Department of Energy
Washington, D.C. 20545

Docket No. 50-537
HQ:S:82:156

DEC 29 1982

Mr. Paul S. Check, Director
CRBR Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Check:

MEETING SUMMARY FOR THE SAFETY EVALUATION REPORT OPEN ITEM MEETING, DECEMBER 21, 1982

The purpose of this letter is to summarize the resolution of items discussed between the Nuclear Regulatory Commission and the Clinch River Breeder Reactor Plant Project on December 21, 1982.

Enclosure 1 is the agreements and commitments from the meeting, Enclosure 2 is the list of attendees, and Enclosure 3 is the handouts.

Any questions regarding the information provided or further activities can be addressed to A. Meller (FTS 626-6355), W. Kelly (FTS 626-6146), P. Washer (FTS 626-6179), or D. Edmonds (FTS 626-6157), of the Project Office Oak Ridge Staff.

Sincerely,

J. E. Stader for

John R. Longenecker
Acting Director, Office of
Breeder Demonstration Projects
Office of Nuclear Energy

3 Enclosures

cc: Standard List
Standard Distribution
Licensing Distribution

D001
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AGREEMENTS AND COMMITMENTS

SER OPEN ITEM MEETING

December 21, 1982

A meeting was conducted to expeditiously resolve concerns NRC arrived at in preparing the draft SER. Discussions were held and agreements/commitments were determined for the following items:

1. Leak Detection

   A. The PSAR will be updated to reflect the 20 hour leak detection requirement for a 100 gram/hr. leak in the IHTS air filled cells.

   B. The Project commits to preparing technical specifications for the IHTS leak detection operability.

   C. The Project commits to upgrading the leak detection capability in the PHTS, DHRS, and EVST systems to safety related; i.e., Seismic Category 1, 1E power, environmental qualification and redundancy or diversity, but not both. The NRC indicated this commitment resolves the leak detection SER concern.

2. Containment

   A. NRC indicated the SER will contain restrictions of 2500 hrs. on purging containment during the first year of operation and that subsequent relaxations will be based on operating experience. The project found NRC's position acceptable.

   B. NRC indicated the detection diversity for containment isolation was acceptable.

   C. The PO will submit a letter to NRC confirming the PSAR modification for the chilled water isolation valve safety classification change.

   D. The Project will upgrade the RSB and annulus filtration system to safety class 2.

3. Piping Integrity

   A. There are no open SER items anticipated.

   B. NRC is currently reviewing the leak before break criteria on the hot leg.

4. Cell Liners

   A. NRC and the Project agreed with the attached "Proposed Plan to Resolve Outstanding NRC Audit Items on CRBRP Cell Liners." The analyses for items 1 and 2 are attached.

   B. The Project will submit a tabulation of the actual cell liner and stud strains from analyses submitted previously along with the analyses submitted as part of items 1 and 2 of paragraph A.

   C. The scope of the analysis for items 3 and 4 was changed from the original plan by request from NRC. This change resulted in the dates for completion of items 3, 4, 5, and 6 being delayed. NRC agrees to use these results as input to the SER when going from the draft to final version.

   D. The attached plan will be used as the basis for NRC's cell liner section of the SER.

5. In Service Inspection

   A. The Project and NRC are currently assessing the inservice inspection program.

   B. Inservice Inspection of the internals of the reactor vessel and EVST was identified as an area in which the Project needs to identify an approach prior to the SER. This will be provided to NRC by January 7, 1983.

Enclosure 2

LIST OF ATTENDEES

NRC BRIEFINGS ON CRBRP LEAK DETECTION

December 21, 1982

Name	Organization
W. Kelly	CRBRP-PO
D. Elias	CRBRP-PO
R. Stark	NRC
D. Edmonds	CRBRP-PO
David H. Moran	NRC
Shelley Kowkabany	Burns & Roe
A. Meller	CRBRP-PO-PMC
P. R. Washer	CRBRP-PO
P. Bradbury	Westinghouse
H. J. Konish	Westinghouse - Waltz Mill
C. H. Fox	DOE-CRBRPO
R. Hottel	Westinghouse
G. Clare	Westinghouse
S. Additon	WLLCO
P. Docherty	WLLCO
P. Gross	CRBRP-PO-DOE
D. Ujifusa	DOE-Germantown

LIST OF ATTENDEES

PIPING INTEGRITY AND ISI MEETING

December 21, 1982

Name	Organization
A. Meller	CRBRP-PO
D. Edmonds	CRBRP-PO
P. Gross	CRBRP-PO
C. Fox	CRBRP-PO
R. Stark	NRC
P. Docherty	WLLCO
H. J. Konish	W-WM
S. Bhatt	NRC-PI
M. Hum	NRC-ISI
C. Y. Cheng	NRC-ISI

LIST OF ATTENDEES

CELL LINER MEETING

December 21, 1982

Name	Organization
P. Washer	CRBRP-PO
G. Clare	W-OR
T. King	NRC
S. Kowkanbany	Burns & Roe
C. Tan	NRC
R. Stark	NRC
A. Meller	CRBRP-PO

LIST OF ATTENDEES

CONTAINMENT MEETING

December 21, 1982

Name	Organization
A. Meller	CRBRP-PO
Shelley M. Kowkabany	Burns & Roe
Jerry J. Swift	NRC-CRBRP
P. Docherty	WLLCO
R. Stark	NRC
G. Clare	W-OR
Farauk Eltawila	NRC/DSI/CSB
P. J. Gross	CRBRP-PO
C. H. Fox	CRBRP-PO
H. J. Konish	W-WM

