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DCP/NRC1232
NSD-NRC-98-5543
Docket No.: 52-003

January 28, 1998

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: T. R. QUAY

SUBJECT: AP600 RESPONSE TO FSER OPEN ITEMS

Dear Mr. Quay:

Enclosure 1 of this letter provides the Westinghouse responses to FSER open items on the AP600. A summary of the enclosed responses is provided in Table 1. Included in the table is the FSER open item number, the associated OITS number, and the status to be designated in the Westinghouse status column of OITS.

The NRC should review the enclosures and inform Westinghouse of the status to be designated in the "NRC Status" column of OITS.

Please contact me on (412) 374-4334 if you have any questions concerning this transmittal.

Cynthia L Haag for BAM

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

jml

Enclosure

cc: W. C. Huffman, NRC (Enclosure)
T. J. Kenyon, NRC (Enclosure)
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Table 1 List of FSER Open Items Included in Letter DCP/NRC1232		
FSER Open Item	**OITS Number**	**Westinghouse status in OITS**
220.125F (R2)	6312	Confirm W
230.146F	6505	Confirm W
280.32F	6498	Confirm W
410.339F (R1)	6194	Confirm W
480.873 (R1)	4915	Action N
650.11F (R1)	5973	Action N
720.440F (R1)	6178	Confirm W
720.441F (R1)	6179	Action N

Enclosure to Westinghouse
Letter DCP/NRC1232

January 28, 1998

AP600

| **Open Item 220.125F** (OITS #6312) Response Revision 2

Because a massive amount of water is to be contained in the PCCWS tank, the staff raised a concern that the COL applicant should monitor the vertical and radial deformation of the tank during initial filling, and compare the measured values with the tank deformation predicted by calculation. The staff identified this issue as Open Item 3.8.4.4-3 and COL Action Item 3.8.4.4-1.

At the meeting on June 12 through 16, 1995, Westinghouse stated that the water weight is small, in comparison with the total weight of the shield building roof structure (estimated to be about 10 percent). Westinghouse also showed that the deflection of the roof structure resulting from the first fill of water should be negligible. On that basis, Westinghouse contended that there is no need to monitor the tank deflections and compare the deflections against predictions.

During the meeting on December 9 through 13, 1996, Westinghouse repeated its justification concerning this issue. However, the staff did not agree with Westinghouse's basis for not monitoring the vertical and radial deformation of the tank during initial tank filling. Moreover, the staff asserted that post-construction testing is necessary to confirm the adequacy of the PCCWS tank. This is because the staff's review experience suggest that the excessive deformation resulting from the massive amount of water may cause cracking of the tank wall and base slab, as well as water leakage from reinforced concrete tanks with steel liners.

In Revision 17 of SSAR Section 3.8.4.1.1, Westinghouse added a statement that leak chase channels are provided over the liner welds to permit monitoring for leakage and to prevent degradation of the reinforced concrete wall which might result from the freezing and thawing of leakage. Also, Westinghouse indicated that the exterior face of the reinforced concrete boundary of the PCCWS tank is designed to control cracking, in accordance with Paragraph 10.6.4 of ACI-349, with reinforcement steel stress based on sustained loads (including thermal effects). However, Westinghouse still did not commit to monitor the vertical and radial deformation of the tank during initial filling and compare the measured values with the tank deformation predicted by analysis. On the basis of the above discussion, the staff concluded that Westinghouse's response to the staff's concern (as stated in Revision 17 of SSAR Section 3.8.4.1.1) is not acceptable. Therefore, Open Item 3.8.4.4-3 and COL Action Item 3.8.4.4-1 remain unsolved.

| **Response (Revision 2):**

The SSAR is revised below to show monitoring of the tank during initial filling. Requirements for visual [illegible]mination are given. The calculated deflections of the roof structure due to the first fill of water [illegible]ss than one quarter of an inch. Monitoring of tank deflections and comparison against predic[illegible] is difficult because of the small magnitude of the deflections due to the water inventory. Vertical deflections could also be caused by thermal changes. The vertical deflection will be measured during tank fill and will be compared to the predicted magnitude. This will be used in combination with the visual examination to confirm acceptability.

SSAR Revision:

SSAR changes included in Response Revision 2 include a sentence added to address monitoring of structures during operation. This was added in response to discussion with NRC staff.

Revise subsection 3.8.4.7 as follows:

3.8.4.7 Testing and In-Service Inspection Requirements

Structures supporting the passive containment cooling water storage tank on the shield building roof will be examined before and after first filling of the tank.

- The boundaries of the passive containment cooling water storage tank and the tension ring of the shield building roof will be inspected visually for ~~any signs of leakage or distress~~ excessive concrete cracking before and after first filling of the tank. Any significant concrete cracking will be documented and evaluated in accordance with ACI 349.3R-96 (reference 50).

- The vertical elevation of the passive containment cooling water storage tank relative to the top of the shield building cylindrical wall at the tension ring will be measured before and after first filling. The change in relative elevation will be compared against the predicted deflection.

- A report will be prepared summarizing the test and evaluating the results.

There are no other in-service testing or inspection requirements for the seismic Category I structures. However, during the operation of the plant the condition of these structures should be monitored by the Combined License applicant to provide reasonable confidence that the structures are capable of fulfilling their intended functions.

Revise subsection 3.8.6 as follows. This includes revision shown in response to Open Item 220.119.

3.8.6 Combined License Information

~~This section has no requirement for additional information to be provided in support of the Combined License application.~~

3.8.6.1 Containment Vessel Design Adjacent to Large Penetrations

The final design of containment vessel elements (reinforcement) adjacent to concentrated masses (penetrations) is completed by the Combined License applicant and documented in the ASME Code design report.

3.8.6.2 Passive Containment Cooling System Water Storage Tank Examination

The Combined License applicant should examine the structures supporting the passive containment cooling storage tank on the shield building roof during initial tank filling as described in subsection 3.8.4.7.

Add to references Subsection 3.8.7 the following:

50 ACI 349.3R-96, "Evaluation of Existing Nuclear Safety-Related Concrete Structures"

230.146F (OITS #6505)

10 CFR Part 50, Appendix S, Section III, requires that the integrity of the reactor coolant pressure boundary be maintained following a safe shutdown earthquake (SSE). The staff is concerned that the CVS piping is non-seismic and, consequently, its integrity cannot be assured following an SSF. The staff believes that the CVS piping should be designed to withstand an SSE without failure. Westinghouse should commit that the CVS system within containment will be designed, analyzed, and constructed to meet the seismic requirements of Seismic Category II structures, systems, and components (SSCs). The staff recognizes that ordinarily, for the CVS to be categorized as Seismic Category II, failure of the CVS SSCs would have to compromise the function of some AP600 safety related SSC. However, to assure the seismic integrity of the CVS, Westinghouse should commit to designing, analyzing, and constructing the portion of the CVS within containment to the same criteria as that used for Seismic Category II SSCs, and document this in both the SSAR and the Certified Design Material.

Response:

To address the concerns of the staff, a seismic evaluation will be performed for the non-seismic portion of the CVS system inside containment to provide for the seismic integrity and pressure boundary integrity of the corresponding piping designated as reactor coolant pressure boundary. Section 5.2.1.1 of the SSAR will be revised as indicated below to identify the specific criteria to be used for this evaluation. This criteria is based on Equation 9 of the ASME Code, Section III, Class 3.

Fabrication, examination, inspection, and testing requirements as defined in Chapters IV, V, VI and VII of the ASME B31.1 Code are applicable and will be used for the corresponding B31.1 (Piping Class D) CVS piping systems, valves, and equipment.

Section 2.3.2 of the AP600 Certified Design Material will be revised as indicated below to confirm that the seismic analysis has been performed and structural integrity maintained for the corresponding non-safety related CVS piping.

SSAR Revision:

Add the following to subsection 5.2.1.1:

Seismic Integrity of the CVS System Inside Containment

To provide for the seismic integrity and pressure boundary integrity of the non-safety related (B31.1, Piping Class D) CVS piping located inside containment and designated as reactor coolant pressure boundary, a seismic analysis will be performed and a CVS Seismic Analysis Report prepared with a faulted stress limit equal to the smaller of 4.5 S_h and 3.0 S_y and based on the following additional criteria :

Additional loading combinations and stress limits for nonsafety-related chemical and volume control system piping systems and components inside containment

Condition	Loading Combination[3]	Equations (ND3650)	Stress Limit
Level D	PMAX[1] + DW + SSE + SSES	9	Smaller of $4.5\ S_h$ or $3.0\ S_y$
	SSES	F_{AM}/A_M[4]	$1.0\ S_h$
	TNU + SSES	i (M1 + M2)/Z[2]	$3.0\ S_h$

Notes:

1. For earthquake loading, PMAX is equal to normal operating pressure at 100% power.

2. Where: M1 is range of moments for TNU, M2 is one half the range of SSES moments, M1 + M2 is larger of M1 plus one half the range of SSES, or full range of SSES.

3. See Table 3.9-3 for description of loads.

4. F_{AM} is amplitude of axial force for SSES; A_M is nominal pipe metal area.

Component supports, equipment, and structural steel frame are evaluated to demonstrate that they do not fail under seismic loads. Design methods and stress criteria are the same as for corresponding Seismic Category I components. The functionality of the chemical and volume control system does not have to be maintained to insure structural integrity of the components.

Fabrication, examination, inspection, and testing requirements as defined in Chapters IV, V, VI, and VII of the ASME B31.1 Code are applicable and used for the B31.1 (Piping Class D) CVS piping systems, valves, and equipment inside containment.

ITAAC Revision:

Section 2.3.2 Chemical and Volume Control System

Insert Item 15.

15. The non-safety related (B31.1, Piping Class D) piping located inside containment and designated as reactor coolant pressure boundary, as identified in Table 2.3.2-2, has been designed to withstand a seismic design basis event and maintain structural integrity.

ITAAC Revision:

Section 2.3.2 Chemical and Volume Control System

Insert Item 15.

15. The non-safety related (B31.1, Piping Class D) piping located inside containment and designated as reactor coolant pressure boundary, as identified in Table 2.3.2-2, has been designed to withstand a seismic design basis event and maintain structural integrity.

Table 2.3.2-2

Insert the following Line Numbers

Table 2.3.2-2		
Line Name	**Line Number**	**ASME Code Section III**
CVS Supply Line to Regenerative Heat Exchanger	BBD L002	No
CVS Return Line from Regenerative Heat Exchanger	BBD L018 BBD L073	No No
CVS Line from Regenerative Heat Exchanger to Letdown Heat Exchanger	BBD L003 BBD L072	No No
CVS Lines from Letdown Heat Exchanger to Demin. Tanks	BBD L004 BBD L005	No No
CVS Lines from Demin Tanks to RC Filters	BBD L020 BBD L021 BBD L022 BBD L029 BBD L037	No No No No No
CVS Lines from RC Filters to Regenerative Heat Exchanger	BBD L030 BBD L031 BBD L034	No No No No
CVS Resin Fill lines to Demin. Tanks	BBD L008 BBD L013 BBD L025	No No No

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
15. The non-safety related (B31.1, Class D) piping located inside containment and designated as reactor coolant pressure boundary, as identified in Table 2.3.2-2, has been designed to withstand a seismic design basis event and maintain structural integrity.	Inspection will be conducted of the as-built components as documented in the CVS Seismic Analysis Report.	The CVS Seismic Analysis Reports exist for the non-safety related (B31.1, Class D) piping located inside containment and designated as reactor coolant pressure boundary as identified in Table 2.3.2-2.

Open Item 280.32F (OITS #6498)

Fire Protection of Safe Shutdown and Cold Shutdown Capability - The NRC staff has developed the following criteria for the protection of safe and cold shutdown capability following a single fire in any fire area of the AP600:

Safe shutdown following a fire is defined for the AP600 as the ability to achieve and maintain the RCS temperature below 420 oF without venting of the primary coolant from the reactor coolant system (RCS). This is a departure from the criteria applied to the evolutionary plant designs, and the existing plants where safe shutdown for fires applies to both hot and cold shutdown capability. Cold shutdown for the AP600 is defined as the ability to achieve and maintain the RCS below 200 oF, consistent with the criteria applicable to the evolutionary designs and existing plants. The use of the non safety related normal shutdown systems and/or the safety related passive systems are acceptable to the staff to achieve and maintain safe shutdown following a fire. The safety related passive systems are considered an alternate shutdown method as described in Branch Technical Position (BTP) CMEB 9.5-1. Consistent with the fire protection criteria for the advanced light water reactors specified in SECY-90-16 and SECY-93-87, redundant divisions of these systems shall be separated such that a fire in any fire area outside of the containment or the main control room will not impair the plant's capability to achieve and maintain safe shutdown as defined above, assuming a loss of all equipment in the affected fire area. Consideration in the safe shutdown analysis upon personnel entry into the affected fire area to repair or operate equipment to achieve safe shutdown is prohibited as prescribed in SECY-90-16. Personnel entry into the affected fire area to repair or operate equipment necessary to achieve and maintain cold shutdown of the AP600 is acceptable, due to the unique capability of the AP600 to remain in safe shutdown using only passive systems for an extended period of time. The criteria concerning cold shutdown capability deviates from the criteria applied to the evolutionary reactor designs, but are consistent with the criteria applicable to existing plants. To enhance the survivability of the normal safe shutdown and cold shutdown capability in the event of a fire, and to reduce the reliance on the infrequently utilized safety-related passive systems, automatic suppression shall be provided in those fire areas outside containment where a fire could damage the normal shutdown capability, or result in a spurious operation of equipment that could result in a venting of the RCS. This criterion is unique to the AP600 and does not ensure that the normal shutdown capability will be free of fire damage or that the equipment necessary to achieve and maintain cold shutdown can be repaired within 72 hours. Due to the inability of the fire brigade to rapidly enter the AP600 containment in the event of a fire, and the potential for damage to safety related and normal shutdown equipment, in addition to potential spurious actuation(s) resulting in a venting of primary coolant from the RCS, the protection of circuits and equipment inside containment should be enhanced beyond the criteria specified in BTP CMEB 9.5.1 for existing plants consistent with the staff's technical position stated in Section 9.3 of NUREG-1242, "NRC Review of Electric Power Research Institute's Advanced Light Water Reactor Utility Requirements Document, Volume 3, Passive Plant Designs," published August 1994.

Several areas outside containment containing equipment and cables necessary to achieve and maintain safe and cold shutdown using the normal systems have not been provided with automatic suppression in accordance with the above criteria. Systems listed in Section 7.4.1.3 of the SSAR as necessary for normal shutdown that have not been provided with automatic suppression include the chemical and volume control system, chilled water system, control power, compressed air, instrumentation, and steam generator power operated relief valves.

