SURFACE EFFECTS
- NO OSCILLATION DAMPENING
- ADIABATIC AIR DISCHARGE - FREQUENCY PREDICTION SLIGHTLY OFF
- NO GEOMETRY EFFECTS

T.Y.F. 2/12/75

REVISED AIR BUBBLE DYNAMICS MODEL

OBJECTIVE: PREDICT RELIEF VALVE LOAD ON CONTAINMENT WALLS INCLUDING REAL LIFE EFFECTS AND TO BECOME COMPATIBLE WITH QUAD CITIES TEST DATA.

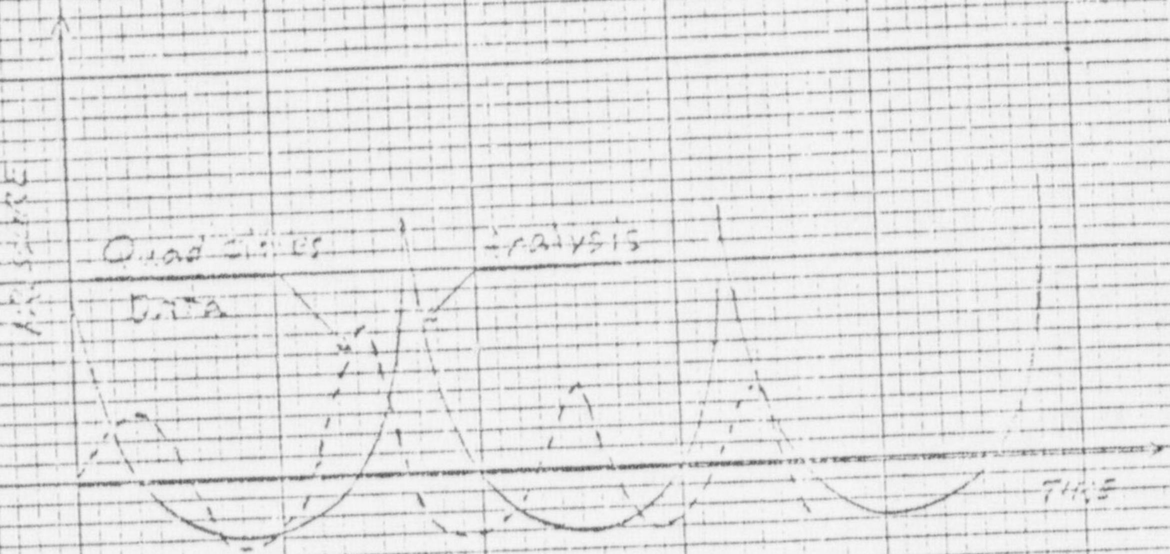
PROBLEM:

(1) BEHAVIOR OF BUBBLE FROM ITS FORMATION TO THE TIME IT REACHES THE POOL SURFACE. THIS INCLUDES PRESSURES, TEMPERATURES, RADIUS, AND ELEVATION AS A FUNCTION OF TIME.

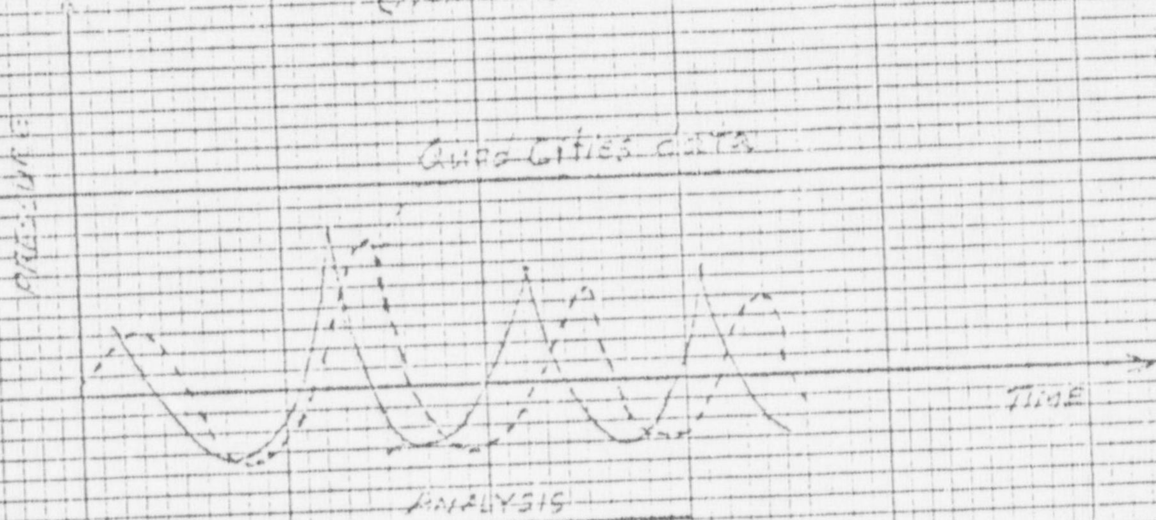
(2) THE PRESSURE INDUCED BY THE BUBBLE AT ANY POINT IN THE POOL AND AT ANY TIME DURING THE TRANSIENT.

T.Y.F. 2/12/75

FIG. I - Comparison of Calculated and Measured Frequencies.



a) ADIABATIC AIR DISCHARGE
(HEAT TRANSFER NEGLECTED)



