TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

August 8, 1980

Director of Nuclear Reactor Regulation
Attention: Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Schwencer:

In the Matter of the Application of) Docket No. 50-327
Tennessee Valley Authority)

A TVA-NRC meeting was held on July 29, 1980, to discuss the design of the TVA interim distributed ignition system for control of hydrogen in the Sequoyah Nuclear Plant containment. Enclosed are TVA's complete responses to 10 of the 11 action items requested of TVA during the July 29, 1980, meeting. Enclosure 1 is a list of the action items with a summary of the TVA response. Action item 7b, an analysis of heat fluence delivered to equipment and resultant equipment temperature environment will be submitted on or before August 12, 1980.

TVA was also requested to provide operational testing data on the igniters. This testing data will be submitted as soon as available.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Regulation and Safety

Enclosure

B021
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1/1

THIS DOCUMENT CONTAINS
POOR QUALITY PAGES

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ENCLOSURE 1

TVA ACTION ITEMS FROM JULY 29, 1980, MEETING ON INTERIM DISTRIBUTED IGNITION SYSTEM

1. Commitment to Use General Motors Glow Plug - TVA commits to the use of the General Motors Glow Plug as the igniter in the interim distributed ignition system for the Sequoyah Nuclear Plant.

2. Location Drawings - Attached are the location drawings, figures 1 to 6, for each elevation.

3. Mounting Details - Attached is a drawing showing mounting details, figure 14.

4. Location of Igniter Switch Panel - Figure 5 shows the location of the lighting switch panel LS-4 which controls the igniters.

5a. Location of Hydrogen Monitors - See figure 7.

5b. Location of Hydrogen Monitor Intakes - See figures 1-6.

6. Hydrogen Monitor Description - See Enclosure 2.

7a. List of Components Required after Hydrogen Burns - See Enclosure 3.

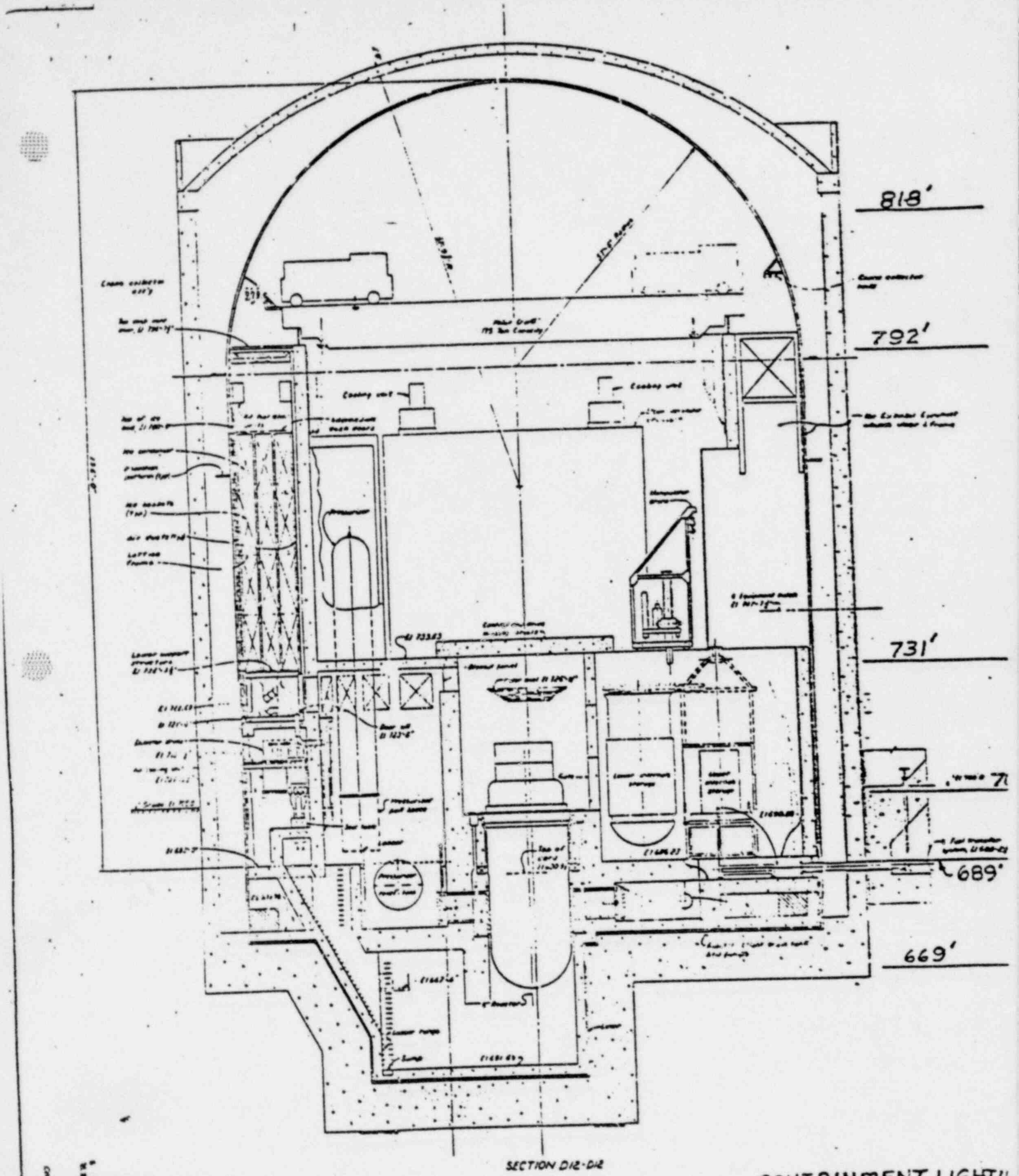
7b. Analysis of Expected Equipment Environment - An analysis of expected temperature and assumed heat fluence will be provided on or before August 11, 1980.

8. Containment Cooling System Capability - See Enclosure 4.

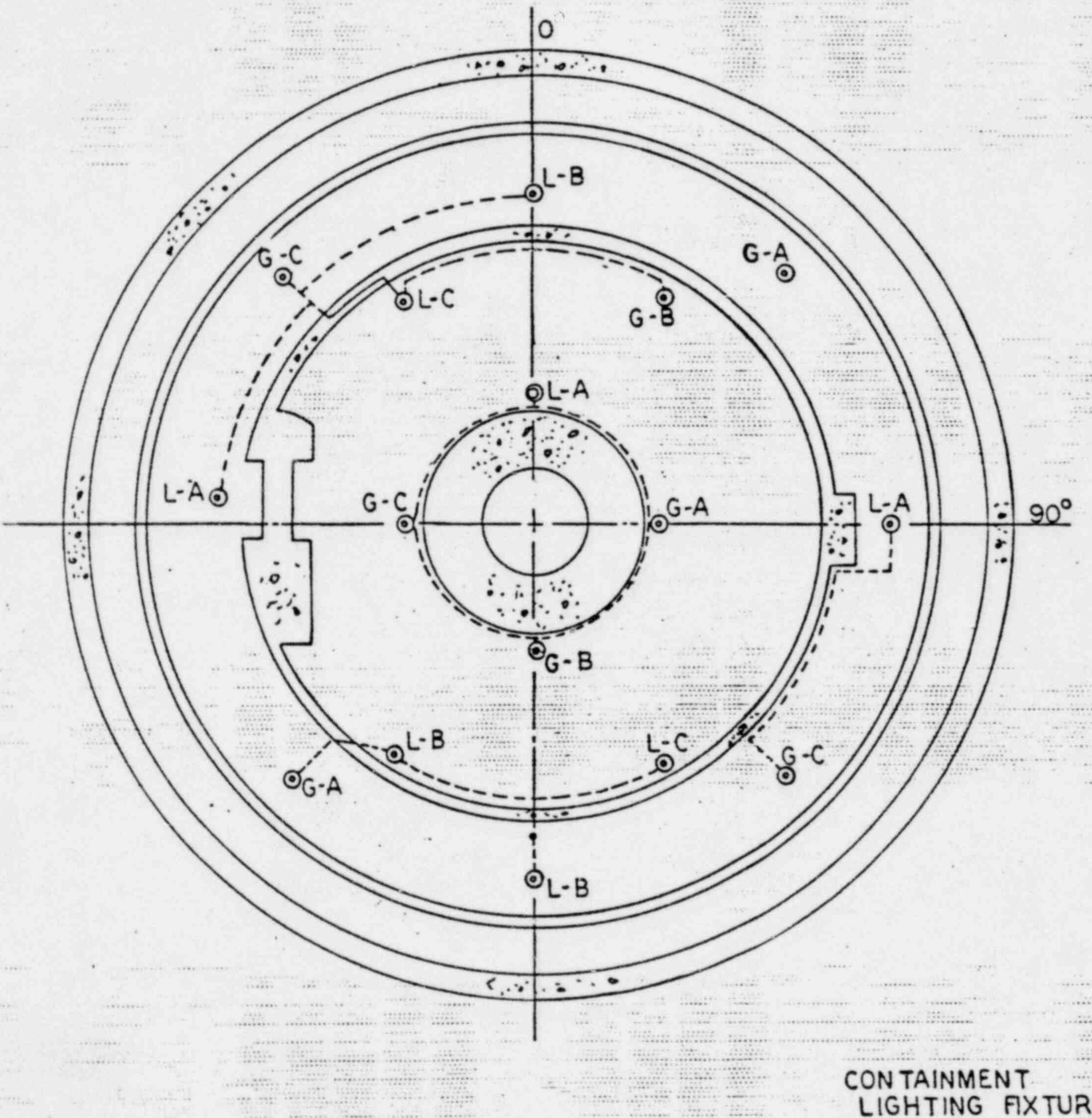
9. Radiative Heat Calculations - See Enclosure 5.

10. Analysis of a Burn without Ice Condenser Benefits - See Enclosure 6.

11. Presentation by R. Bruce, OPS, on July 29, 1980 - See Enclosure 7.



CONTAINMENT LIGHTI
FIXTURE ELEVATIC
FIGURE 1..



CONTAINMENT
LIGHTING FIXTURES
EL. 689.0′
FIGURE 2

KEY TO FIGURES 2 THROUGH 6

Denotes normal lighting fixtures (LC) - ○

Denotes standby lighting fixtures (LS) - ◎

Fixture Description

Format: "X-Y" , where

X is one of the following;
- L- fixture containing a lightbulb
- G- fixture containing glowplug type igniter

Y is one of the following;
- A- phase A electricity
- B- phase B electricity
- C- phase C electricity

Denotes H_2 sampling location:

① El. 674.78 Az. 280°

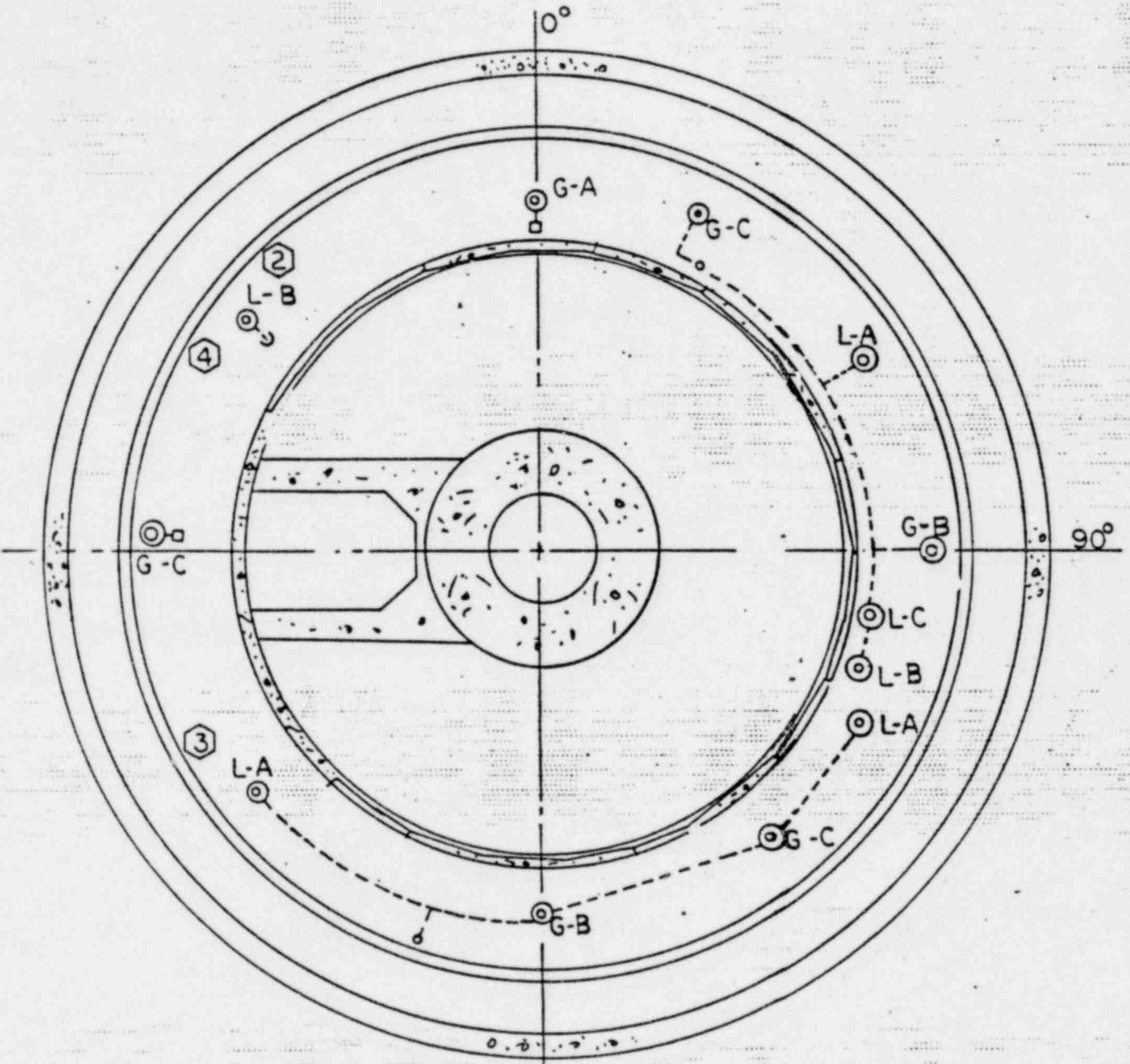
② El. 716.0 Az. 310°

③ El. 716.6 Az. 230°

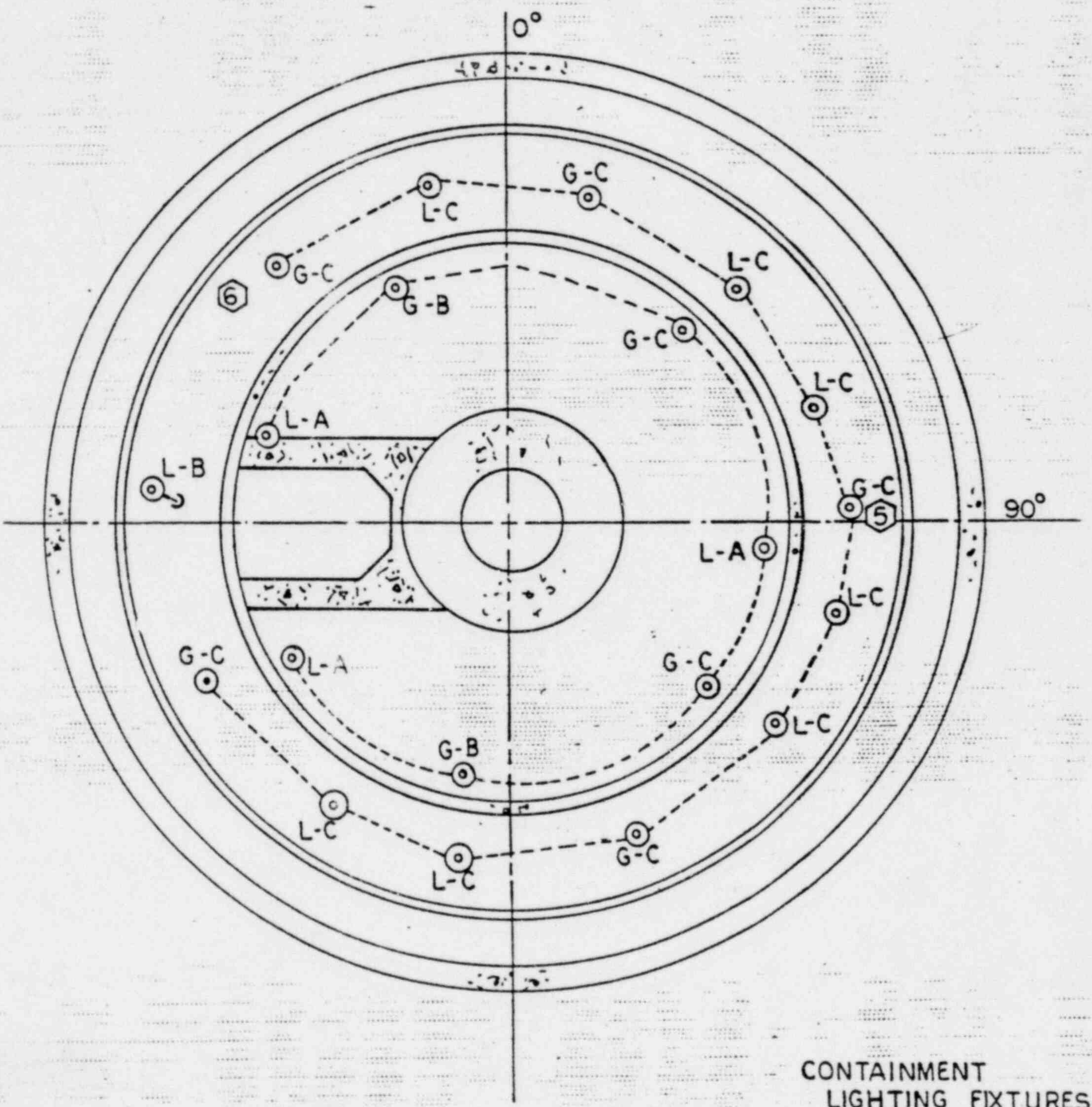
④ El. 730.0 Az. 310°

⑤ El. 756.0 Az. 90°

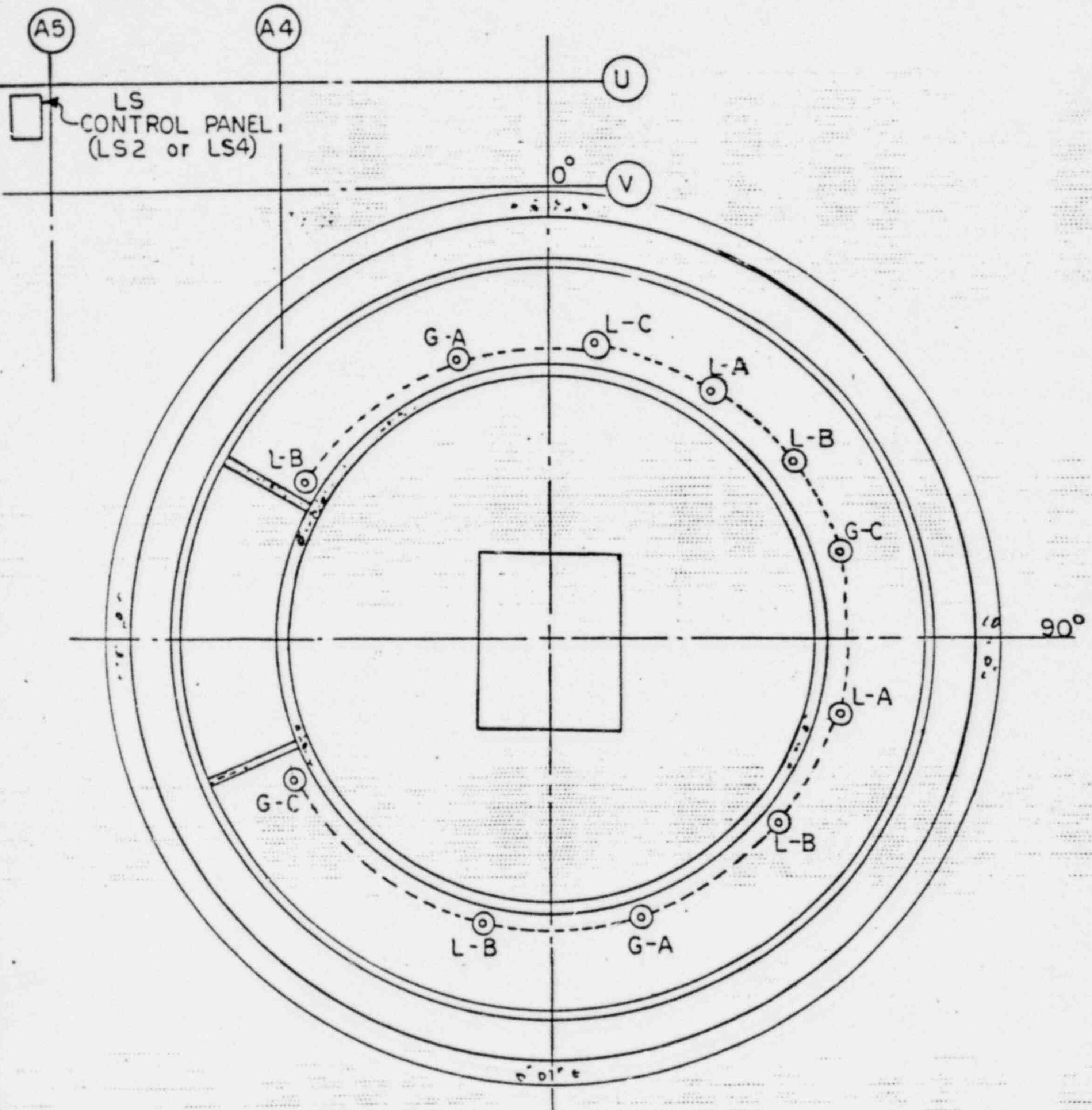
⑥ El. 756.0 Az. 315°



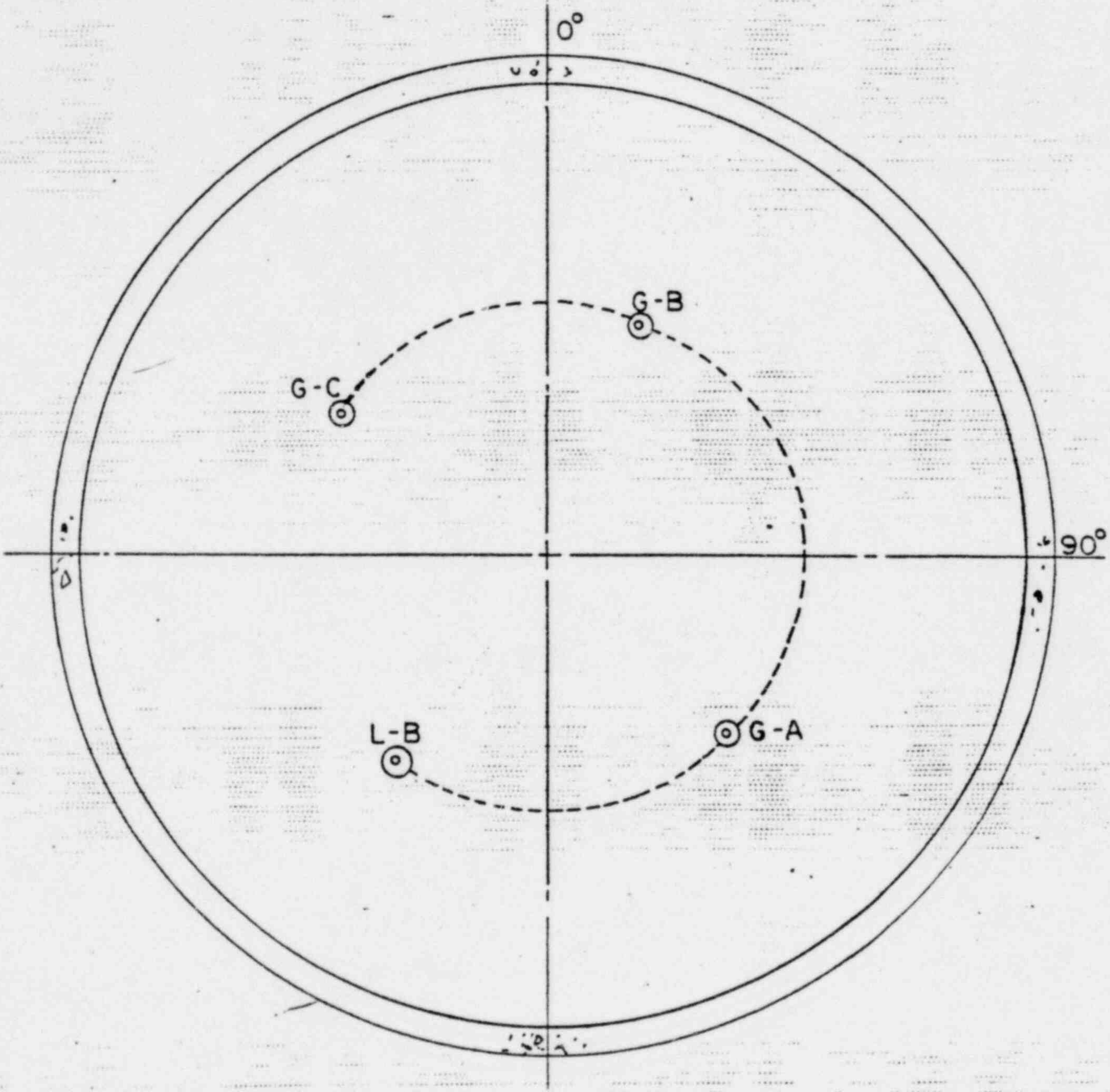
CONTAINMENT
LIGHTING FIXTURES
EL 700.0
FIGURE 3



CONTAINMENT
LIGHTING FIXTURES
EL 731.0'
FIGURE 4



CONTAINMENT
LIGHTING FIXTURES
EL 792.0'
FIGURE 5



CONTAINMENT
LIGHTING FIXTURE
EL. 818. 0'
FIGURE 6

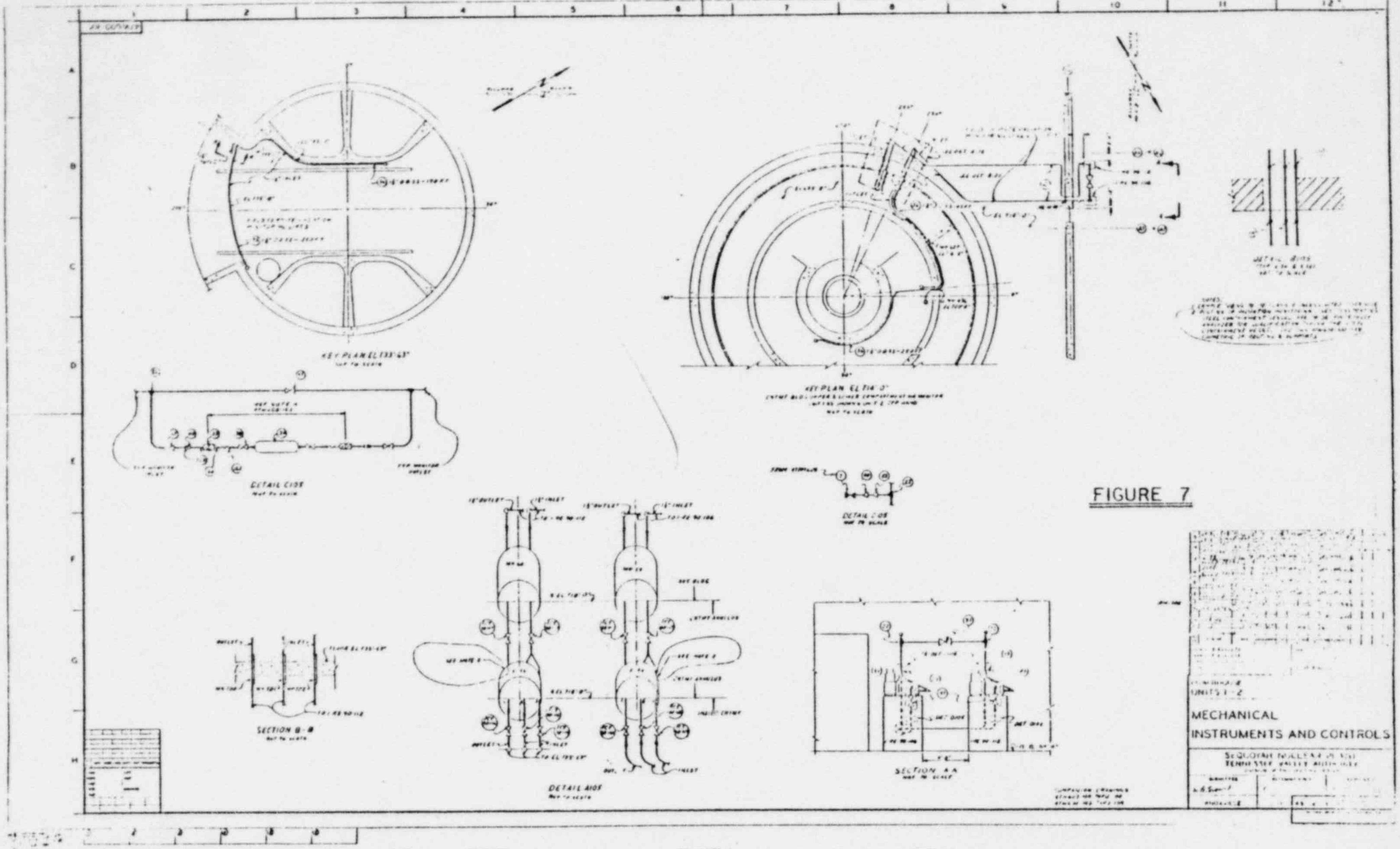

KEY PLAN
DETAIL C105
SECTION B-B
DETAIL A105
SECTION A-A
UNITS 1-2
MECHANICAL
INSTRUMENTS AND CONTROLS
SEQUOYAH NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