Section 9A.2.7.1 of the SSAR states that manual throttling and closing of the first stage automatic depressurization (ADS) valve to reduce the RCS pressure to the operating pressure of the normal residual heat removal system (RNS) will be used. The use of the first stage ADS results in a venting of the RCS to the in containment refueling water storage tank (IRWST) in conflict with the fire protection criteria established for safe shutdown of the AP600. In a letter dated October 14, 1997, the applicant submitted its description of the AP600 response to a loss of offsite power with "realistic" assumptions using the LOFTRAN code. The loss of offsite power (LOOP) analysis is used as a surrogate for the plant response following a fire as it can cause similar failure modes as the LOOP. In the analysis the applicant states that after approximately 24 hours the RCS hot leg temperature is less than 420 oF and the pressurizer pressure is approximately 600 Pia. A RELAP5 analysis prepared by the Analytical Support Group, SASG-95-02, dated May 1995, indicates that after approximately 24 hours the RCS hot leg temperature will be approximately 430 oF and the pressurizer pressure is approximately 1600 psig. Both of these analyses are above the cut in point for RNS of approximately 350 oF and 400 psig.

Adequate fire protection of equipment and circuits located inside containment required for safe shutdown has not been provided by the applicant to provide reasonable assurance that one division will remain free of fire damage in accordance with the criteria specified above. Hose stations for manual suppression have been provided inside containment. However, due to the potential hazard associated with personnel entry into containment during a plant transient, the response of the plant fire brigade may be significantly delayed, therefore no credit for manual suppression of fires inside containment during power operations is considered acceptable by the staff. In fire zone 1100 AF 11300B the applicant has provided a manually actuated water spray system over the non safety related open cable trays in this zone. Both divisions of the passive residual heat exchanger (PRHR) control valves and PRHR flow transmitters are located in this zone in close proximity to each other. In addition, Divisions A and C of the IRWST level transmitters are located in this zone with the redundant IRWST level transmitters located in the adjacent fire zone 1100 AF 11300A. There is no fire barrier or automatic suppression separating zone 1100 AF 11300A from zone 1100 AF 11300B. The applicant has not provided reasonable assurance that the limited manual water spray system in zone 1100 AF 11300B will maintain one division of the normal or passive safe shutdown capability free of fire damage.

Based on the unresolved technical issues associated with the automatic suppression provided for equipment and circuits required for normal shutdown, capability to depressurize to the RNS cut in point without venting of the RCS, and the protection of safety related equipment and circuits located inside containment this item remains open.

Response:

This RAI contains several separate questions. One question is what nonsafety-related features should have automatic fire suppression. A second question is whether venting steam from the pressurizer is an acceptable method to depressurize the RCS following a fire. A third question is the adequacy of protection of safety-related equipment and circuits inside containment

1. **Which Nonsafety-Related Features Should Have Automatic Fire Suppression**

   The NRC criteria stated in this RAI is, "*To enhance the survivability of the normal safe shutdown and cold shutdown capability in the event of a fire, and to reduce the reliance on the infrequently utilized safety-related passive systems, automatic suppression shall be provided in those fire areas outside containment where a fire could damage the normal shutdown capability, or result in a spurious operation of equipment that could result in a venting of the RCS.*"

   The AP600 provides the following:

   - The NRC has stated that the safety-related systems can be the basis for fire evaluations. This is the approach that is used in the AP600 SSAR, in section 9A.

   - SSAR section 7.4.1.3 describes nonsafety-related features that are used to bring the AP600 to a safe shutdown and to a cold shutdown. However, this section was not written to describe the situation following a fire. It does not describe the minimum set of features required. Not all support functions listed in 7.4.1.3 are required including certain HVAC, chilled water and non-1E instruments. These systems support front line nonsafety-related systems but the front line systems can function adequately without them. A table will be added to SSAR section 9.5.1.3 to define the system capabilities used to shutdown the plant to cold conditions following a fire.

   - In some cases, a safety-related capability will be used to assist the nonsafety-related capabilities used to achieve cold shutdown. For example, the initial shutdown of the reactor will be performed by insertion of control rods which are safety-related. The control rods will be used to provide this function for both the safe shutdown case evaluated in SSAR Appendix 9A and in the cold shutdown case. Another example is the instrumentation used to monitor the RCS conditions to verify that it is safely shutdown. Use of such safety-related features is acceptable considering that their operation does not result in steaming to the containment or in loss of the RCS pressure boundary. It is also acceptable to use safety-related features to back up the CVS RCS makeup and boration functions and its RCS pressure reduction function as long as they meet the criteria of not steaming to the containment and not losing the RCS pressure boundary.

   - Acceptable means of protecting cold shutdown features from the effects of a fire include automatic fire suppression or separation. Separation between redundant components within a system or between different systems are both acceptable. The CVS is not separated or provided with automatic fire suppression because a core makeup tank can be used to provide

RCS makeup / boration and a ADS stage 1 valve can be used to provide a controlled, limited depressurization of the RCS. The RNS pumps and the SG PORVs are located in separate fire areas. The component cooling water system, the service water system, and the instrument air system are provided with fire suppression. Those portions of the instrumentation and control system required are either separated or provided with fire suppression. The chilled water system and HVAC systems are not required to support cold shutdown except for two HVAC fans that ventilate the non-1E switchgear rooms.

In order to clarify the SSAR with respect to this question, several SSAR sections have been revised. The revised SSAR sections include 9.5.1.3 and 9A.2.7. In addition, a table has been added to section 9.5.1.3 that lists the capabilities used to shutdown the plant to cold conditions following a fire.

2. **Acceptability of Pressurizer Steam Venting for RCS Pressure Reduction**

The limited use of ADS stage 1 to provide a controlled reduction of the RCS pressure is consistent with our understanding of the NRC criteria that prohibits use of the ADS during a fire. Venting of steam from the RCS does not cause loss of the RCS pressure boundary or an increase in the containment temperature / pressure. System level actuation of the ADS would violate this criteria. However, the operators can open the ADS stage 1 valves individually in a way that the stage 1 control valve only partly opens. Note that this valve is specifically designed to throttle flow. In this way, the operators can reduce the RCS pressure in a slow / controlled manner. When the desired reduction in RCS pressure is accomplished the partially open ADS stage one valve is re-closed; depressurizing the RCS to the RNS cut-in pressure takes more than 6 minutes using the ADS stage 1 valve. The operator remains in control of the RCS pressure. A stable / visible water level is maintained in the pressurizer. The RCS pressure boundary is not lost. Water is not discharged from the pressurizer. Steam released from the pressurizer is condensed in the IRWST and is not released to the containment. Use of the ADS stage 1 for this purpose has been added to SSAR subsection 9.5.1.3

During several discussions with the NRC concerning spurious valve actuations, the staff stated that spurious opening of pressurizer PORV was acceptable as long as the block valves could be closed before control of the RCS inventory was lost. In addition, Generic Letter 81-12 says in section 4.2 that "Power operated relief valves may be required to reduce pressure to allow use of the high pressure injection pumps." Another example of the NRC accepting the use of limited RCS steam venting to effect a controlled reduction in RCS pressure is found in the Vogtle FSAR, rev. 4. Table 9.5.1-3 of the Vogtle FSAR lists the pressurizer PORVs as a means of controlling RCS pressure.

In the Open Item, the NRC discusses a RELAP5 analysis that shows that the RCS conditions at 24 hours are higher than Westinghouse has calculated (430 F vs 420 F and 1600 psig vs 600 psig). It is not clear that the RELAP5 analysis uses similar inputs and assumptions as the Westinghouse analysis including best estimate decay heat, PRHR HX performance, and heat losses from the pressurizer. In any case the RCS pressure can be reduced to about 400 psig to allow RNS cut-in by limited use of the ADS stage 1 valves. Note that the RNS is designed for a limited number of actuations with RCS temperatures at 420 F.

3. Is Protection of Safety-Related Equipment and Circuits Inside Containment Adequate

One of the NRC concerns is the protection of the redundant PRHR HX control valves. These redundant safety-related valves are fail-open air-operated valves. They are located in one fire zone (11300B) within several feet of each other. Figure 1 attached to this response shows the location of these valves. To address this concern, a noncombustible barrier has been added between the PRHR HX control valves. The barrier is made of noncombustible materials, steel or steel composites. One of the PRHR HX control valves is located close to the IRWST wall. This valve is assigned to division B. The cables for this valve are enclosed in conduit or enclosed raceways and routed up through the operating deck. Separate fire detectors are provided near each valve. The only combustibles in the area are the valves themselves and their cables. As a result, a fire that would affect these valves would start at one of the valves. The barrier protects the other valve from the initial affects of the fire. The fire detectors would alert the operators and allow them to actuate the other valve before the fire could spread and damage it. The PRHR HX control valves are qualified to operate with elevated environmental temperatures (340 F). Note that the PRHR HX flow instruments are not required to verify PRHR HX operation and have been removed from SSAR Table 9A-2. The PAMS provides this function by monitoring the RCS conditions. SSAR subsection 9A.3.1.1.8 and Table 9A-2 have been revised to reflect these changes.

For the PRHR HX to be able to cool the RCS to safe shutdown conditions in 36 hours, the IRWST gutter isolation valves must close to maintain an adequate long term PRHR HX heat sink. These redundant safety-related valves are fail closed air-operated valves. They are located in one fire zone (11300A). They are separated from each other by at least 20 feet horizontal. Figure 2 attached to this response shows where these valves will be located. In addition, separate fire detectors are provided near each valve. Given the low combustible materials in this fire zone, a fire will only affect one of the valves initially. The fire detector located at the valve that is initially affected will alert the operators so that they can actuate the unaffected valve before the fire can spread and damage it to the point it will not close. The IRWST gutter isolation valves are qualified to operate with elevated environmental temperatures (340 F). SSAR subsection 9A.3.1.1.7 and Table 9A-2 have been revised to reflect these changes.

Figure 3 shows the large vents through the roof of zones 11300A/B. Figure 4 shows cable trays in the 11300B fire zone. Note that the safety-related cable trays are enclosed types. The nonsafety-related cable trays are open types. The division B/D cable trays in zone 11399S will be enclosed by noncombustible barriers made of steel or steel composite materials. The limited amount of combustibles located in this zone together with its high ceiling and large volume indicate that it would not heat up rapidly. Hot gases from a fire in the cable tray area will rise away from the cable trays and exit to the upper containment volume above operating deck. These hot gasses are impeded from crossing over from zone 11300B to 11300A by the large I-beams that support the concrete operating deck (see Figure 4). Some of these I-beams are about 3 feet deep. If some hot gas is not vented to the upper containment volume and works its way past the I-beams under the operating deck, it would be vented up to the upper containment volume through the large vents in the operating deck in zone 11300A (see Figure 3). Note that safety-related equipment is not located near the ceiling of these two fire zones. Also note that safety-related equipment located inside containment is qualified for elevated temperatures of 340 F. As a result, safety-related equipment located in 11300A or 11300B would not see elevated temperatures from a fire in the other zone that would exceed their environmental conditions.

SSAR Change:

9.5.1.3	Safety Evaluation (Fire Protection Analysis)
Subsection 9A.2.7	Safe Shutdown Evaluation
Subsection 9A.3.1.1.7	Fire Zone 11300A
Subsection 9A.3.1.1.8	Fire Zone 11300B
Table 9A-2	Safe Shutdown Components

ITAAC Change:

None

Revision to SSAR 9.5.1.3 Safety Evaluation (Fire Protection Analysis)

9.5.1.3 Safety Evaluation (Fire Protection Analysis)

The fire protection analysis evaluates the potential for occurrence of fires within the plant and describes how fires are detected and suppressed. It also confirms that the plant can be safely shut down following a postulated fire. The fire protection analysis is in Appendix 9A.

The fire protection analysis includes a set of fire area drawings and a discussion of the analysis methodology. It also provides the following information for each fire area in the plant:

- A description of the fire area and its fire barriers, its associated fire zones, as well as fire detection and suppression capabilities
- Identification of the type, quantity, and location of in-situ and anticipated transient combustible materials, and combustible loading
- A listing of safety-related mechanical and electrical equipment
- Fire severity category and equivalent duration
- An evaluation of fire protection system adequacy and the consequences of a fire, including a discussion of the control and removal of smoke and hot gases, and drainage system adequacy.

For fire areas containing safety-related structures, systems, and components the following information is also provided:

- An evaluation of fire protection system integrity. This includes a determination of whether the credible failure of a fire protection system component could cause inadvertent operation of an automatic fire suppression system in the fire area, and the resulting consequences. Also included is verification that no potential single impairment of the fire protection system could incapacitate both the automatic suppression system and the backup manual suppression system (generally a hose station), for fire areas where both types of suppression systems are provided.
- A safe shutdown evaluation confirming the capability to safely shut down the reactor and maintain it in a safe shutdown condition following a fire

The safe shutdown evaluation is based upon all components in a single fire area outside containment or any fire zone inside containment being disabled by the fire. Success is based upon the plant being able to achieve safe shutdown as discussed in Section 7.4.. Safe shutdown is a safe, stable condition that can be maintained indefinitely with the reactor subcritical and reactor coolant pressure at a small fraction of its design pressure. As described in Section 7.4.1.1, safety-related systems achieve this condition automatically using reliable, passive processes. The passive residual heat removal heat exchanger transfers heat to the in-containment refueling water storage tank. Steam from this tank enters the containment which is cooled by the passive containment cooling system. These systems reduce the reactor temperature and pressure to less than 420° F and 600 psia in 36 hours. The containment heats up to less than 225° F and less than 22 psig during this time. This is a safe and acceptable end state which is used to show compliance with BTP 9.5-1. The safe shutdown fire evaluation in Appendix 9A shows that there is sufficient safety-related equipment available after a fire which destroys a single fire area outside containment or any fire zone inside containment, to bring the plant to this safe shutdown condition.