b) Energy Transfer Considered

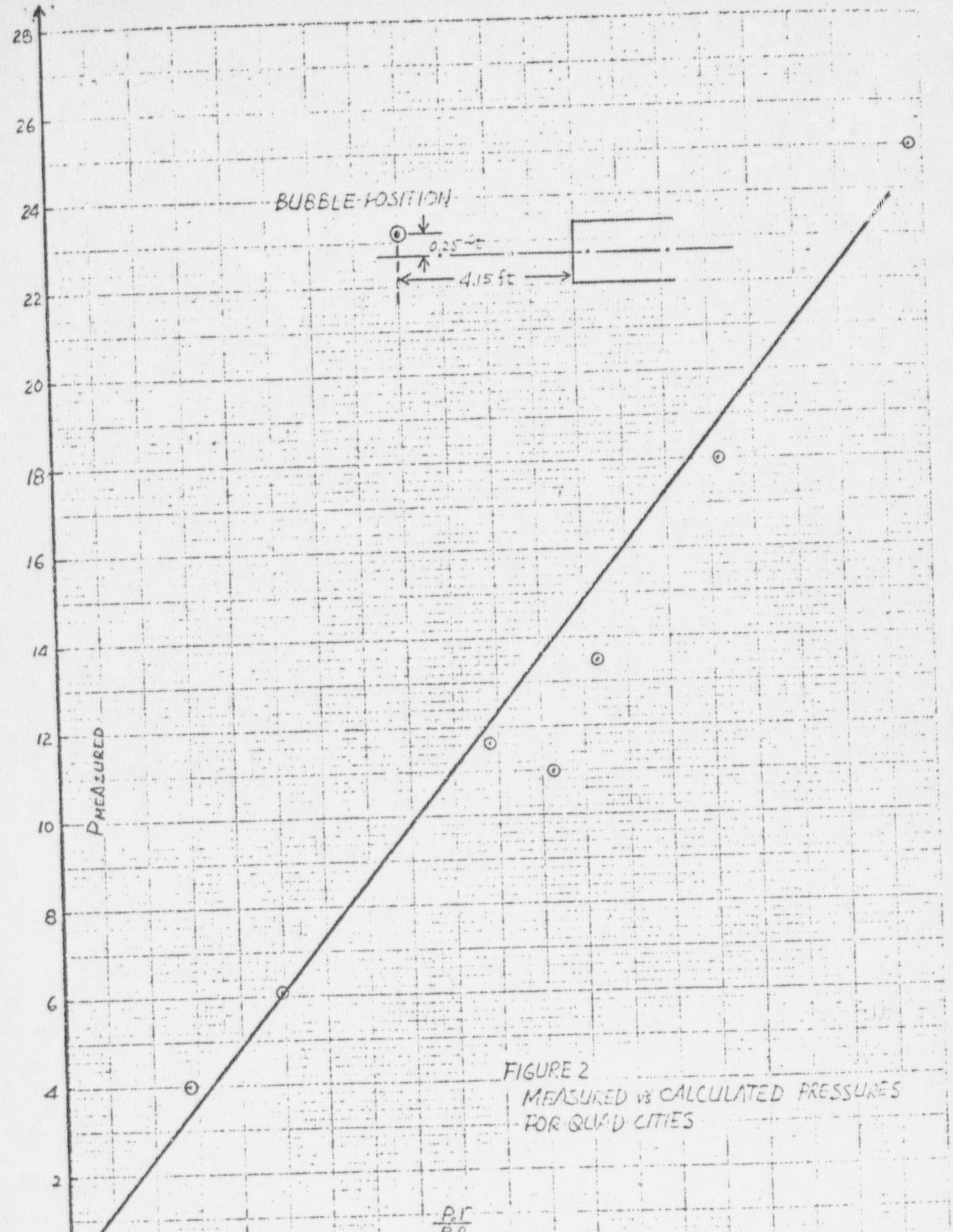


FIGURE 2
MEASURED vs CALCULATED PRESSURES
FOR QUAD CITIES

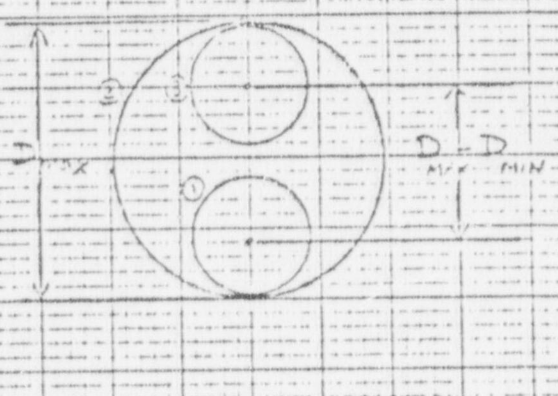


FIG. 3 - "Snake" Motion of Bubble

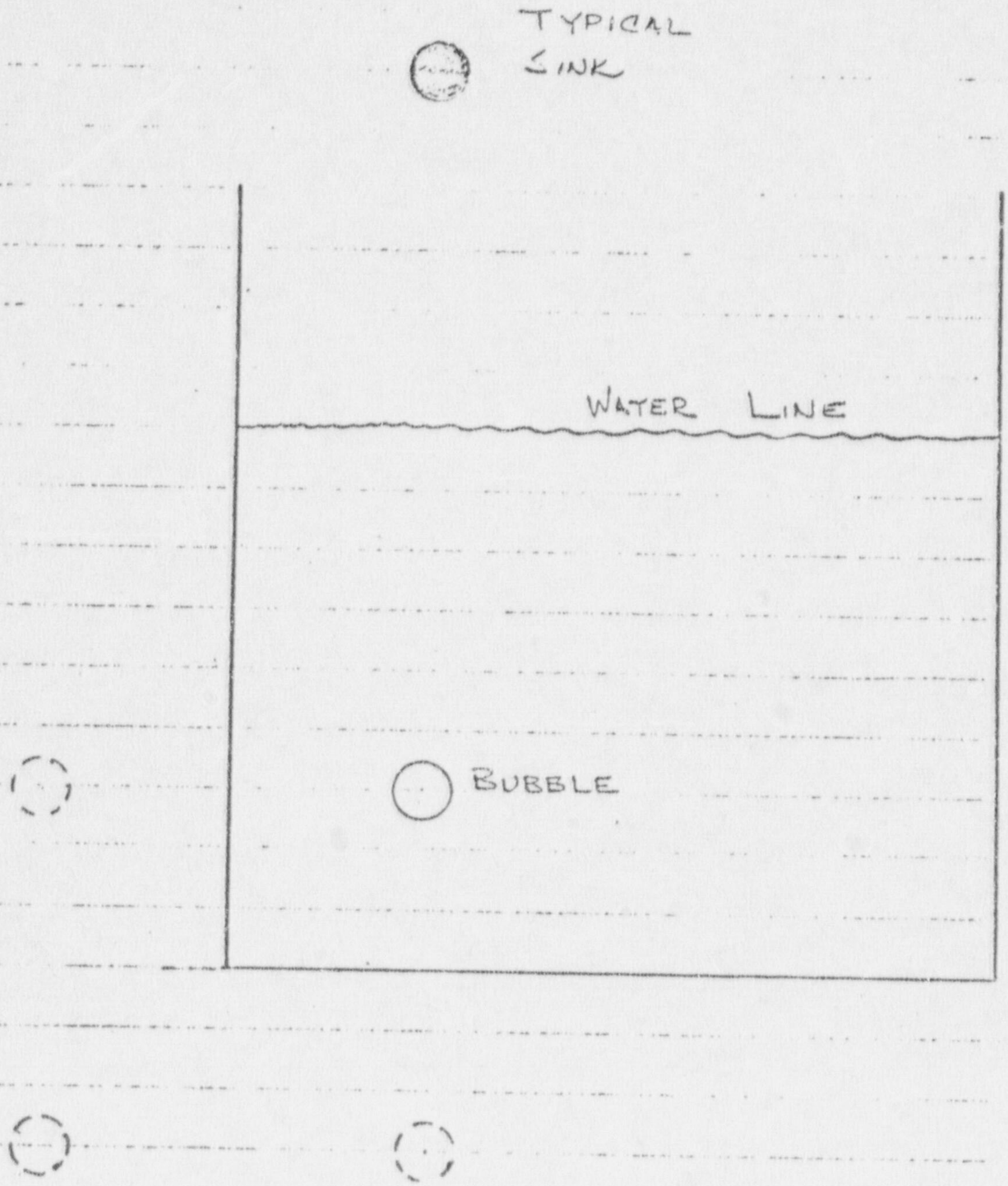


FIGURE 4 METHOD OF IMAGES

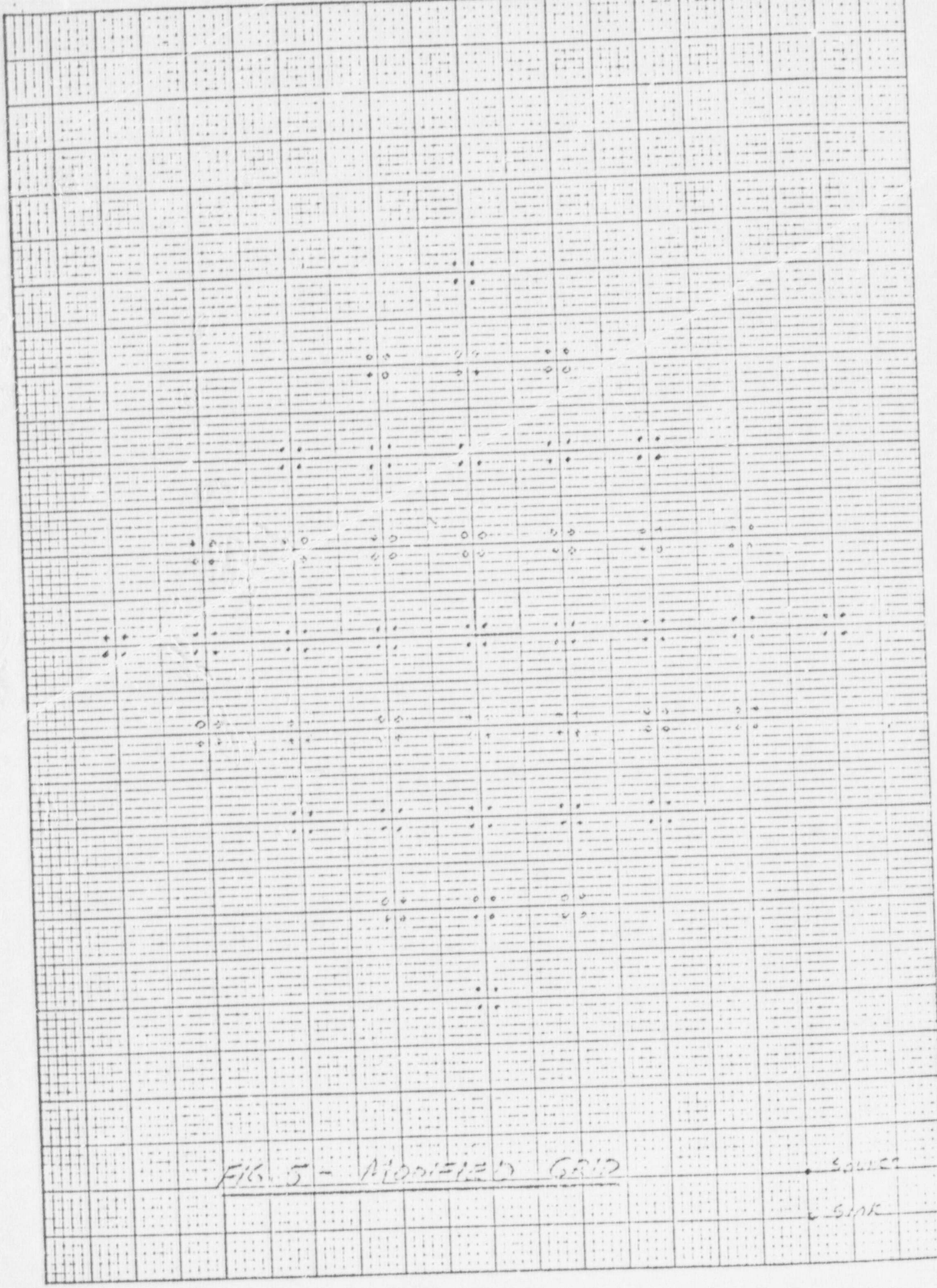


FIG. 5 – MODIFIED GRID

MODEL VERIFICATION TEST FOR

RELIEF VALVE AIR CLEARING

OBJECTIVE:

(1) VERIFY THE IMAGE TECHNIQUE

(2) OBTAIN DATA FOR BUBBLE INTERACTION EFFECTS

T.Y.F. 2/12/75

S/R Valve Clearing load

MODEL VERIFICATION TEST

OBJECTIVE

To Verify The Prediction Model.

