52-001

GE Nuclear Energy

ABWR

Date 5-22-92

To CHANG-YANG LI / Fax No. UCS-02
CHET POSLUSNY

This page plus 17 page(s)

From UMESH C. SAXENA Mail Code
175 Curtner Avenue
San Jose, CA 95125

Phone (408) 925-6579 FAX (408) 925-1193
or (408) 925-1687

Subject STATUS/RESPONSE TO OPEN ITEMS

Message ATTACHMENT A PROVIDES STATUS/ RESPONSE TO OPEN ITEMS WHICH WERE IDENTIFIED AND DISCUSSED IN GE/NRC MEETING, 5/6/92.

BEST REGARDS.

9206290282 920522
PDR ADOCK 05200001
A PDR

D050
1/1

(1/17)

ATTACHMENT A

GE Response to DSER Questions
Identified and Discussed in May 6, 1992 GE/NRC Meetings

ISSUE:

GE has not provided a detailed description of how the ABWR drywell volumes and the unique vent system are modeled in the code and how air carryover from the drywell volumes to the wetwell is treated in the code. What is the difference, if any, between the hydrostatic force due to venting between the Mark III and ABWR designs.

RESPONSE:

ABWR Vent System Configuration

In the ABWR design, as described in SAR, the cylindrical RPV pedestal which is connected rigidly to the diaphragm floor separates the lower drywell from the wetwell, as shown in Figure 1. The pedestal is a prefabricated steel structure filled with concrete after erection. Ten drywell connecting vents (DCVs) are built into the RPV pedestal and connect the UD and LD. The DCVs are extended downward via 1.2M inside diameter steel pipes, each of which has three horizontal 0.7M diameter vent outlets into the suppression pool.

The drywell-to-wetwell connecting vent system features in the ABWR design are similar to the Mark III vent system features, as shown in Figure 2. The diameter, length, and vertical spacing of horizontal vents are same as that in Mark III design. Vertical vents total area in ABWR corresponds to vent annulus area in Mark III. Horizontal vents and vertical vents total area ratio in ABWR is comparable with the horizontal vents and vent annulus total area ratio in Mark III.

(4/17)

Hydraulic diameter of vent annulus area in Mark III is comparable with the vertical vents diameter in ABWR.

In view of vent system configuration similarity between ABWR and Mark III, it is expected that vent clearing process in the ABWR design will be hydrodynamically similar to that observed for the Mark III design. Vent clearing process for the Mark III vent system design has been well investigated through extensive test programs and analytical studies performed by GE over a number of years, and this phenomenon is now well understood.

In view of geometrically similar ABWR and Mark III vent systems, both ABWR and Mark III are expected to be subjected to quite similar hydrostatic pressure loading conditions (on the structure housing the vent system) due to venting. However, considering that the ABWR vent system is well encased inside the RPV pedestal (see Figure 1), pressure loading on the overall vent system due to venting should be of no significant structure concern. The portion of horizontal vent extending into the pool, in the ABWR design, is designed for structural adequacy against pressure loading conditions due to venting

Containment Pressure/Temperature Response to LOCA

ABWR containment pressure and temperature transient following a loss-of-coolant accident (LOCA) were determined using approved analytical methods (described in NEDO-20533). These analytical methods, which have been developed based on extensive horizontal vent test data, describe the pressure/temperature transient and the attendant containment system inventories due to a primary system pipe rupture. Therefore, these analytical methods are considered to be appropriate for modeling and analyzing ABWR containment pressure/temperature response due to LOCA. Presence of discrete vertical vents connecting to horizontal vents in ABWR, compared to

3/17

vent annulus connecting to horizontal vents in Mark III, is not expected to produce vent clearing process significantly different than that expected for Mark III. Slight geometrical differences, if any, are expected to produce second order or negligible effects on the overall vent clearing process. Furthermore, given that for the ABWR design the containment peak pressure occurs substantially later in time after the vent clearing process is complete, as seen in Figure 3, any slight geometrical differences should be of no practical significance.

These analytical methods permit modeling multi-node drywell feature of the ABWR design. However, for conservatism, the drywell in SAR calculations was modeled as a single node representing upper drywell volume plus 50% of the lower drywell volume. This credit for transfer of 50% of the lower drywell contents into the wetwell is considered to be a conservative approach. Because of the ABWR unique containment configuration feature of separate upper and lower drywells, the inert atmosphere in the lower drywell would not transfer to the wetwell airspace region until the peak pressure in the drywell is achieved. Because the lower drywell is connected to the upper drywell via connecting vents, no gas can escape from the lower drywell until the peak pressure in the drywell is attained. For this situation lower drywell can be compared to a bottle whose opening is exposed to an atmosphere with increasing pressure.

In order to confirm conservatism in the single-node drywell modeling approach as employed in SAR calculations, containment pressure transient calculations were done modeling upper drywell and lower drywell as separate nodes, using the same analytical methods as that used for SAR calculations. The calculated drywell pressure response due to a feedwater line break modeling upper drywell and lower drywell as separate nodes is shown in Figure 4. When compared with the SAR single-node model results (shown in Figure 3), it is evident that the simplified single-node model (UD plus 50% of LD) approach used in SAR

calculations produces conservative containment response.

ISSUE:

Provide detailed information on the vacuum breakers.

How can we verify that the vacuum breakers and containment will perform as predicted following a LOCA?