It should be noted that following most fires, that nonsafety-related systems are expected to be available to bring the plant to a cold shutdown for repairs. ~~These systems include the normal residual heat removal system, component cooling water system, and the service water system. These systems are described in SSAR Sections 5.4.7, 9.2.2, and 9.2.1.~~ These systems are defense in depth systems with redundant active components. ~~Use of nonsafety-related systems to achieve cold shutdown is described in Section 7.4.1.3.~~ These systems are expected to be available because of the use of redundant equipment and ~~active~~ fire protection features, *including separation or automatic fire suppression.*

Table 9.5.1-4 lists the system capabilities that are expected to be available following a fire to bring the plant to a cold shutdown. This list does not contain the nonsafety-related support systems that are not necessary to operate following a fire. For example, chilled water cooling and non-1E instrumentation are not required following a fire. Heating and ventilating are not required except for two fans used to ventilate the non-1E switchgear rooms. The following safety-related capabilities are used together with these nonsafety-related capabilities to achieve cold shutdown:

- *Insertion of control rods to provide reactor shutdown,*
- *Instrumentation to monitor reactor coolant system conditions,*
- *Operation of one core makeup tank in a natural circulation mode to provide reactor coolant makeup and boration in case the chemical and volume control system makeup is unavailable due to a fire,*
- *Manual partial opening (and closing) of one first stage automatic depressurization valve to provide a controlled, limited depressurization of the reactor coolant system to allow initiation of the normal residual heat removal system in case the chemical and volume control system auxiliary spray is unavailable due to a fire.*

The use of these safety-related capabilities does not result in significant plant transients. The reactor coolant system pressure boundary is maintained and containment pressure and temperature conditions are not affected by the use of these safety-related capabilities.

If a less likely, more severe fire occurs, these systems are expected to be recovered after reasonable actions are taken to utilize temporary connections or to perform repairs (see subsections 9.2.2.4.5.5 and 9.5.1.1.1). Recovery of these systems allows the plant to be brought to a cold shutdown for plant repairs. No credit is taken in the Appendix 9A fire evaluation for nonsafety-related systems. As a result, fire separation is not required for these systems.

New SSAR Table 9.5.1-4

Table 9.5.1-4
Capabilities Used To Achieve Cold Shutdown FOllowing a Fire

Function	System Capability	Fire Protection
RCS Reactivity Control . Short Term . Long Term	- Control Rods - (1)	- separation - (1)
RCS Makeup	- (1)	- (1)
RCS Pressure Control . Increase . Decrease	- Pressurizer heaters - Auxiliary spray (2)	- separation - (2)
Decay Heat Removal (high temperature)	- SFW pumps feeding CST water to SG - SG PORV discharge to atm.	- fire suppression - separation
Decay Heat Removal (cold temperature)	- RNS pumps circulating RCS - CCS cooling RNS - SWS cooling CCS	- separation - fire suppression - fire suppression
Process Monitoring	- RCS monitoring instruments (PMS) - Non-1E Instrumentation and Control (3)	- separation - separation
Support Systems	- Instrument Air - Standby Diesel Generators - Non-1E AC Power (3) - Non-1E Room Ventilation Fans (4)	- fire suppression - fire suppression and separation - separation - separation

New SSAR Table 9.5.1-4 (cont.)

Notes:
(1) CVS makeup from the BAT provides RCS makeup and boration. If the CVS is damaged by a fire, one CMT can provide this capability without heating up the containment.
(2) CVS auxiliary spray provides pressurizer pressure reduction. If the CVS is damaged by a fire, one ADS stage 1 valve used in a low capacity throttled vent mode of operation can slowly depressurize the RCS without loss of RCS pressure boundary or heating up of the containment.
(3) The portions of the non-1E AC power and the non-1E instrumentation and control system required are those needed to operate components; local control is sufficient (switchgear / control cabinet).
(4) Portions of the non-1E heating and ventilating systems are required to ventilate the main control room, non-1E switchgear rooms, and the required portions of the non-1E instrumentation and control system (see note 3).

Revision to SSAR 9A.2.7 Safe Shutdown Evaluation

9A.2.7 Safe Shutdown Evaluation

This subsection describes the methodology for evaluation of the effects of postulated fires in each fire area on the ability of the operator to achieve a safe shutdown of the plant. The criteria and assumptions upon which the evaluation is based are described in subsection 9A.2.7.1. The safety-related features of the plant designed to provide the safe shutdown capability are described in subsection 9A.2.7.2.

As indicated in subsection 9.5.1, this evaluation is based upon satisfying the requirements of BTP CMEB 9.5-1. This basis includes using safe shutdown as defined in section 16.1 in lieu of cold shutdown wherever stated in BTP CMEB 9.5-1. The ~~use of the~~ automatic depressurization system is not used as the method for achieving safe shutdown after a fire *and spurious actuation of the automatic depressurization system is avoided. The passive residual heat removal heat exchanger is used to remove decay heat for safe shutdown as described in subsection 7.4.1.3.*

In addition, the plant has enhanced capability to achieve cold shutdown following a fire as discussed in subsection 9.5.1. This capability is not relied upon in the fire evaluation contained in Appendix 9A. ~~In addition, it assumes an enhanced capability of the normal residual heat removal system to be available following a fire (see subsection 5.4.7). Passive residual heat removal or normal systems area available.~~

Revision to 9A.3.1.1.7 and 9A.3.1.1.8

9A.3.1.1.7 Fire Zone 1100 AF 11300A

This fire zone is comprised of the following room(s):

Room No.	
11300	Maintenance floor (southern part)
11400	Maintenance floor mezzanine (southern part)

Safe Shutdown Evaluation

The quantity and arrangement of the combustible materials in this fire zone, and the characteristics of the barriers that separate this zone from other fire zones are such that a fire which damages safe shutdown components in this zone does not propagate to the extent that it damages redundant safe shutdown components in another fire zone.

The quantity of combustible materials in this fire zone is low, consisting primarily of cable insulation. There are small concentrations of cables at the top of the zone and at several separate locations along the walls. This fire zone is physically separated from fire zones below by the maintenance floor, with a concrete thickness of more than one foot, except for openings described in the evaluation of fire zone 1100 AF 11206. This fire zone is separated from the operating deck above (fire zone 1100 AF 11500) by a ceiling with a concrete thickness of more than one foot, except for the hatches near the containment maintenance hatch, which are covered with steel grating. The walls of this fire zone are the steel containment vessel, the steel wall of the in-containment refueling water storage tank, or walls with a concrete thickness of more than one foot, except for two designated boundaries with the adjacent portion of the maintenance floor (fire zone 1100 AF 11300B). These boundaries are approximately at the centerline of containment, one located in the narrow annular space behind the in-containment refueling water storage tank and the other near the personnel hatch. The steam generator compartments, the refueling cavity, and the in-containment refueling water storage tank provide barriers between the two large maintenance floor fire zones. Safe shutdown components fire zone 1100 AF 11300A are separated from redundant safe shutdown components in fire zone 1100 AF 11300B by these barriers or by a horizontal distance of more than 20 feet with no intervening combustible or fire hazards. In addition, safety-related cables in both of these fire zones are routed in closed cable trays or conduit, minimizing the likelihood that a fire originating in a raceway of one division can propagate to a raceway of another division. Furthermore, open-nozzle water spray suppression systems are provided for nonsafety-related electrical cables routed in open cable trays in fire zone 1100 AF 11300B (there are no such cable trays in fire zone 1100 AF 11300A), providing additional assurance that a fire will not propagate between these fire zones.

Most of the smoke and hot gases from a fire in this fire zone rises through the large steel grating covered hatches between the containment maintenance hatch and the steam generator 2 compartment into the large air space in the upper portion of containment(fire zone 1100 AF 11500). Small quantities of smoke, especially that which has already cooled, may migrate horizontally into the adjacent portion of the maintenance floor (fire zone 1100 AF 11300B). The smoke and gases are cooled by mixing with the air and by contact with structural surfaces and thus do not cause propagation of the fire beyond this fire zone. Temperature effects on the electrical cables routed high above the operating deck and passing over the large steel-grating covered hatches are not expected to be significant, but are not a concern as these are the same cables that continue into this fire zone and are assumed to be lost. Safe shutdown components listed in Table 9A-2 for the adjacent fire zones are not susceptible to damage by the diluted and cooled smoke and gases from this fire zone.

Table 9A-2 lists the safe shutdown components located in this fire zone. *The passive core cooling system has two IRWST gutter isolation valves located in this zone. These valves close to divert condensate from the passive containment cooling system (on the inside of the containment shell) into the IRWST. This condensate maintains the passive residual heat removal heat exchanger heat sink for the long term. These valves are fail closed air operated valves. They are located at least 20 feet apart horizontally and a fire detector is located close to each valve. Given the low combustible materials in this fire zone, a fire will only affect one of the valves initially. The fire detector located near the valve that is initially affected will alert the operators so that they can actuate the unaffected valve before the fire can prevent operation of the second valve. These valves are qualified to operate with elevated temperatures of 340 F.*

Although the consequences of a fire are expected to be very limited, a fire in this fire zone is conservatively assumed to *eventually* disable all of the safe shutdown components in this fire zone.

The redundant passive core cooling system, passive containment cooling system and steam generator system safe shutdown components (listed in Table 9A-2), located in fire zones 1100 AF 11207 and 1100 AF 11300B, are sufficient to perform applicable functions to achieve and maintain safe shutdown.

The primary sampling system and containment air filtration system containment isolation valves, located outside the containment fire area, are redundant to the containment isolation valves in this fire zone and are sufficient to maintain containment integrity.

The redundant reactor coolant system cold leg flow instrumentation located in fire zones 1100 AF 11300B and 1100 AF 11301 is sufficient to perform applicable functions to achieve and maintain safe shutdown.

No fire in this zone can cause spurious actions which could cause a breach in the reactor coolant boundary or defeat safety-related decay heat removal capability or cause an increase in shutdown reactivity of the reactor.

9A.3.1.1.8 Fire Zone 1100 AF 11300B

This fire zone is comprised of the following room(s):

Room No.	
11300	Maintenance floor (northern part)
11400	Maintenance floor mezzanine (northern part)

Safe Shutdown Evaluation

The quantity and arrangement of the combustible materials in this fire zone, and the characteristics of the barriers that separate this zone from other fire zones are such that a fire which damages safe shutdown components in this zone does not propagate to the extent that it damages redundant safe shutdown components in another fire zone.

The quantity of combustible materials in this fire zone is low, consisting primarily of cable insulation in the termination boxes and cable trays. There is a concentration of cables on the south side of the zone near the refueling cavity and small concentrations of cables at the top of the zone and at several locations along the walls. This fire zone is physically separated from fire zones below by the maintenance floor, which has a concrete thickness of more than one foot, except for access stairways and hatches. This fire zone is separated from the operating deck above (fire zone 1100 AF 11500) by a ceiling that has a concrete thickness of more than one foot, except for several openings for an access stairway, elevator, hatches and blockouts. The walls of this fire zone are the steel containment vessel, the steel wall of the in-containment refueling water storage tank, the noncombustible enclosure for the division B and D penetrations and raceways (fire zone 1100 AF 11500), or walls with a concrete thickness of more than one foot, except for the designated boundaries with the adjacent portion of the maintenance floor, described in the evaluation of fire zone 1100 AF 11300A. There is a doorway to lower pressurizer compartment (fire zone 1100 AF 11303) that is closed.

Safety-related cables are routed in closed cable trays or conduit. For open cable trays, which represent the only significant in-situ combustibles in this fire zone, open-nozzle water spray suppression systems are provided. These systems are automatic except that, to preclude inadvertent actuation, operator action is required to open the outboard containment isolation valve. These suppression systems rapidly extinguish a fire in these cable trays and prevent fire propagation to adjacent fire zones.

The use of water spray systems for the open cable trays in this fire zone limits smoke and heat generation. Small quantities of smoke and hot gases from a fire in this fire zone rise through openings in the ceiling, or migrate via the large steel grating covered hatches between the containment maintenance hatch and the steam generator 2 compartment in the adjacent portions of the maintenance floor (fire zone 1100 AF 11300A), into the large air space in the upper portion of containment. They are cooled by mixing with the air and by contact with structural surfaces and thus do not cause propagation of the fire beyond this fire zone. Safe shutdown components listed in Table 9A-2 for the adjacent fire zones are not susceptible to damage by the diluted and cooled smoke and gases from this fire zone.

Table 9A-2 lists the safe shutdown components located in this fire zone. The division A and C electrical penetrations listed in Table 9A-2 are conservatively assumed to be disabled as a result of a fire in this fire zone. The B and D electrical penetrations and their cable trays routed from the electrical penetrations up to the operating deck are functionally part of fire zone 1100 AF 11500. These two divisions are sufficient to perform applicable functions to achieve and maintain safe shutdown.

These division B and D electrical penetrations and their associated raceways are protected from a fire in this fire zone by a combination of barriers, distance and fire suppression systems. Noncombustible barriers of steel or steel-composite construction form vertical shaft(s) from the floor up to the operating deck, surrounding the division B and D penetrations and the associated cable trays. The significant combustible materials in this fire zone are the nonsafety-related cables routed in open cable trays. These cable trays are located at least 20 feet from the division B and D penetrations and their associated raceways, and they are protected by water spray suppression systems.

The passive core cooling system *has*~~, the~~ two passive residual heat removal heat exchanger control valves *which* are located in this fire area. These valves are fail-open air-operated valves. *They are located within several feet of each other. The valves are separated from each other by a noncombustible barrier of steel or steel composite materials. One of the valves is located close to the IRWST wall. This valve is assigned to division B. The cables for this valve are enclosed in conduit or enclosed raceways and routed up through the operating deck. Separate fire detectors are provided near each valve. The only combustibles in the area are the valves themselves and their cables. A fire that would affect these valves would be expected to start at one of the valves. The barrier protects the other valve from the initial effects of the fire. The fire detectors would alert the operators and allow them to actuate the other valve before the fire could spread and damage it. These valves are qualified to operate with elevated temperatures of 340 F.* ~~The solenoid valve associated with the valve operator is mounted on the valve operator. A fire in this fire zone located near the valve will cause the solenoid valve to fail such the valve fails open. A fire in this fire zone that damages the electrical power supply to the valves will result in the air-operator causing the valve to fail-open.~~

Reactor coolant system, and steam generator system instrumentation located in this fire zone are conservatively assumed to be disabled as a result of a fire in this fire zone. The redundant passive core cooling system instrumentation, and the passive containment cooling system, reactor coolant system pressurizer and steam generator system instrumentation located in fire zones 1100 AF 11206, 1100 AF 11300A, 1100 AF 11301 and 1100 AF 11500 are sufficient to perform the applicable functions to achieve and maintain safe shutdown.

Reactor coolant system temperature instrumentation located in fire zones 1000 AF 11301 and 1000 AF 11302 are sufficient to provide the monitoring function accomplished by the passive residual heat removal heat exchanger flow instrumentation located in this fire zone.

The reactor coolant system to chemical and volume control system stop valves located in this fire zone are conservatively assumed to be disabled as a result of a fire in this fire zone. The chemical and volume control system containment isolation valves located outside of this fire zone provide backup isolation capability to maintain the reactor coolant pressure boundary.