FIGURE 7

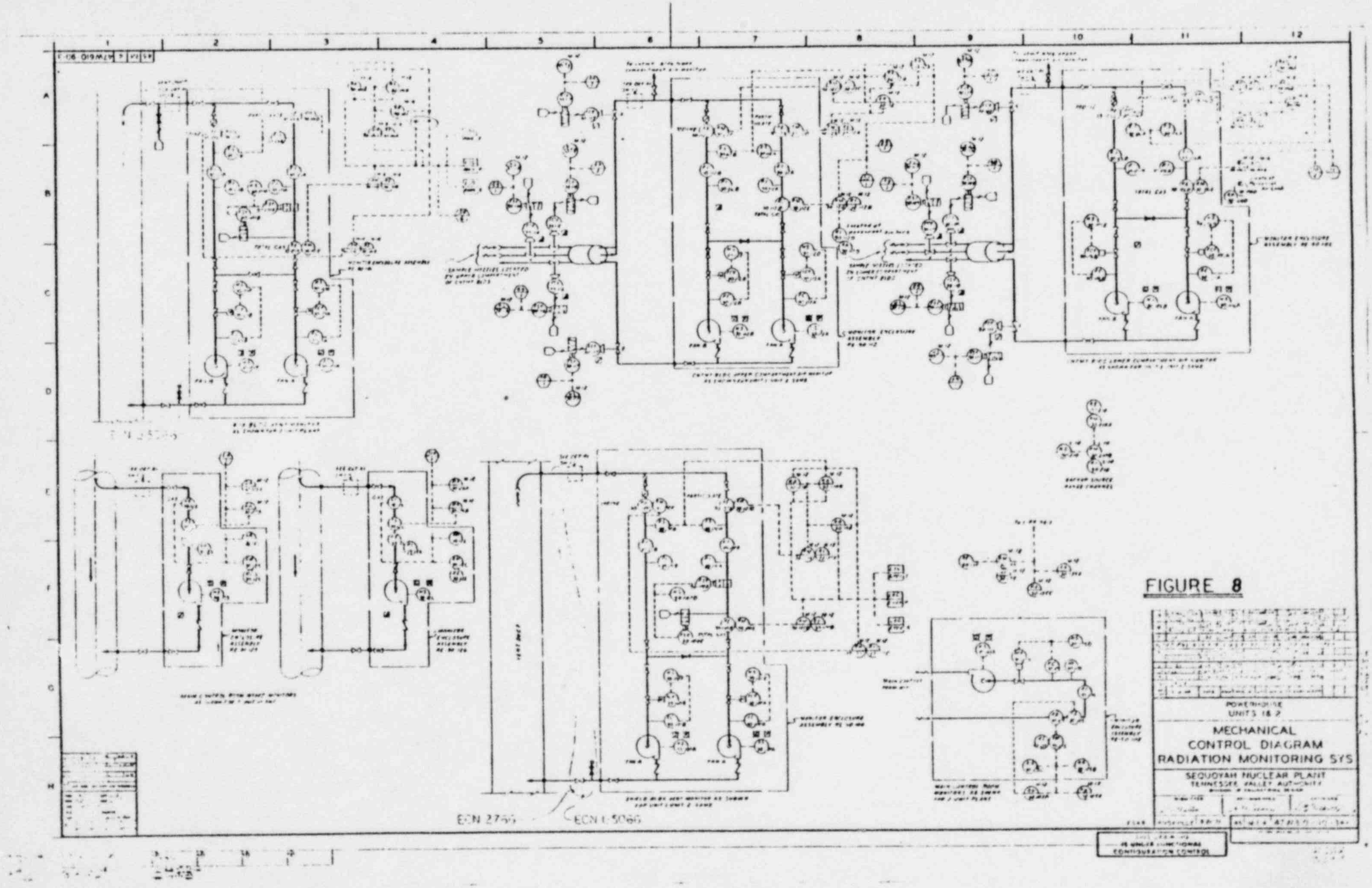


FIGURE 8

POWERHOUSE
UNITS 1 & 2
MECHANICAL
CONTROL DIAGRAM
RADIATION MONITORING SYS
SEQUOYAH NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

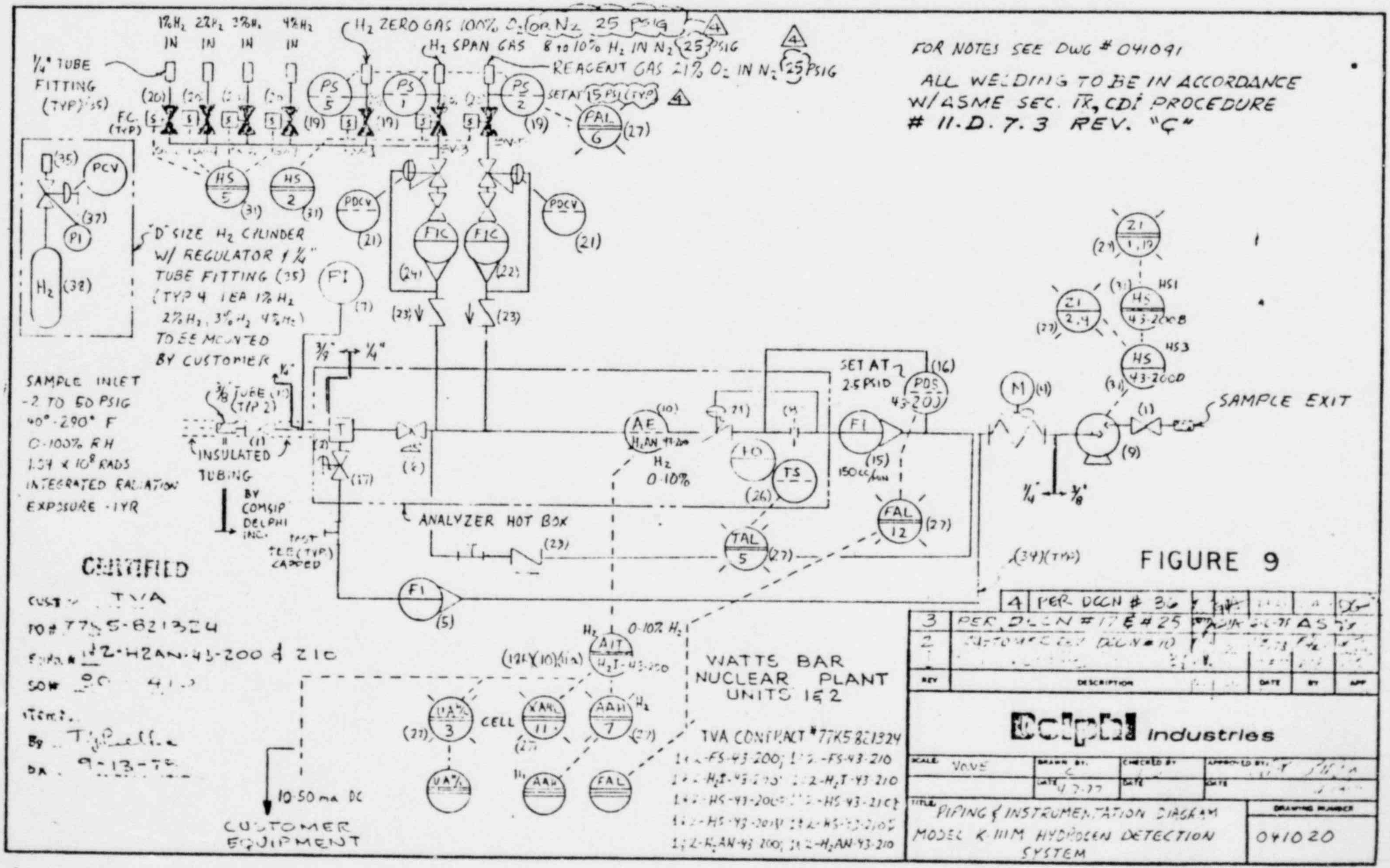

1/4" TUBE FITTING (TYP)(35)
1% H2 IN
2% H2 IN
3% H2 IN
4% H2 IN
H2 ZERO GAS 100% O2 OR N2 25 PSIG
H2 SPAN GAS 8 TO 10% H2 IN N2 25 PSIG
REAGENT GAS 21% O2 IN N2 25 PSIG
4
FOR NOTES SEE DWG # 041091
ALL WELDING TO BE IN ACCORDANCE W/ASME SEC. IX, CDI PROCEDURE # 11.D.7.3 REV. "C"
F.C. (TYP)
(20)
(19)
S
PS 5
PS 1
PS 2
SET AT 15 PSI (TYP)
FAL 6
(27)
SV-3
HS 5
HS 2
(31)
PCV
PI
(35)
(37)
H2
(38)
"D" SIZE H2 CYLINDER W/ REGULATOR & 1/4" TUBE FITTING (35) (TYP 4 1 EA 1% H2, 2% H2, 3% H2, 4% H2) TO BE MOUNTED BY CUSTOMER
PDCV
(21)
FIC
(24)
(22)
(23)
FI
(7)
3/8" → 1/4"
1/4"
SAMPLE INLET
-2 TO 50 PSIG
40°-290° F
0-100% RH
1.34 x 10^8 RADS
INTEGRATED RADIATION
EXPOSURE -1YR
3/8" TUBE (TYP 2)
(1)
INSULATED TUBING
BY COMSIP DELPHI INC.
TEST TEE (TYP) CAPPED
T
(2)
(17)
(6)
ANALYZER HOT BOX
(23)
AE H2AN 43-200
(10)
H2 0-10%
21)
(4)
TO
TS
(26)
TAL 5
(27)
SET AT 2.5 PSID
PDS 43-200
(16)
FI
(15)
150 cc/min
FAL 12
(27)
M
(4)
(9)
(1)
SAMPLE EXIT
1/4" → 3/8"
(34)(TYP)
ZI 1,19
ZI 2,4
(27)
(31)
HS 43-200B
HS1
HS 43-200D
HS3
FI
(5)
H2
AIT H2T-43-200
0-10% H2
(12)(10)(13)
UA% 3
CELL
XAHL 11
AAH 7
H2
(27)
UA%
AAH
FAL
10-50 ma DC
CUSTOMER EQUIPMENT
CERTIFIED
CUST. TVA
PO# 77K5-821324
EQPT. # 1&2-H2AN-43-200 & 210
SO# 90 41
ITEM
BY T J Pelle
DA. 9-13-78
WATTS BAR NUCLEAR PLANT UNITS 1 & 2
TVA CONTRACT # 77K5-821324
1&2-FS-43-200; 1&2-FS-43-210
1&2-H2T-43-200; 1&2-H2T-43-210
1&2-HS-43-200C; 1&2-HS-43-210C
1&2-HS-43-200D; 1&2-HS-43-210D
1&2-H2AN-43-200; 1&2-H2AN-43-210
4 PER DCCN # 36
3 PER DCCN #17 & #25 AS
2 CUSTOMER DCCN #10
REV
DESCRIPTION
DATE
BY
APP
Delphi Industries
SCALE NONE
DRAWN BY
DATE 4-7-77
CHECKED BY
DATE
APPROVED BY
DATE
TITLE PIPING & INSTRUMENTATION DIAGRAM MODEL K-IIIM HYDROGEN DETECTION SYSTEM
DRAWING NUMBER 041020