INVOLVING

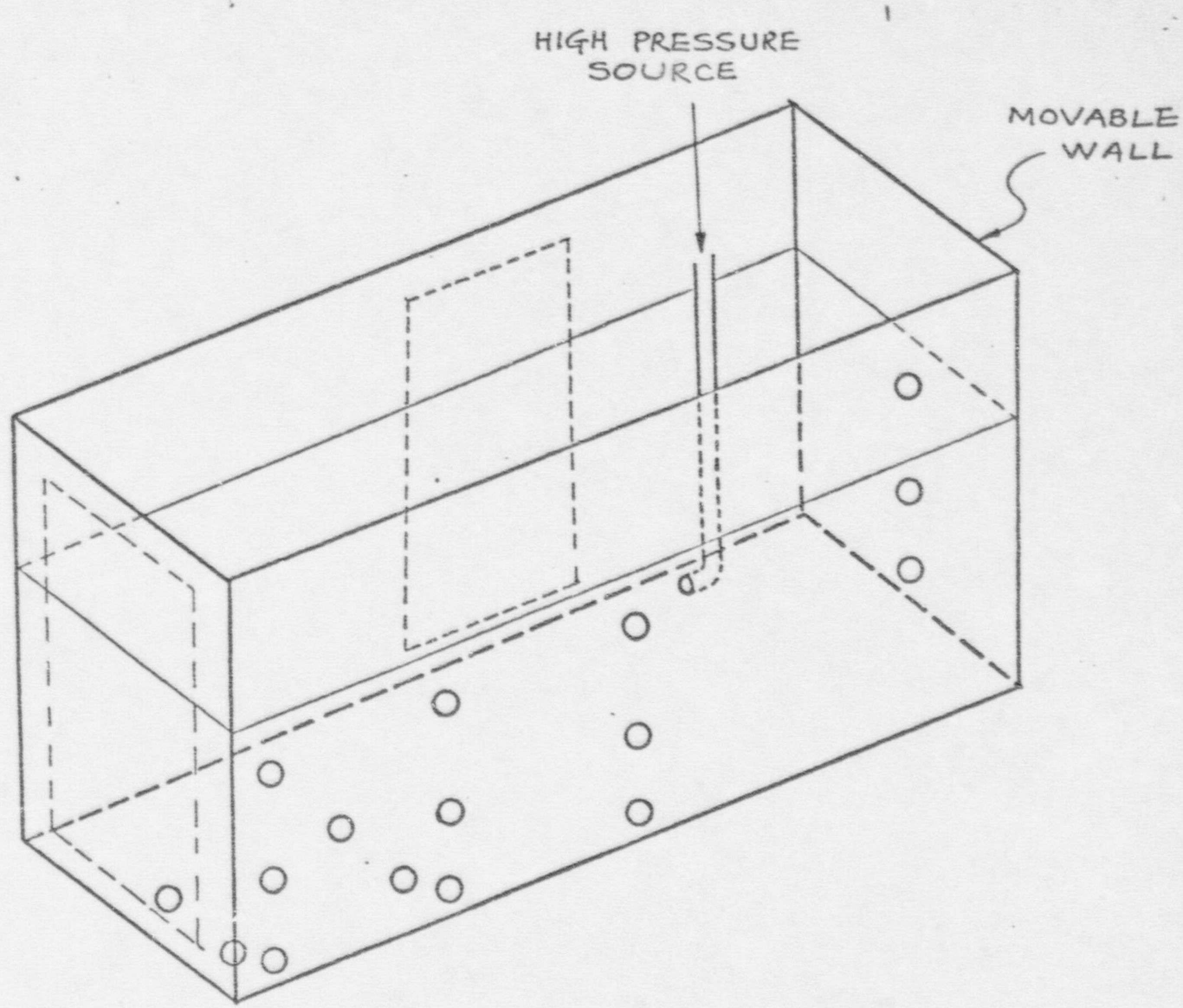
1. Method of Images.
2. Superposition Method.

FOR

S/R Valve Discharge Air Clearing Load.

TEST FACILITY

- 1/8 Scale
- Rectangular Tank
  - 12-Inch Thick Wall
  - Observation Window
  - Less Than .020-Inch Deflection on Wall
- Data Acquisition
  - Pressure Transducer
  - Motion Picture


HIGH PRESSURE
SOURCE
MOVABLE
WALL

TEST SCHEDULE

TASK	EXPECTED TIME
- SHAKEDOWN	NEARLY COMPLETE
- SINGLE BUBBLE TEST	TWO WEEKS AFTER SHAKEDOWN

TO VERIFY METHOD OF IMAGES

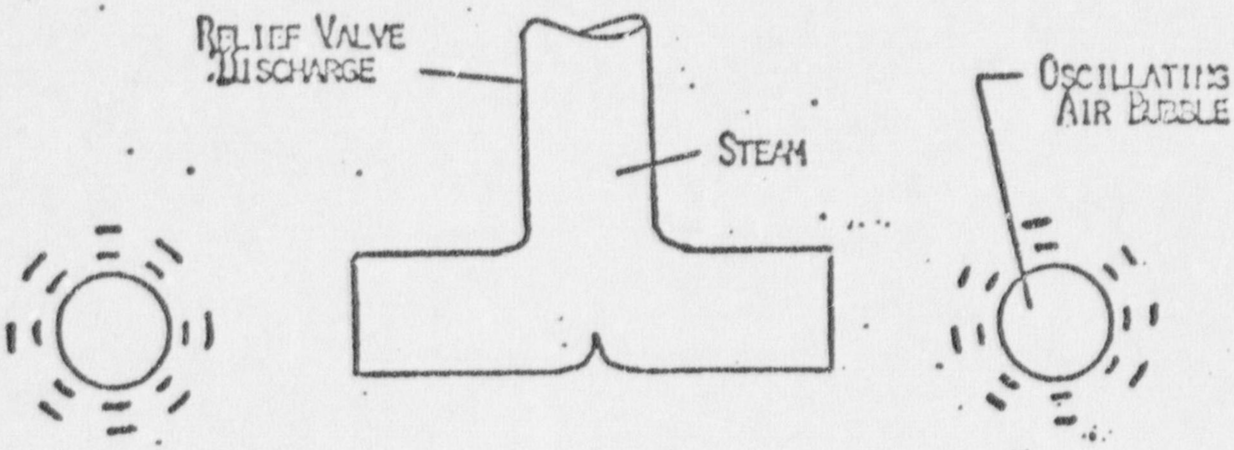
TASK	EXPECTED TIME
- TWO BUBBLE TEST	THREE WEEKS AFTER SINGLE BUBBLE TEST

TO VERIFY SUPERPOSITION METHOD

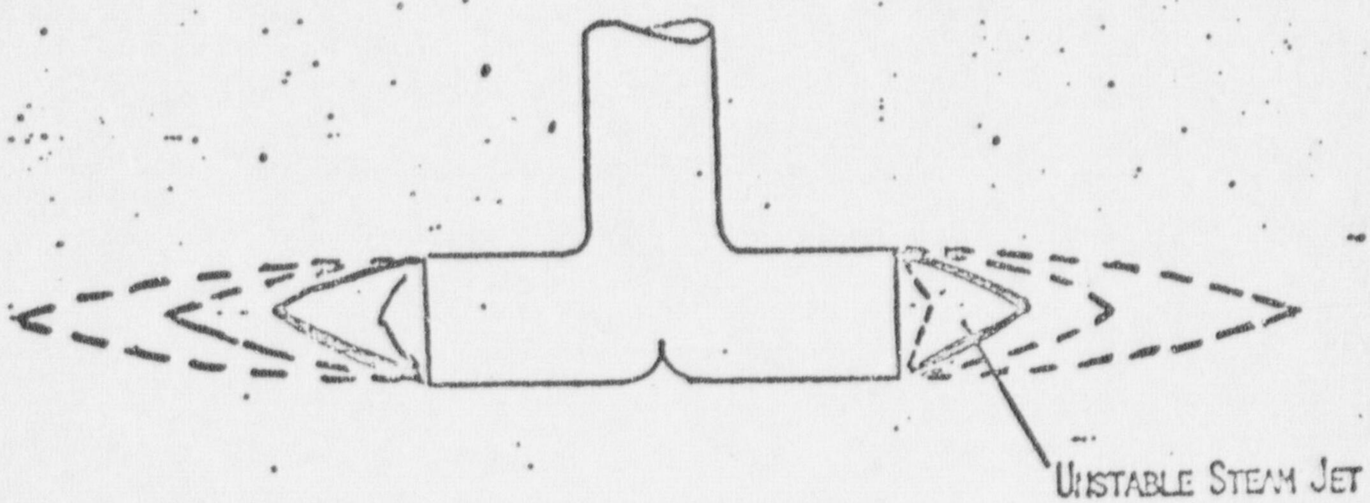
CURRENT STATUS

SHAKEDOWN DATA ARE BEING ANALYZED.