The redundant reactor coolant system cold leg flow instrumentation located in fire zones 1100 AF 11300A and 1100 AF 11301 is sufficient to perform applicable functions to achieve and maintain safe shutdown.

The chemical and volume control system and the liquid radwaste system containment isolation valves located outside the containment fire area are redundant to the containment isolation valves inside containment in this fire zone and are sufficient to perform the applicable functions to maintain containment integrity.

The redundant steam line pressure instruments located in fire area 1201 AF 05 for steam generator 1 and in fire area 1201 AF 06 for steam generator 2 are sufficient to perform the applicable functions to achieve and maintain safe shutdown.

The redundant core exit thermocouples located in fire zone 1100 AF 11500 are sufficient to provide the applicable safe shutdown monitoring function.

No fire in this zone can cause spurious actions which could cause a breach in the reactor coolant boundary or defeat safety-related decay heat removal capability or cause an increase in shutdown reactivity of the reactor.

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Revision to SSAR Table 9A-2

Table 9A-2 (Sheet 2 of 17)

SAFE SHUTDOWN COMPONENTS

Fire Area/ Fire Zone	System	Description	Class 1E Division A	C	B	D
1000 AF 01/ 1100 AF 11207		Core Makeup Tank B Discharge Isolation Valve	V015B	V014B		
1000 AF01/ 1100 AF 11208	RNS	Suction from IRWST Cont. Isolation Valve			V023	
		Return from CVS Cont. Isolation Valve			V061	
1000 AF 01/ 1100 AF 11300A	PSS	Containment Air Sample Cont. Isolation Valve			V008	
		Liquid Sample Line Cont. Isolation Valve			V010A	V010B
	RCS	Cold Leg 2A Flow			FT-103B	FT-103D
		Cold Leg 2B Flow			FT-104B	FT-104D
	VFS	Containment Purge Discharge Cont. Isolation Valve				V009
	VFS	Containment Purge Inlet Cont. Isolation Valve				V004

Table 9A-2 (Sheet 3 of 17)

SAFE SHUTDOWN COMPONENTS

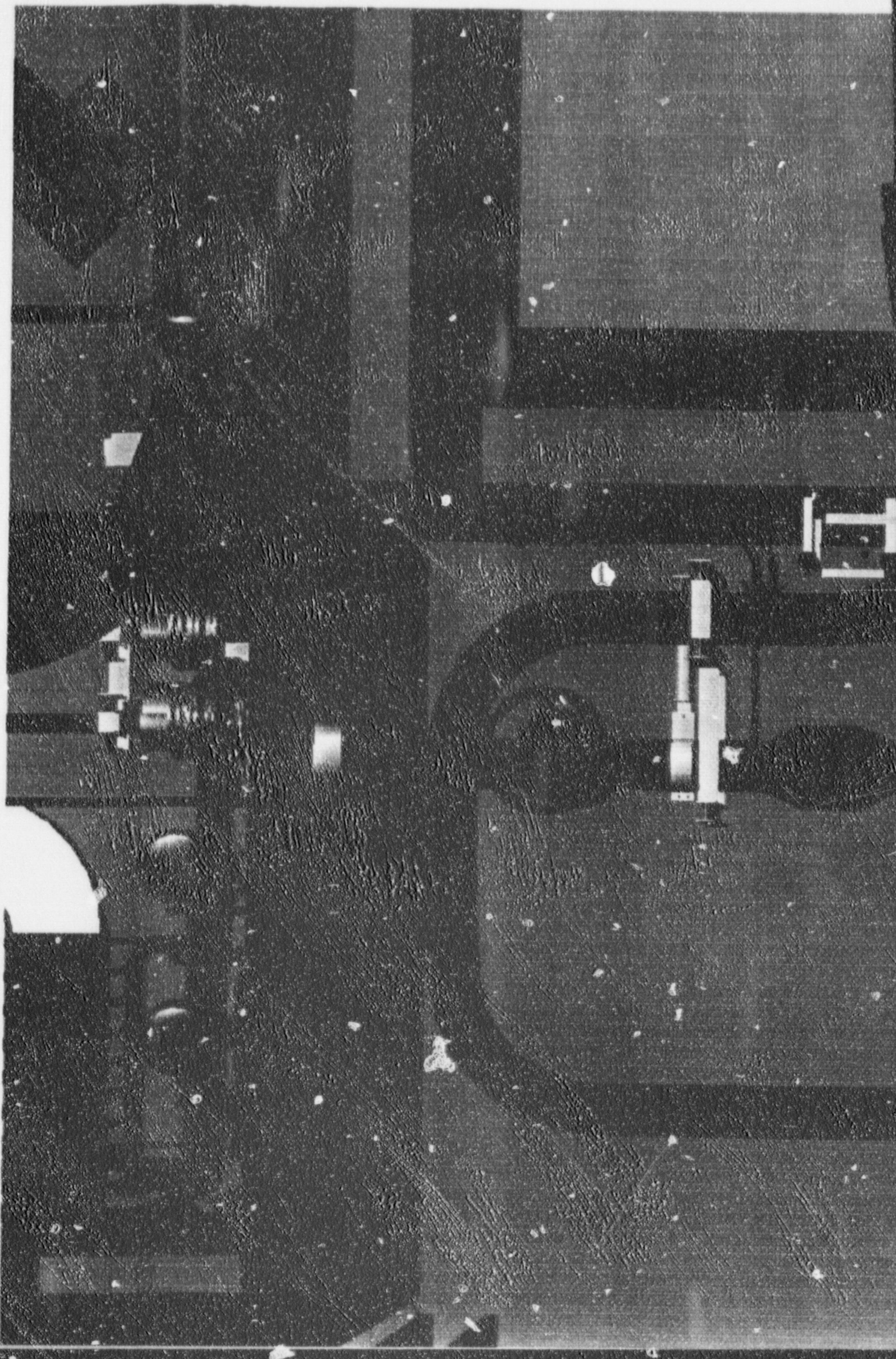
Fire Area/ Fire Zone	System	Description	Class 1E Division A	C	B	D
1000 AF 01/ 1100 AF 11300A	PXS	IRWST Level			LT-046	LT-048
		IRWST Gutter Isolation Valve		*V130A*	*V130B*	
		Core Makeup Tank (MT-02A)				
	PCS	Containment Pressure			PT-006	PT-008
	SGS	Steam Generator 2 Wide Range Level			LT-014	LT-018
1000 AF 01/ 1100 AF 11300B	CCS	Outlet Line Cont. Isolation Valve	V207			
	CVS	Letdown Containment Isolation Valve	V045			
		Makeup Line Cont. Isolation Valve	V091			
		RCS Purification Stop Valve (RCPB)	V001	V002		
	IDS	Class 1E Electrical Penetrations	EY-P11Z	EY-P27Z		
		Class 1E Electrical Penetrations	EY-P12Y	EY-P29Y		
	-	Class 1E Electrical Penetrations	EY-P13Y	EY-P28Y		
		Class 1E Cable Trays	Note 1	Note 1		
	PCS	Containment Pressure	PT-005	PT-007		

Table 9A-2 (Sheet 4 of 17)

SAFE SHUTDOWN COMPONENTS

Fire Area/ Fire Zone	System	Description	Class 1E Division			
			A	C	B	D
1000 AF 01/ 1100 AF 11300B	PXS	PRHR Heat Exchanger Control Valve		V108*B*	V108*A*	
		IRWST Level	LT-045	LT-047		
		~~PRHR Flow~~		~~FT-049A~~	~~FT-049B~~	
		Core Makeup Tank (MT-02B)				
	RCS	Pressurizer Pressure	PT-191A	PT-191C		
		Reference Leg Temperature	TE-193A	TE-193C		
		Pressurizer Level	LT-195A	LT-195C		
		PRHR Heat Exchanger Outlet Temperature		TE-161		
		Cold Leg 1A Flow	FT-101A	FT-101C		
		Cold Leg 1B Flow	FT-102A	FT-102C		
		Cold Leg 2A Flow	FT-103A	FT-103C		
		Cold Leg 2B Flow	FT-104A	FT-104C		
	SGS	Steam Generator 1 Narrow Range Level	LT-001	LT-003		
		Steam Generator 2 Narrow Range Level	LT-005	LT-007		
	-	Steam Generator 2 Wide Range Level	LT-013	LT-017		
		Steam Generator 1 Wide Range Level	LT-011	LT-015		
		SG1 Steam Line Pressure	PT-030	PT-032		
		SG2 Steam Line Pressure	PT-034	PT-036		