FIGURE 9

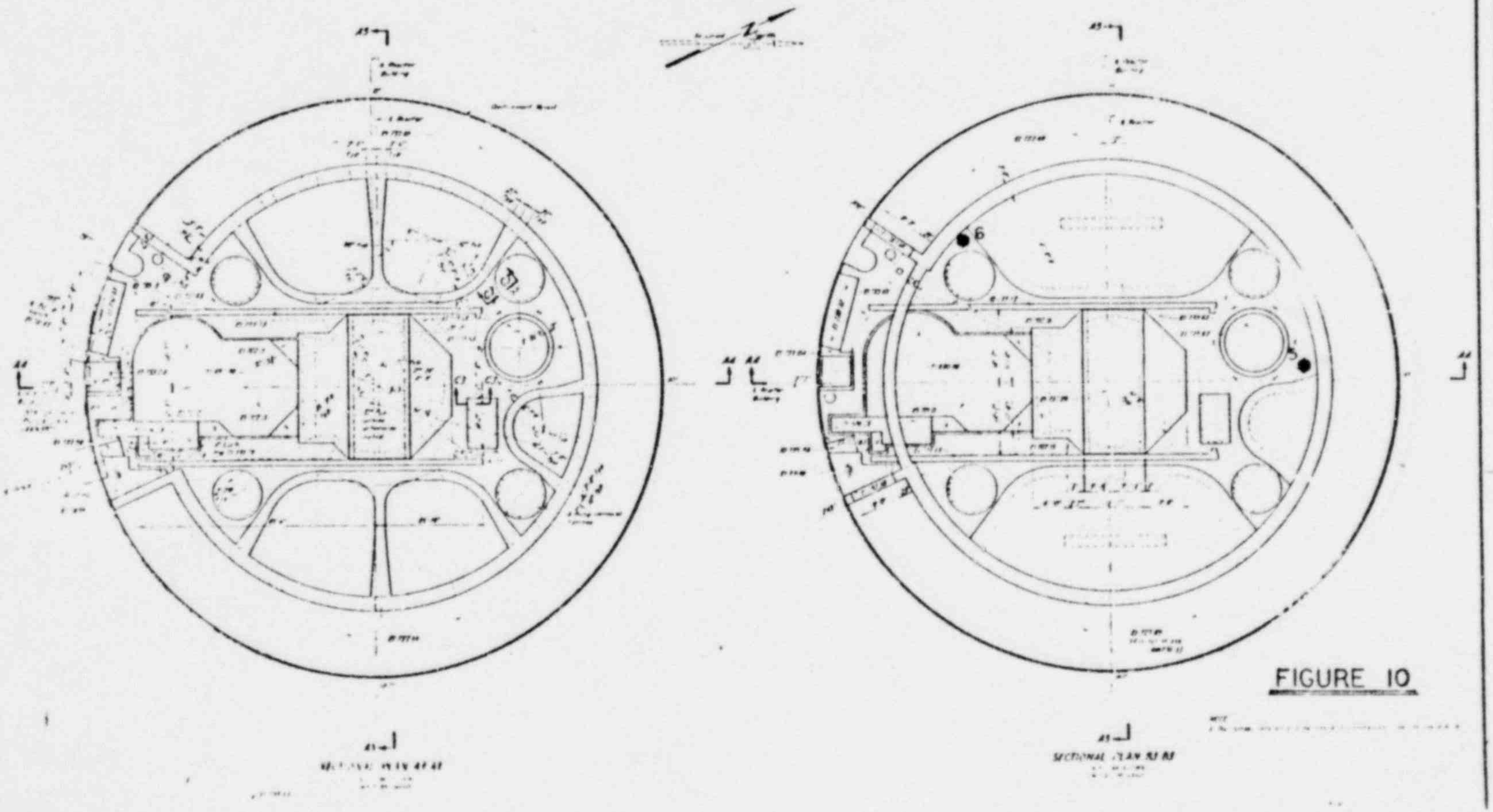


FIGURE 10

CONCRETE
INTERIOR STRUCTURE
OUTLINE

SEQUOYAH NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

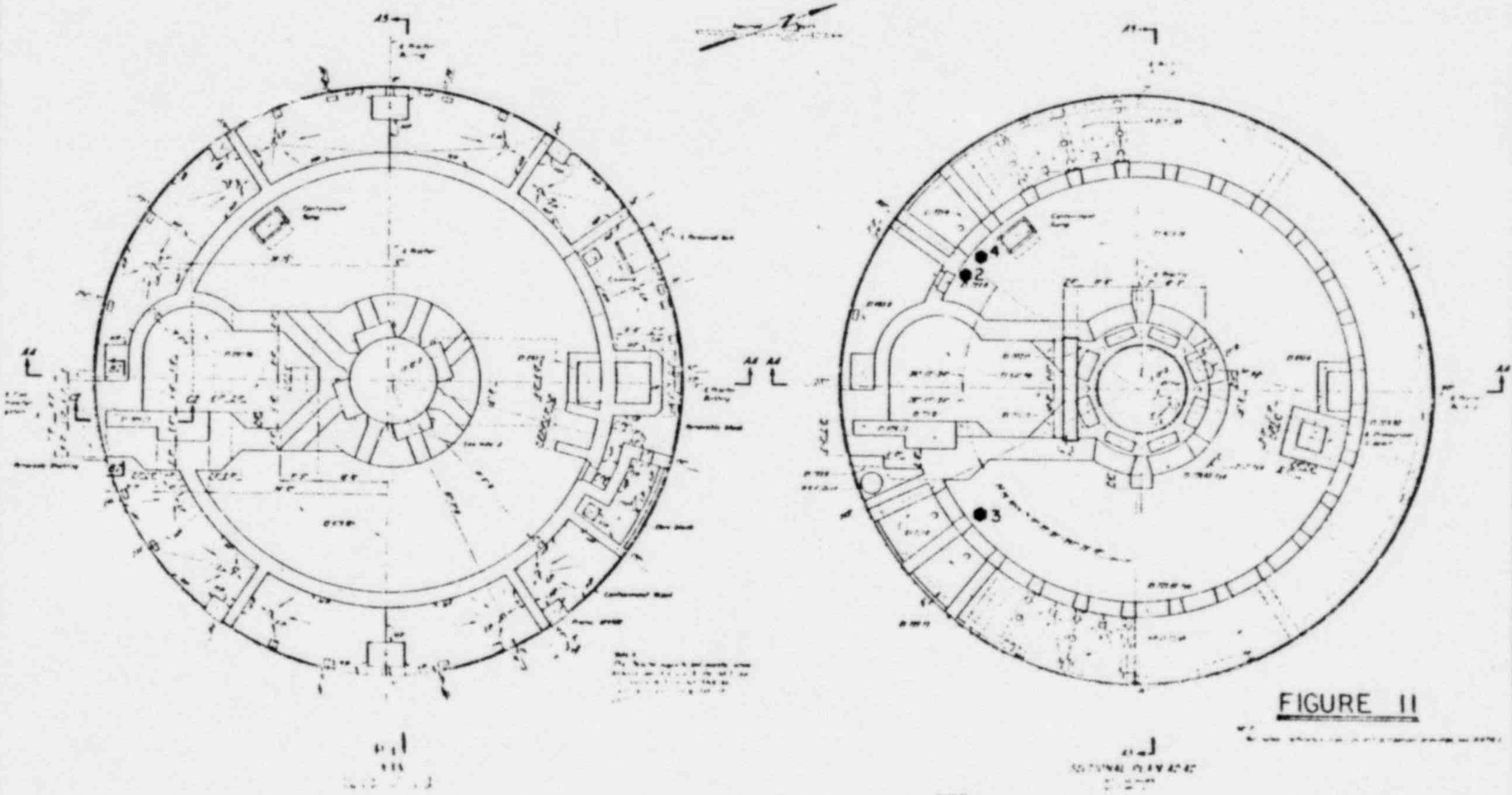


FIGURE 11

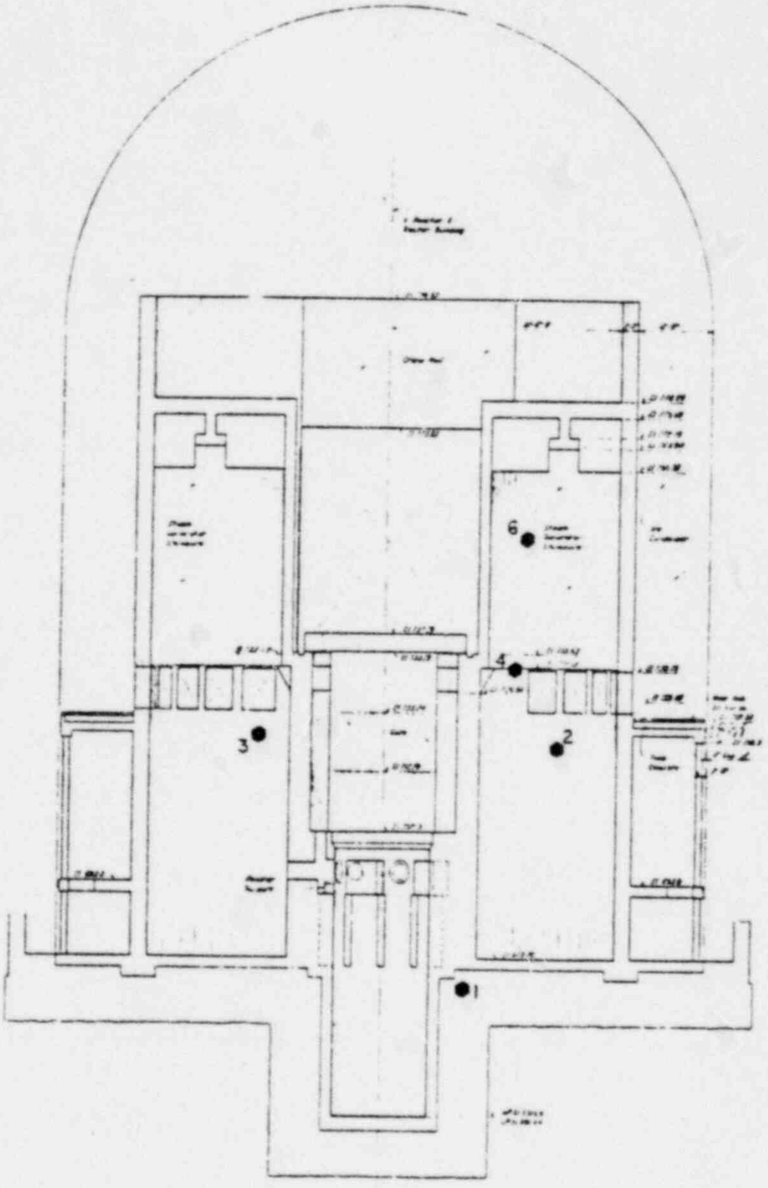


FIGURE 12

UNITS 1 & 2

CONCRETE
INTERIOR STRUCTURE
OUTLINE

SEQUOYAH NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

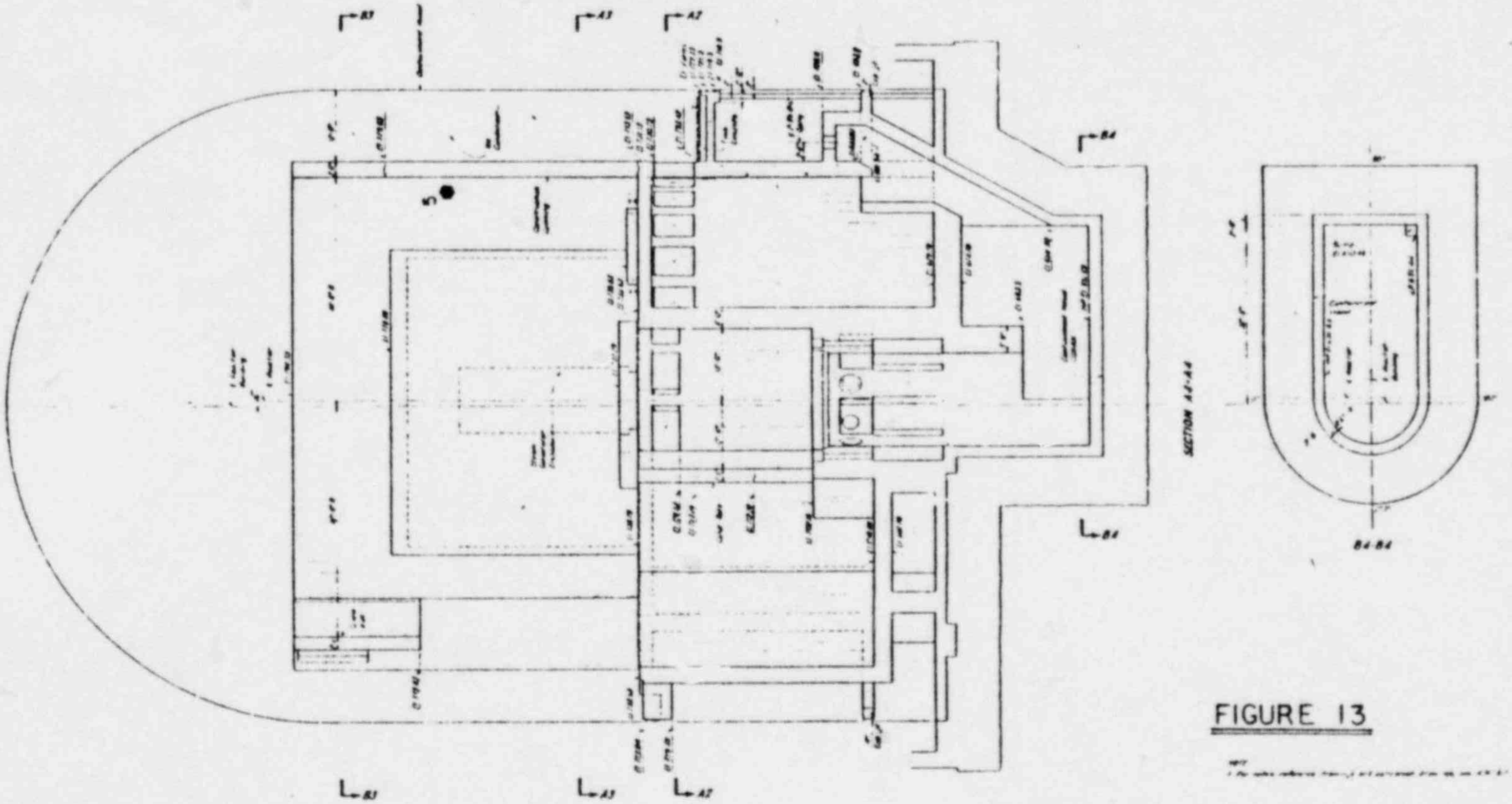
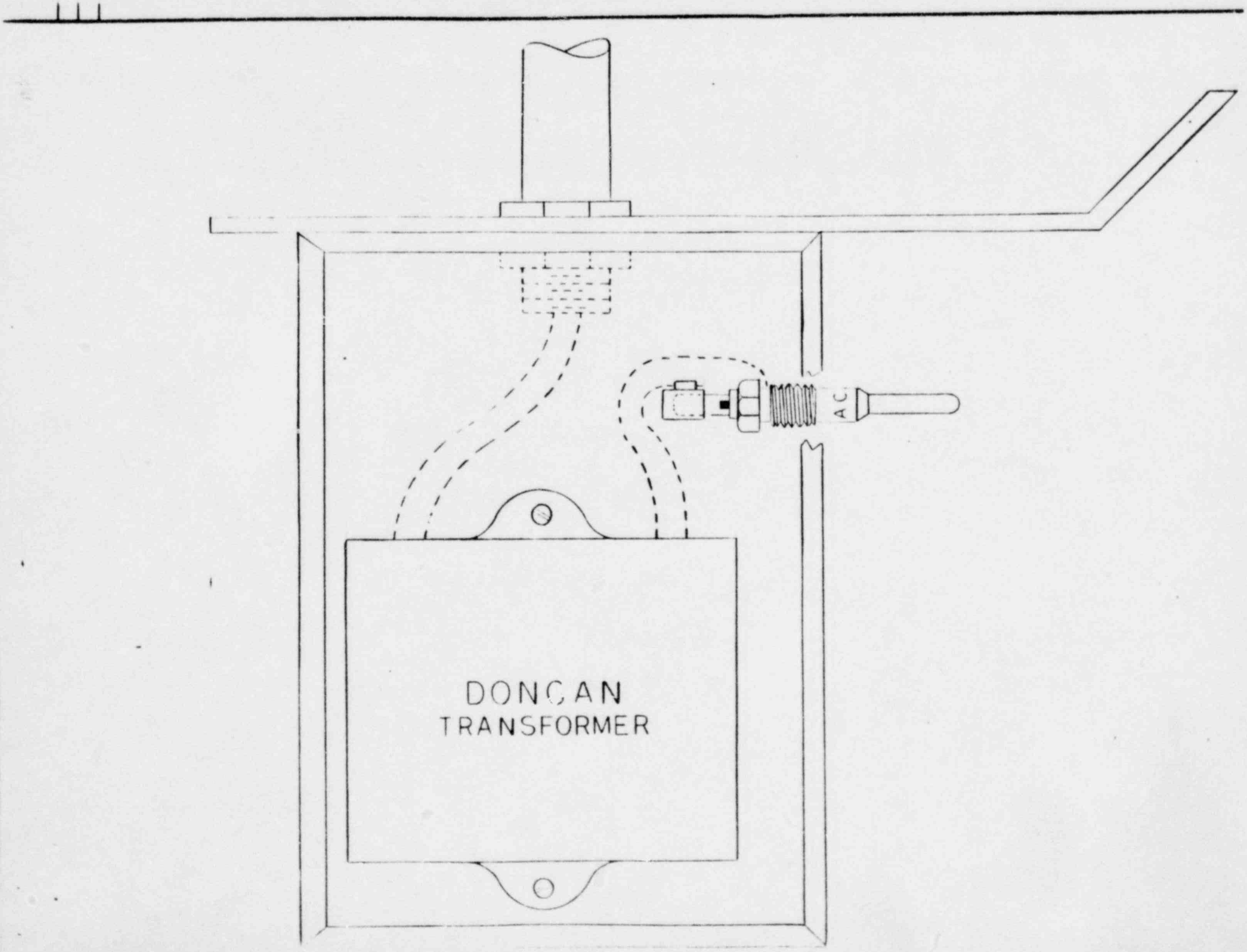