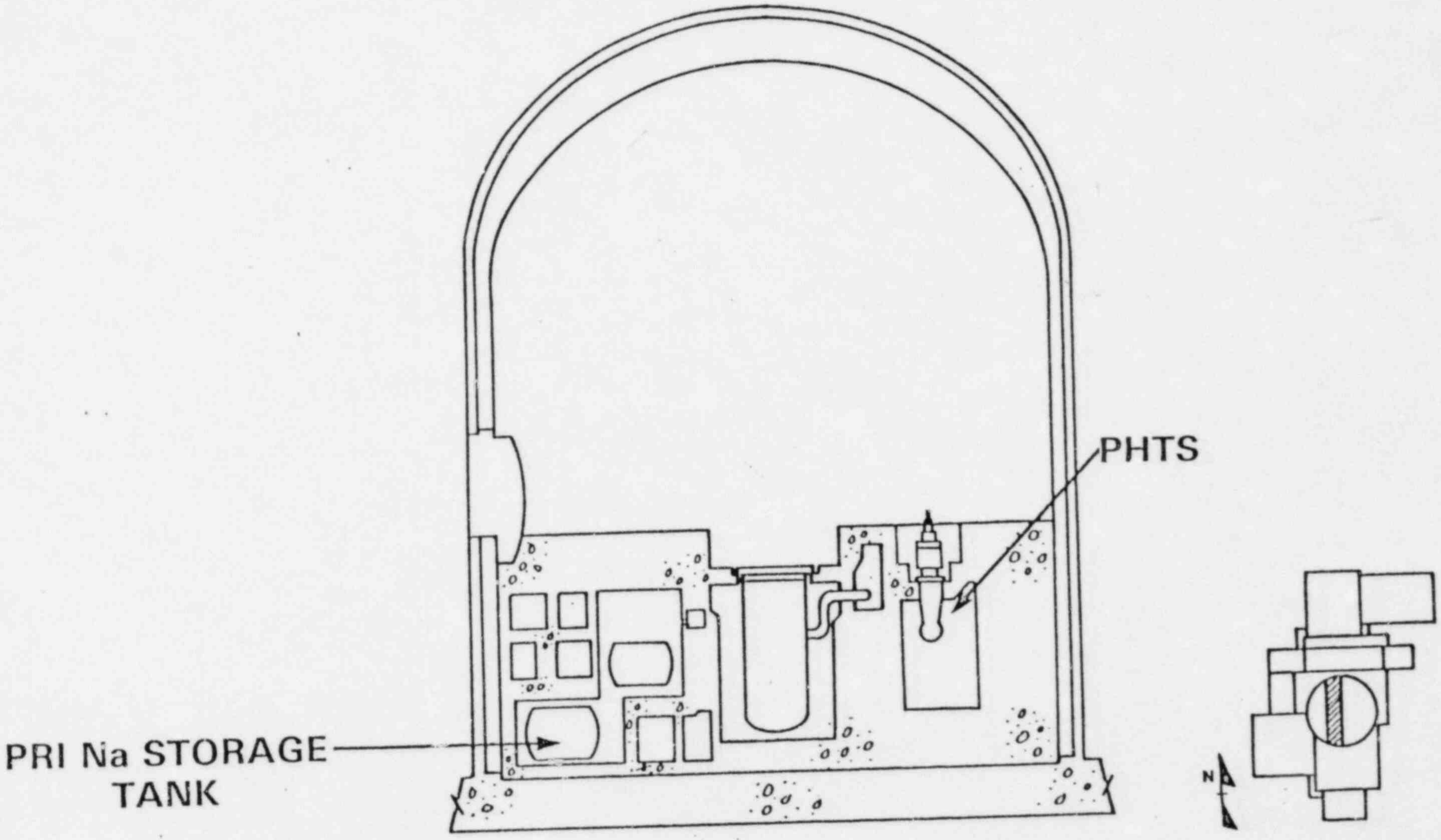
TYPICAL LMFBR ACCIDENT RELATED CHARACTERISTICS

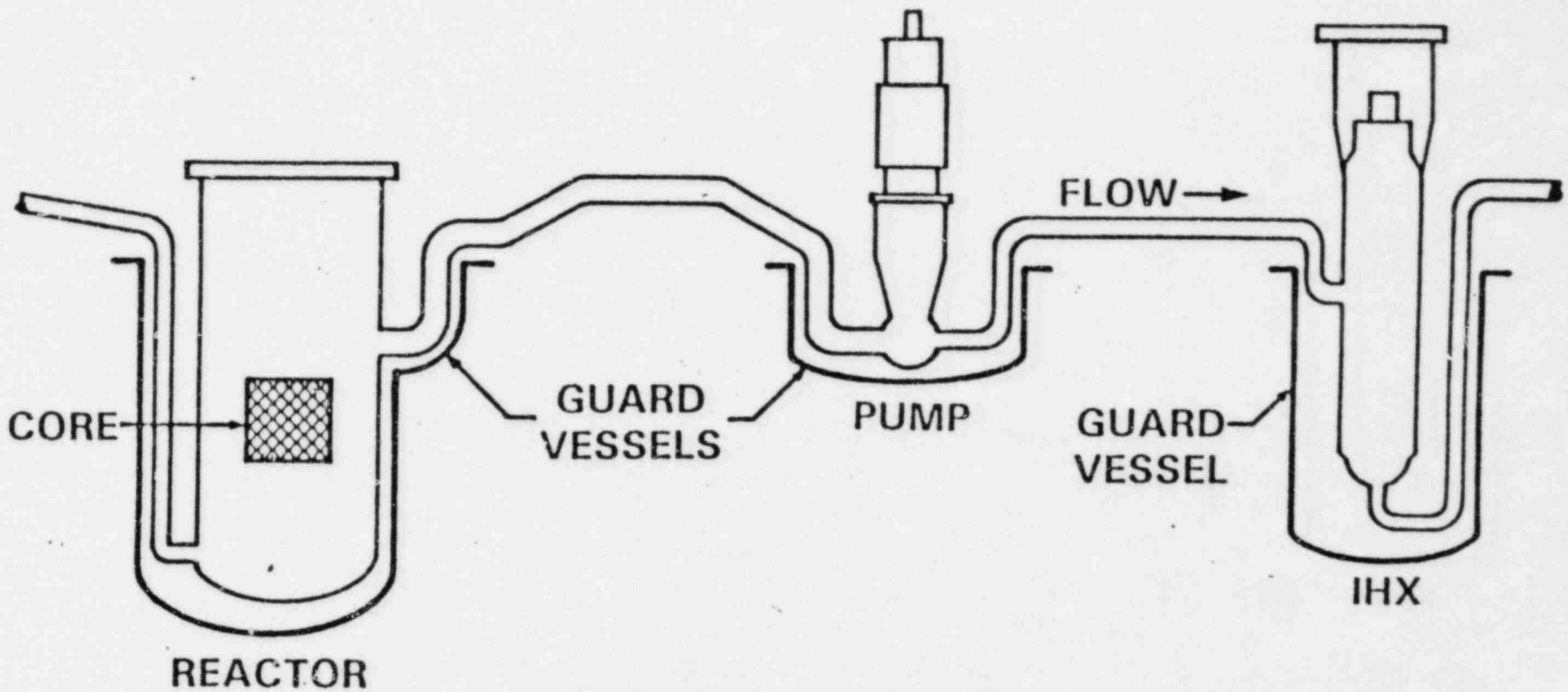
- LOW PRESSURE COOLANT SYSTEM
  - MAX. SYSTEM PRESSURE < 200 PSI
  - MUCH OF SYSTEM, INCLUDING REACTOR VESSEL OUTLET PLENUM, IS AT ATMOSPHERIC OR SUB-ATMOSPHERIC PRESSURE
- NORMAL TEMPERATURES ARE HUNDREDS OF DEGREES BELOW COOLANT BOILING TEMPERATURE
- ALL RADIOACTIVE SODIUM-CONTAINING COMPONENTS ARE HOUSED WITHIN SEPARATED, STEEL-LINED CELLS WITH MASSIVE CONCRETE WALLS, WITH INERT ATMOSPHERES.
- BECAUSE OF LOW STORED ENERGY AND BECAUSE STEEL IS IN DUCTILE TEMPERATURE RANGE, LARGE SPILLS FROM THE PHTS ARE NOT ENVISAGED.
- PHTS COMPONENTS ARE WITHIN GUARD VESSELS WHICH WILL CONTAIN SODIUM SPILLS. PIPING IS ELEVATED BETWEEN COMPONENTS.

Encl 3

155-11

PRIMARY SODIUM STORAGE TANK & PHTS CELLS IN RCB REACTOR CONTAINMENT BUILDING (RCB)




FLOW
CORE
GUARD
VESSELS
PUMP
GUARD
VESSEL
IHX
REACTOR

CURRENT DESIGN APPROACH

- LEAK DETECTION SYSTEMS ARE PROVIDED IN CRBRP TO MINIMIZE PLANT DAMAGE INCLUDING ASSURANCE THAT THERE WILL NOT BE SIGNIFICANT CORROSION OF THE COOLANT BOUNDARY.
- UNLIKE LWRs, LMFBRs WILL NOT OPERATE WITH COOLANT LEAKAGE IN THE SODIUM SYSTEMS.
- DETECTION OF SODIUM TO GAS LEAKS BY THE LMGLDI SYSTEM HAS BEEN DEMONSTRATED FOR VERY SMALL LEAKS - - WELL BELOW LEAKS OF ANY OPERATIONAL CONCERN.