Figure



- PRHR HX Valve Location

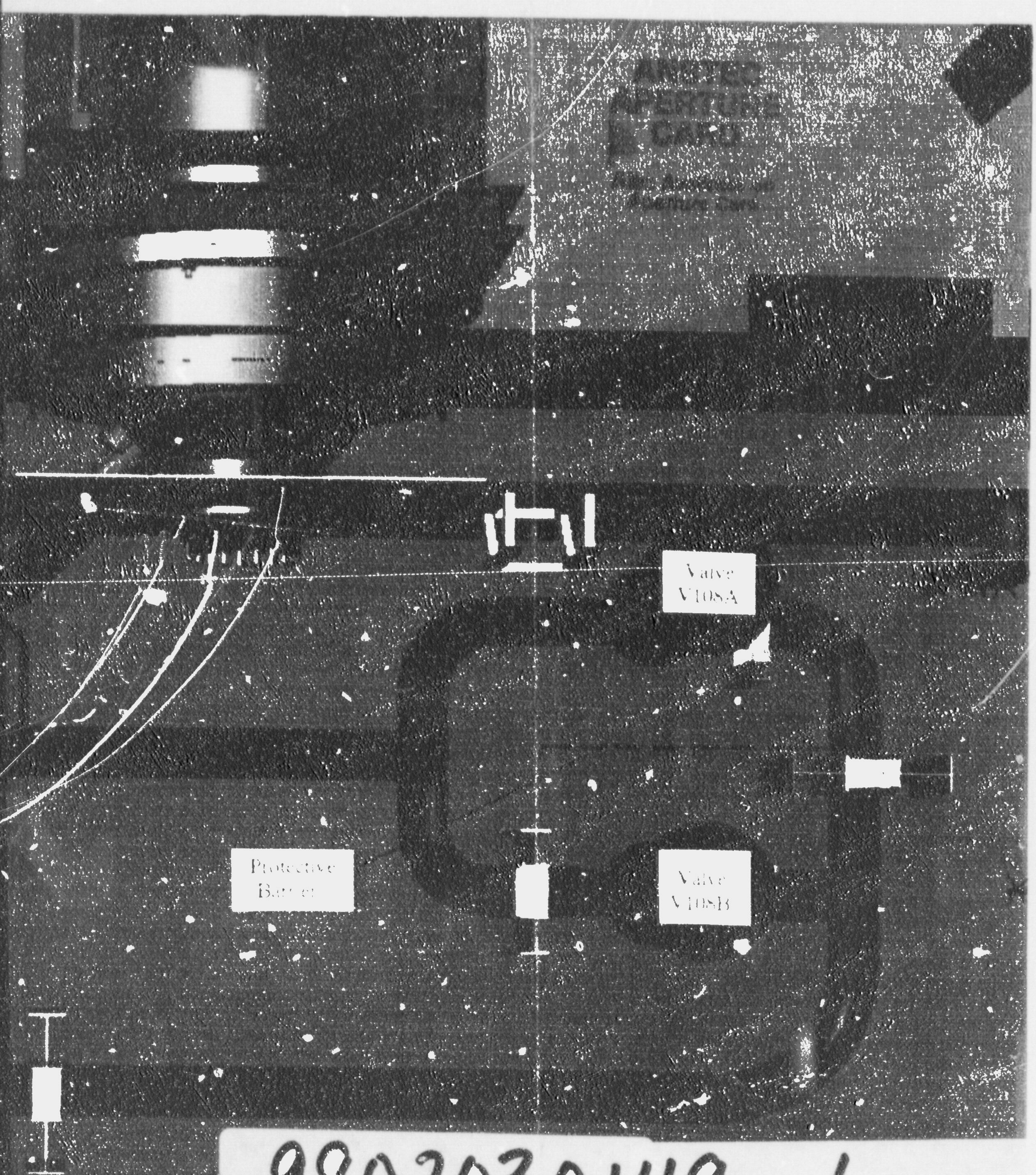


Figure 2 - IRWST Gutter Isolation Valves

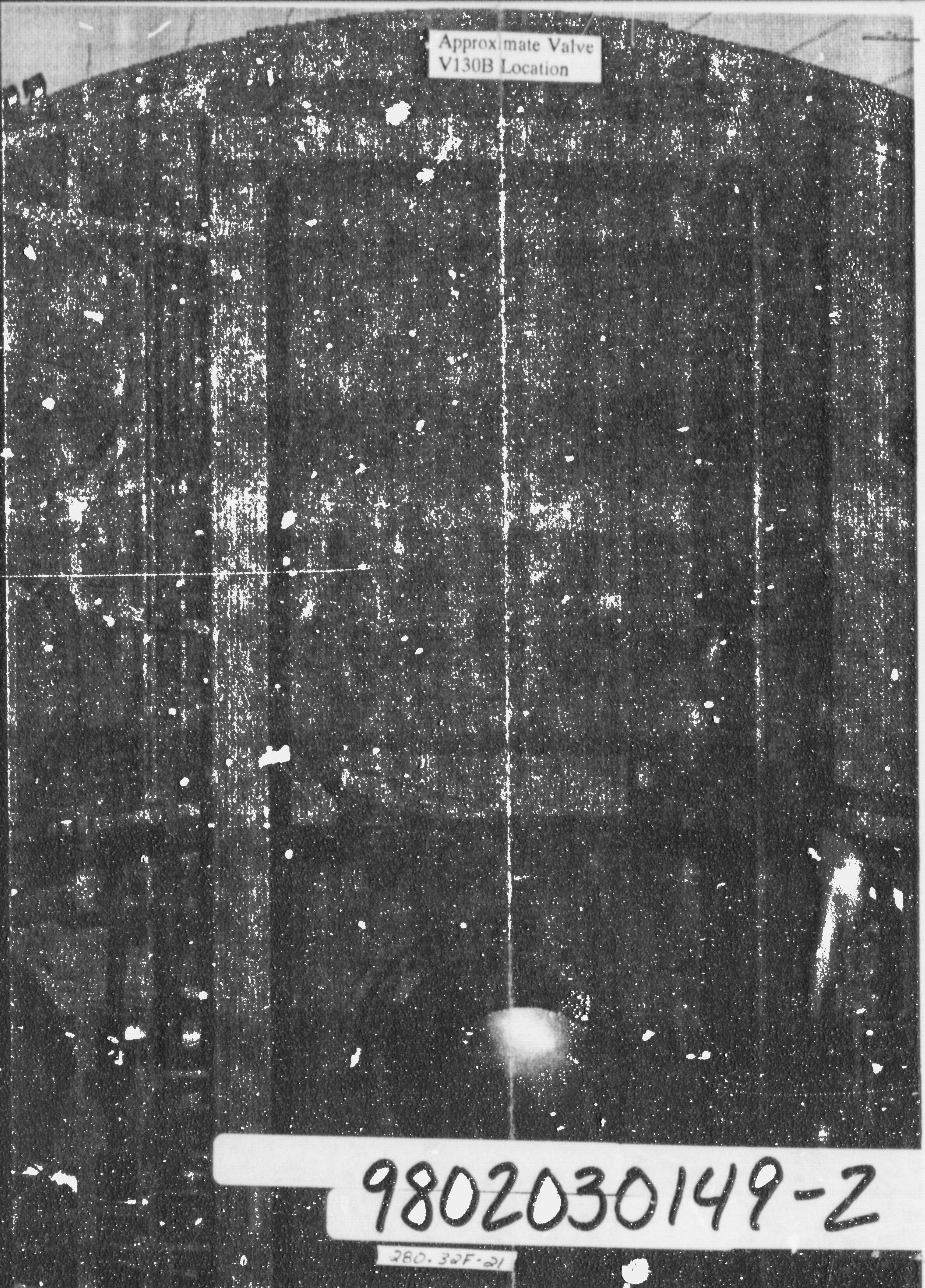
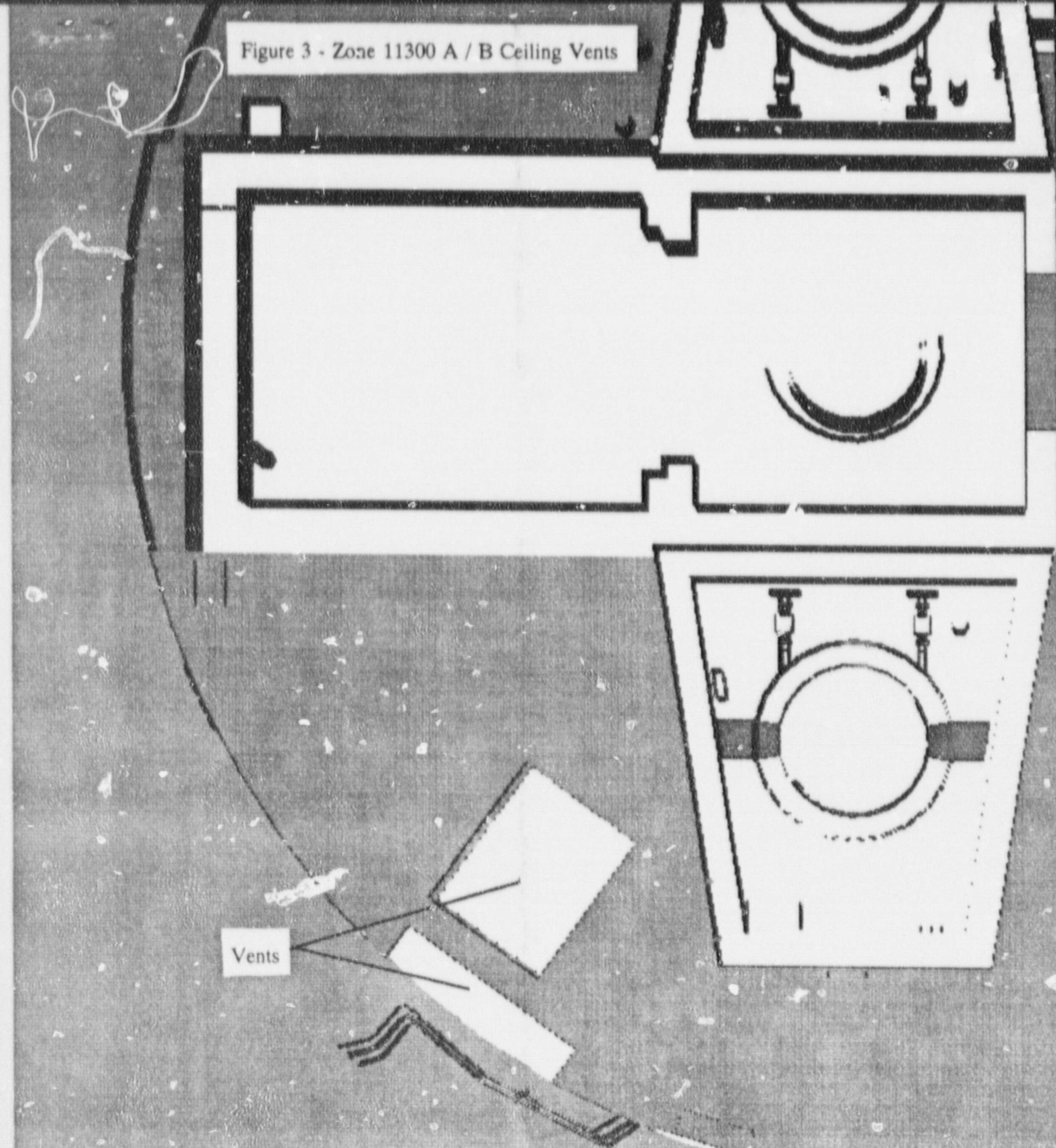
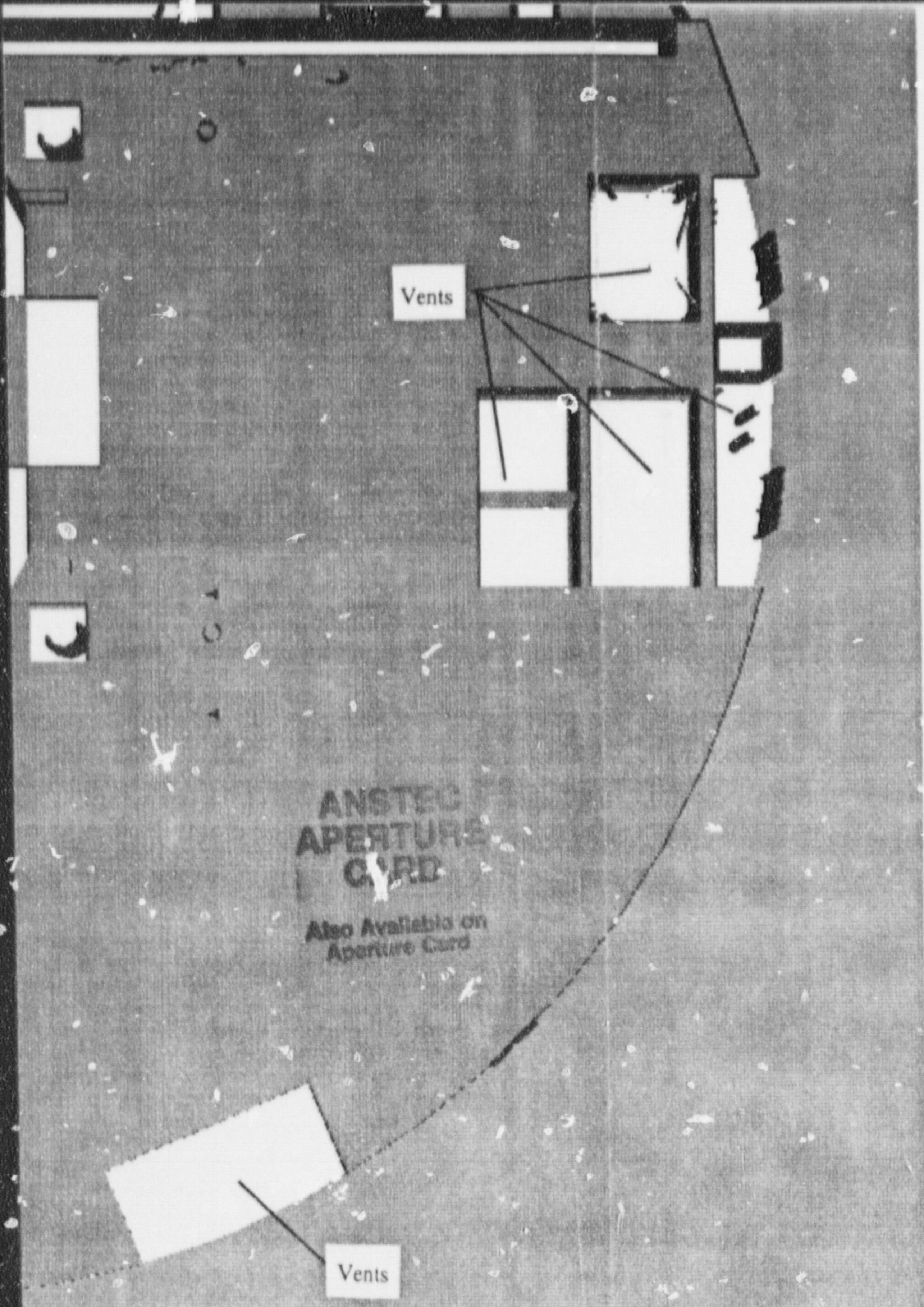