RELIEF VALVE LOAD PHENOMENA



AIR CLEARING LOAD



HIGH TEMPERATURE CONDENSATION

T.Y.F. 11.17.74 XV

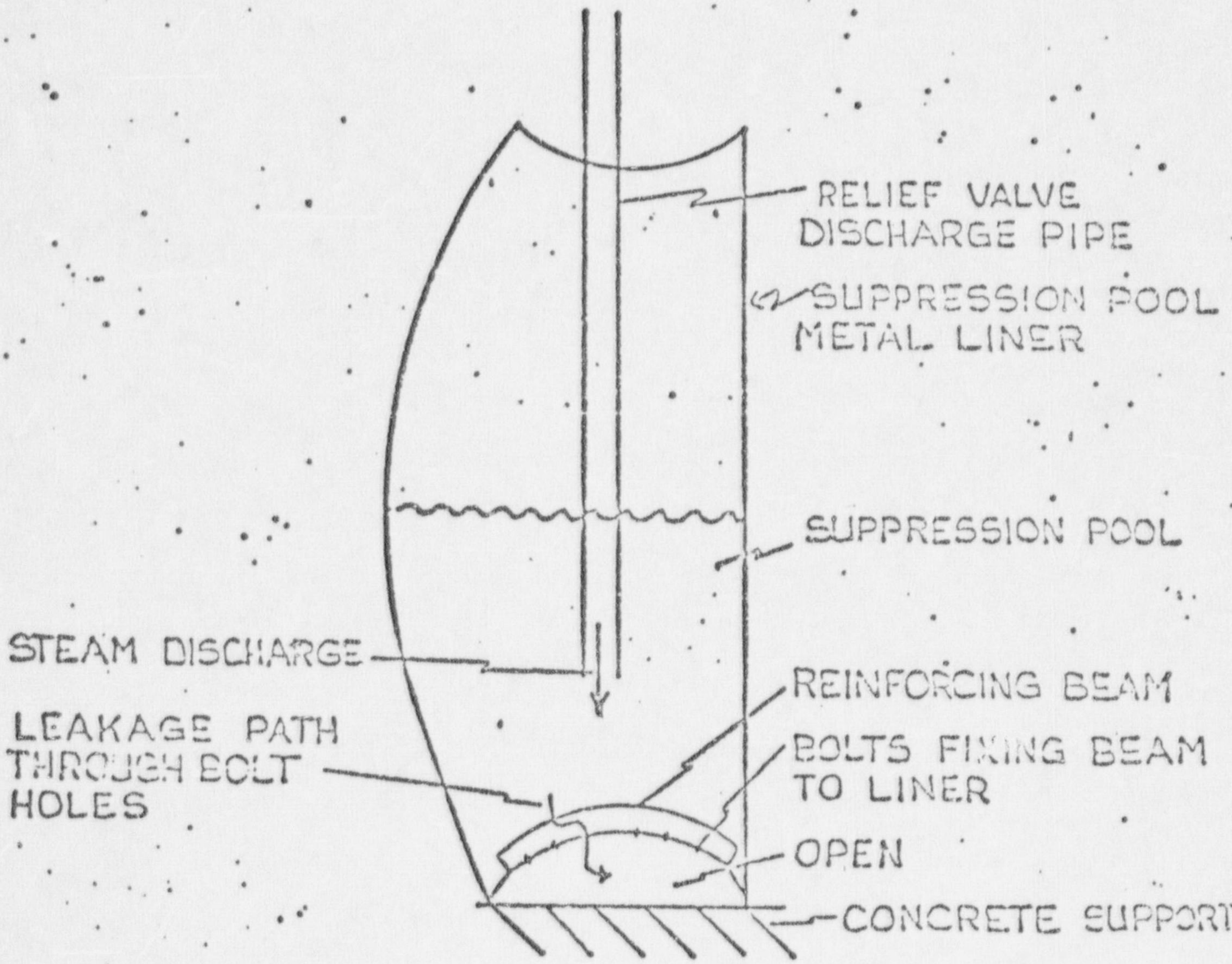
RELIEF VALVE CONCERN

AIR CLEARING LOAD

- INDEPENDENT OF POOL TEMPERATURE
- OCCURS ON EACH VALVE ACTUATION
- FATIGUE LIFE CONCERN

HIGH TEMPERATURE VIBRATION

- OCCURS IF CONCURRENT HIGH POOL TEMPERATURE AND HIGH MASS FLUX DISCHARGE
- POTENTIALLY VERY HIGH AMPLITUDE LOADS


RELIEF VALVE
DISCHARGE PIPE
SUPPRESSION POOL
METAL LINER
SUPPRESSION POOL
STEAM DISCHARGE
REINFORCING BEAM
LEAKAGE PATH
THROUGH BOLT
HOLES
BOLTS FIXING BEAM
TO LINER
OPEN
CONCRETE SUPPORT

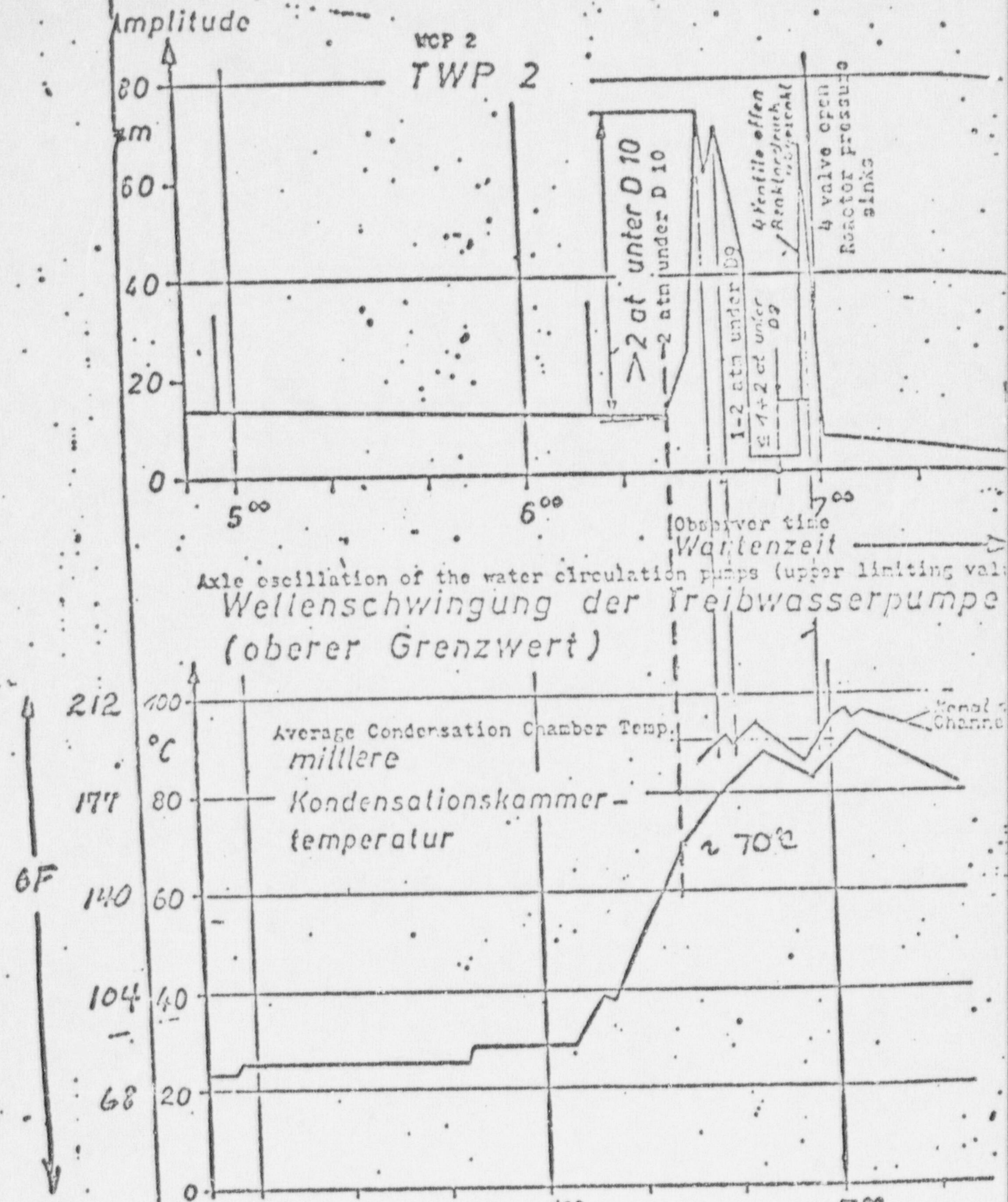


Bild 3.1: FIGURE 3.1:

Zusammenhang zwischen Wassertemperatur in der Kondk. und Wellenschwingung der Treibwasserp.

Relationship between water temperature in the condensation chamber and axle oscillations of the water circulation pumps

RELIEF PIPE OUTLET GEOMETRIES

(Immersion depths are not represented according to scale)