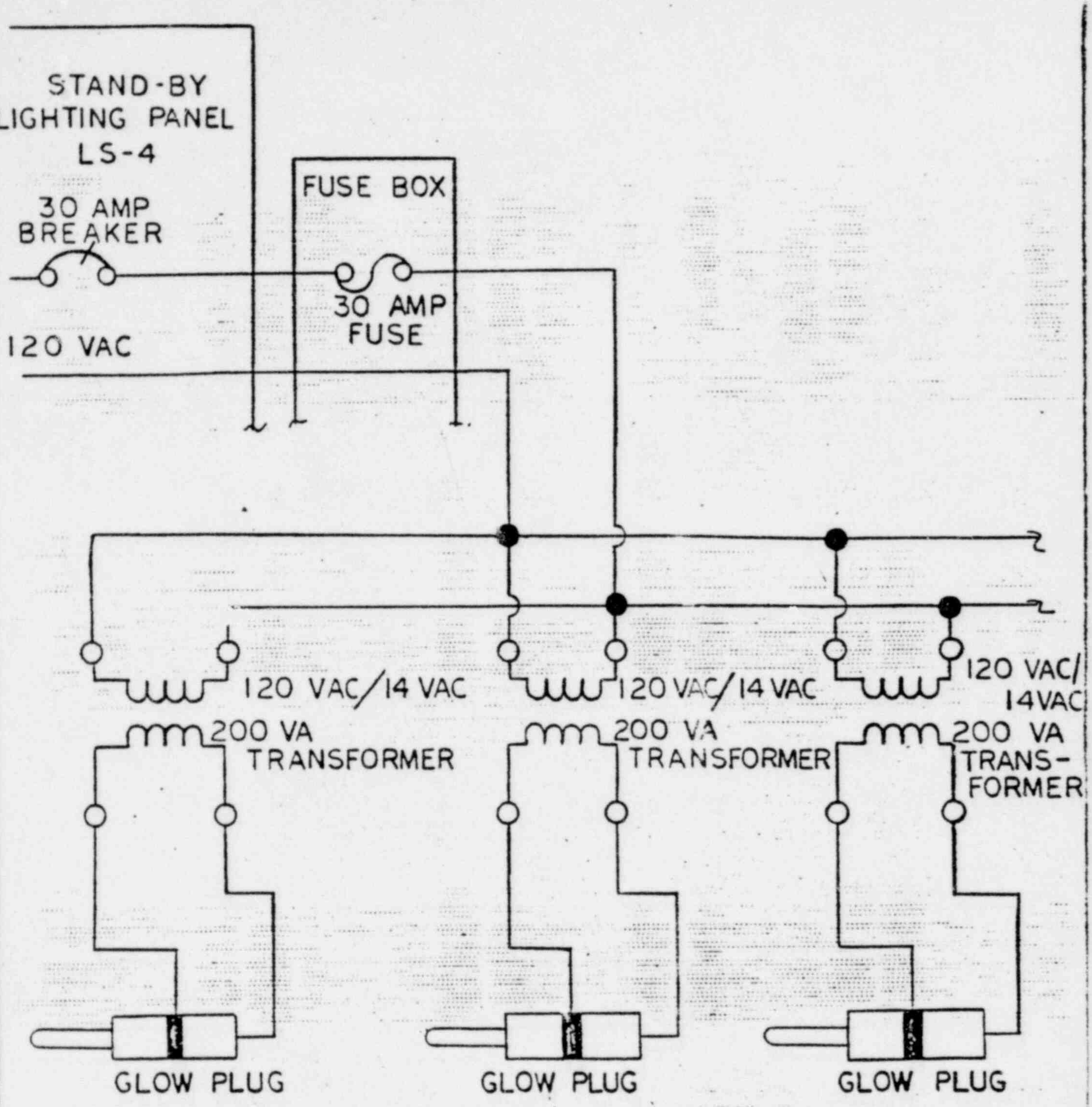
FIGURE 13

REACTOR BUILDING
UNITS 1 & 2

CONCRETE
INTERIOR STRUCTURE
OUTLINE

SEQUOYAH NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY


DONGAN
TRANSFORMER
AC



TYPICAL OF ONE CIRCUIT

(NUMBER OF GLOW PLUGS PER CIRCUIT VARIES FROM ONE TO EIGHT)

REV NO.	ECN NO.	DATE	DSGN	DRWN	CHKD	SUPV	ENGR	INSP	SUBM	RECM	APPD

DSGN
DRWN
CHKD
SUPV
INSP
ENGINEER

ELECTRICAL SCHEMATIC
FIGURE 15

TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED	RECOMMENDED	APPROVED

KNOXVILLE

RECORD DRAWING AS CONSTRUCTED

ENCLOSURE 2

Description of Hydrogen Analyzer System at Sequoyah Nuclear Plant

The hydrogen analyzer system installed in each unit of Sequoyah Nuclear Plant consists of two independently-trained, redundant, hydrogen analyzers and is designed to sample the containment atmosphere for the presence of hydrogen and relay the measured atmospheric hydrogen concentrations to the main control room. System design calls for continuous operation during an accident under containment conditions of 2 to 50 psig and 40 to 290° F. The sampling system is seismic category I, and conforms to ASME Section III, Class 2, and Section IX requirements: ANSI B16.5, B16.11, N45.2, and B46.1 requirements; and the applicable requirements of the ASTM, IEEE, etc.

Each analyzer has a single 3/8" input sampling line which branches into two 3/8" lines immediately before entering primary containment - one line penetrating into the upper compartment and the other into the lower compartment. See Figure 7. Each branch line is equipped with a normally closed, air operated, remote manually controlled, isolation valve. Upon actuation of the system the containment atmosphere is drawn through a series of sample conditioners including a trap, moisture separator, and filter before entering the analyzer. The sample is returned to primary containment via a 3/8" line. The return line is also equipped with a remote manually controlled isolation valve, normally closed. The analyzer is designed to operate under the conditions of pressure, temperature, humidity and radiation associated with a LOCA. Each analyzer is calibrated to measure hydrogen concentrations between 0 and 10 percent with an accuracy of one percent full scale. A schematic drawing of an analyzer is given in Figures 8 and 9. Sample suction and expulsion locations are shown in Figures 10, 11, 12, and 13.

Analysis is accomplished by utilizing the technology for thermal conductivity measurements of gases. The analysis technique utilizes a hot filament fixed in the center of a temperature controlled metal cavity. The filament temperature is determined by the amount of heat conducted to the cavity wall by the gas present. Thermal conductivity varies with gas species, thus causing the filament temperature to change as the gas in the cavity changes. Since filament resistance changes with temperature; by using two filaments in separate cavities and connecting them in an electrical bridge, the difference in thermal conductivity of gases in the separate cavities may be determined electrically. Electrical zero is set by first introducing the same gas to both cavities and then, adjusting the bridge so that the bridge will be balanced, resulting in zero output. Then, as different gases are introduced to the two individual cavities, the bridge will become unbalanced, and the electrical output will increase with increasing differences in themal conductivity of the gases used.

The measurement of hydrogen in the presence of nitrogen, oxygen, and water vapor is possible because the thermal conductivity of hydrogen is approximately seven times greater than nitrogen, oxygen, or water vapor, which have nearly identical thermal conductivities at the filament operation temperature of approximately 500° F. Hydrogen measurement is accomplished by using a thermal conductivity measurement cell and a catalytic reactor. The sample first flows through the reference section of the cell, then passes through the catalytic converted where free oxygen is catalytically recombined with hydrogen to form water vapor, and finally flows through the sample section of the measuring cell. The hydrogen content is indicated by the difference in thermal conductivity between the sample and reference sides of the cell.

The hydrogen analyzers will be in the "stand-by" mode at all times during normal operation. Upon occurrance of an accident, the reactor operator opens the isolation valves and switches the analyzer to the "ON" mode to obtain hydrogen concentration information.

ENCLOSURE 3

Components Required After Hydrogen Burns

Component	Location Inside Containment	Function
Limit switches	Upper and lower	
FCV67-87, -95, -103, -111	Lower compartment	Lower containment cooler discharge
FCV67-295, -296, -297, -298	Upper compartment	Upper containment vent cooler
FCV70-87	Lower compartment	RCP thermal barrier
FCV7-89	Lower compartment	RCP oil cooler
LT3-148, -156, -164, -171, -172, -173, -174, -175	Lower compartment	Steam generator level transmitters (narrow range)
30-1AA, 30-1BB	Lower compartment	Containment air return fans
Penetrations		Medium voltage power, low voltage power, and control and instrumentation
Splices		
Junction boxes	Lower compartment	RTD connections to measure TCS temperature
FCV62-61	Lower compartment	Valve motor operator
FCV63-67, -80, -98, -118, -172	Lower compartment	Valve motor operator
TE68-2A&B, -14, -25, -37, -44, -56, -67, -79 (-410, 411, 420, 421, 430, 431, 440, 441)	Lower compartment	Narrow range RTD's
TE68-1, -18, -24, -41, -43, -60, -65, -83 (413, 423, 433, 443)	Lower compartment	Wide range RTD's
NC41, 42, 43, 44	Lower compartment	Excore neutron detectors
H_2 recombiners	Upper compartment	

PT68-322, -323, -334, -340 (455, 456, 457, 458)	Lower compartment	Pressurizer pressure transmitters
PT68-320, 335, 339 (459, 460, 461)	Lower compartment	Pressurizer level transmitters
PT68-66 (403)	Lower compartment	RCS wide range pressure transmitter
LT3-56, -111 (502, 504)	Lower compartment	Steam generator level transmitters (wide range)
FT1-3A&B, -10A&B, -21A&B, -28A&B (512, 513, 522, 532, 533, 542, 543)	Lower compartment	Steam flow transmitters
LT3-43, 98 (501, 503)	Lower compartment	Steam generator level transmitters (wide range)
LT3-38, -39, -42, -51, -52, -55, -93, -94, -97, -106, -107, -110, -111 (517, 518, 519, 527, 528, 529, 537, 538, 539, 547, 548, 549)	Lower compartment	Steam generator level transmitters (narrow range)

ENCLOSURE 4

ASSESSMENT OF THE CAPABILITY OF THE NORMAL CONTAINMENT COOLING

8. There are eight normal reactor building coolers, four in the lower compartment and four in the upper compartment. The lower compartment coolers have a capacity of eight million Btu/hr, and the upper compartment coolers provide an additional eight hundred thousand Btu/hr. This total capacity of 8.8 million Btu/hr is based on an affirmed atmospheric temperature of 327°F and river temperature of 83°F. The coolers are located above the maximum expected post-LOCA water level, are seismically qualified with full QA, and are supplied with ERCW. These coolers would be of some benefit in removing heat from hydrogen burns although no credit has been taken for them.

   Several conditions tend to limit the effectiveness of the coolers:

   a. After unit 2 startup, offsite power and the new ERCW pumping station must be available or there will be insufficient ERCW to meet plant requirements for one unit in hot standby with a LOCA in the other unit.

   b. Present containment isolation logic isolates the ERCW lines to the coolers when the containment pressure exceeds three psig. This would require modifications for the coolers to be of benefit during degraded core events.

   The CRDM coolers were also considered in assessing the capability of normal cooling systems. These coolers are located on the lower compartment floor and are therefore flooded early in a LOCA. It has been concluded that no credit can be taken for these coolers.

ENCLOSURE 5

ESTIMATE OF CONTAINMENT SHELL TEMPERATURE DUE TO HYDROGEN BURN IN THE LOWER COMPARTMENT

An estimate was made of the temperature rise in the containment shell due to hydrogen burning in the lower compartment. It was assumed that the gas will lose heat to the containment shell by radiation and convection and to the ice condenser. Due to the relatively low temperature of the gas in the dead-ended compartment, it was assumed that only the water vapor emitted and absorbed radiation. The containment shell will reradiate a portion of the energy it receives from the gas, some of which will be absorbed by the gas. Simple finite difference equations were used to represent the heat balances for the containment shell and gas for a time increment Δt. The gas and shell temperatures were updated at the end of each time step and the calculation repeated until thermal equilibrium was reached. For a single burn of 100 pounds of hydrogen in the lower compartment, the average temperature of a 1" thick steel containment shell increased by approximately $8^{\circ}F$. Assuming a similar temperature rise for each of the nine burns for the S_2D accident scenario, the mean temperature of the shell should increase by roughly $72^{\circ}F$. This corresponds to a total energy deposition in the wall of about 4.5×10^6 BTU.

The one inch thick containment shell was modelled as a one-dimensional slab. The total heat input of 4.5×10^6 BTU was added to the shell over a 200 second time interval which corresponds to a surface heat flux of about 5370 BTU/Hr-Ft^2. The TAP-A computer program was utilized to compute the transient temperature distribution in the shell. The maximum temperature difference in the wall from inner surface to outer surface was approximately $21.4^{\circ}F$. The corresponding temperature difference from the inner surface of the shell to the center of the shell was roughly $15.7^{\circ}F$.

ESTIMATE OF CONTAINMENT SHELL TEMPERATURE DUE TO HYDROGEN BURN IN LOWER COMPARTMENT: NO ICE IN ICE CONDENSER AFTER FIRST TWO BURNS

An estimate was made of the temperature rise in the containment shell due to hydrogen burning in the lower compartment. The accident scenario is similar to that for the S_2D base case except that no ice remains in the ice condenser after the first two burns. The calculational assumptions are similar to those used in making the previous estimate of the shell temperature rise for the S_2D base case.

Since ice is available for the first two burns, it was assumed that the average temperature of 1" thick steel shell increased by 8°F for each burn as previously calculated. When no ice is available in the ice condenser the average shell temperature increases by approximately 17°F per burn. There are a total of seven burns, two with ice and five with no ice. The total temperature rise in the shell is estimated to be 101°F (2 X 8 + 5 X 17). This corresponds to a total energy deposition in the wall of about 6.3 X 10^6 BTU.

It was assumed that this amount of heat is added to the containment shell over a 200 second time interval which corresponds to a heat flux of approximately 7520 BTU/HR-FT^2. The TAP-A computer program was utilized to compute the transient temperature distribution in the shell. The maximum temperature difference in the shell from inner surface to outer surface was approximately 32°F. The corresponding temperature difference from the inner surface of the shell to the center of the shell was roughly 22°F.