Approximate Valve
V130B Location

Figure 3 - Zone 11300 A / B Ceiling Vents





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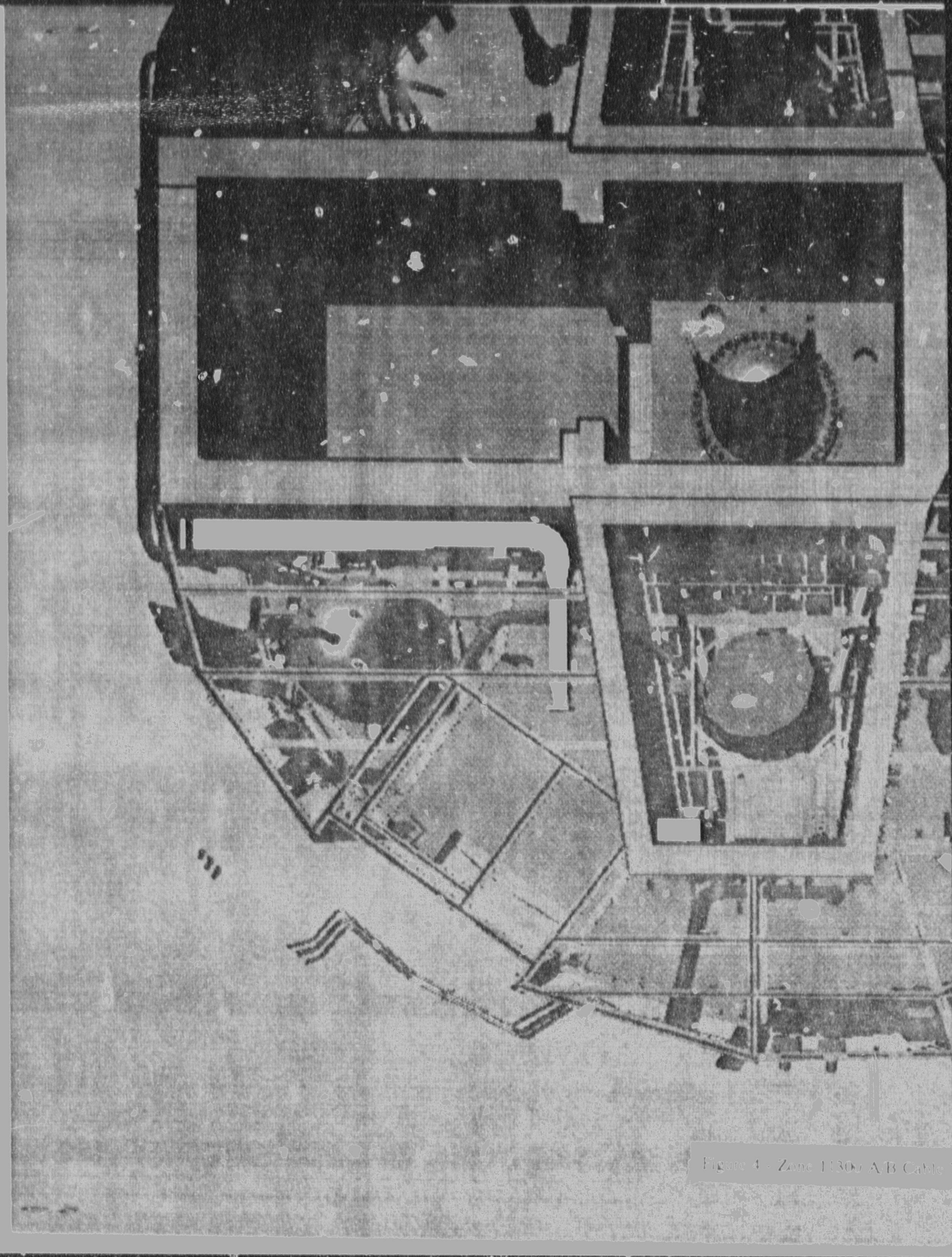
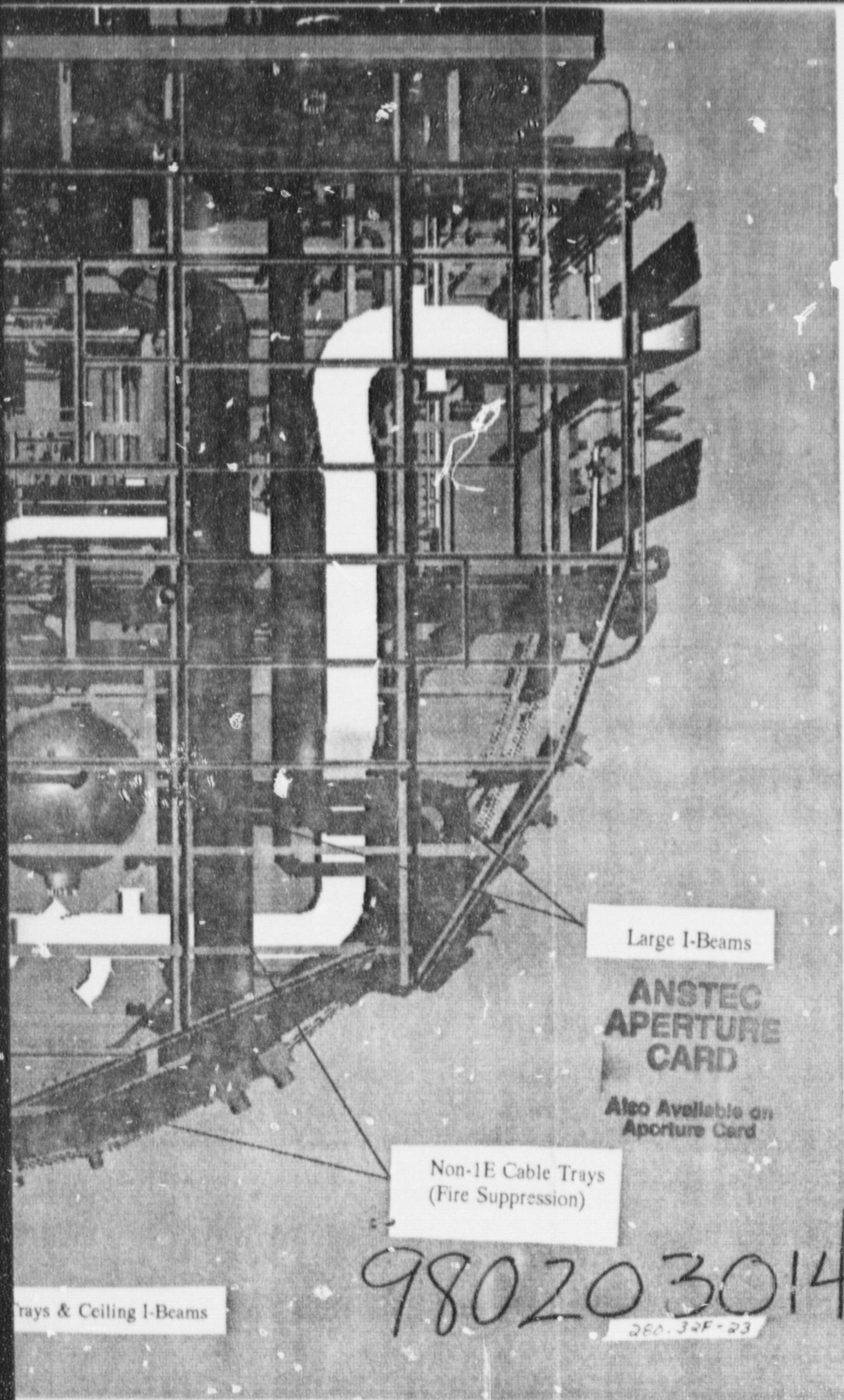
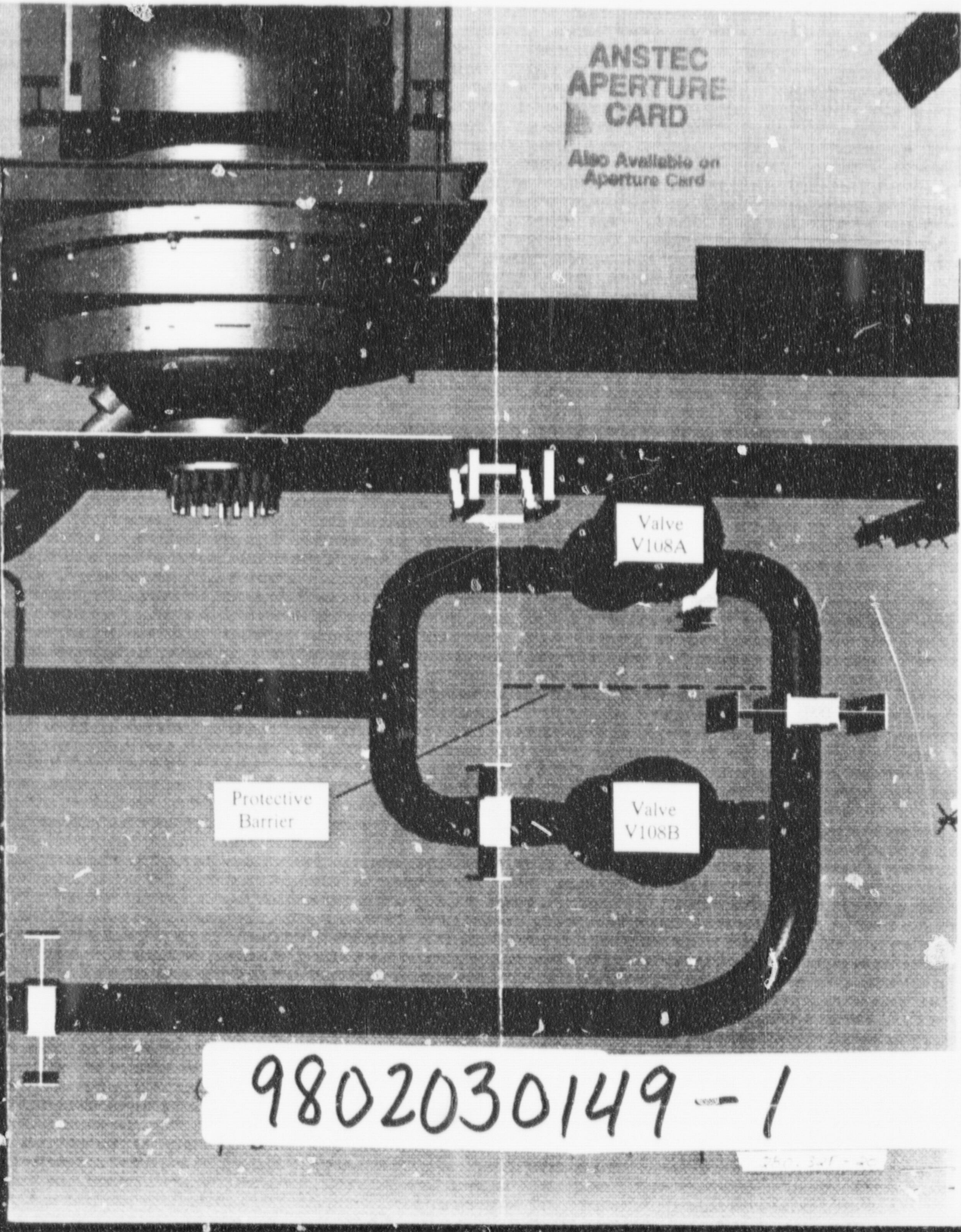