LIQUID METAL/GAS LEAK DETECTION SYSTEM
FUNCTION

- CONTINUOUS MONITORING OF LIQUID METAL SYSTEMS FOR LEAKAGE INTO SURROUNDING GAS SPACES

- DETECTION OF SMALL LEAKS PRIOR TO SIGNIFICANT CORROSION

- DETECTION OF LARGER LEAKS PRIOR TO SIGNIFICANT LOSS OF LIQUID METAL INVENTORY OR ONSET OF SIGNIFICANT ECONOMIC DAMAGE

LIQUID METAL/GAS LEAK DETECTION SYSTEM
TYPICAL REQUIREMENTS (MHTS)

- DETECTION SENSITIVITY
  - LK 100 grams/hr OR GREATER — LESS THAN 250 hr
  - LK 30 gpm OR GREATER — LESS THAN 5 min
- DETECTION DIVERSITY (PHTS ONLY)
- LEAK LOCATION
  - CELL
  - MAJOR COMPONENT (PUMP, HEAT EXCHANGER, REACTOR)
  - PIPING SECTION (HOT LEG, COLD LEG)
- LEAK CONFIRMATION
- SEISMIC CATEGORY II
- ALARM AND INDICATOR IN CONTROL ROOM

CRBRP PROVIDES THE CAPABILITY TO DETECT LEAKAGE FROM LIQUID METAL SYSTEMS THROUGHOUT THE PLANT. THE MAJOR AREAS OF CONCERN FOR LIQUID METAL LEAKAGE ARE:

- THE PRIMARY COOLANT BOUNDARY
- THE INTERMEDIATE HEAT TRANSPORT SYSTEM
- THE DIRECT HEAT REMOVAL SERVICE
- THE EX-VESSEL STORAGE TANK COOLING SYSTEM

CRBRP PROVIDES THE CAPABILITY TO DETECT BOTH LARGE AND SMALL LEAKS FROM THE PRIMARY COOLANT BOUNDARY.

BASED ON THE LEAKAGE CHARACTERISTICS AND THE CORROSION EFFECTS ON THE PRIMARY PIPING, A LEAK DETECTION SYSTEM IS PROVIDED TO DETECT SMALL LEAKAGE WHILE THE SYSTEM IS OPERATING SO THAT CORROSION OVER THE LONG TERM DOES NOT LEAD TO SUDDEN, LARGE FAILURES OF PIPING.

82-3117-2

THE METHODS PROVIDED TO DETECT LEAKAGE FROM THE PRIMARY SYSTEM INCLUDE:

- PLUGGING FILTER AEROSOL DETECTORS
- SODIUM IONIZATION DETECTORS
- PARTICULATE RADIATION MONITORS

CRBRP ALSO PROVIDES THE CAPABILITY TO DETECT BOTH LARGE AND SMALL LEAKS FROM THE INTERMEDIATE HEAT TRANSPORT SYSTEM.

THE OBJECTIVE OF DETECTING LARGE LEAKS IN THE IHTS IS TO PREVENT RELEASE OF SIGNIFICANT QUANTITIES OF SODIUM AEROSOL FROM THE SITE. REDUNDANT, SEISMIC CATEGORY I INSTRUMENTATION IS PROVIDED FOR THIS PURPOSE.

- AEROSOL RELEASE MITIGATION SYSTEM (ARMS)

AN ADDITIONAL LEAK DETECTION SYSTEM IS ALSO PROVIDED FOR THE IHTS IN ORDER TO DETECT SMALL AMOUNTS OF LEAKAGE

- PLUGGING FILTER AEROSOL DETECTORS
- SMOKE DETECTORS IN AIR FILLED CELLS
- SODIUM IONIZATION DETECTORS IN INERT CELLS

DETECTOR TAG NO	ANNULI SNIFFERS	MANI-FOLD NO.	CELL NO
NEAE 300*	▽ 6	2031	227
NEAE 301	⬡ 7	2033	227
NEAE 302	◯ 8	2035	227
NEAE 313	□ 6	2036	224
NEAE 314	△ 7	2037	224 244
NEAE 308*	◇ 7	2032	227
REF. INFORMATION			

*FOR CONTINUATION OF SNIFFERS CONNECTED TO NEAE 300 AND NEAE 308 SEE PAGE 15

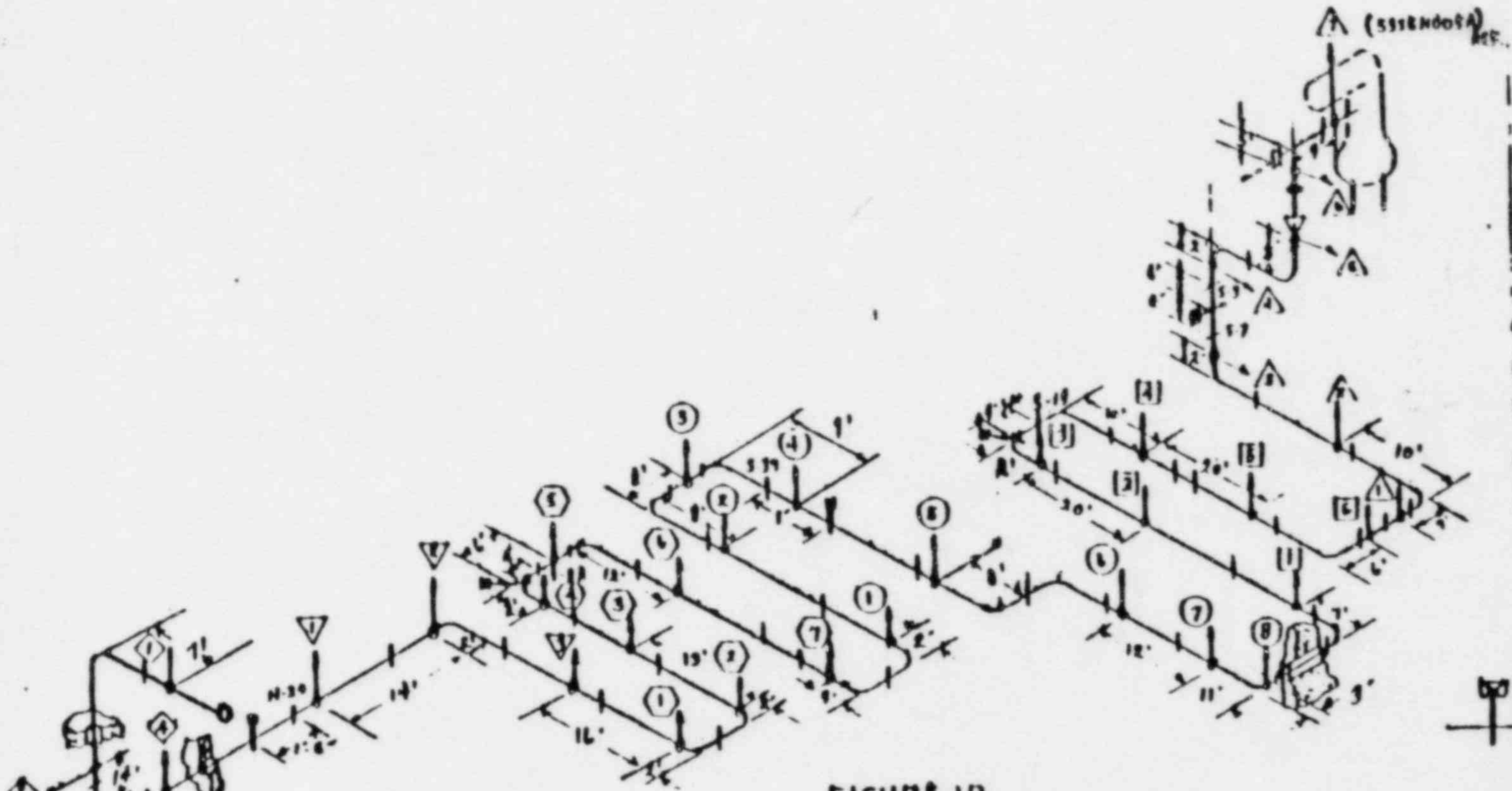


FIGURE 10

LOOP I RCB TO SUPERHEATER INLET PIPING SNIFFER LOCATIONS

INDICATES MANIFOLD TAKE-OFF FOR CONNECTION TO DETECTOR

INDICATES HANGER OR SNUBBER LOCATION

REF GENERAL ELECTRIC CO. DRAWING NO RS26512 REV 6

FOR THE DIRECT HEAT REMOVAL SERVICE, CAPABILITY FOR LEAK DETECTION IS PROVIDED BY:

- PLUGGING FILTER AEROSOL DETECTORS FOR BOTH ANNULUS AND CELL MONITORING
- PARTICULATE RADIATION MONITORS

12 82-3158-7

FOR THE EX-VESSEL STORAGE TANK COOLING SYSTEM, CAPABILITY FOR LEAK DETECTION IS PROVIDED BY:

- PLUGGING FILTER AEROSOL DETECTORS FOR BOTH ANNULUS AND CELL MONITORING
- CONTACT DETECTORS
- SMOKE DETECTORS

SAFETY RELATIONSHIP OF PHTS LEAK DETECTORS

1. RADIATION MONITORS ARE CATEGORY I DEVICES AND WILL RAPIDLY DETECT INCIPIENT LEAKS.

2. MULTIPLE DIVERSE, REDUNDANT BUT NON-SAFETY RELATED DETECTION DEVICES EXIST AS BACKUP TO THE RADIATION MONITORS. TECH. SPECS. REQUIRE THESE TO BE OPERATIONAL

   - CORROSION AND OTHER CRACK PROPAGATION MECHANISMS ARE EXTREMELY SLOW

   - THE OPERATOR WOULD HAVE MONTHS IN WHICH TO TAKE MITIGATING ACTION IN EVENT OF SMALL LEAK

3. IN THE HYPOTHETICAL SITUATION WHERE THE OPERATOR DOES NOT TAKE MITIGATING ACTION, TWO DIVERSE REDUNDANT TRIP FUNCTIONS ENSURE REACTOR SHUTDOWN WITHOUT SIGNIFICANT LOSS OF COOLANT INVENTORY

   - REACTOR VESSEL LEVEL PROBES
   - FLUX/REACTOR INLET PRESSURE

SAFETY RELATIONSHIP OF IHTS LEAKS AND MITIGATING DEVICES

1. IHTS LEAKS CAN ONLY AFFECT COOLANT INVENTORY/FUNCTION OF ONE HEAT TRANSPORT LOOP

2. IN THE EVENT OF AN IHTS LEAK, NUCLEAR SAFETY CONSIDERATIONS ARE

   - DECAY HEAT REMOVAL REDUNDANCY
   - STEAM GENERATOR BUILDING INTEGRITY
   - AEROSOL ENVIRONMENT FOR SAFETY EQUIPMENT

3. DECAY HEAT REMOVAL REDUNDANCY IS ASSURED BY REMAINING TWO LOOPS AND BY DHRS.

4. SBG INTEGRITY/AEROSOL ENVIRONMENTS ONLY APPLY TO THAT PORTION OF THE IHTS IN AIR-FILLED CELLS

5. SAFETY RELATED SMOKE DETECTORS ENSURE PROPER FUNCTIONING OF SGB VENT SYSTEM TO PROTECT SGB AND LIMIT AEROSOL RELEASE.

6. MULTIPLE, REDUNDANT BUT NON-SAFETY RELATED DETECTION DEVICES EXIST TO ALERT OPERATOR. TECH. SPECS. REQUIRE THESE TO BE OPERATIONAL

   - ALTHOUGH CORROSION RATES ARE FASTER IN AIR, THE OPERATOR WOULD HAVE SOME TENS OF HOURS IN WHICH TO ACT

SAFETY CONSIDERATIONS OF DHRS LEAKS IN INERTED CELLS AND DETECTION DEVICES

1. THAT PORTION OF THE DHRS WHICH IS IN INERTED CELLS IS NOT NORMALLY IN SERVICE. IN THE EVENT OF A LEAK, THE SAFETY CONSIDERATIONS ARE:

   - INTEGRITY OF CELL

   - ASSURANCE OF CORRECTIVE ACTION BEFORE DHRS USE MIGHT BE REQUIRED

2. CELL DESIGN BASE INCLUDES DESIGN BASIS SPILL.

3. MULTIPLE REDUNDANT, DIVERSE, BUT NON-SAFETY RELATED LEAK DETECTION DEVICES EXIST. TECH. SPECS. REQUIRE THESE TO BE OPERATIONAL

   - OPERATOR WOULD HAVE AMPLE TIME TO TAKE CORRECTIVE ACTION IN EVENT OF SMALL LEAK

SAFETY RELATIONSHIP OF DHRS/ABHX LEAKS INTO AIR-FILLED AREAS, AND MITIGATING DEVICES

1. FAILURES OF THIS TYPE AFFECT ONE DHRS/EVST SECONDARY LOOP ONLY AND DO NOT AFFECT CORE OR EVST COOLANT INVENTORY.

2. IN THE EVENT OF SUCH A LEAK, THE NUCLEAR SAFETY CONSIDERATIONS ARE:

   - EVST/DHRS DECAY HEAT REMOVAL REDUNDANCY
   - AEROSOL ENVIRONMENT FOR SAFETY EQUIPMENT

3. DECAY HEAT REMOVAL REDUNDANCY IS PROVIDED AS FOLLOWS:

   - FOR THE EVST BY THE REMAINING ABHX
   - FOR THE DHRS BY THE MAIN LOOPS

4. AEROSOL ENVIRONMENT IS PROTECTED BY SAFETY RELATED DEVICES WHICH CLOSE ABHX DAMPERS.

5. MULTIPLE, REDUNDANT BUT NON-SAFETY RELATED DETECTION DEVICES EXIST TO ALERT OPERATOR. TECH. SPECS. REQUIRE THESE TO BE OPERATIONAL.

   - ALTHOUGH CORROSION RATES ARE FASTER IN AIR THE OPERATOR WOULD HAVE SOME TENS OF HOURS IN WHICH TO ACT.

SAFETY RELATIONSHIP OF EVST PRIMARY COOLING SYSTEM LEAKS AND DETECTION DEVICES

1. FOR EVST PRIMARY COOLING SYSTEM LEAKS:

   - THE CORE IS NOT AFFECTED
   - SPILLS ARE INTO INERTED CELLS - SLOW CORROSION RATES
   - GV PLUS ELEVATED LOOPS ENSURES SPENT FUEL REMAINS COVERED
   - SPENT FUEL DECAY HEAT IS MUCH LESS THAN CORE

2. MULTIPLE DIVERSE, REDUNDANT BUT NON-SAFETY RELATED DETECTION DEVICES EXIST. TECH. SPECS. REQUIRE THESE TO BE OPERATIONAL

   - THE OPERATOR WOULD HAVE MONTHS IN WHICH TO TAKE MITIGATING ACTION IN EVENT OF SMALL LEAK

CONCLUSION

1. SAFETY RELATED MITIGATING DEVICES ARE PROVIDED TO ENSURE APPROPRIATE AUTOMATIC ACTIN WHERE RAPID MITIGATION IS REQUIRED.

2. FOR SPILLS FOR WHICH THE ACCEPTABLE REACTION TIME IS VERY LONG, MULTIPLE,REDUNDANT, DIVERSE,BUT NON-SAFETY RELATED DETECTION DEVICES ARE PROVIDED.