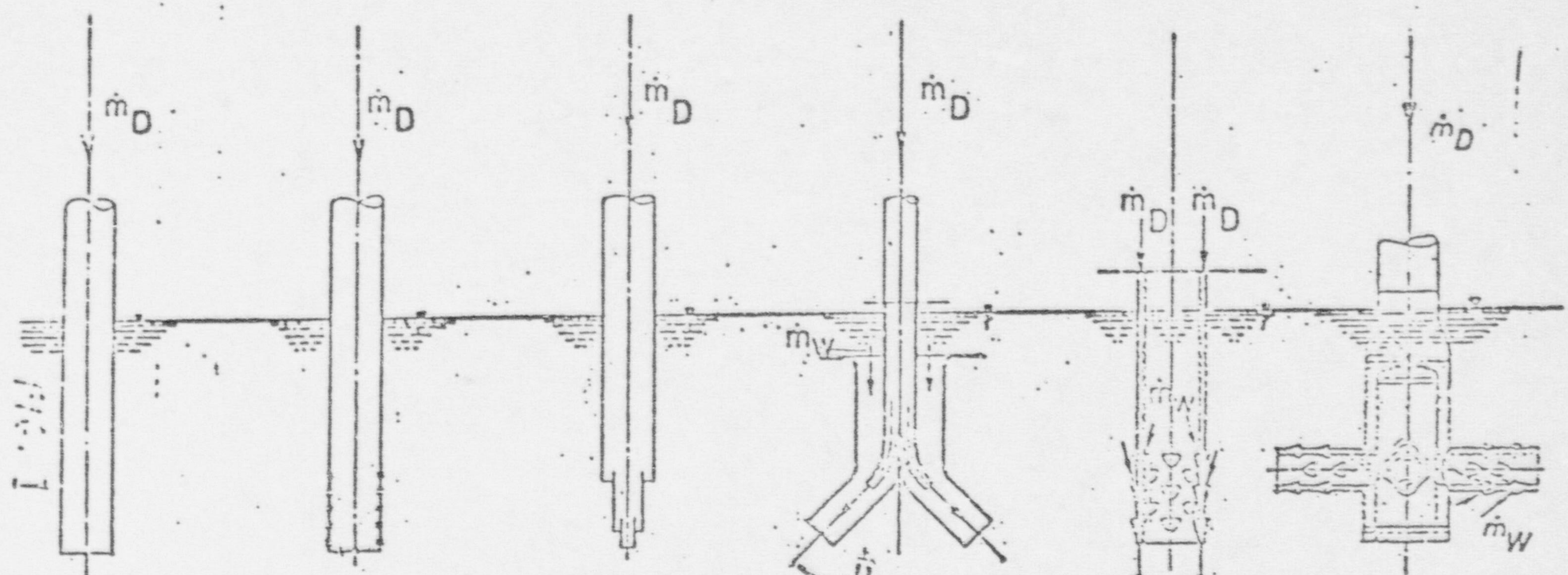
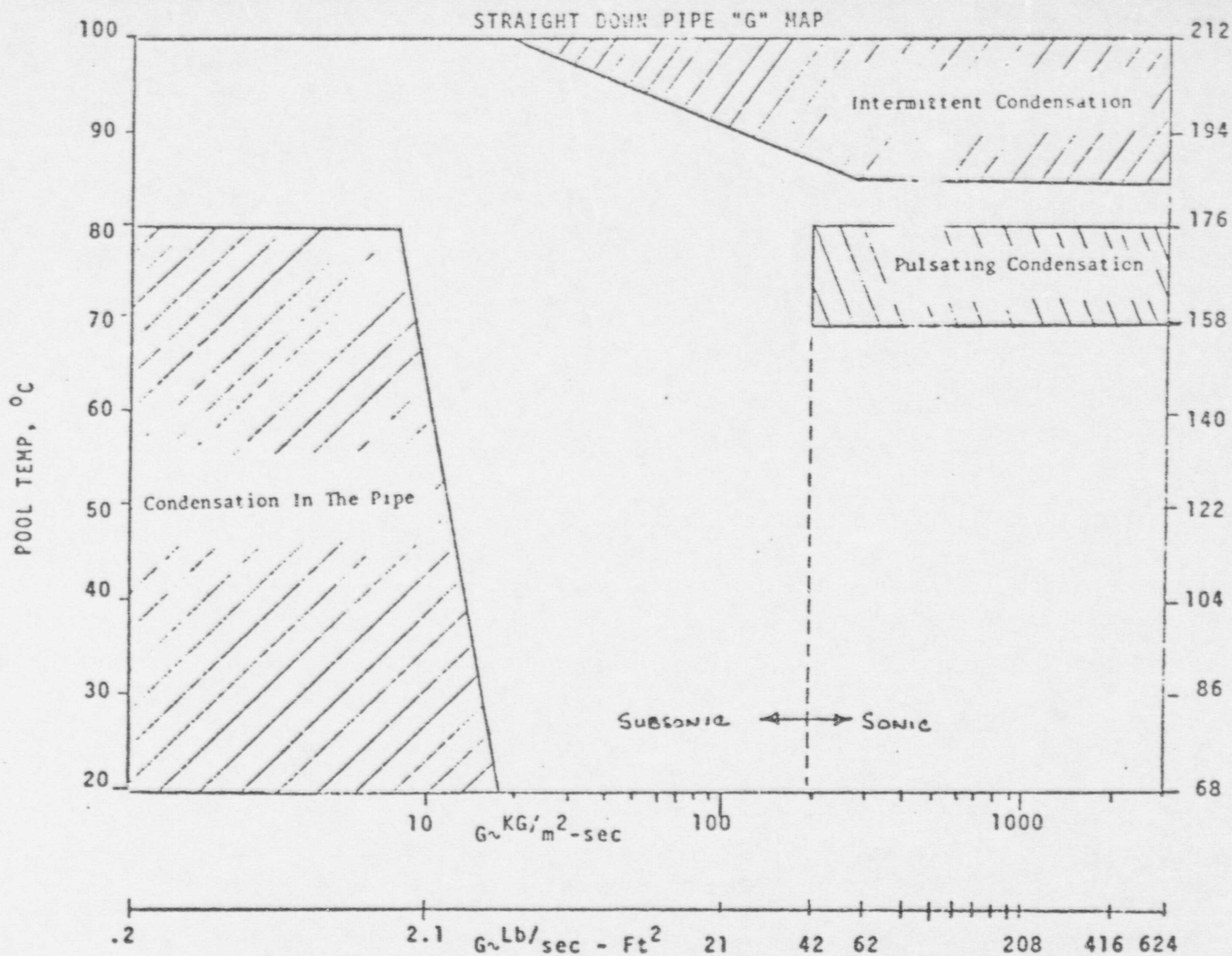


FIG. 1

smooth pipe	perforated pipe	graduated pipe	fork nozzle	Nedel nozzle	Cross nozzle
Model Test Stand	M.T.S.	M.T.S.	M.T.S. (GKM)	M.T.S. (cut out)	
GKM Scram Tank	Scram Tank	Scram Tank		GKM	GKM


STRAIGHT DOWN PIPE "G" MAP
Intermittent Condensation
Pulsating Condensation
Condensation In The Pipe
SUBSONIC
SONIC
POOL TEMP, °C
100
90
80
70
60
50
40
30
20
POOL TEMP, °F
212
194
176
158
140
122
104
86
68
10
100
1000
G~KG/m2-sec
.2
2.1
21
42
62
208
416
624
G~Lb/sec - Ft2

RELIEF VALVE OPERATION HISTORY

			Pool Temp
MILLSTONE	10/71	STUCK OPEN RELIEF VALVE	~ 106 °F
PILGRIM	9/73	PLANT DEPRESSURIZATION	~ 118 °F
MONTICELLO	9/71	STUCK OPEN RELIEF VALVE	?
BROWNS FERRY	1/74	ISOLATION TRANSIENT	~ 120-130 (calc)
COOPER	7/74	STUCK R.V.	~ 145 °F
PEACH BOTTOM	10/74	INADVERTANT OPEN R.V.	~ 135 °F

MODEL APPLICATION

I. SINGLE NODE - SCAM

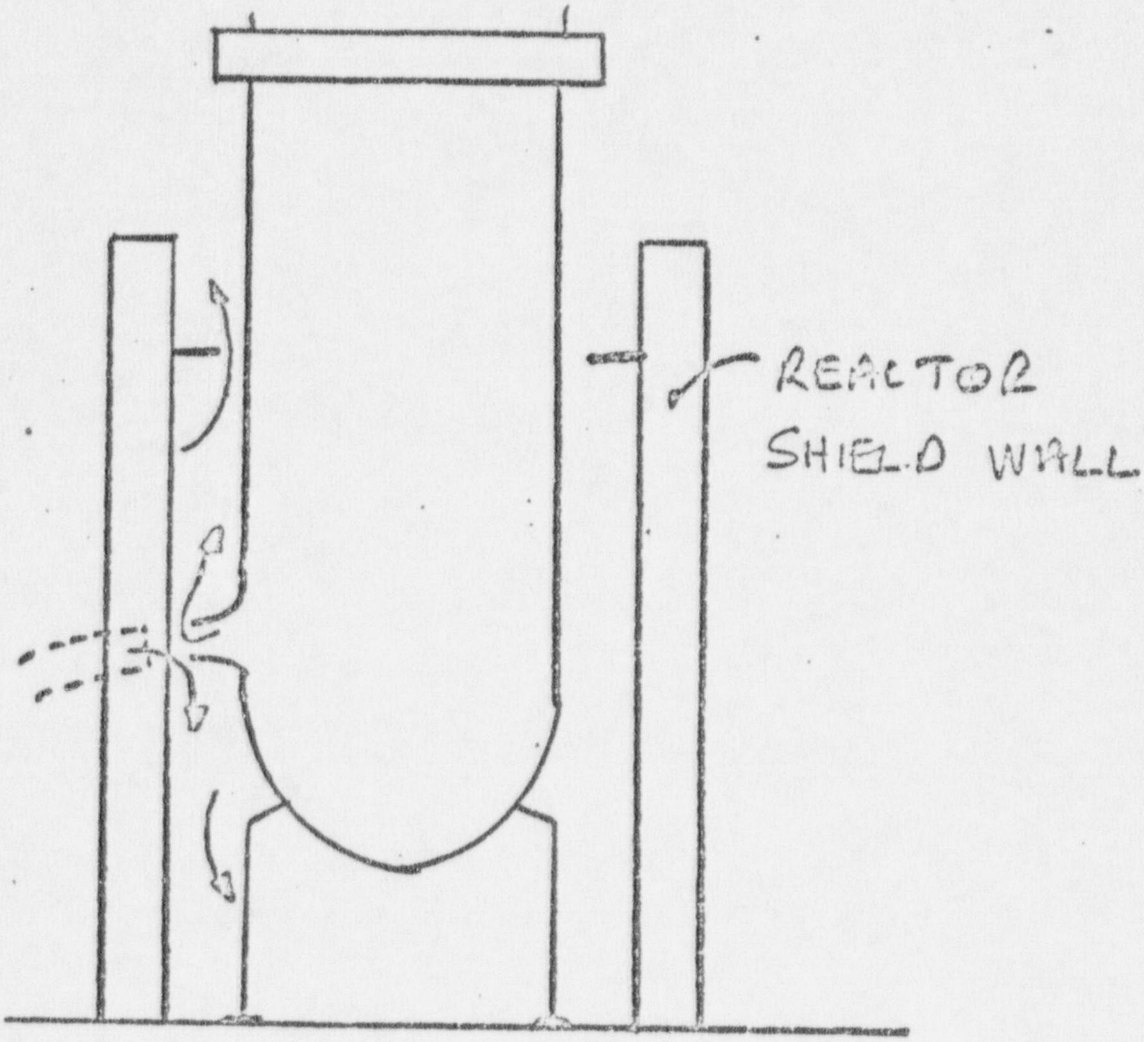
- SUBCOMPARTMENTS WHERE UNIFORM PRESSURE IS APPLIED TO SURROUNDING STRUCTURE.