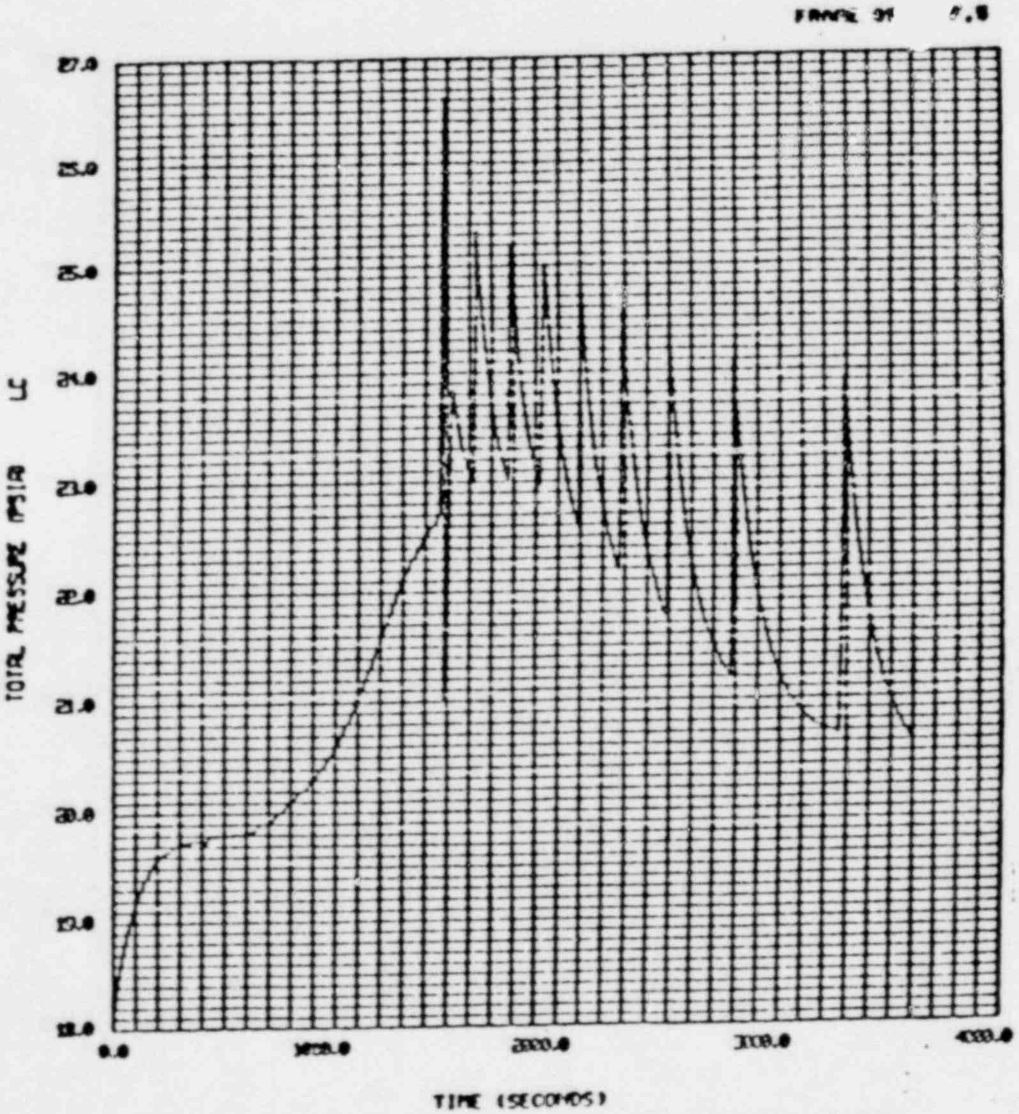
ENCLOSURE 7

BASE CASE PARAMETERS

1. INITIAL CONDITIONS:	VOLUMES	LOTIC
	TEMPERATURES	
	PRESSURES	
	ICE MASS	
	ICE HEAT TRANSFER AREA	
2. BURN PARAMETERS:	H_2 FOR IGNITION	10 V/O*
	H_2 FOR PROPAGATION	10 V/O
	O_2 FOR IGNITION	5 V/O
	O_2 TO SUPPORT COMBUSTION	0 V/O
	FLAME SPEED	6 FPS
3. AIR RETURN FANS:	NUMBER OF FANS	2
	CAPACITY OF EACH FAN	40000 CFM
4. SPRAY SYSTEM:	FLOW RATE	6000 GPM
	TEMPERATURE	125 F
	DROP SIZE	680
	FALL TIME	10 SEC
	HEAT TRANSFER COEFFICIENT	20 BTU/HR FT^{2}F
5. ICE CONDENSER DRAIN TEMPERATURE		32 F
6. BREAK RELEASE DATA		MARCH

* EXCEPT IN THE ICE CONDENSER

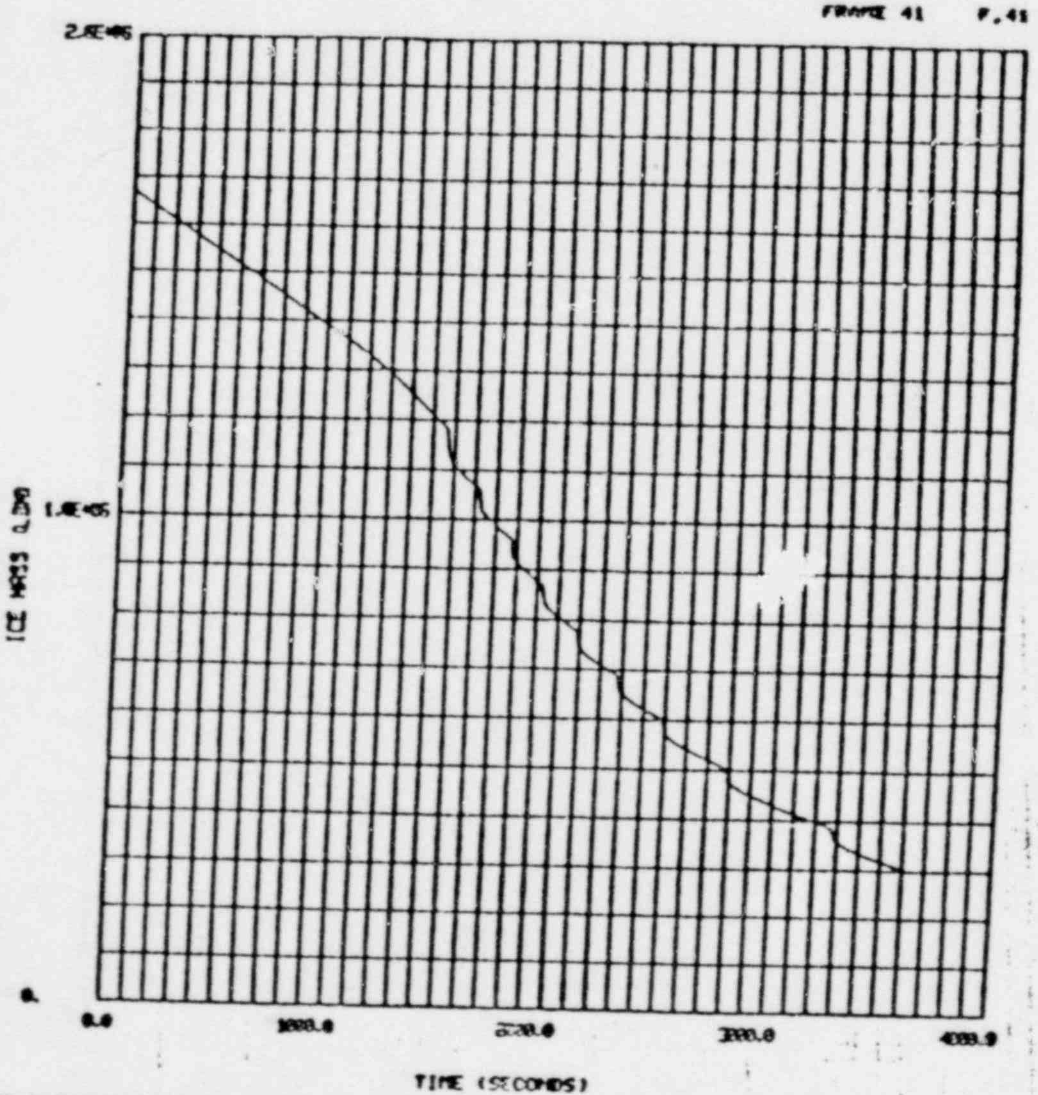
READY-



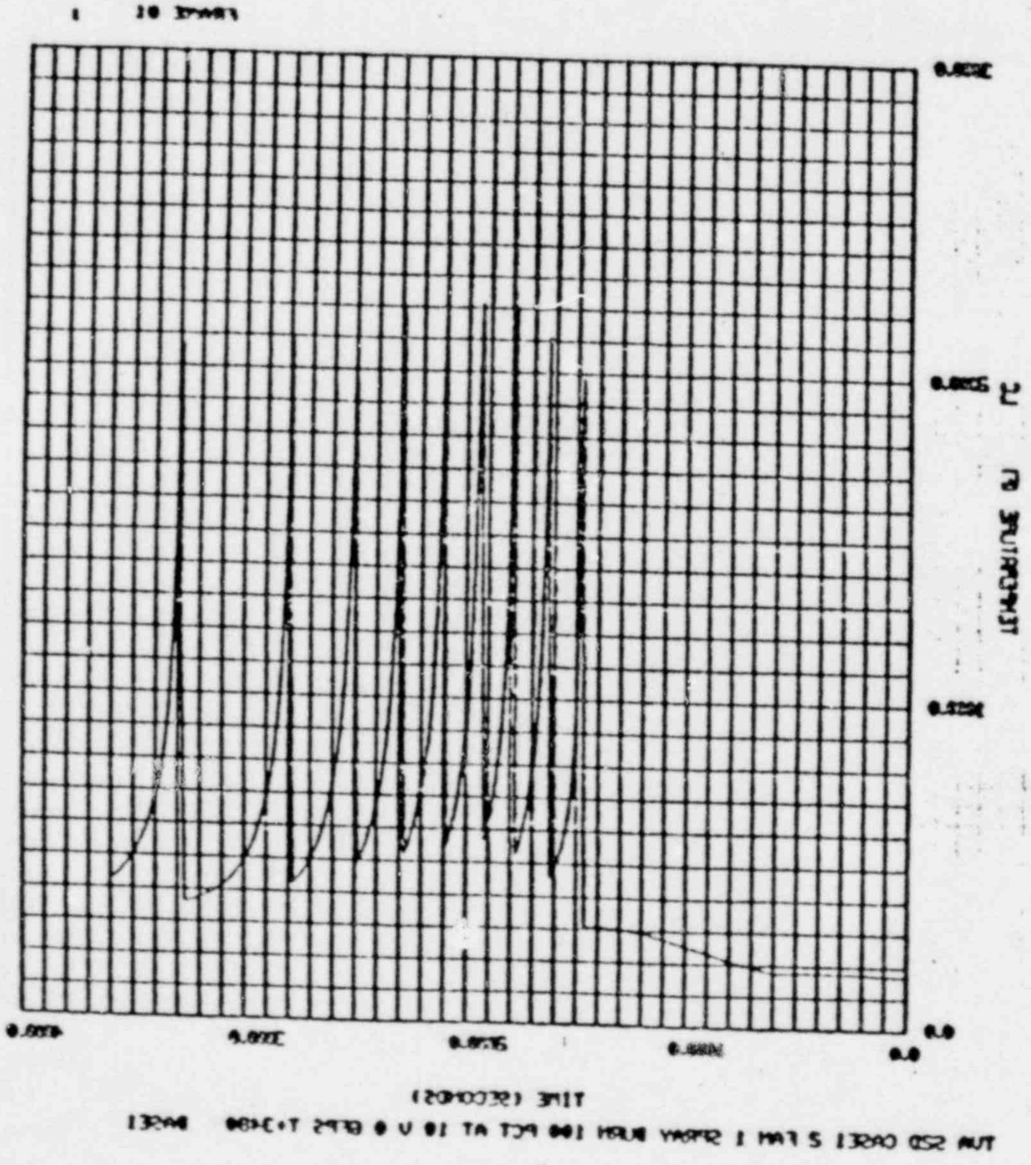
TUM S2D CASE1 2 FAN 1 SPRAY BURN 100 PCT AT 10 V 0 EFPS T+3480 BASE1