CELL LINER FAILURE CRITERION RESOLUTION

- o RESULTS OF SYMMETRICAL BUCKLING CASE USING FINE 3-D MESH PROVIDED.
- o RESULTS OF ANALYSIS WITH CHECKERBOARD BUCKLING PATTERN PROVIDED. LESS SEVERE THAN PREVIOUS SUBMITTAL.
- o RESULTS OF CIRCULAR PENETRATION ANALYSIS WITH INWARD AND OUTWARD BUCKLED PLATE TO NRC BY JANUARY 7, 1983.
- o RESULTS OF SQUARE PENETRATION ANALYSIS TO NRC BY JANUARY 22, 1983.
- o FROM THESE ANALYSES, DETERMINE WORST CONDITION. USE THIS CONDITION AND INPUT BOUNDARY CONDITIONS FROM LARGE MODEL TO LOCAL FINER MESH MODEL. RESULTS TO NRC BY FEBRUARY 8, 1983.
- o FROM ANALYSIS DETERMINE CRITICAL EFFECTS IN TERMS OF STRESS AND STRAIN. VALIDATE RESULTS WITH TEST PROGRAM. PLAN TO NRC BY MARCH 1, 1983.
- o BASED ON LOW TEMPS FOR WALL AND FLOOR FROM SMALL SODIUM SPILL, TRIPLANAR CORNER ANALYSIS IS NOT NECESSARY.

- APPROACH TO RESOLVE CONCERN OVER CELL LINER FAILURE CRITERION IS ACCEPTABLE.

TABLE I

			ACCIDENT CONDITIONS	
CELL NO.	POOL DEPTH (inches)	Ta (^{o}F) Gas Temp.	Ta (oF) UW (Unwetted Liner)	Ta (oF) W (Wetted Liner)
107A	1"	370	126	300
	3"	440	147	479
122	2.2"	687	140	467

Information transmitted by W/ARD per Telecon CS-299-82, H. Geiger to R. C. Burrow dated 12/6/82.

Cell Liners

PROPOSED PLAN TO RESOLVE OUTSTANDING NRC AUDIT ITEMS ON CRBRP CELL LINERS

1) Results of an analysis for the symmetrical buckling case that has been completed will be submitted to NRC by December 22, 1982. This model includes a fine three dimensional mesh around the stud and consists of an axisymmetrical model with a 15 inch diameter and a stud at the center.

2) Results of an analysis of a typical 15 x 15 inch liner panel with a stud at the center and a checkerboard buckling pattern has been completed and will be submitted to NRC by December 22, 1982. The results show that the non-symmetrical buckling condition already submitted to NRC at the November 17, 1982 meeting (Audit Finding I.A-1d) was more severe.

3) An analysis of a circular penetration is being performed and stresses, strains and displacements will be reported to NRC by January 28, 1983. This model results in a non-symmetrical buckling pattern. Two cases will be considered: with the liner plate adjacent to the penetration buckling both inward and outward.

4) Square penetration analysis.

   This analysis is being performed and results will be reported to NRC by February 14, 1983.

5) From the analyses of typical panel, embedment, square and circular penetrations, the most severe condition with regard to stud and liner plate will be identified. A local analysis for that condition will be performed using a finer finite element mesh. The detailed model will include a 15 x 15 inch panel plate with a stud at the center and will have as boundary conditions the displacements calculated in the analysis of the larger model. Results will be submitted by February 25, 1983.

6) Based on the above analyses and those already submitted to NRC, the most critical effects in terms of strains and stresses will be identified. A validation test program will be conducted based on the results of the analysis. This test plan will be provided to the NRC by March 18, 1983.

7) For the case of a triplanar corner having a hot floor liner and colder wall liners, an investigation of liner temperatures under shallow sodium pools (1 inch and 3 inch depths) has been conducted. The cell considered was 107A which is the cell where the most severe DBA liner temperatures have been identified. Also, a shallow pool (2.2 inch deep) was considered in a representative PHTS Cell (122). The results are given in Table I. The worst results, for Cell 107A with a 3 inch pool, show a floor and wetted wall liner temperature of 479°F and an unwetted wall temperature of 147°F. Based on these low temperature values it is considered that a stress analysis of the liner for a triplanar corner is not necessary.

Item 1

Dr. C. H. Fox
DOE/PO at WLLCO

CELL LINER

SYMMETRICAL BUCKLING PATTERN

DETAILED ANALYSIS IN THE VICINITY OF STUD

For this analysis, an axisymmetrical finite element mathematical model was developed (Figure A-1). A 7.5 inch radius (half the spacing between studs) was selected for the plate, with the stud at the center.

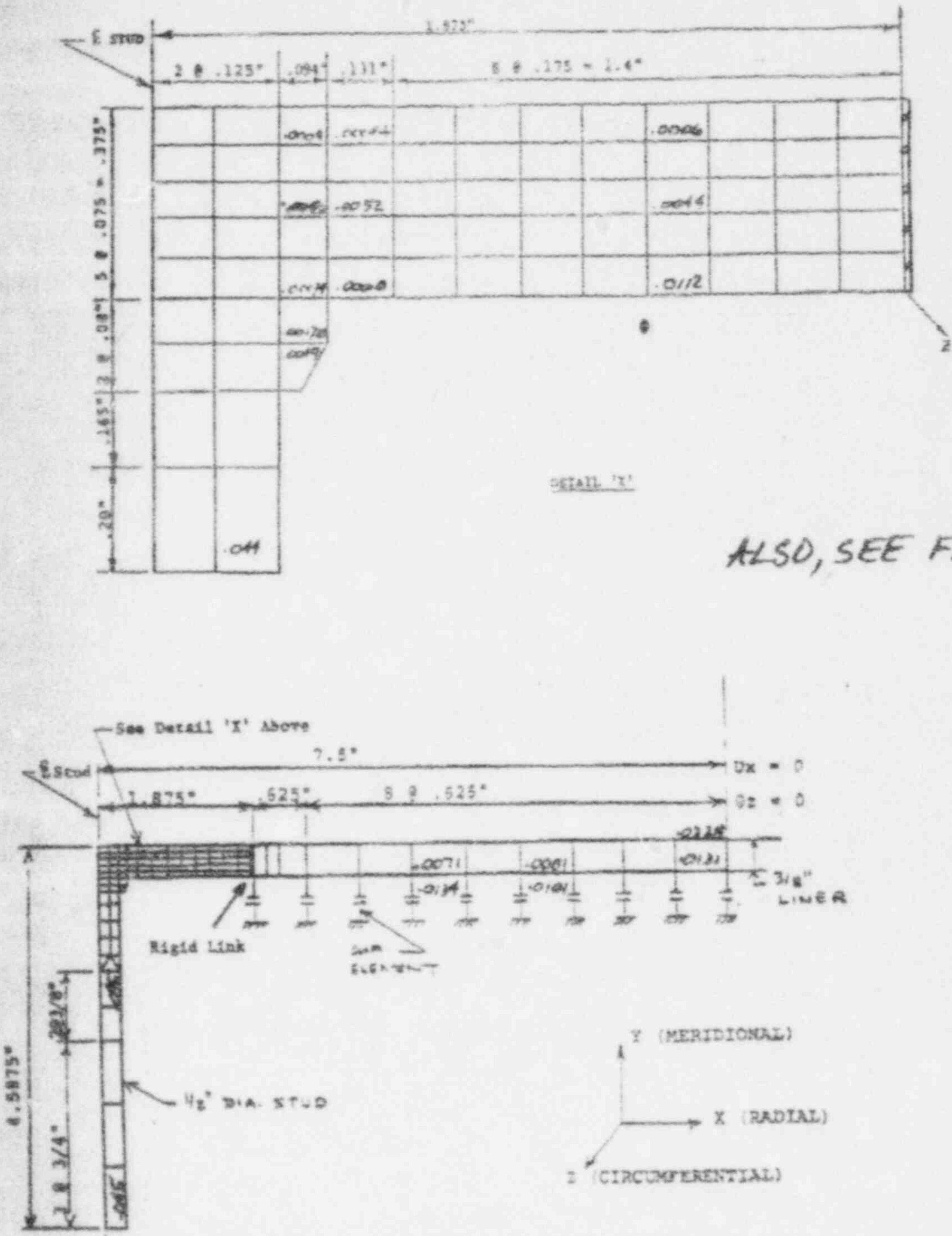
A fine mesh was used in the vicinity of the stud/liner plate juncture and a coarser mesh in areas beyond that region.