RESPONSE:

The ABWR containment design requires provision of a total of eight (20-inch) vacuum breakers, which includes one valve for single failure (valve fail to open) criterion. These vacuum breakers are intended to be simple swing check type valves, similar to that used on earlier BWR plants. These valves will open passively due to a negative differential pressure (WW airspace greater than the DW pressure) across the valve disk and close by gravity, thus requiring no external power to actuate them. Consistent with the vacuum breaker sizing analysis assumptions, vacuum breaker valve will be required to start opening at a negative pressure differential of 0.1 psi and fully open at a negative pressure differential of 0.5 psia. Figure 5 shows key features of a typical simple swing check type valve.

Vacuum breaker valves are installed horizontally locating in WW airspace, one valve per penetration (through pedestal wall) opening into lower drywell. Position locations of these valves, both axially and azimuthally, are identified in Figures 1.2-3C and 1.2-13K in SAR, Amendment 6, and they are reproduced here in Figures 6 and 7. The vertical position location of these valves precludes them from being subjected to direct pool swell impact loading (valves position well above expected maximum pool swell height. Also, appropriate design

features (shield etc.,) protecting these valves from possible froth impact loading condition will be provided.

Consistent with the requirements defined for earlier BWR designs, ABWR design will require periodic inspection and testing of vacuum breakers during plant outage, in order to assure that they will perform as intended when challenged to actuate during a given drywell depressurization event. Valve disk will be manually tested for its freedom to move and functionality. Also, vacuum breakers will be equipped with position switches facilitating monitoring of valve open/close position inside the control room.

ISSUE:

Resolve the discrepancies between the drywell and wetwell pressure and temperature plots at various break sizes and peak values shown in Table 6.2-1 of SAR.

RESPONSE:

Drywell and wetwell pressure/temperature plots in SAR which correspond to the peak values shown in Table 6.2-1 of SAR are identified below.

	Design Parameter	Design Value	Calculated Value	Reference Figure*
1.	Drywell pressure	45 psig	39 psig	Figure 6.2-6
2.	Drywell temp.	340°F	338°F	Figure 6.2-13
3.	Wetwell pressure	45 psig	26 psig	Figure 6.2-6

(6/17)

4.	Wetwell temp.	219°F	207°F	Figure 6.2-8
5.	Drywell-to-Wetwell differ. pressure	(+) 25 psid	(+) 16 psid	Figure 6.2-6
		(-) 2	(-) 1.5	Figure 6.2-17

(*: Figures correspond to those in SAR)

ISSUE:

Provide additional information concerning the subcompartment analysis (This information has been provided and is being reviewed)

In May 6, 1992 meeting, GE identified and described analytical methods and assumptions used in performing the SAR subcompartment analysis, and NRC identified and described a couple of inconsistencies observed in the subcompartment analysis results presented in SAR. In conclusion, GE agreed to

1. make available mass and energy blowdown data used in the subcompartment analysis to NRC;

2. check SAR analysis input data and calculation results, and explain and clarify the inconsistencies observed by NRC;

3. provide a detailed description of computer program used for the subcompartment pressurization analysis; and

4. address SRP requirement for a 40% design margin in the calculated peak pressure values.

RESPONSE:

(7/17)

The following paragraphs provide status and response to the items identified as above.

1. Blowdown Data

Mass and energy blowdown data for all break cases which were considered and analyzed in the SAR subcompartment analyses were made available to NRC (Chang-Yang Li/Chet Poslusny), faxed on May 11, 1992.

2. SAR Results

In 5/19/92 GE/NRC phone call, GE explained the SAR input data, assumptions and results, noted that the SAR results are consistent with the analysis input data, assumptions and interconnection paths among subcompartment nodes. GE explained and provided clarification for the inconsistencies identified by NRC in 5/6/92 meetings. NRC understood GE explanation and clarification of the SAR analysis results.

3. Subcompartment Analysis Method

The following paragraphs provide a description of GE engineer computer program, Subcompartment Analysis Method (SCAM), which was used in performing the subcompartment pressurization analyses presented in SAR. Subcompartment pressurization analyses for Mark III standard plant were based on SCAM. This computer program, SCAM, has been checked out against NRC specified 13 subcompartment standard problems, and overall SCAM meets the criteria for subcompartment analysis set forth by the NRC.

SCAM is a transient, thermal-hydraulic digital computer program for use in calculating thermodynamic conditions in containment subcompartments after a loss-of-coolant accident. This program

(8/17)

permits calculation of multiple node cases with user-defined flow paths between nodes, a self-choking compressible flow model, and modeling of momentum effects in inter-compartmental flow at the beginning of the problem.

SCAM integrates mass and energy for each of the flow components in each subcompartment through each time step. These are known at each time step and are used to determine the temperature and pressure of each subcompartment as a function of time. The transient thermodynamic model is given the mass and energy present in each compartment and required outputs are the temperature and pressure of each compartment. Liquid is treated as a separate thermodynamic system in SCAM, and flow of liquid between subcompartments is proportional to entrained volume. The flow model used in SCAM for inter-compartmental flow is same vent flow model as that used in GE M3CPT computer code. Extensive verification of the model with experimental results has been conducted, as described in document NEDO-20533.

The key assumptions embedded in the code are:

a. No heat transfer is calculated between the flowing components and the subcompartment walls.

b. Homogeneous mixing of air and water vapor is assumed in the subcompartments and in the flow paths.

c. No gravitational potential energy is included in the flow energy equation.

d. Initial compartment components are assumed to be air and water vapor.

e. Air is treated as an ideal gas.