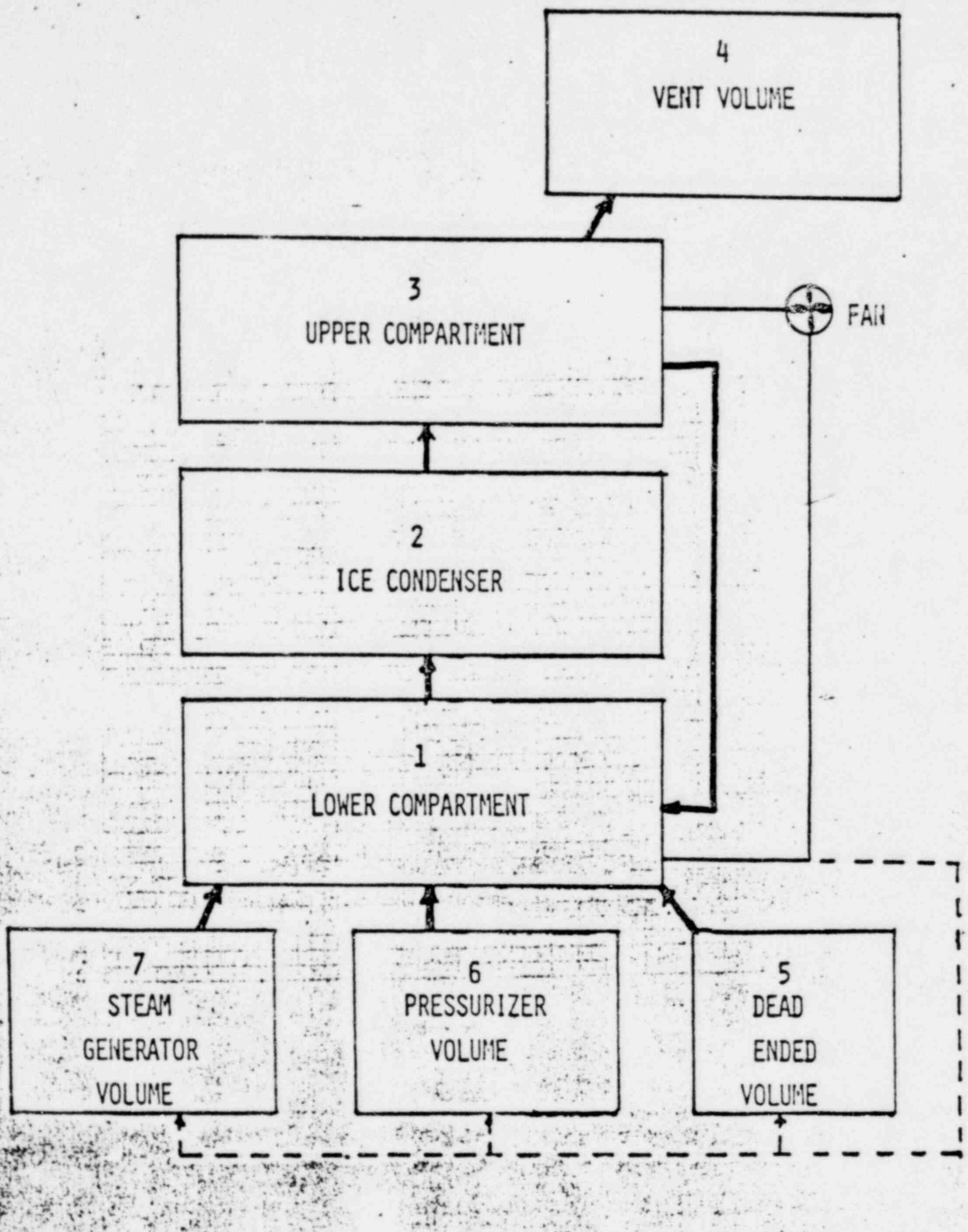
READY-

FRAME 41 F.41



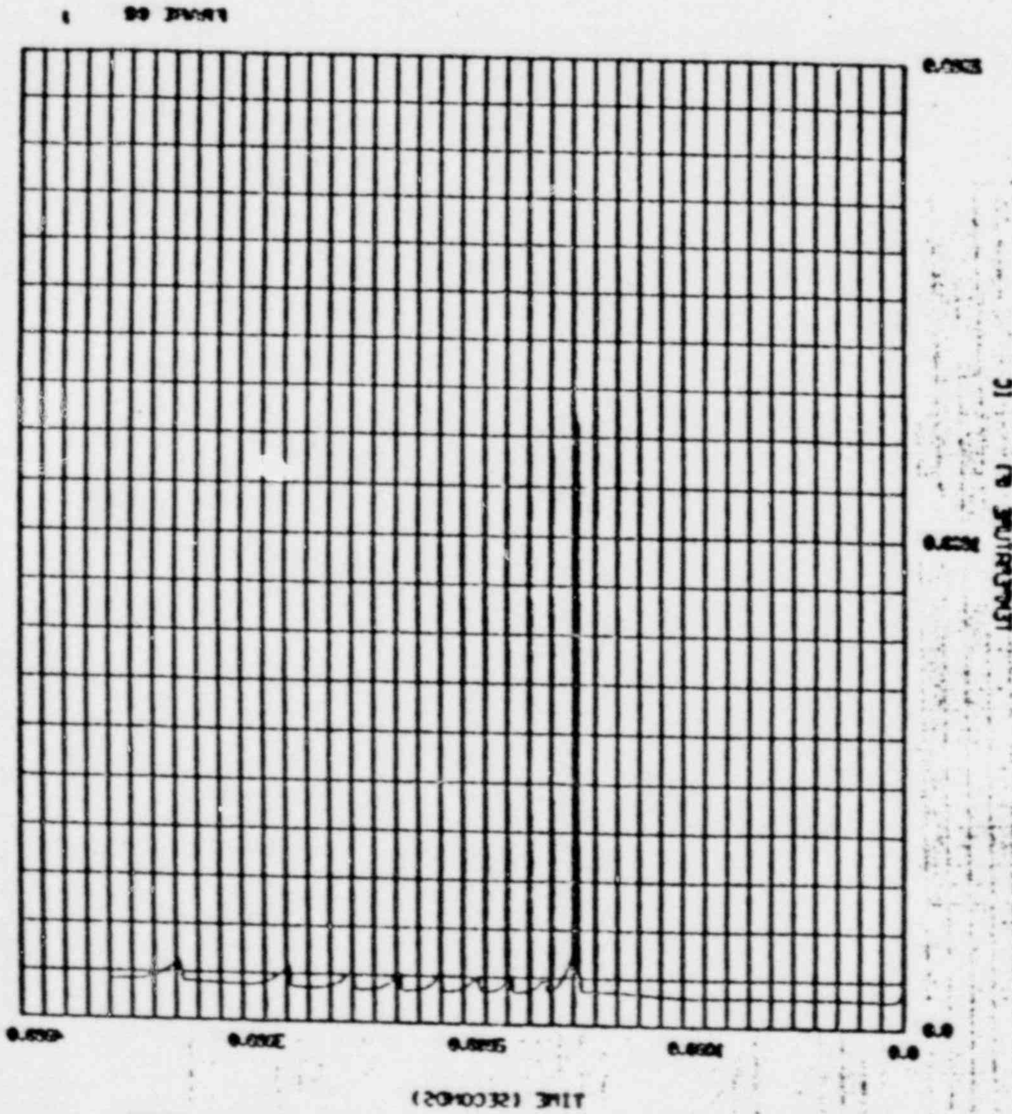
TVA S2D CASE1 2 FAN 1 SPRAY BURN 100 PCT AT 10 V @ 6FPS T+3480 BASE1


TEMPERATURE (F)
0.0
TIME (SECONDS)


4
VENT VOLUME
3
UPPER COMPARTMENT
FAN
2
ICE CONDENSER
1
LOWER COMPARTMENT
7
STEAM
GENERATOR
VOLUME
6
PRESSURIZER
VOLUME
5
DEAD
ENDED
VOLUME

CLASIX CAPABILITIES

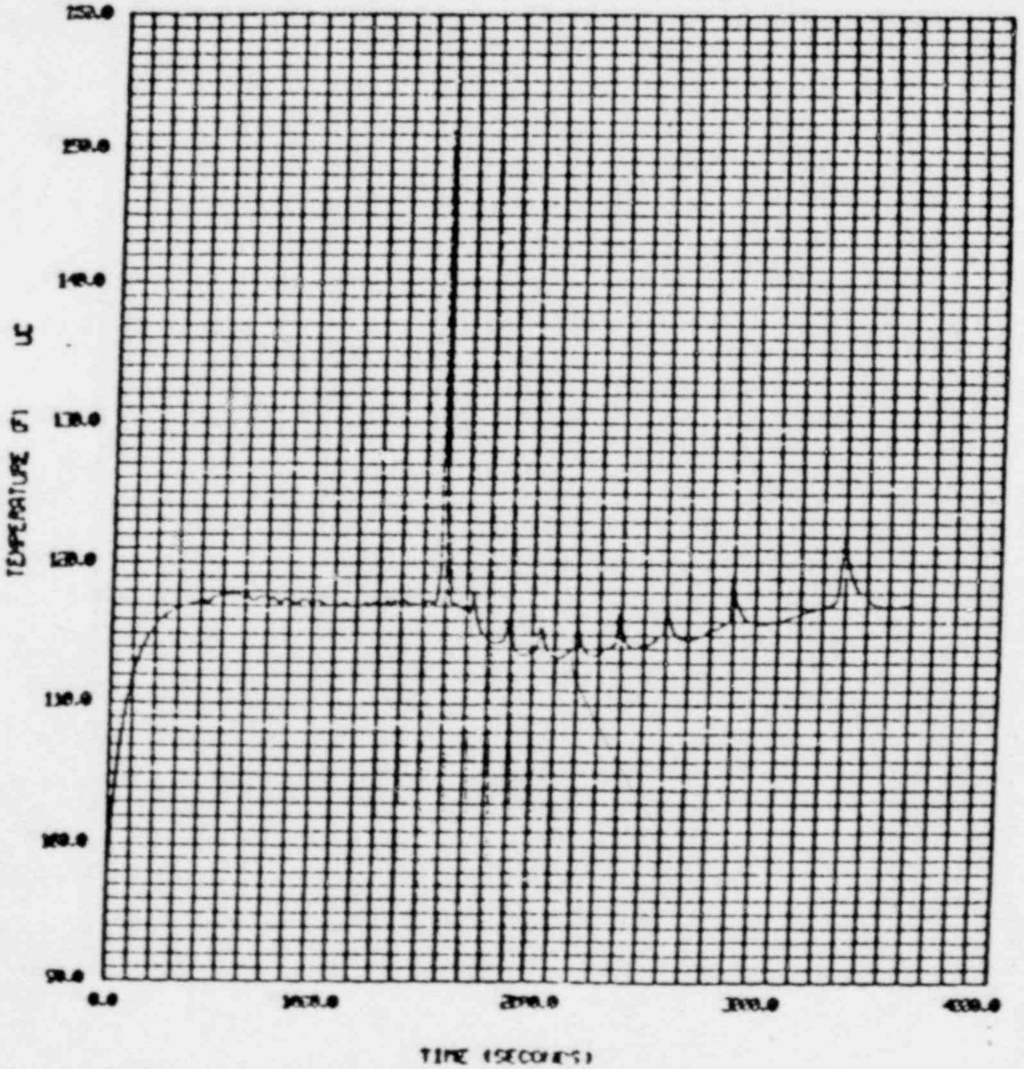
1. VENT FROM UPPER COMPARTMENT
2. ICE CONDENSER
3. RECIRCULATION FAN
4. DOORS - LOWER INLET AND INTERMEDIATE
5. INDIVIDUAL REPRESENTATION OF O_2, H_2, N_2 AND H_2O
6. SATURATED AND SUPER-HEATED STEAM
7. SPRAYS
8. H_2, N_2 AND HEAT ADDITIONS
9. BREAK FLOW
10. BURN CONTROL



TVA SGD CASE1 2 FAN 1 SPRAY BURN 100 PCT AT 10 V 0 GFPS T+3400 BASE1

READY-

FRAME 03



TVA 52D CASE1 2 FAN 1 SPRAY BURN 100 PCT AT 10 V 0 GFPS T+3480 BASE1

BURN CONTROL

1. v/o H_2 IGNITION
2. v/o H_2 PROPAGATION
3. o/o H_2 CONSUMED
4. v/o O_2 IGNITION
5. v/o O_2 SUPPORT COMBUSTION
6. PROPAGATION DELAY TIME
7. BURN TIME

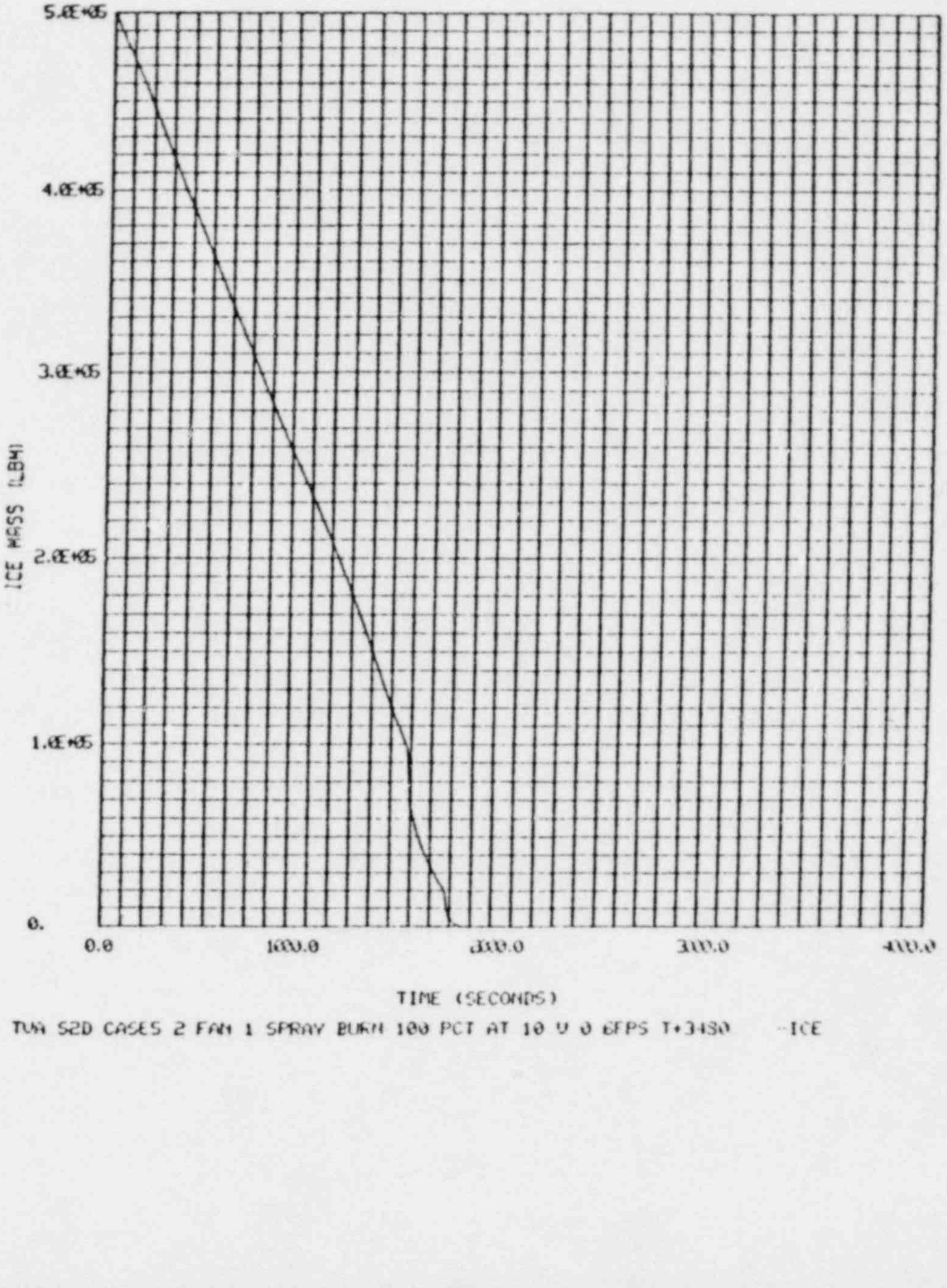
MARCH

- H_2O MASS RELEASE RATES
- H_2O ENERGY RELEASE RATES
- H_2 GENERATION RATES
- H_2 TEMPERATURES
- FISSION PRODUCT ENERGY RELEASE RATES

LOTIC

- SUBCOMPARTMENT VOLUMES
- SUBCOMPARTMENT TEMPERATURES
- SUBCOMPARTMENT PRESSURES: O_2
  - N_2
  - STEAM
- ICE MASS
- ICE HEAT TRANSFER AREA