STIF 42 axisymmetrical ANSYS elements were used for plate and stud. The interface (gap) between liner and concrete was represented by STIF 12 elements. A rigid beam (represented by STIF 3) was used to connect the nodes of the five layer elements to those of the one layer, at the radius of 1.875 inches. Boundary conditions at the plate edge were: free out-of-plane displacement and fully restrained radial displacement and edge rotation. The stud end was fully restrained. The results of the analysis in terms of equivalent von Mises strains are given in Figure A-1.

The maximum equivalent von Mises strains are .023 in/in for the plate and 0.045 in/in for the stud. These are below the limits established by the Criteria.

The maximum out-of-plane shear stress in the plate is 11.7 ksi at the section adjacent to the stud weld (lower element).

The maximum out-of-plane shear stress is 0.45 of the yield strength of the material at the 900°F temperature. The average out-of-plane shear stress in the same plate section is 8.4 ksi or 31% of yield. The maximum shear stress in the weldment is 14.6 ksi. Figure A-2 shows the deflected shape of the model. Figure A-3 lists stresses at some elements in the vicinity of the stud.



ALSO, SEE FIG A-4.

FIGURE A-1 AXISYMMETRIC MODEL MATHEMATICAL MODEL AND EQUIVALENT STRAINS (900°.)

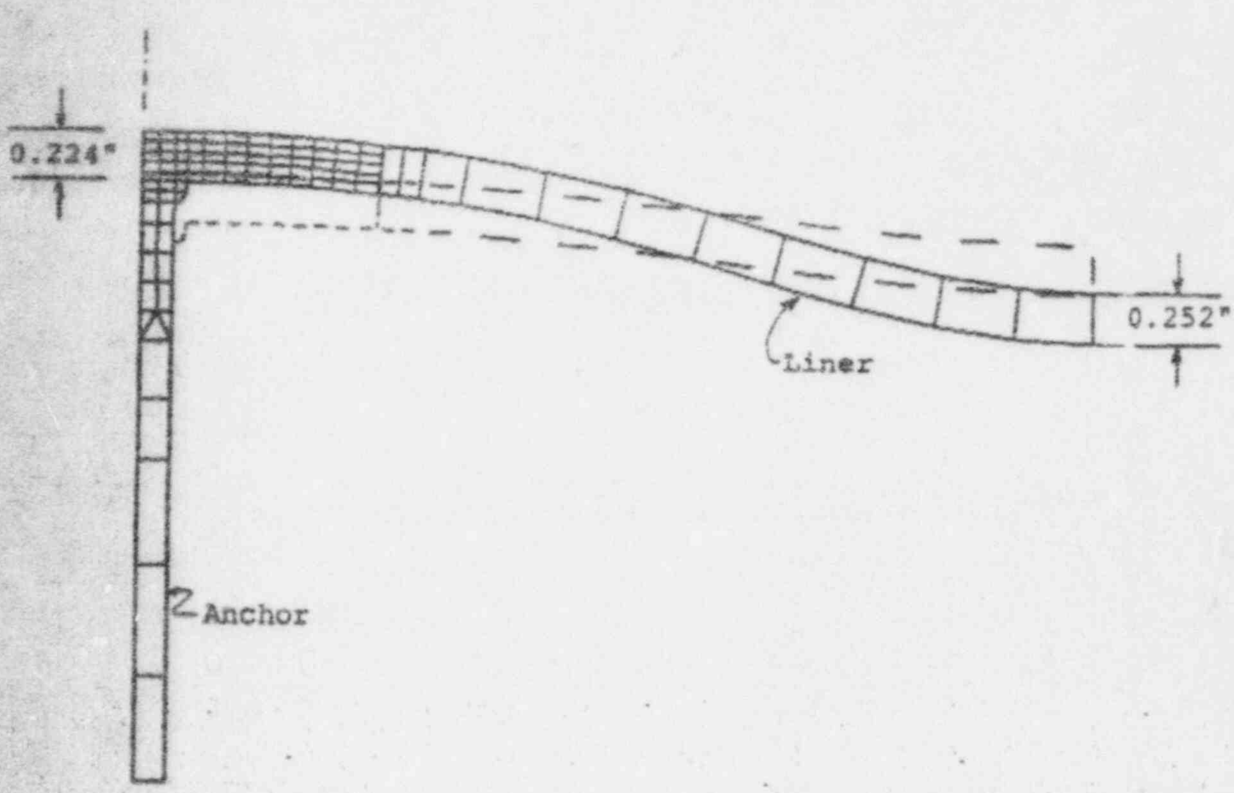
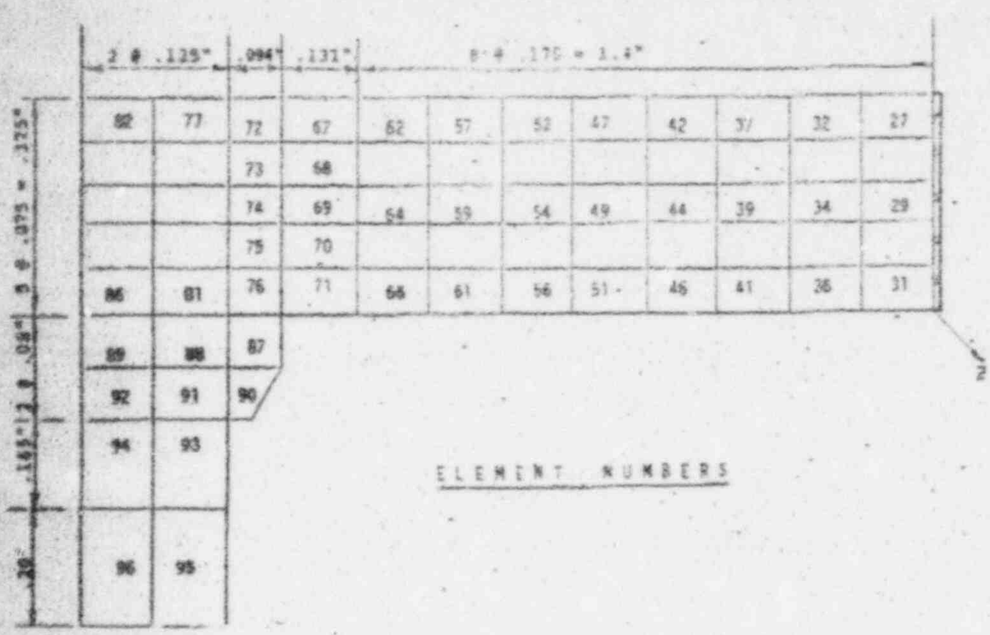