Figure 4 - Zone 1130 A/B Cable


Large I-Beams
Non-1E Cable Trays
(Fire Suppression)
Trays & Ceiling I-Beams

Figure

1 - PRHR HX Valve Location



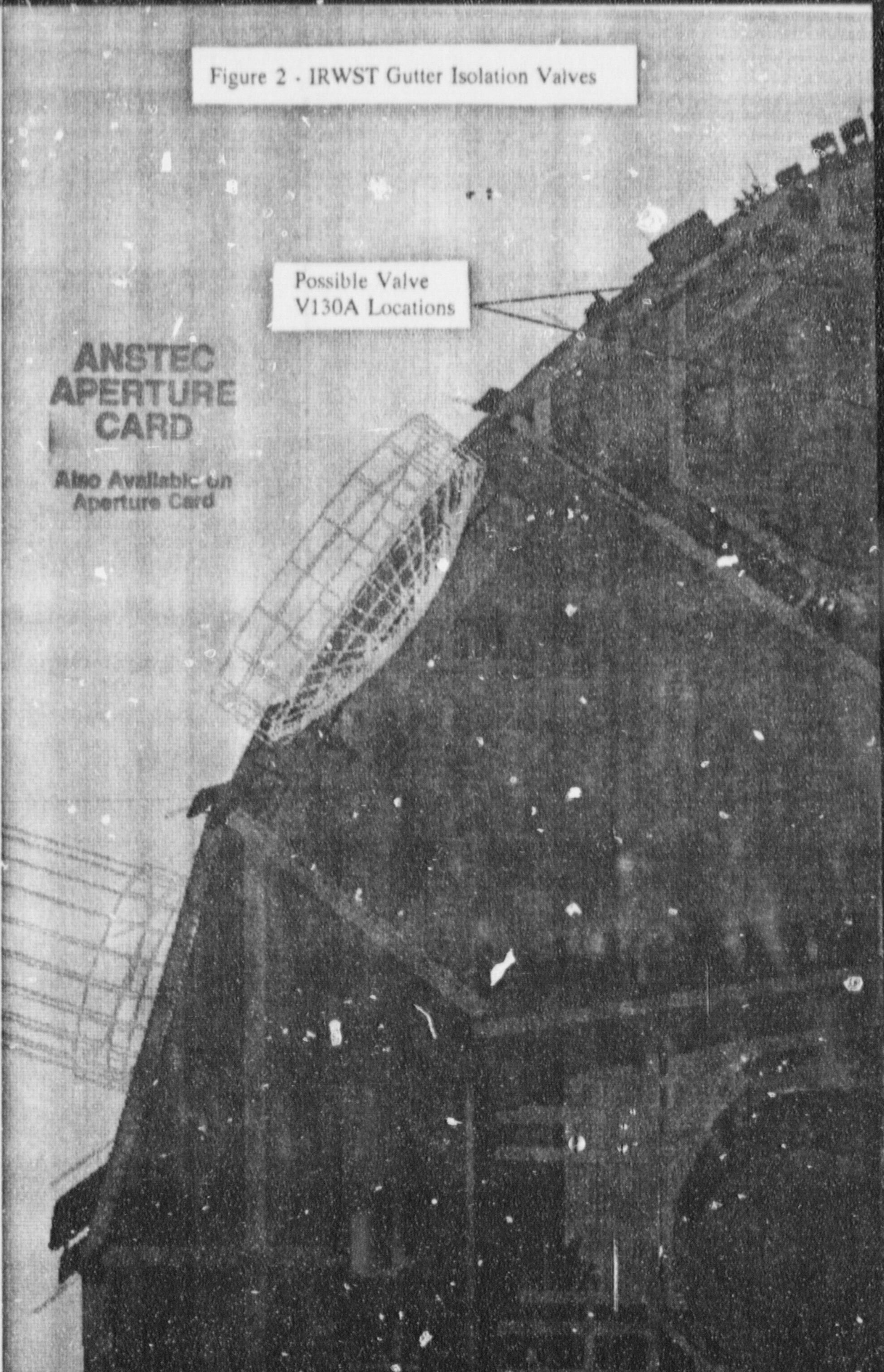


Figure 2 - IRWST Gutter Isolation Valves

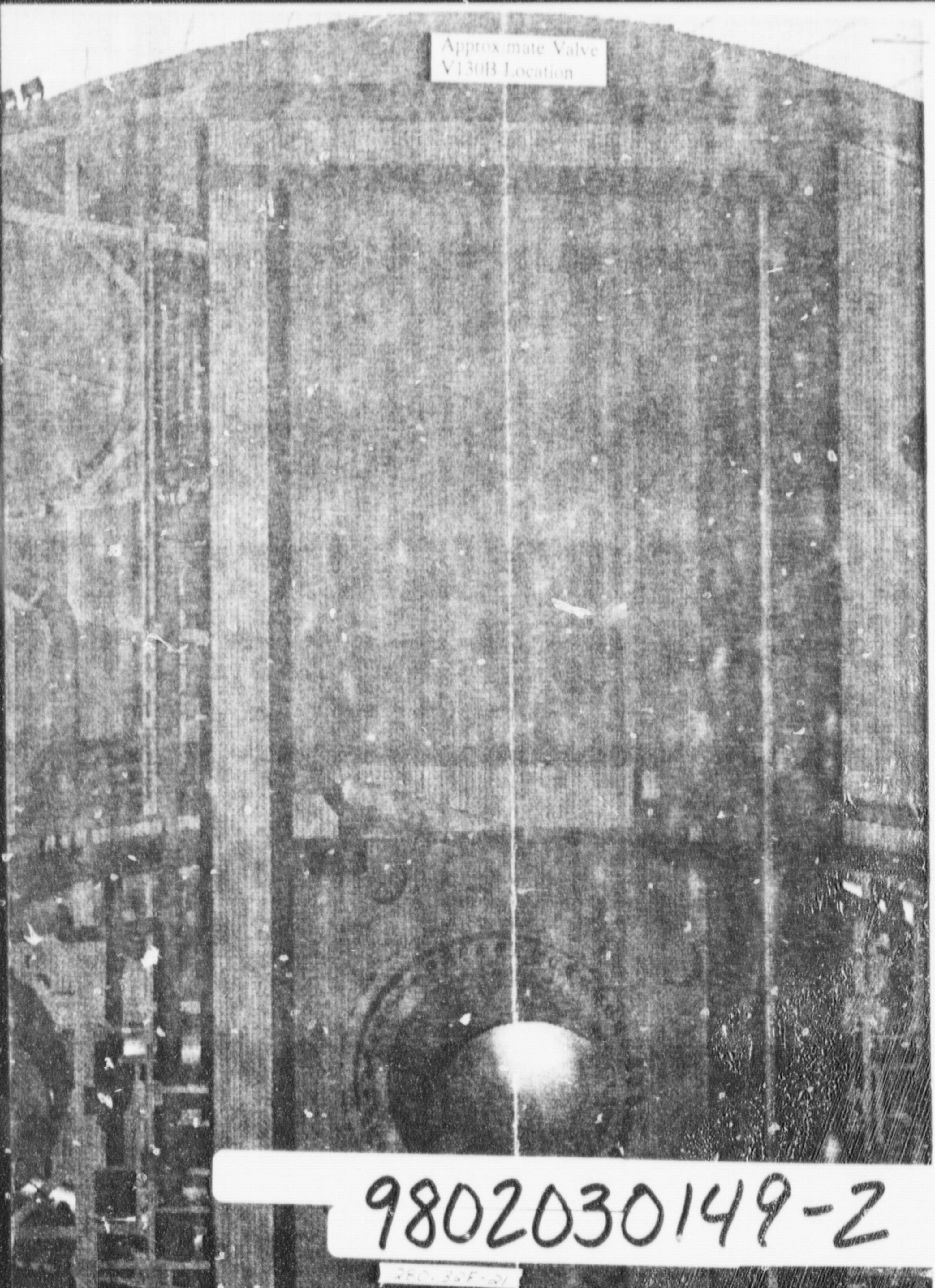


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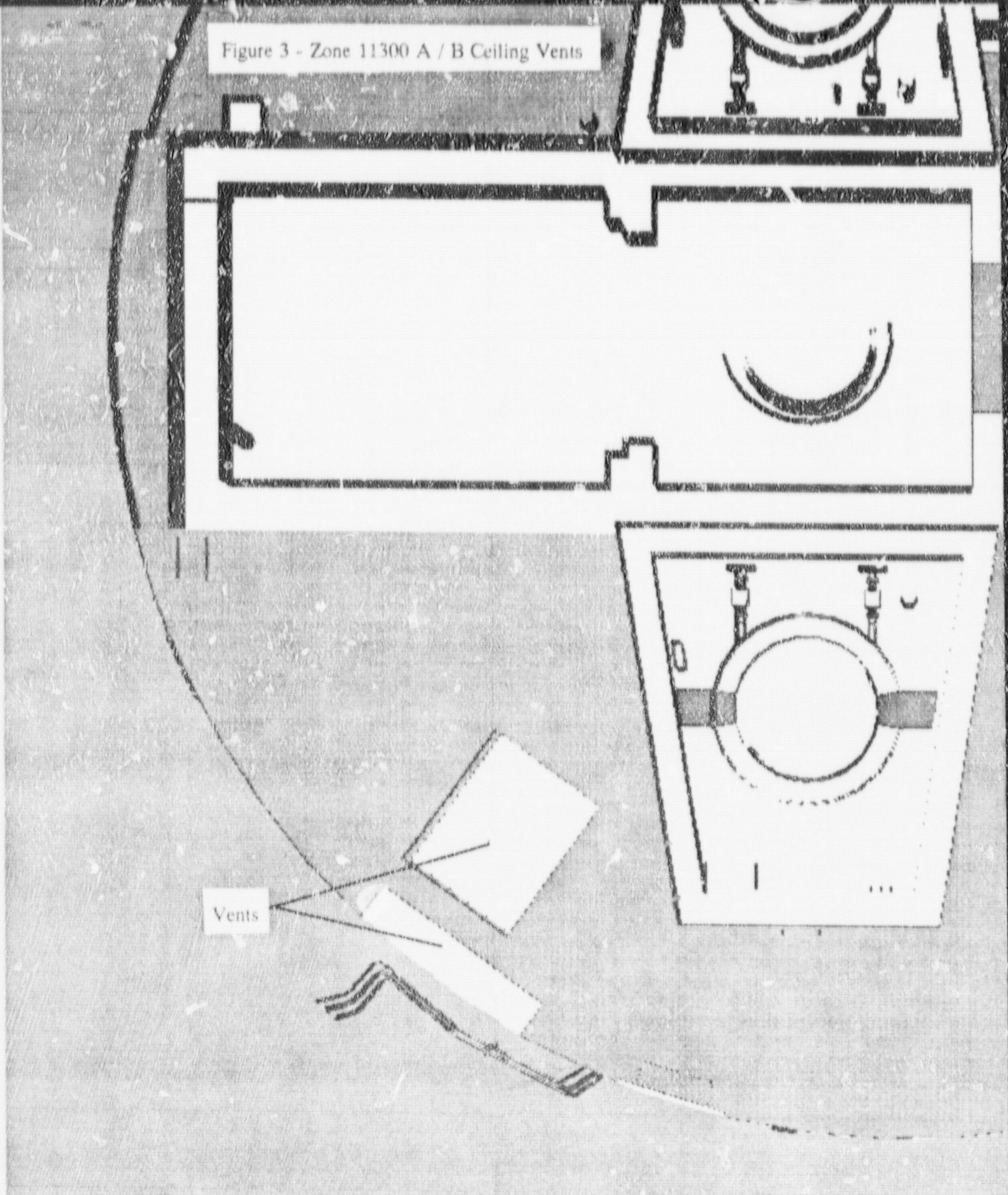
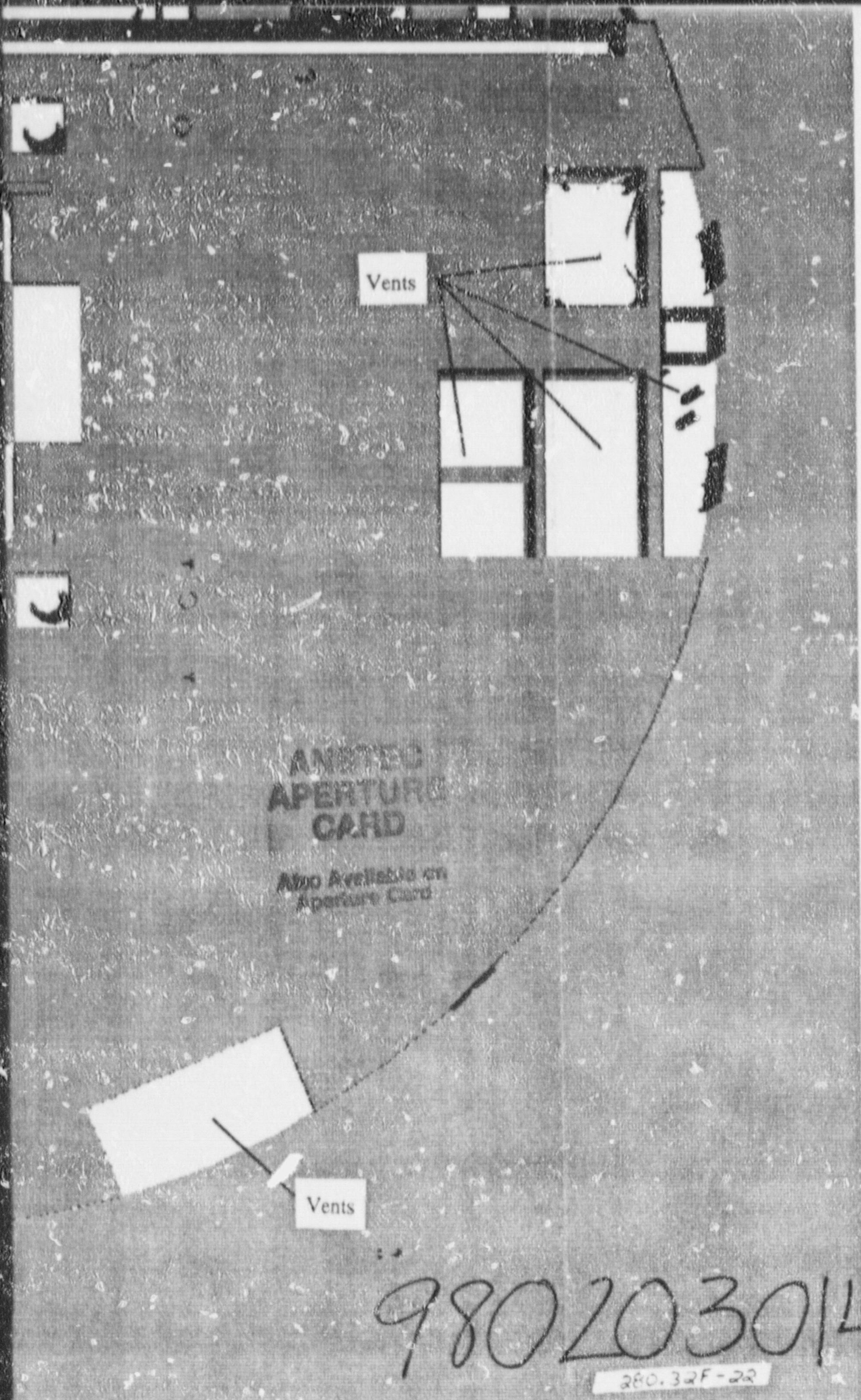
Figure 3 - Zone 11300 A / B Ceiling Vents





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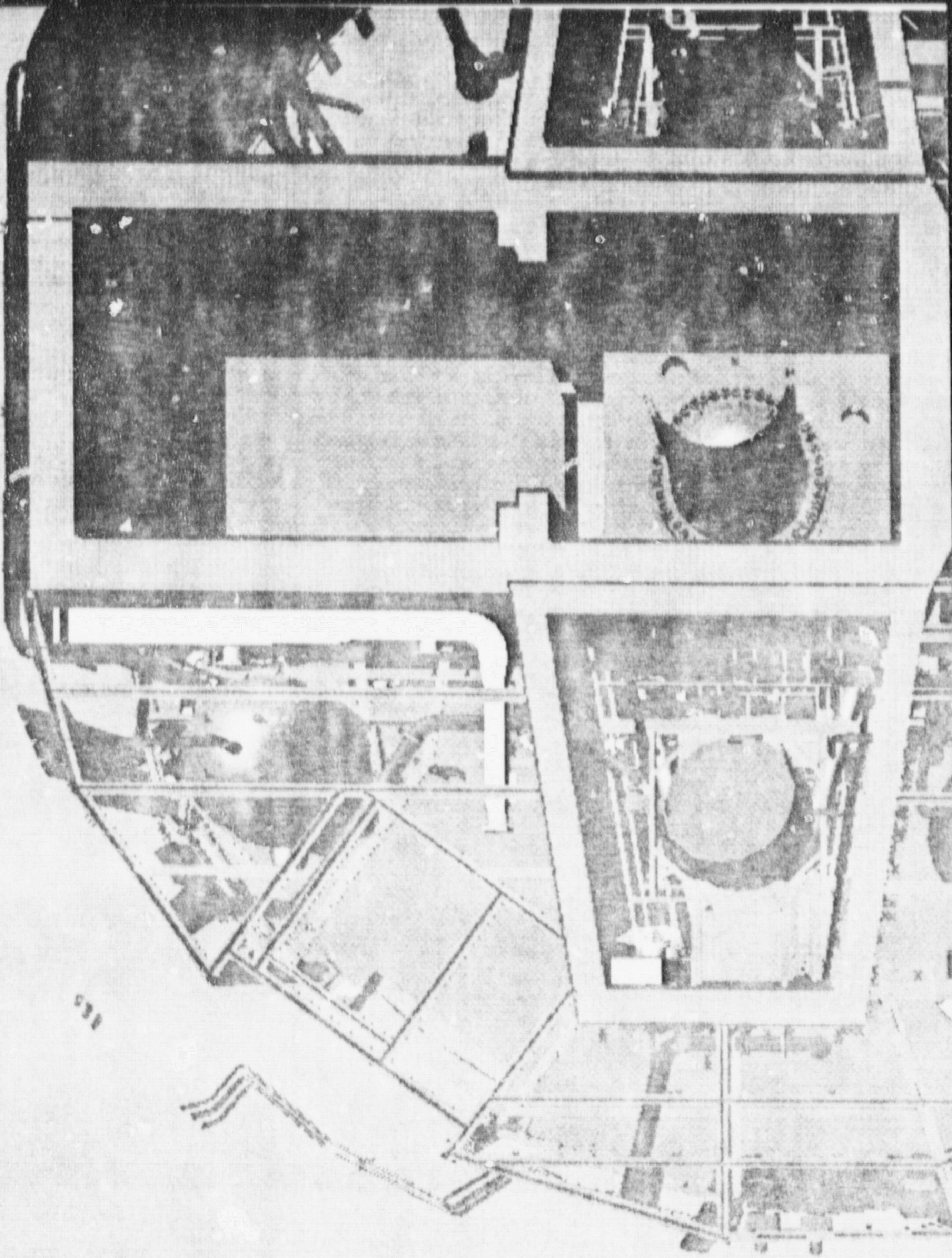
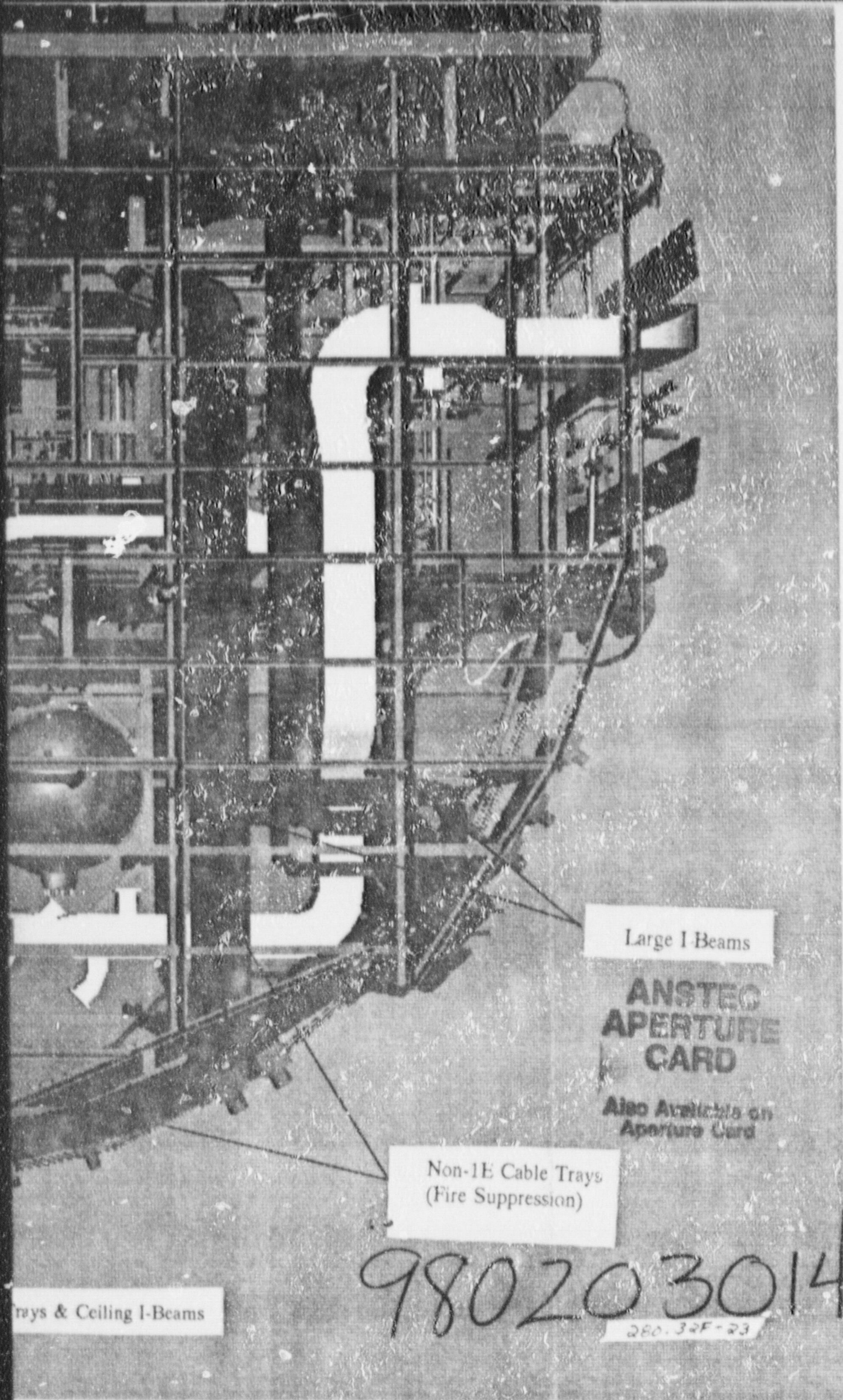


Figure 4 - Zone 11300 A,B Cable



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Question 410.339F (OITS 6194) REVISION 1 - See page 4

The system description, design parameters, and P&IDs are provided in Section 9.4.2, Table 9.4.2-1 through 9.4.2-7, and Figure 9.4.2-1, of the SSAR, respectively. Table 3.2-3 of the SSAR provides the classification of the annex/auxiliary buildings non-radioactive heating ventilation and air conditioning system (VXS) system and components. However, Westinghouse needs to provide the following:

1. updated P&IDs
2. a standard safety analysis report (SSAR) figure reflecting the updated P&IDs showing major instrumentation, and system interactions with other systems such as supply of the chilled and hot water as provided from the central chilled water system (VWS) and plant hot water system (VYS).
3. a figure for the ancillary diesel generator room showing air supply to and from the mechanical equipment room heating ventilation and air conditioning system (HVAC) subsystem.
4. SSAR table listing major subsystem component parameters for the VXS including air handling units, supply and exhaust fans, electric unit heaters and heating coils, and ancillary diesel generator room exhaust fan.
5. update SSAR Table 3.2-3 to include classification data for the ancillary diesel generator room exhaust fan and correct code data for filters and fans.
6. revise SSAR Section 9.4.2.2.2 to include descriptions for humidifiers, hot water unit heaters, and isolation dampers.
7. revise SSAR Section 9.4.2.2.3.5 to state that "To replace the filters of an air handling unit, the unit is stopped and isolated from the duct system by means of isolation dampers."
8. revise SSAR Section 9.4.2.2.1.3 to designate "reactor switchgear" as "reactor trip switchgear."
9. revise SSAR Section 9.4.2.2.3.1 to state that the served areas in the annex building are maintained at a positive pressure (state pressure) with respect to the adjacent areas during filter replacement mode.
10. revise SSAR Section 9.4.2.1.2 to provide the design temperature conditions for the elevator machine room and boric acid batching room.