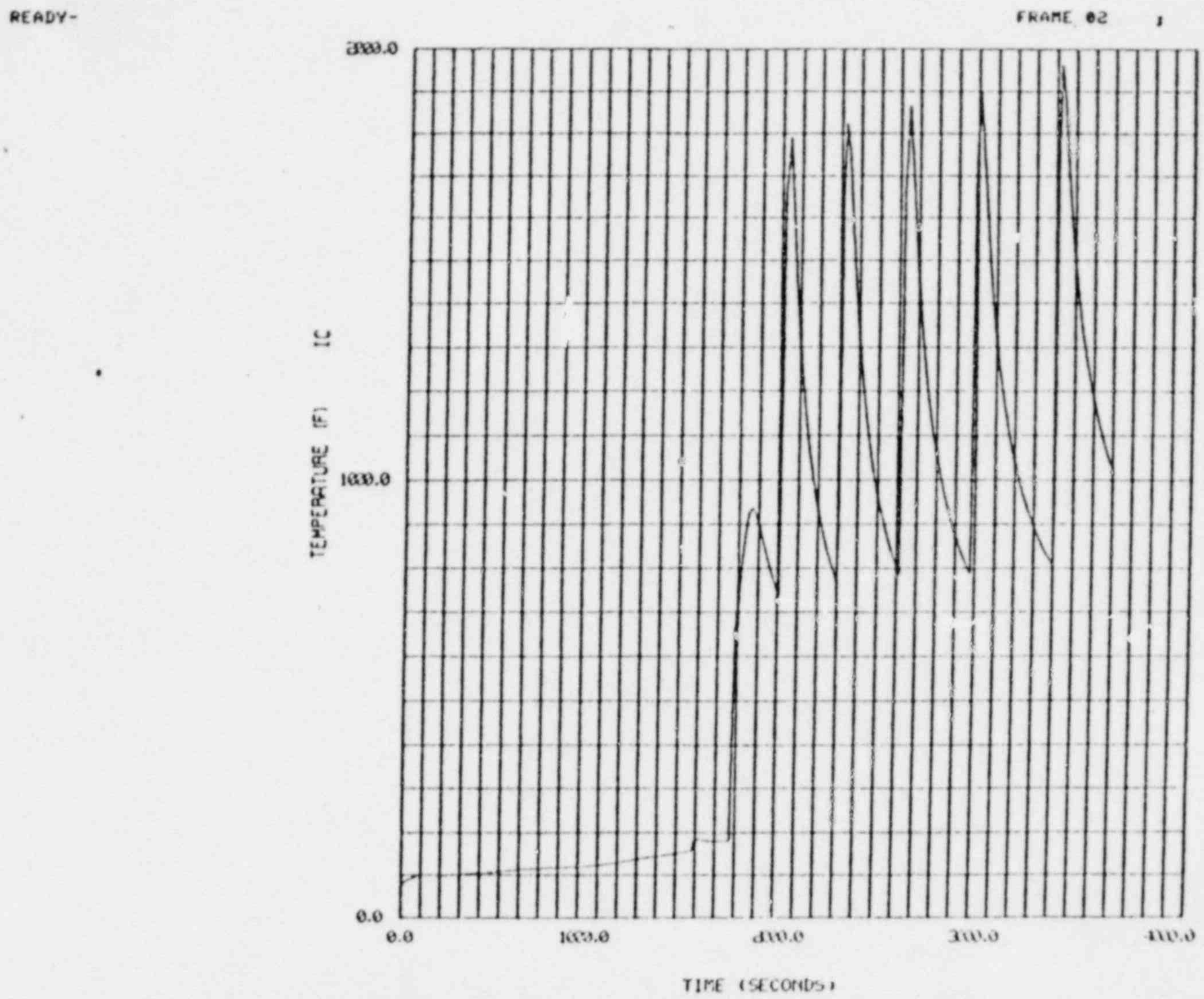
READY- FRAME 41 F.41



TVA S2D CASES 2 FAN 1 SPRAY BURN 100 PCT AT 10 V 0 6FPS T+3480 -ICE

READY-

TVA S2D CASES 2 FAN 1 SPRAY BURN 100 PCT AT 10 V 0 6FPS T+3480 -ICE



TVA S2D CASES 2 FAN 1 SPRAY BURN 100 PCT AT 10 V O G/PS T+3450 -ICE

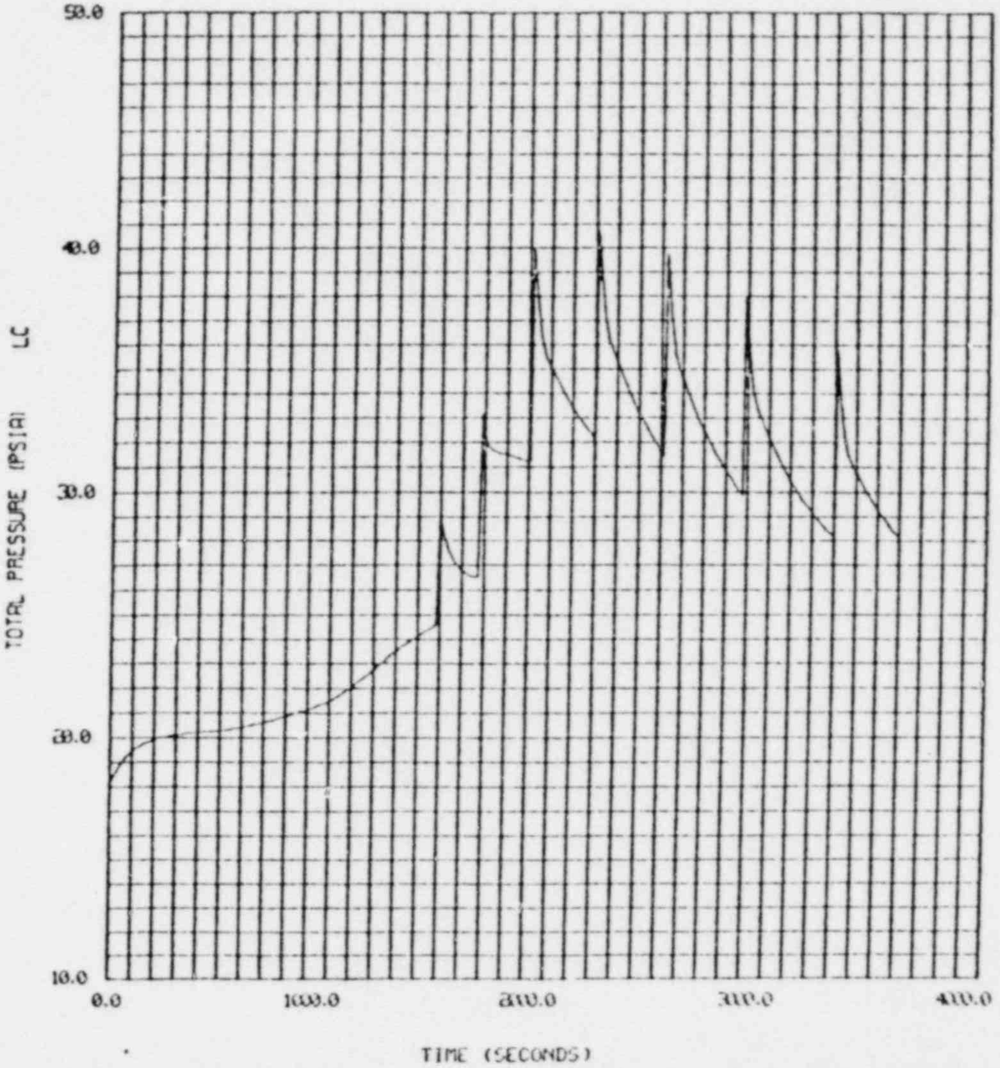
READY-

FRAME 03

TVA S2D CASES 2 FAN 1 SPRAY BURN 100 PCT AT 10 V 0 EFPS T+3480 -ICE

READY-

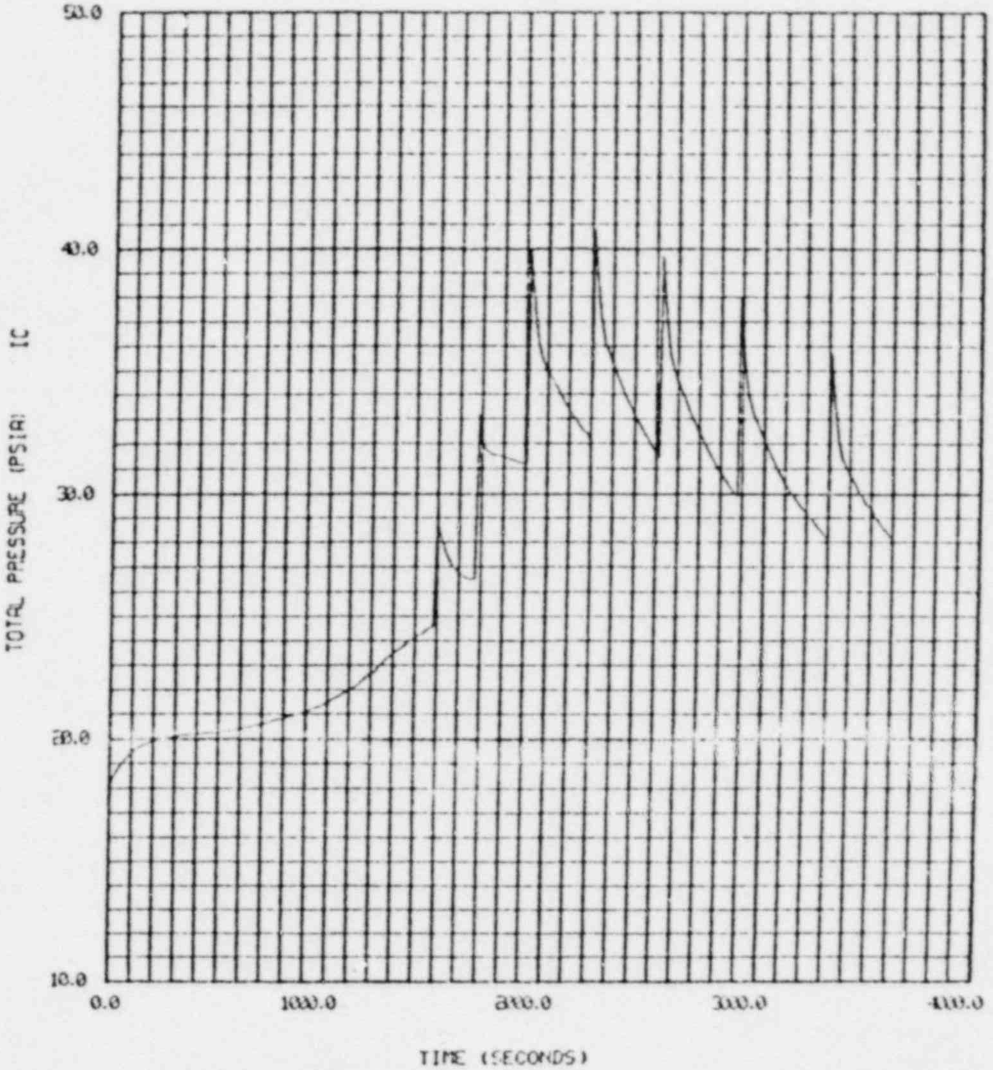
FRAME 05 F,5



TVA S2D CASES 2 FAN 1 SPRAY BURN 100 PCT AT 10 V 0 6FPS T+3480 -ICE

READY-

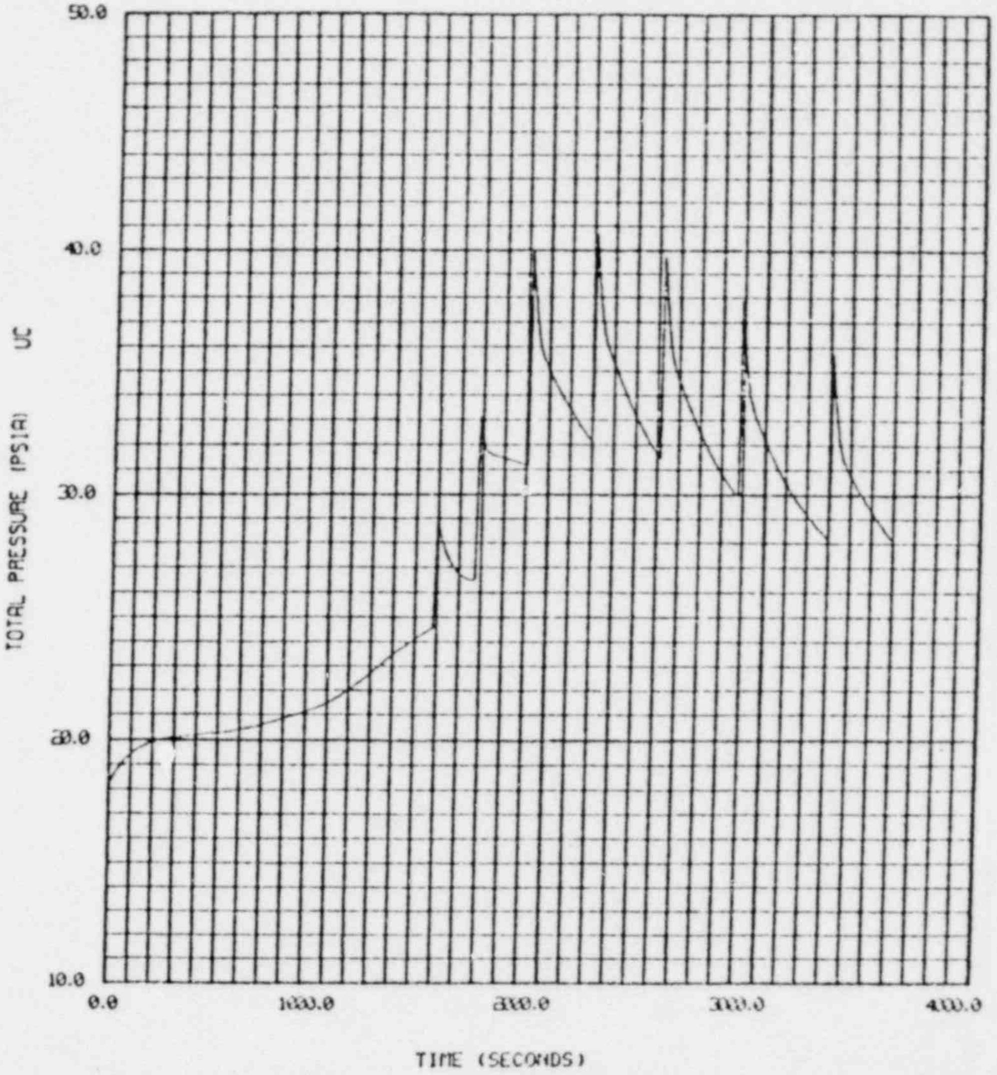
FRAME 06 F.6



TVA 52D CASES 2 FAN 1 SPRAY BURN 100 PCT AT 10 V 0 6FPS T+3480 -ICE

READY-

FRAME 07



TVA S2D CASES 2 FAN 1 SPRAY BURN 100 PCT AT 10 V 0 6FPS T+3480 -ICE