FIGURE A-2 WALL LINER - AXISYMMETRIC MODEL; DISPLACEMENT AT 900°F



ELEMENT NUMBER	ELEMENT STRESSES				
	σ_{xy}	S.I.	σ_1	σ_2	σ_3
2		29.6	1.06	-27.9	-28.5
8	-1.3	31.9		-19.5	-32.0
12	-0.4	29.8	3.5	-21.2	-26.3
42	2.3	16.6	12.1	-1.2	-4.5
44	2.8	23.7	2.5	-19.6	-21.3
46	0.3	32.3	0.5	-17.1	-31.7
67	2.3	26.1	0.3	-17.0	-25.9
69	9.12	25.8	6.57	-18.9	-19.2
71	11.7	24.1	18.3	0.28	-5.88
72	1.89	26.4	0.48	-21.2	-25.9
74	7.89	27.3	10.2	-14.2	-17.1
76	7.03	21.2	22.9	4.16	1.70
87	13.0	29.6	32.4	15.5	2.78
90	14.6	30.0	25.2	1.85	-4.89
95	-1.12	36.2	36.1	-2.1	[illegible]

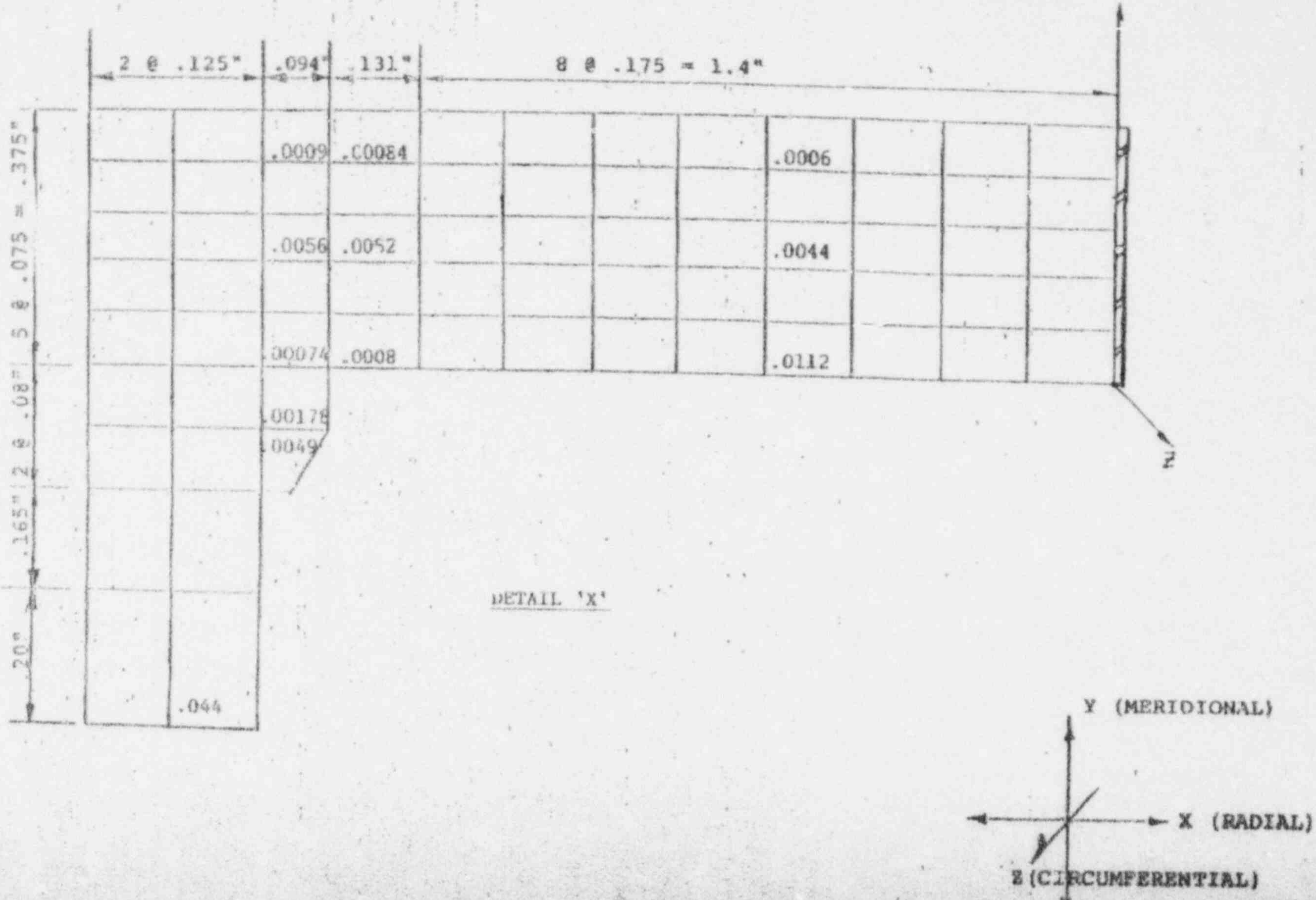
Units: ksi

σ_{xy} = Out of Plane Shear Stre

S.I. = Stress Intensity

$\sigma_1, \sigma_2, \sigma_3$ = Principal Stresses

FIGURE A-3 AXISYMMETRIC MODEL-ELEMENT STRESSES (KSI)



2 @ .125"
.094"
.131"
8 @ .175 = 1.4"
.0009
.00084
.0006
.0056
.0052
.0044
.00074
.0008
.0112
.00178
.00049
.044
5 @ .075 = .375"
2 @ .08"
.165"
.20"
DETAIL 'X'
Y (MERIDIONAL)
X (RADIAL)
Z (CIRCUMFERENTIAL)

Fig 4-4

Item 2

CELL LINER

CHECKERBOARD BUCKLING PATTERN

DETAILED ANALYSIS OF TYPICAL LINER PANEL

An evaluation of the strain conditions under a checkerboard pattern of buckling with the mathematical model of Figure B-1 was performed. It consists of a 15 inch square plate panel with a stud at the center. (Fifteen inch is the spacing between studs). The boundary conditions at the edge of the plate are: free out-of-plane displacement, and full restrained in-plane displacement and edge rotation. The following ANSYS elements were used in the model: STIF 48 for plate, STIF 20 and STIF 8 for studs and STIF 12 for gaps between plate and concrete. To induce the desired buckling pattern a 1 lb. force was applied at the diagonal corners that displaced away from the concrete. The other two diagonal corners displaced in the opposite direction.

Figure B-1 shows the maximum strains and Figure B-2 the displacement contours. The maximum equivalent von Mises strains are:

Plate: 0.011 in/in (Membrane), 0.019 in/in (Membrane + Bending)

Stud: 0.0058 in/in (Membrane and Membrane + Bending)

The strain allowable limits in accordance with the liner criteria are 0.070 in/in for membrane and 0.094 in/in for membrane plus bending strains. A comparison of the results of this case with that of unsymmetrical buckling (Response to Audit Finding I.A.1d) shows that the latter imposes higher strains on the liner and stud.