9/1-1

4. 40% Margin

As noted in 5/19/92 phone call, SAR analysis results will reflect 40% design margin in calculated values, consistent with SRP requirements.

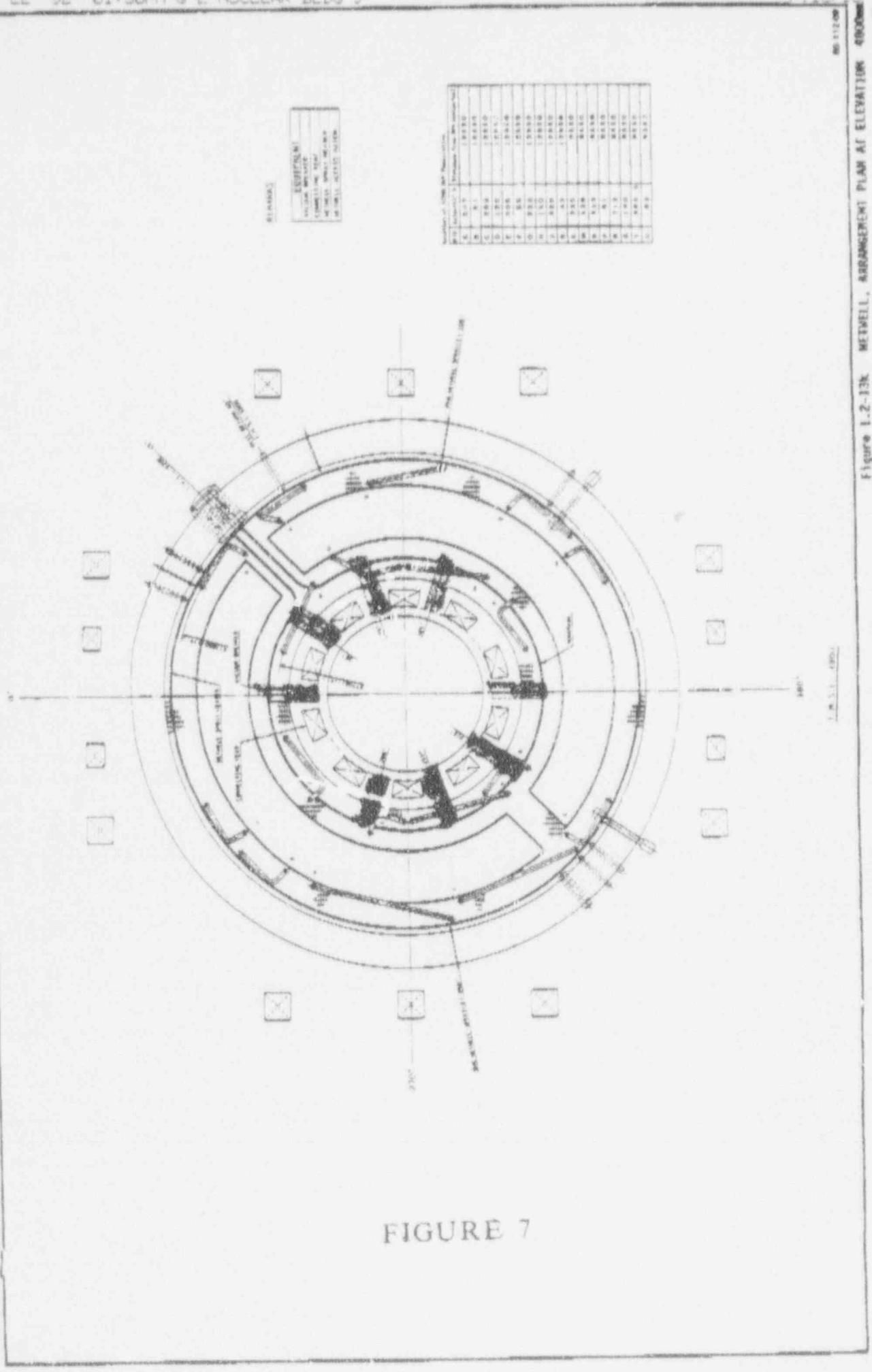