II. NODALIZED MODEL - RELAP - 4

- SUBCOMPARTMENTS WHERE LOCAL RESTRICTION CAN OCCUR THEREBY APPLYING LOCAL PRESSURES ON STRUCTURE.

T.Y.F. 1/16/75

REACTOR SHIELD WALL PRESSURE TRANSIENTS



CONCERNS:

- BULK PRESSURE ON RSW
- BULK PRESSURE ON RPV SKIRT
- ASYMMETRIC LOAD ON RSW
- OVERTURN MOMENT ON SKIRT

RELAP 4 ANALYSIS
OF REACTOR SHIELD
WALL PRESSURE TRANSIENTS

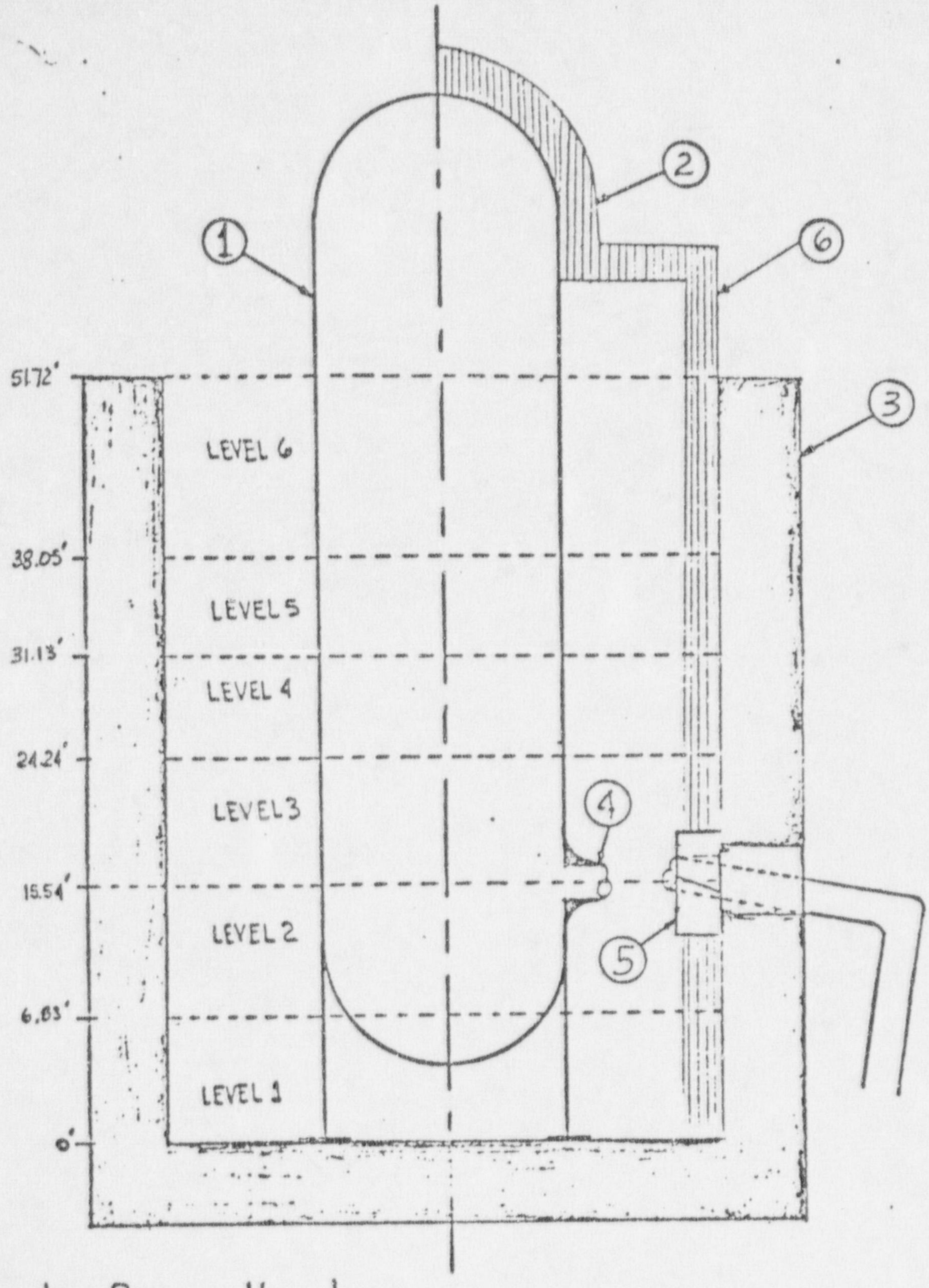
RELAP 4 MODEL

- 29 NODES
- 53 JUNCTIONS
- ASSUME SYMMETRY

MAJOR ASSUMPTIONS

- ALL RECIRC. BREAK FLOW INTO ANNULUS
- .6 MULTIPLIER ON MOODY FOR CHOKED FLOW CHECK
- HOMOGENEOUS FLOW

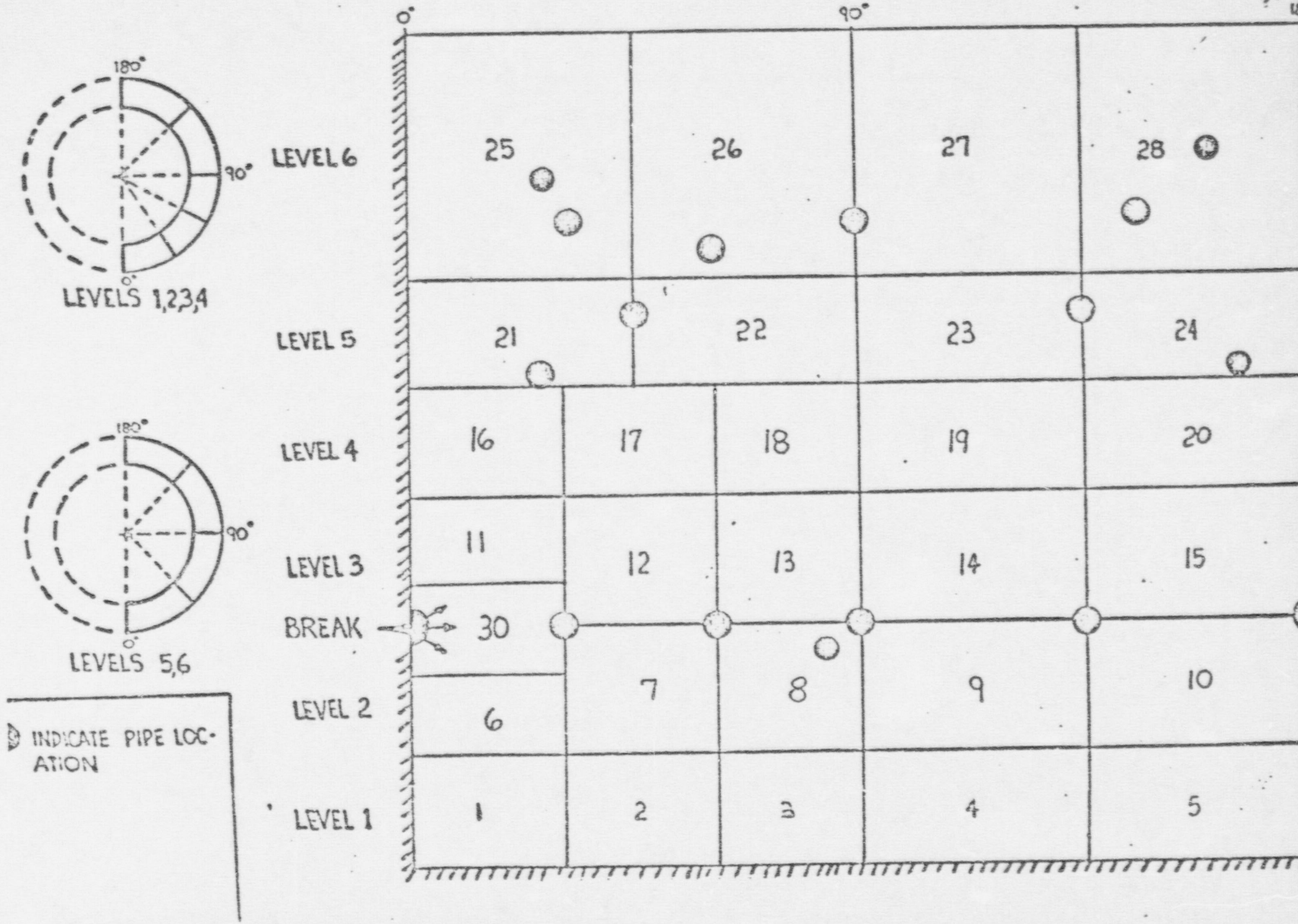
T.Y.F. 1/16/75



① - Reactor Pressure Vessel
② - Insulation
③ - Biological Shield
④ - Break Nozzle
⑤ - Shield Doors
⑥ - BLOW OUT PANELS

DRWG. # 1

Not To Scale


180°
90°
0°
LEVELS 1,2,3,4
180°
90°
0°
LEVELS 5,6
INDICATE PIPE LOCATION
LEVEL 6
LEVEL 5
LEVEL 4
LEVEL 3
BREAK
LEVEL 2
LEVEL 1
0°
90°
25
26
27
28
21
22
23
24
16
17
18
19
20
11
12
13
14
15
30
6
7
8
9
10
1
2
3
4
5

EXCERPT FROM SUMMARY OF
136TH ACRS MEETING
AUGUST 5-7, 1971

EXECUTIVE SESSION

3.2 Limerick Station

3.2.1 Executive Session

The Subcommittee review of the status of Limerick design to accommodate safeguards concerns was presented in the form of a comparison of Limerick and Newbold features. The following major differences were noted.