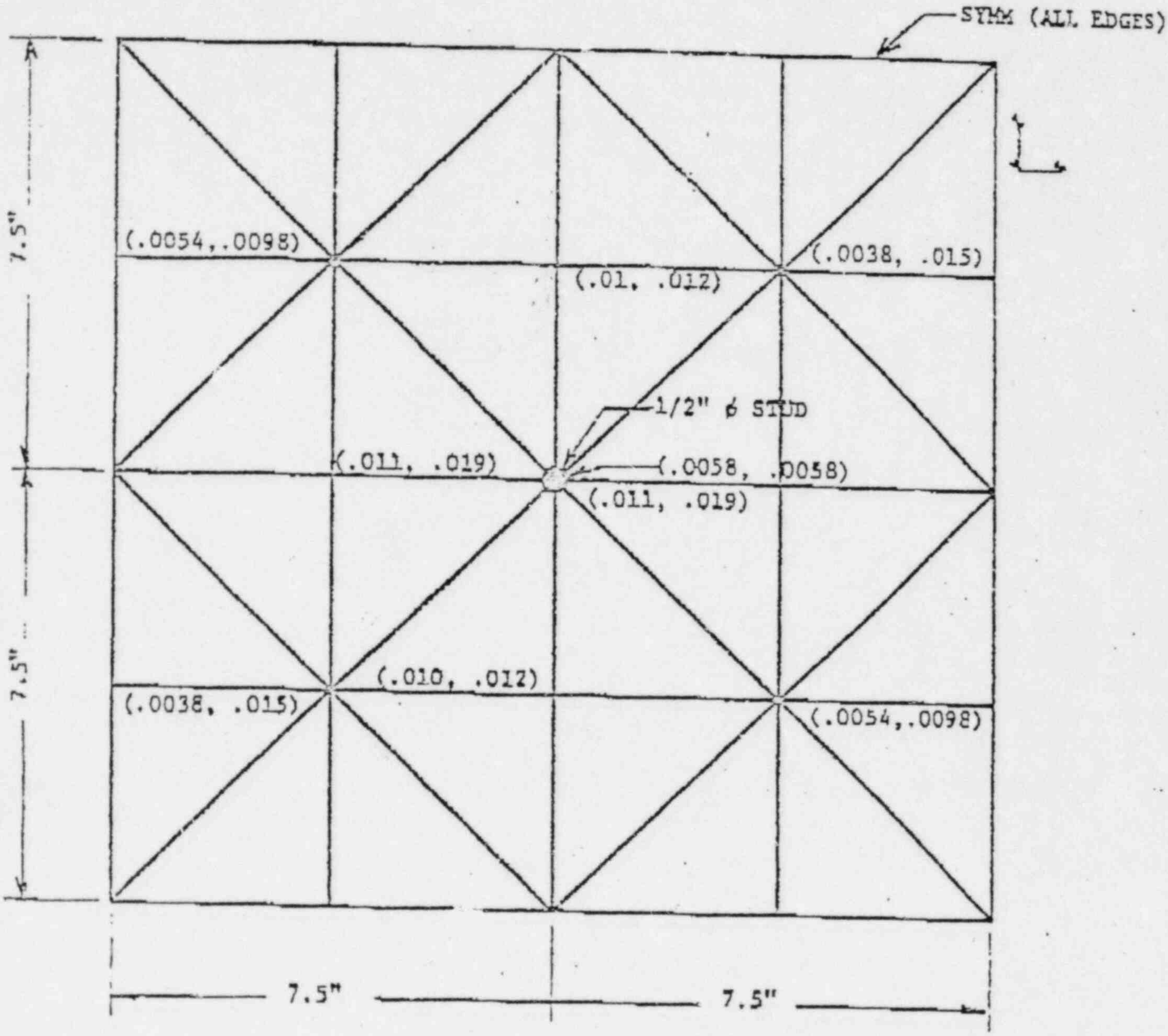
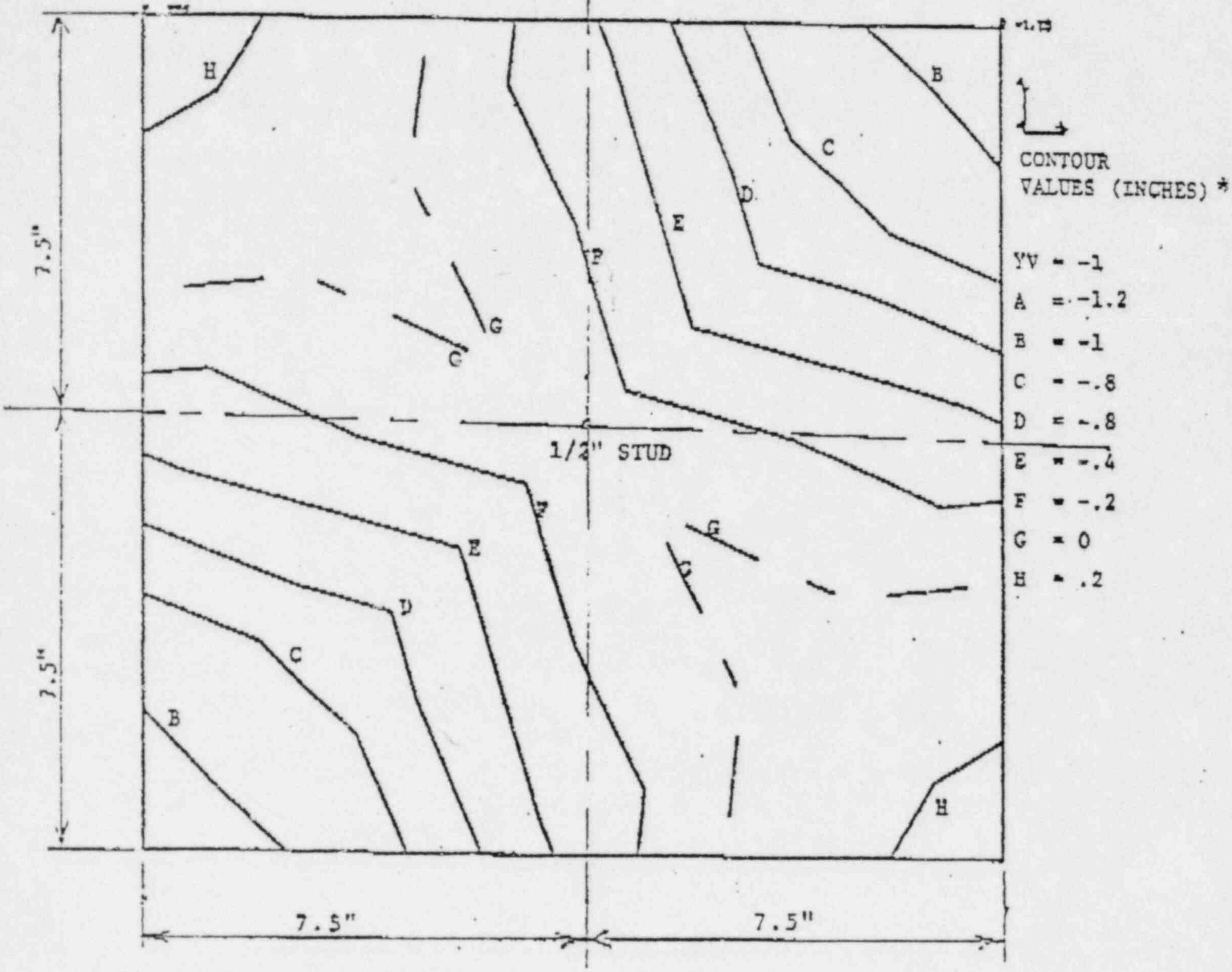


FIGURE B-1 WALL LINER TYPICAL PANEL - CHECKERBOARD BUCKLING - STRAINS AT 900°F (Membrane, Membrane + Bending) In/In



* Negative value indicates displacement away from concrete

FIGURE B-2 WALL LINER TYPICAL PANEL - CHECKERBOARD BUCKLING - DISPLACEMENTS @ 900°F

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PREVIOUS Agreements with NRC

- BASELINE UT inspection on high stress welds in IHTS
- Perform volumetric examination of high stress welds in IHTS during operation on same frequency as transition weld inspections
- Perform double volumetric examination of all PHTS, IHTS during fabrication
- Perform volumetric inspection of PHTS exposed welds
- DEVELOP HIGH TEMPERATURE UT INSPECTION TECHNIQUES – DRS