Figure 1.2-13k REACTOR BUILDING, ARRANGEMENT PLAN AT ELEVATION 4000mm

ABWR
Standard Plant

FIGURE 7

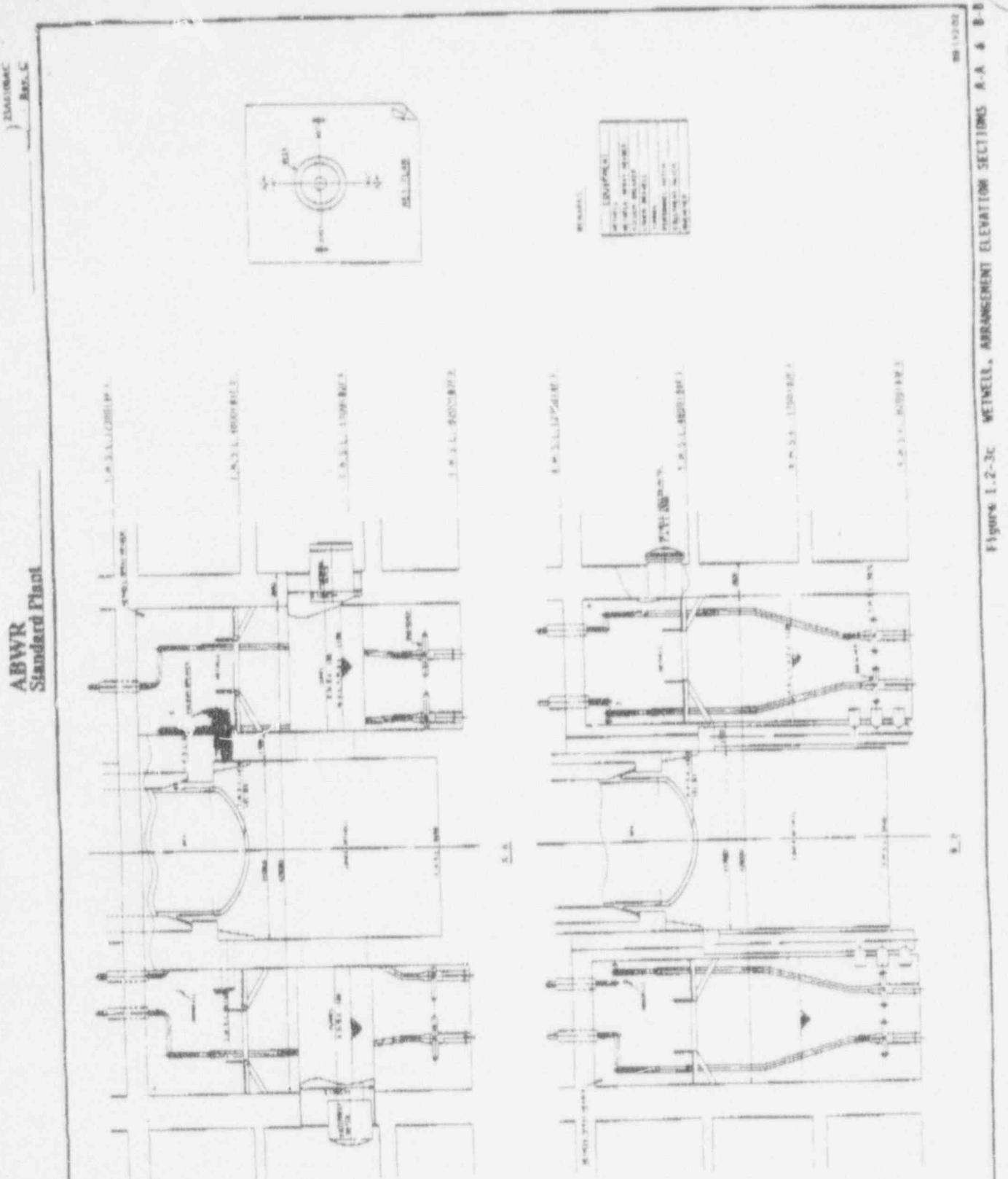
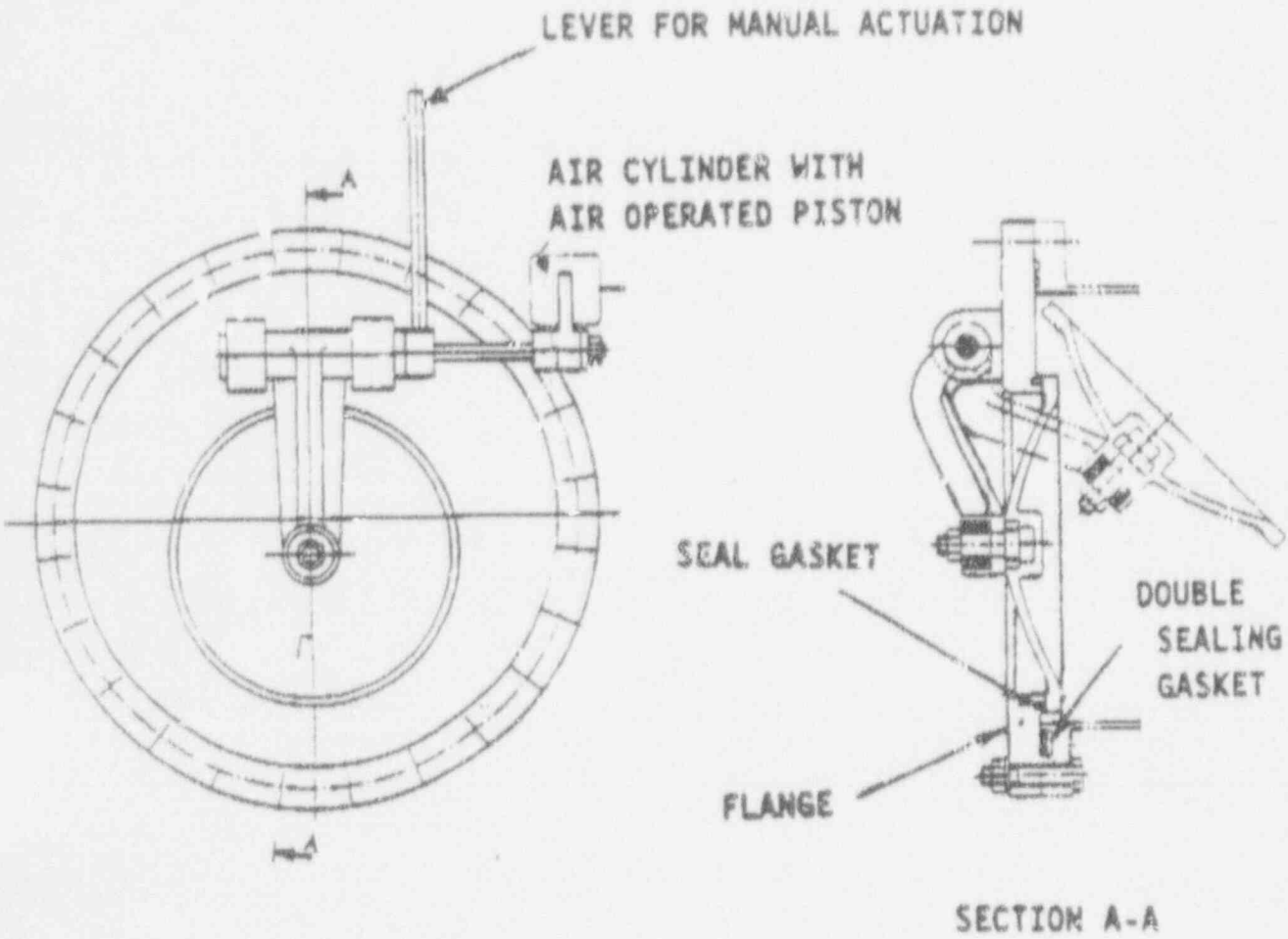