Siting

	Limerick	Newbold
SPI	0.81	1.25
Wind Direction	1	1
Wind Speed	<1	1

Building - Limerick reactor building is rectangular and upper floor extends over both reactors

Containment pressure - Limerick blowout panels relieve at 7" H_2O. This relief pressure is adequate to accommodate 11 orificed instrument line breaks. (Two psig will accommodate only 15 such breaks.)

ECCS - Comparable to Newbold except for lack of redundancy in LPCI piping.

.Drywell Volume - Limerick 40% greater than Newbold

.DBE - Limerick 0.12 g horizontal, MM7

.Radwaste Storage Capacity - Limerick greater by factor of 3.75

Discussion was directed mainly toward satisfying remaining safeguards information requirements related to main steam line stop valve leakage and measures to stop the leakage; capability for inservice inspection; seismic design bases; nearby railroad; containment liner weld inspection; spent fuel cask handling.

Committee positions and information needs with respect to the major concerns were as follows:

a. MSL Stop Valve Leakage - The Staff does not include the contribution of this leakage to the post-LOCA dose calculations; assumptions regarding integrity of steam line system between isolation valves and turbine are important to the assessment of effects of 11 cfm stop valve leakage; MSL is Class I design, but the lines connected to it and the turbine building are not.

b. Inservice Inspection - Applicant will give attention to design for adequate space. Committee will probe this item with Staff and applicant to gain assurances that such design provisions are feasible in an effort to avoid repetition of the James A. FitzPatrick reversal.

c. Seismic Design - Recommendations of ACRS consultants (Page, Wilson and Philbrick) range from unenthusiastic acceptance of the proposed 0.15 g DBE to a recommendation for 0.2 g for the DBE.

d. Railroad - Committee members expressed concern about hazards to the plant attributable to shipments of toxic materials and explosives on the nearby railroad.

e. Containment Liner Weld Inspection - Some concern was expressed regarding the applicant's proposal for 4% radiography of welds. However, structural strength is secondary to leakage for liners, and the entire structure will be leak tested. The welds will receive a pressurized channel or soap bubble leak test in conformance with the new safety guide. Two percent weld radiography has been accepted for PWR containment liners.

f. Spent Fuel Cask Handling - Proposed procedures and design for protection against hazards associated with dropping a spent fuel cask into spent fuel storage areas would be probed with the Staff and applicant.

3.2.2 Regulatory Staff Meeting

All major concerns have been resolved except the following:

a. Seismic design of MSL piping

b. Post-LOCA control room exposure doses

c. ATWS

d. Post-LOCA MSL isolation valve leakage exposure doses

e. Gaseous radioactivity releases

f. Dilution and dispersion factors

g. Nuclear fuel integrity

h. Guide tube collapse

i. Seismic design

j. Heat load on filters

k. Post-LOCA hydrogen control

l. Gaseous Radwaste treatment system

m. Common-mode failure

In discussion between Staff and the Committee on these items, the following information was developed:

a. Seismic design of MSL piping - Applicant has accepted Class I requirement for pipe sizes 6" and larger. Staff is pressing for 2-1/2" and larger.

b. Post-LOCA control room doses - Applicant's calculation techniques and assumed filter efficiencies differ from those of the Staff.

c. ATWS - Applicant will use pump trips and boron injection; no occurrence probability figure is available and none is expected.

d. Post-LOCA MSL isolation valve leakage exposure dose - The Staff is not yet satisfied with either of the applicants' proposals for preventing excessive leakage; for the design leak rate of 11 ft^3/hr, a ground level release and the worst meteorological conditions would give a thyroid dose of 100 rem/min; if time delay credit can be given for leakage path through piping, turbine and condenser, the calculated dose decreases to a few rem.

e. Nuclear fuel integrity - Need updated information on production fuel, particularly with regard to performance of gadolinia in comparison with boron.

f. Guide tube collapse - Karwat oscillations are not considered to be a problem with the guide tubes.

g. Seismic design - The Staff is satisfied with the bases used by the applicant. Soil amplification effects account for the 0.15 g DBE at Limerick and the 0.2 g DBE at Newbold.The horizontal acceleration values assigned to Newbold and Limerick are comparable.

h. Post-LOCA hydrogen control - Applicant has accepted the Safety Guide requirement.

In addition, there was considerable discussion regarding the following concerns:

a. Primary system pressure relief - Applicant assumptions regarding number of relief valves operable are unknown; relief capacity is distributed 10% to safety valves and 60% to relief valves; the total fractional capacity is the same as for Newbold and is satisfactory to the Staff; there is sufficient redundancy in valves to ensure the required relief capacity; a reactor scram must be assumed to take place.

b. Spent fuel cask drop safeguards - Cask loading and transport area is above a 3'-wide concrete wall between the fuel storage pools.

c. Railroad hazards - The Staff is satisfied with the applicant's attention to toxic and hazardous materials transport matters.

d. Adequacy of cooling water supply - The Staff feels that the applicant has met required criteria.

3.2.3 Meeting with Philadelphia Electric Company

Primary System Activity (Buildup of Iodine following plant shutdown)

Information obtained from San Jose relative to post-scram radioiodine buildup in coolant was reviewed by General Electric Company. Representatives of Public Service Electric and Gas Company attended this portion of the meeting since it was applicable to both Newbold and Limerick (see attachment B for a summary).

General conclusions and points of discussion were:

a. Tech Spec limit for iodine activity in liquid is now 1.5 μci/cc. Dr. Hendrie recommended that the possibility of an iodine spike in primary water after depressurization should be taken into account in setting the Tech Spec for normal operation. It may develop that the Tech Spec for noble gas release will define a control point for fuel failure that will keep radioiodine within acceptable limits.

b. Effect of depressurization on iodine release to coolant should be investigated.

Limerick Review

The major remaining issues with respect to Limerick safeguards concerns were reviewed and discussed with development of the following conclusions and information.

a. Limerick/Newbold Population Distribution - Population to a distance of about three miles from Limerick is less than for Newbold; beyond three miles the populations are about the same.

b. River Flow - Will not be significantly affected by withdrawal of water for plant use.

c. Cooling Towers - Seismic design is Class I, but they are not designed to withstand a tornado; missiles generated by a disintegrating cooling tower are not considered a threat to the plant; the cooling towers are not essential for safety of the plant following a major earthquake.

d. Radwaste System - Liquid radwastes will be recycled, and a radwaste processing system will be purchased from Union Carbide. Releases are estimated to be less than 1.5×10^{-2} ci/yr.

e. Over-Under Containment - Is an improvement with respect to seismic considerations and pipe whip.

f. Bodega Bay/Limerick Containment Design Bases - In response to a question from the Committee, the considerations involved in the design of containment for the two reactors were compared. The designer and applicant took the position that no significant extrapolations were required in basing the design on tests related to the Bodega Bay configuration and that the model had 25 to 40% built-in conservatism. Some of the Committee appeared unconvinced of the claimed similarities. However, it was established that economic considerations were not a guiding influence in the applicant's decision to go to the over and under design.

g. HPCI

- System will be changed to reflect Newbold design (will inject directly into one core spray sparger).
- The difficulties associated with adding a second HPCI system for Limerick are the same as for Newbold.

- The Limerick HPCI system is being reviewed to determine the feasibility of increasing the flow capability. Thus far, no feasible alternate shows reduced peak clad temperatures.

h. Main Steam Line

- Applicant proposes to design 14" and 8" headers and bypass headers to Class I seismic standards up to and including the turbine stop valves and bypass valves.

- Sensor/transmitter time delay for initiation of isolation valve closure is estimated to be one second.

- The applicant can provide a seal to limit leakage without installing a third isolation valve. This will be reviewed with Staff and, if necessary to obtain agreement, a third valve will be installed. By applicant's analysis, the reliabilities of the two alternates would be the same.

- The applicant's two-hour thyroid doses at the site boundary for process steam line (HPCI) breaks are low (~1 rem) because credit is taken for df provided by steam separators. For Limerick, the steam line can be isolated by temperature trip in 20 seconds. If the main steam line breaks, moisture carryover and resulting doses will be high. For a TID release, doses of 100 rem/min are calculated.

i. Reactor Shield - Will be reinforced to take safe-end nozzle failure without loss of integrity of shield. However, the applicant proposed to strengthen shield only in area of nozzles because this is the most likely site for a failure.

j. Inservice Inspection Space - An inspection annulus will be provided between vessel and shield.

k. Seismic Design - In response to Committee questioning regarding seismic parameters and earthquake probabilities, the applicant stated that the assumption must be made that the probability of exceeding the DBE during the life of the plant is nil--by definition. The concern of the Committee was directed toward the magnitude of the g values assigned to the DBE.

l. Hydrogen - Post-LOCA inerting and adequate mixing of the containment atmosphere is provided in the design to ensure elimination of any hydrogen pocketing. However, a system design for monitoring the hydrogen content of the containment atmosphere has not been developed.

m. Railroad - Is 60 feet below grade; toxic gas and explosives hazards potential will be minimized by notification and other procedures in cooperation with the railroad; control room air intake is on the side of the building opposite the railroad; the railroad does not constitute a danger to the cooling water supply system.

n. Containment

1. The adequacy of the secondary containment to contain process steam line failures was discussed. The applicant noted that:

   - Temperature and flow sensors will promptly isolate the HPCI line if a break occurs. For small leaks, they would provide indication so the line can be manually isolated.