ABWR
Standard Plant
Figure 1.2-3c WETWELL, ARRANGEMENT ELEVATION SECTIONS A-A & B-B

FIGURE 6

(15/17)



SWING CHECK VALVE - TYPICAL

FIGURE 5

14/17

PRIMARY CONTAINMENT PRESSURE RESPONSE FEEDWATER LINE BREAK (TWO-NODE DRYWELL MODEL)

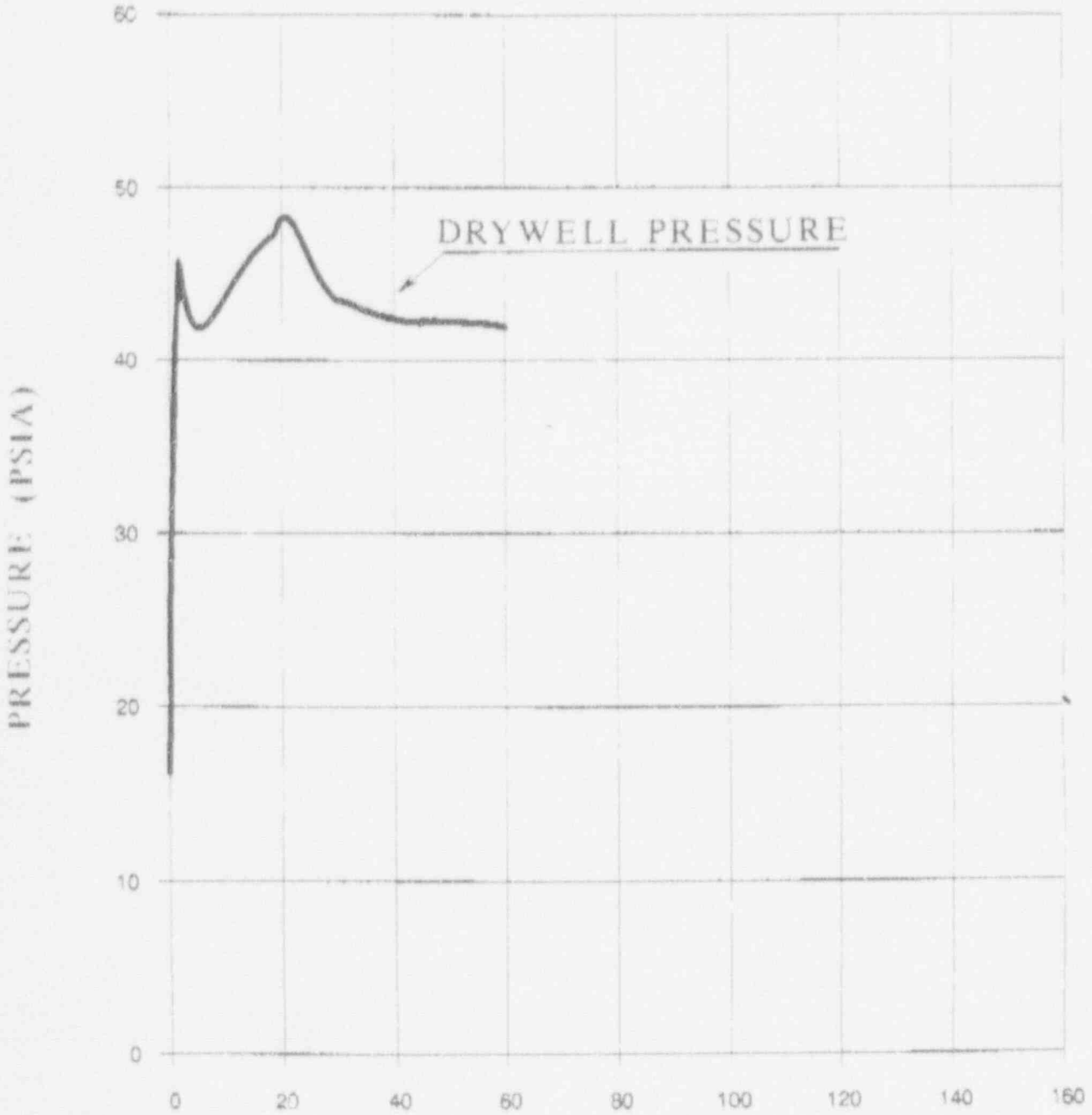


FIGURE 4

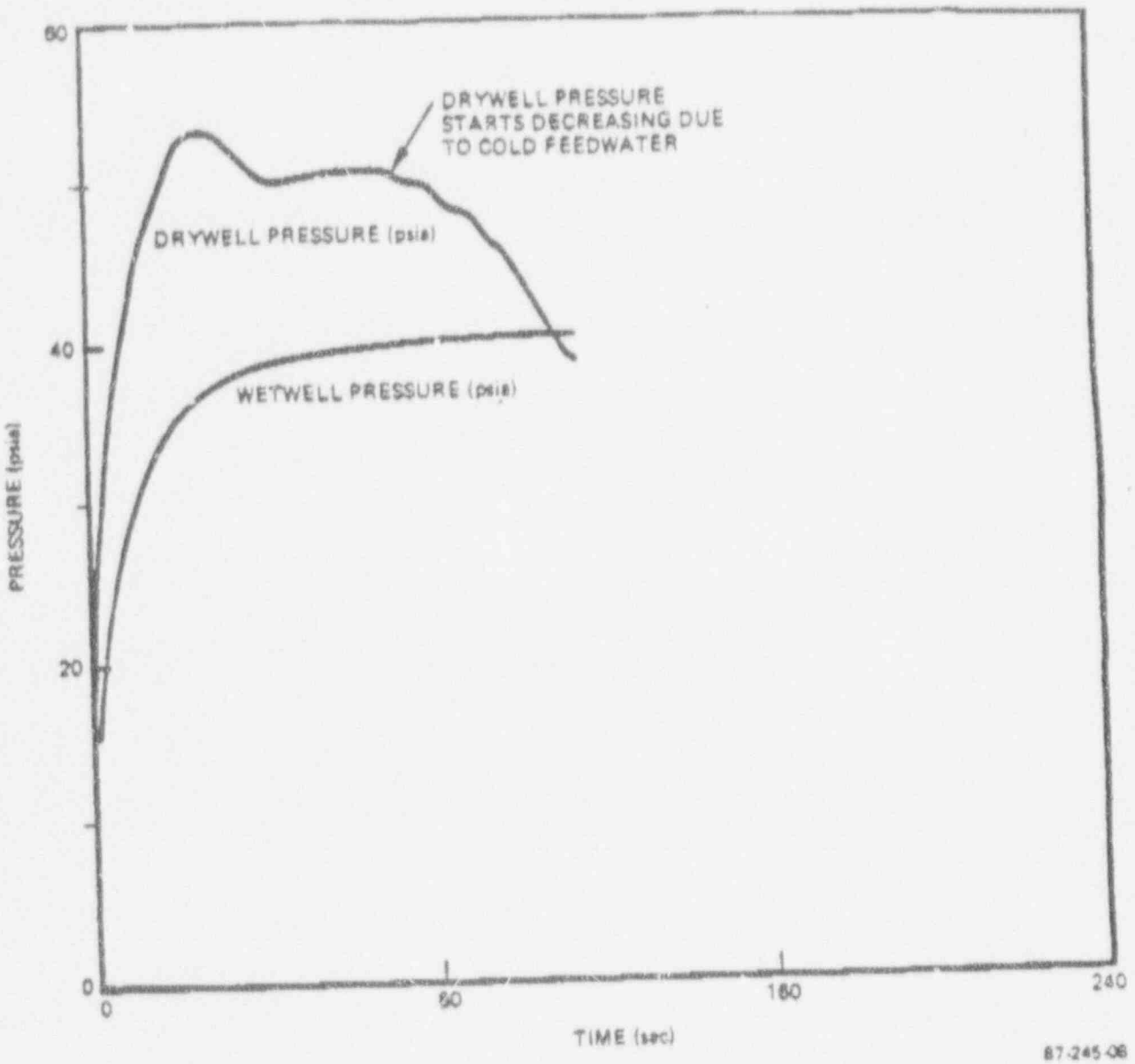
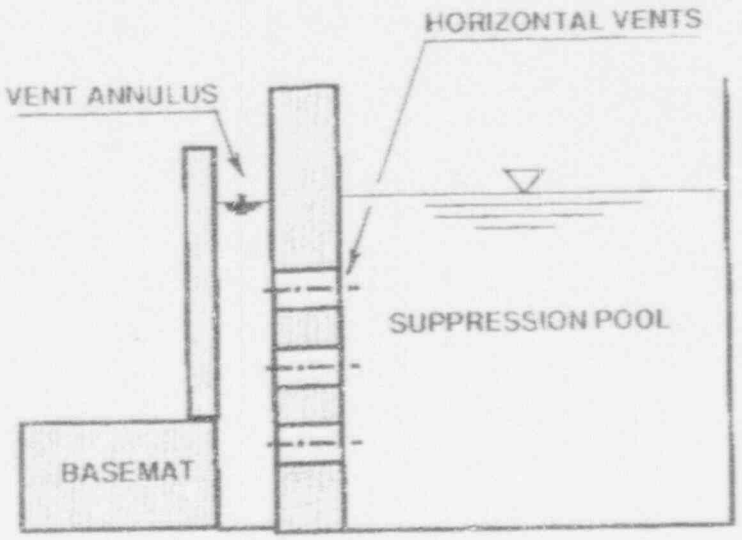


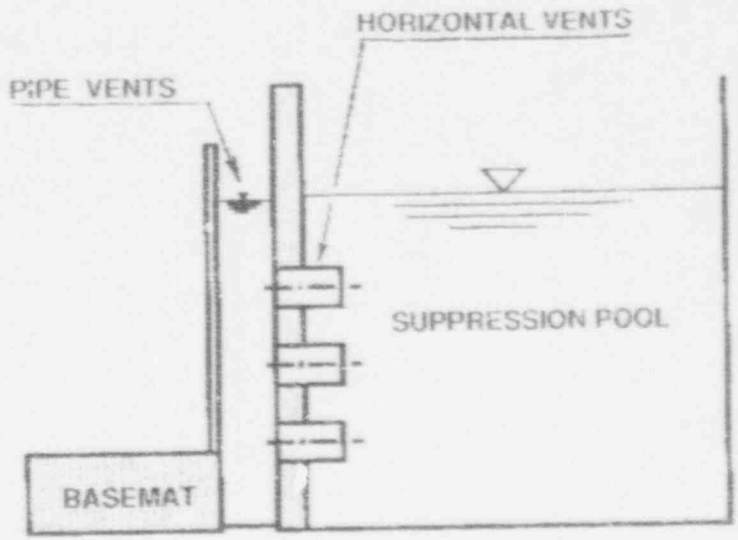
Figure 6.2–6 PRESSURE RESPONSE OF THE PRIMARY CONTAINMENT FOR FEEDWATER LINE BREAK

FIGURE 3



MARK III CONFIGURATION

ANNULUS AREA	= 44.8	SQ. METERS
HORIZONTAL VENTS AREA	= 45.92	SQ. METERS
HORIZONTAL VENTS/ ANNULUS AREA	= 1.025	SQ. METERS
HORIZONTAL VENT LENGTH	= 1.524	METER
ANNULUS HYDRAULIC DIAMETER	= 1.32	METER



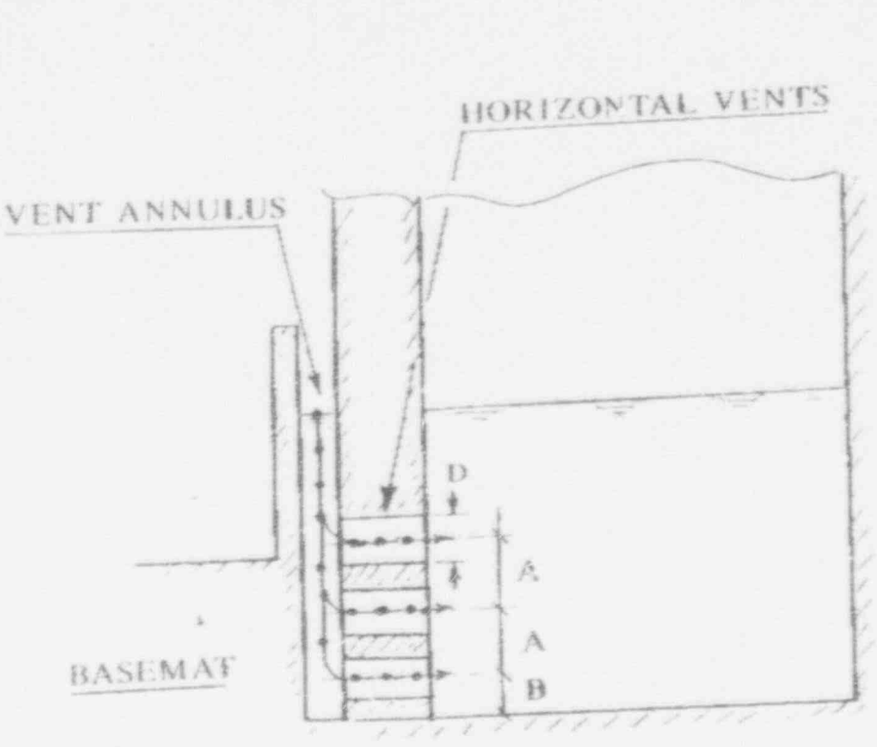
ABWR CONFIGURATION

VERTICAL VENTS AREA	= 11.31	SQ. METERS
HORIZONTAL VENTS AREA	= 11.454	SQ. METERS
HORIZONTAL VENTS/ VERTICAL VENTS AREA	= 1.021	SQ. METERS
HORIZONTAL VENT LENGTH	= 1.524	METER
VERTICAL VENT HYDRAULIC DIAMETER	= 1.2	METER