   - For some HPCI line break conditions, the building would relieve. A major break would cause even a 2-psig building to relieve.

   - No probability figures are available for leaks or breaks capable of causing containment pressure relief. (Isolation valve reliability and the bases for decisions regarding low-pressure release to the environs vs. design for higher containment pressure were discussed at length.)

   - The blowout panels in the secondary containment would accommodate complete fracture of the HPCI system without overpressuring the containment.

   - Compartmentalization minimizes chance for compounding effects of disruptive failure in any cell.

   - The pressure relief arrangement would accommodate about 11 instrument line breaks.

2. For a LOCA, the containment arrangement provides for complete mixing of the containment atmosphere and controlled recirculation and filtering in the SGTS.

3. In response to questions directed toward exploring the relative consequences of a 25-in^2 break in primary containment with a 1/4 or 2 psi secondary containment, the applicant confirmed

that the panels would relieve for a hole greater than 25-in^2 for both designs. If the 25-in^2 hole is also associated with a LOCA and TID release, the doses can be expected to be measured in kilo rads.

4. Although the effect cannot be quantified, the heavy concrete construction of the primary containment can be expected to act as an energy absorber and thereby improve resistance to penetration of the liner by missiles or pipe whip. However, some types of small, sharp, high-speed missiles could penetrate the liner.

5. Pipe whip constraint will be provided where needed.

6. The applicant's comparison of containment pressure alternates have not included a 10 psi secondary containment building. For high-pressure secondary containment, the spent fuel pool, switchgear and electrical equipment would probably have to be located outside the containment structure.

o. Primary System Relief Capacity - Is based on the requirements of Section III of the ASME Code. It is assumed that all valves will operate, but there is redundancy to the extent that only 9 of 13 valves are required to operate. Safety and relief valve capacity sizing were explored in relation to the sizing diagram (Attachment C), and there was much discussion of ways, means, bases and justification for increasing the pressure relief capacity above that proposed. There would be room to install additional valves, but the header flow capacity would have to be analyzed. The assumption of a scram is basic to the proposed pressure relief capacity.

p. ECCS:

- The Limerick ECCS is the same as that of Newbold, except for the degree of redundancy in the LPCI piping.

- Failure of one core spray header connection will result in fuel clad temperature of 1800°F.

- The flow capacity of the core spray system is 100% greater than required, and for any of the postulated accidents, the proposed system would maintain clad temperatures below 1800°F.

- The core spray flow threshold for loss of spray distribution is not known.

3.2.4 Caucus

The consensus of the Committee was that an attempt should be made to write a letter, recognizing that there were still some unresolved concerns of individual members in regard to adequacy of:

- HPCI/ECCS system
- Containment
- Primary system pressure relief capacity
- g value assigned to DBE

3.2.5 Conclusion

The applicant was informed that an attempt would be made to write an ACRS report although there might be some dissents on matters discussed.

* * *

DRAFT TF:mev/7-15-71

ACRS meetings are informal, round-table discussions which are considered working sessions in the same category as inter or intra-agency correspondence, minutes of internal meetings, etc., which are precluded from public disclosure in accordance with the provisions of 10 CFR Part 9. In the course of these meetings preliminary data and exchange of preliminary views are frequently discussed and precede the issuance of a matured and completed report by the ACRS. These reports, which include the conclusions and recommendations of the ACRS are made available to the public in accordance with the provisions of the Atomic Energy Act.

See ACRS ltr of 8/3/66 re: 39-437

The Committee believes that in performing its functions of investigation, this mode of operation, which allows for full and frank discussion of reactor safety questions, is important to fulfilling its responsibilities.

In addition, since the ACRS was established as a statutory group to assist and advise the Commission with respect to safety responsibilities, the ACRS meetings and the related deliberations are considered part of the internal, decision making process that is precluded from public disclosure by executive privilege.

It should be noted that the statute which established the ACRS as a statutory body requires that only ACRS reports related to reactor license applications be made available to the public. The Commission has made it a practice, however, to publish all ACRS reports except in those few cases where security considerations preclude such actions.

ATTACHMENT A

IODINE IN [illegible]

Normal Operation

Theory $I \cong N.G.$

Measured $I < N.G.$

Small leaks $I \ll N.G.$
Large leaks $I \cong N.G.$

Accident – Assumes Max. leaks

Shutdown

$I_s > I_p$

Small leaks $I_s \gg I_p$ (Obs.)
Large leaks $I_s \geq I_p$ (Calc.)

Mechanism

Not Too Easy

Iodine Catches Up With N.G.

ATTACHMENT B

[illegible]

[illegible] TB < I

[illegible] TB ~ 0

[illegible]

[illegible] TB 106 → I 106
(72%) ([illegible])

[illegible]

[illegible] Largest Contributor

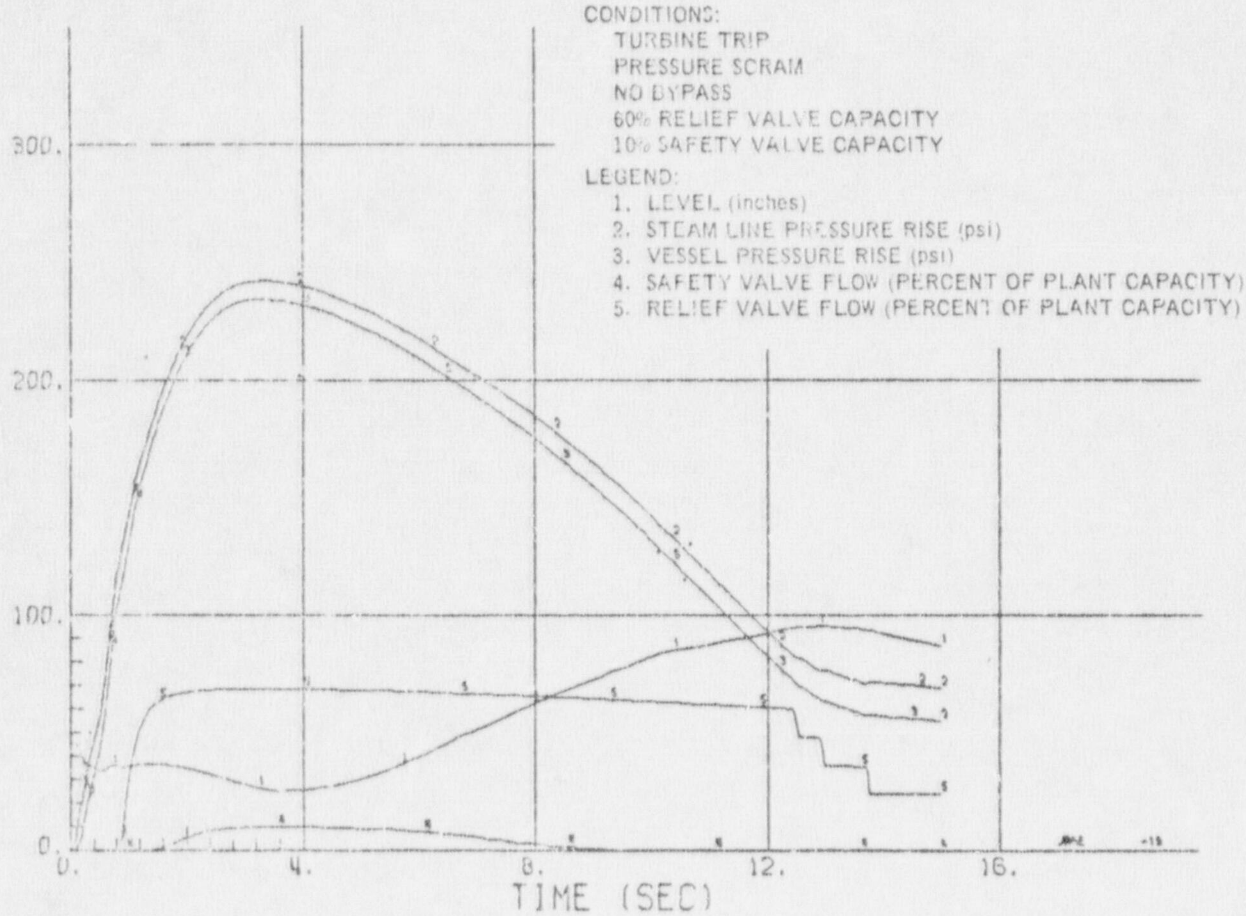
[illegible] → [illegible] → [illegible]
([illegible]) ([illegible]) ([illegible])

[illegible]

TB Not a Source

[illegible] Small-Plant Leaks

[illegible] OK



PHILADELPHIA ELECTRIC COMPANY
LIMERICK GENERATING STATION
UNITS 1 AND 2
PRELIMINARY SAFETY ANALYSIS REPORT

SAFETY VALVE SIZING ANALYSIS

FIGURE 4.4.4 ATTACHMENT (