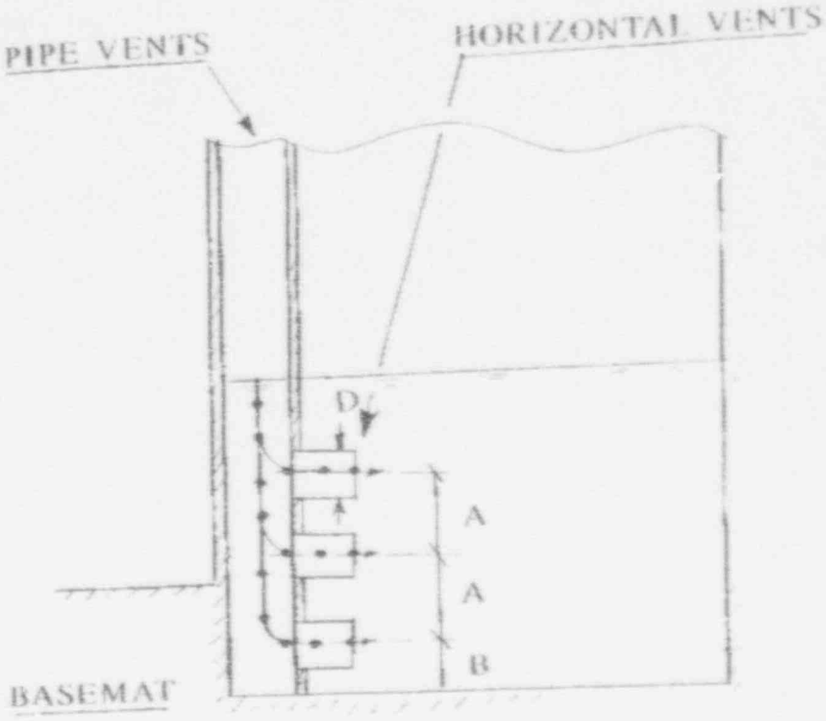
FIGURE 2

VENT GEOMETRICAL CONFIGURATION - - MARKIII AND ABWR DESIGNS

MAY 22 '92 01:28PM G E NUCLEAR BLDG 1 P.13/18



MARK III CONFIGURATION



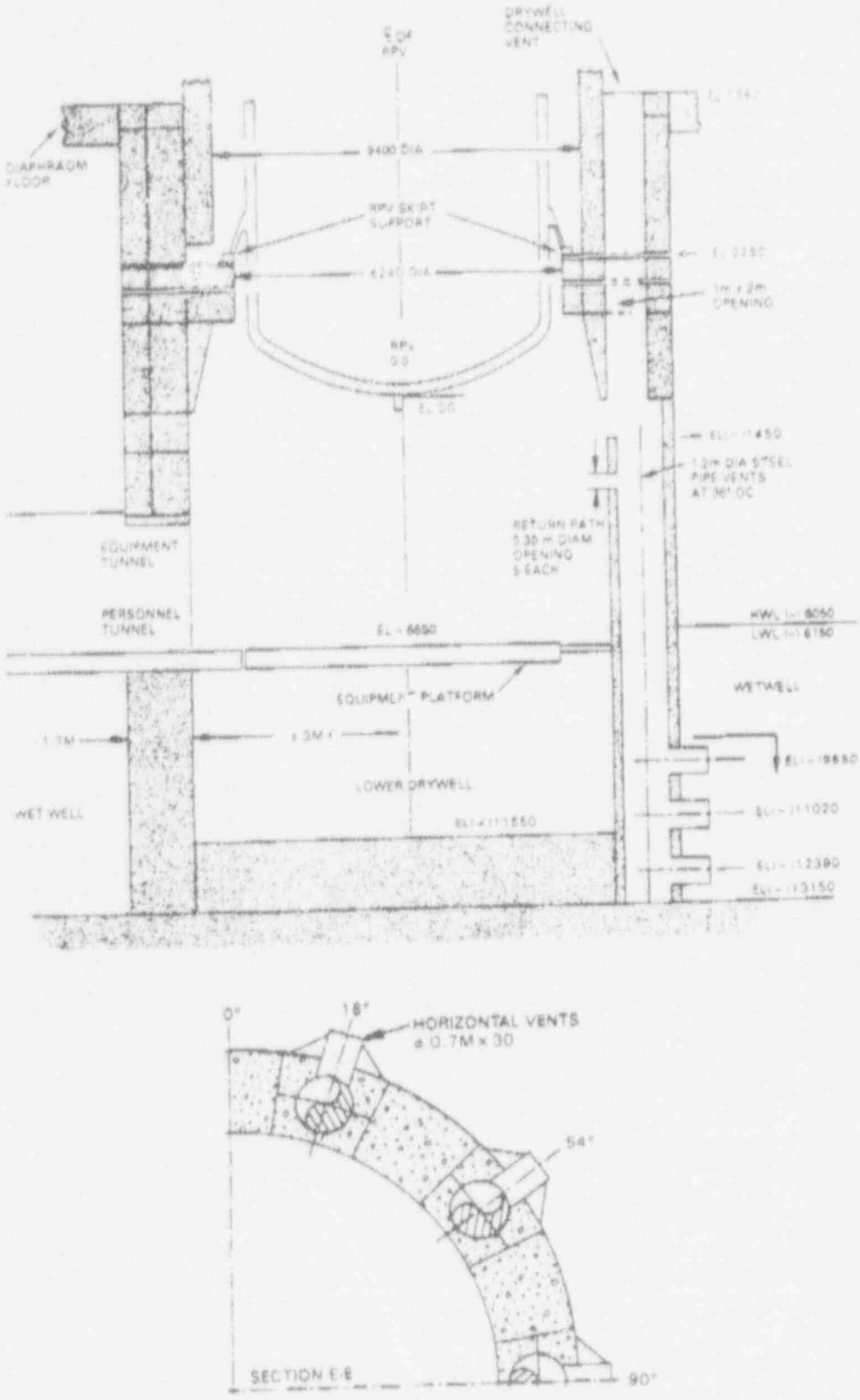
ABWR CONFIGURATION

A = 1.37 M; B = 0.76 M; D = 0.7 M

FIGURE 1a: ABWR AND MARK III VENT SYSTEM CONFIGURATION

MAY 22 '92 01:28PM G E NUCLEAR BLDG 1 P.12/18

10/17



RPV Pedestal
Note: Dimensions are in millimeters unless noted.
Elevations relative to RPV invert EL. 0.0.

FIGURE 1