Response:

1. VXS P&IDs (Rev. 5) will be forwarded to the NRC via separate correspondence.
2. Applicable updated SSAR figures for VXS are attached.
3. SSAR figure 9.4.2-1 (Sheet 5 of 5) is attached and has been revised to show the HVAC servicing the ancillary diesel.
4. SSAR Tables 9.4.2-1 and 9.4.2-2 provide major subsystem component parameters for the VXS defense-in-depth systems. Similar information requested for nondefense-in-depth components is considered to be excessive since basic information is already provided in the text. Also, there is no reason to control this nondefense-in-depth information in Tier 2. For these reasons, no change to the SSAR is necessary.
5. The exhaust fan for the ancillary diesel generator room provides ventilation for the diesel fuel stored in the area. The fan does not operate during operation of the ancillary diesel generator. "Ventilation and cooling for the room when the ancillary diesel generators operate is provided by means of manually operated dampers and opening doors to allow radiator discharge air to be exhausted direct to outdoors.", as noted in SSAR 9.4.2.2.1.5. For this reason, no change to the SSAR is necessary.

6. SSAR 9.4.2.2.2 will be updated to include descriptions for humidifiers, hot water unit heaters, and isolation dampers.
7. SSAR 9.4.2.2.3.5 will be revised to state, "To replace the filters of an air handling unit, the unit is stopped and isolated from the duct system by means of isolation dampers.", as requested.
8. SSAR 9.4.2.2.1.3 will be revised to designate "reactor switchgear" as "reactor trip switchgear.", as requested.
9. The general area HVAC subsystem will maintain a slightly positive pressure during filter replacement as ...d in the SSAR. A positive pressure exists because the supply air flow rate is maintained greater than the exhaust air flow rate. The reason for maintaining a positive pressure in this subsystem is to provide additional assurance that controlled access areas such as the health physics area are maintained at a negative pressure relative to other areas of the building. This is a nonsafety-related function Since the health physics and hot machine shop HVAC system normally maintains a slightly negative pressure by design, even if the general area HVAC subsystem is not operating, the controlled access areas would still be maintained at a negative pressure. For this reason, no change to the SSAR is necessary.
10. The design temperature conditions for the elevator machine room and boric acid batching room will be added to SSAR 9.4.2.1.2 as requested.

SSAR Revision:

1. None. However, forward VXS P&IDs (Rev. 5) to the NRC via separate correspondence.
2. Update SSAR figure information based on attached VXS figures.
3. Update SSAR figure 9.4.2-1 (Sheet 5 of 5) to show the HVAC servicing the ancillary diesel. (Attached.)
4. None.
5. None.
6. Update SSAR 9.4.2.2.2 to include descriptions for humidifiers, hot water unit heaters, and isolation dampers as follows:

   Just before the section entitled **Shutoff, Control, Balancing and Backdraft Dampers** add these three subsections:

   "***Humidifier***

   The humidifier is a packaged electric steam generator type which converts water to steam and distributes it through the supply duct system. The humidifier is performance rated in accordance with ARI 620 (Reference 13)."

Hot Water Unit Heaters

The hot water unit heaters consist of a fan section and hot water heating coil section factory assembled as a complete and integral unit. The unit heaters are either horizontal discharge or vertical downblast type. The coil ratings are in accordance with ANSI/ARI 410 (Reference 12).

Isolation Dampers

Isolation dampers are bubble tight, single- or parallel-blade type. The isolation dampers have spring return actuators which fail closed on loss of electrical power or loss of air pressure. The isolation dampers are constructed, qualified and tested in accordance with ANSI/AMCA 500 (Reference 14)."

7. Add the following to the end of the second paragraph of SSAR 9.4.2.2.3.5: "*To replace the filters of an air handling unit, the unit is stopped and isolated from the duct system by means of isolation dampers.*"
8. Revise SSAR Section 9.4.2.2.1.3 to designate "reactor switchgear" as "reactor *trip* switchgear."
9. None.
10. Revise SSAR Section 9.4.2.1.2 to add the following design temperature conditions at the end of the **Normal Operation** list:

Room or Area	**Temperatures (°F)**
Normal Operation	
"elevator machine room	*50-105*
boric acid batching room	*50-105"*

Note: This response deals with VXS and HVAC exhaust fans for VAS, VRS and VHS. These items are being addressed in this response as the result of a meeting between Westinghouse and the NRC held on 01/16/98 in Rockville.

Action W - Per Meeting Minutes:

Action W - W will provide additional figures as identified in open item. W will ensure that VXS describes the elevator machine room ventilation subsystem. W will ensure that descriptions of exhaust fans for areas where a negative pressure is required states that the fans can maintain the pressure (VAS, VXS, VRS, VHS). This status was established during an NRC/W meeting in White Flint on January 15 & 16, 1998.

Response: (Revision 1)

1. The additional figures are being addressed by the response to FSER Open Item 410.415F revision 1.

2. In the meeting, it was not clear where the SSAR described the elevator machine room ventilation subsystem. A review of SSAR 9.4 shows that the elevator machine room ventilation subsystem is adequately described in SSAR 9.4.2.2.3.3, Equipment Room HVAC Subsystem, last paragraph under Normal Operation. It states, "A temperature controller opens the outside air intake and starts and stops the elevator machine room exhaust fan as required to maintain room design temperature conditions. A local thermostat controls the electric unit heater."

3. The issue was that Westinghouse did not want to provide a specific sizing value for the exhaust fans and the NRC wanted to identify that the exhaust fans where adequately sized to allow the system to maintain the "negative pressure" when noted in the SSAR. It was agreed in the meeting that Westinghouse should review the SSAR and modify it where appropriate to state that the exhaust fans where adequately sized to maintain a negative pressure. Consistent with the agreement, changes to VAS, VRS, and VHS are shown below under "SSAR Revision". (Note: Since VXS does not keep the area at a negative pressure, no change to VXS is required.)

SSAR Revision:

1. See Response to FSER Open Item 410.415F, revision 1.

2. None.

3. Change VAS, VRS, and VHS as shown below:

A. Re: Radiologically Controlled Area Ventilation System (VAS)

9.4.3.2.1.1 Auxiliary/Annex Building Ventilation Subsystem 2nd para.

The two 50 percent capacity exhaust air fans ***sized to allow the system to maintain a negative pressure*** are located in the upper radiologically controlled area ventilation system equipment room at elevation 145'-9" of the auxiliary building. The exhaust air ductwork is routed to minimize the spread of airborne contamination by directing the supply airflow from the low radiation access areas into the radioactive equipment and piping rooms with a greater potential for airborne radioactivity. Additionally, the exhaust air ductwork is connected to the radioactive waste drain system (WRS) sump to maintain the sump atmosphere at a negative air pressure to prevent the exfiltration of potentially contaminated air into the surrounding area. The exhaust air ductwork is connected to the radwaste effluent holdup tanks to prevent the potential buildup of airborne radioactivity or hydrogen gas within these tanks. The exhaust fans discharge the exhaust air into the plant vent for monitoring of offsite airborne radiological releases.

9.4.3.2.1.2 Fuel Handling Area Ventilation Subsystem 2nd para.

The two 50 percent capacity exhaust air fans ***sized to allow the system to maintain a negative pressure*** are located in the upper radiologically controlled area ventilation system equipment room at elevation 145'-9" of the auxiliary building. The supply and exhaust ductwork is arranged to exhaust the spent fuel pool plume and to provide directional airflow from the rail car bay/filter storage area into the spent resin equipment rooms. The exhaust fans discharge the normally unfiltered exhaust air into the plant vent for monitoring of offsite airborne gaseous and other radiological releases.

B. Re: Radwaste Building HVAC System (VRS)

9.4.8.2.1 General Description 3rd para.

The exhaust air system consists of two 50 percent capacity exhaust centrifugal fans ***sized to allow the system to maintain a negative pressure***, an exhaust air duct collection system, and automatic controls and accessories. The airflow rates are balanced to maintain a constant exhaust design air flow through the fans. The exhaust fans are located in an equipment room on Elevation 100'-0" in the northwest corner of the radwaste building.

C. Re: Health Physics and Hot Machine Shop HVAC System (VHS)

9.4.11.2.1 General Description

The exhaust air system consists of two 100 percent capacity exhaust centrifugal fans ***sized to allow the system to maintain a negative pressure*** with ductwork and automatic controls, and a separate machine shop exhaust fan and high efficiency filter for exhausting from machine tools and other localized areas in the hot machine shop. The exhaust fans are located in the staging and storage area on elevation 135'-3" of the annex building. The machine shop exhaust fan and filter are located locally in the machine shop. The air flow rates are balanced to maintain a constant exhaust design air flow through the fans.

OITS: 4915
RAI: 480.873 Rev. 1

Please provide details of the calculations Westinghouse performed to assure that the evaporation-limited PCS flow is equivalent to using the actual PCS film flow with a time and elevation dependent coverage fraction.

Response:

The PCS film coverage model calculates the time and elevation dependent coverage, and the resulting evaporation rate that is input to the WGOTHIC code. The PCS film coverage model uses the actual flow rate delivered to the shell. The PCS film coverage model is described in Reference 480.873-1, Sections 7.3, 7.4, and 7.5.

Clarification Question 1 *- RAI response does not answer question. Provide the requested comparison.*

Response:

The question was based on methodology in WCAP-14407, Rev. 0, Section 7. The following response is consistent with methodology in WCAP-14407, Rev. 1.

The flow rate applied to the shell surface in the WGOTHIC model is called the evaporated flow rate. Time and elevation dependent coverage is calculated with a spreadsheet, as described in Section 7.5.1.3 of WCAP-14407 Revision 1, which involves an iteration with WGOTHIC on the shell heat flux. Note that for the first three hours when delivered PCS flow is at 440 gpm, coverage is assumed to be 90% of the vessel perimeter, conservatively based on the Water Distribution Test at 220 gpm equivalent delivered flow to the external surface of the shell. During the first three hours, evaporation does not cause the minimum film flow rate criterion of 120 lbm/hr-ft to be reached; thus, coverage is constant until well beyond the time that peak pressure is predicted to occur at about 20 minutes after initiation of the transient.

After three hours, the evaporated flow calculation (Section 7.5.1.3 of WCAP-14407 Revision 1) explicitly models time and elevation dependent coverage, with an iteration on WGOTHIC shell heat flux. The evaporated flow rate is then input to WGOTHIC along with a coverage area that assures the code will evaporate the applied flow. Sensitivities have been performed in which WGOTHIC evaporated all the water on (a) the dome only; (b) the sidewall only; or (c) evenly split between the sidewall and the dome. The sensitivities showed that WGOTHIC calculated pressure is not sensitive to the location that water was applied.

AP600

Clarification Question 2 - Received via email from D.C. Scaletti to B.Rarig 1/13/98

In the original RAI the staff requested Westinghouse provide analyses using the actual PCS flow rates not the limited evaporated flow rates to confirm that the two are identical or at least prove that the evaporated flow model is clearly conservative. The issues are identified in our interim FSER provided you on 12/31/97.

In the clarification response dated 1/6/98, the requested analyses are again not provided.

If Westinghouse does not provide these analyses to demonstrate that the two results are identical (as claimed) or that the evaporated flow model is clearly conservative, then we will apply (an as yet undetermined) penalty on the final SSAR pressure results. Both the LOCA and MSLB must be analyzed through the peak pressure period since the PCS is credited for both events.

Response:

The PCS film coverage model calculates the time and elevation dependent coverage and the resulting evaporation rate that is input to the WGOTHIC code. The PCS film coverage model is described in Reference 480.873-1, Sections 7.3, 7.4, and 7.5.

Sensitivity cases for the LOCA and MSLB pressure response were made using the actual PCS flow rate, instead of the evaporation limited PCS flow rate, in the WGOTHIC AP600 Containment Evaluation Model. Except for the PCS flow, these cases were run with the model described in Reference 480.873-1.

The actual PCS flow rate is greater than the evaporation limited PCS flow rate. The predicted peak pressure is lower for both the LOCA and MSLB cases using actual PCS flow rate. The peak pressure for each case is listed in the table below. The transient pressure comparison for each event is shown in Figures 480.837-1 and 480.873-2.

	Base Case	Full PCS Flow
LOCA	43.9 psig	43.8 psig
MSLB	44.8 psig	44.5 psig

Increasing the PCS flow rate in the evaluation model (from the evaporation limit) reduces the predicted pressure because additional heat can be removed through sensible heating of the additional flow.

References:

480.873-1 WCAP-14407, Revision 1, "WGOTHIC Application to AP600", July 1997, Westinghouse Electric Corporation.

SSAR Revision: NONE

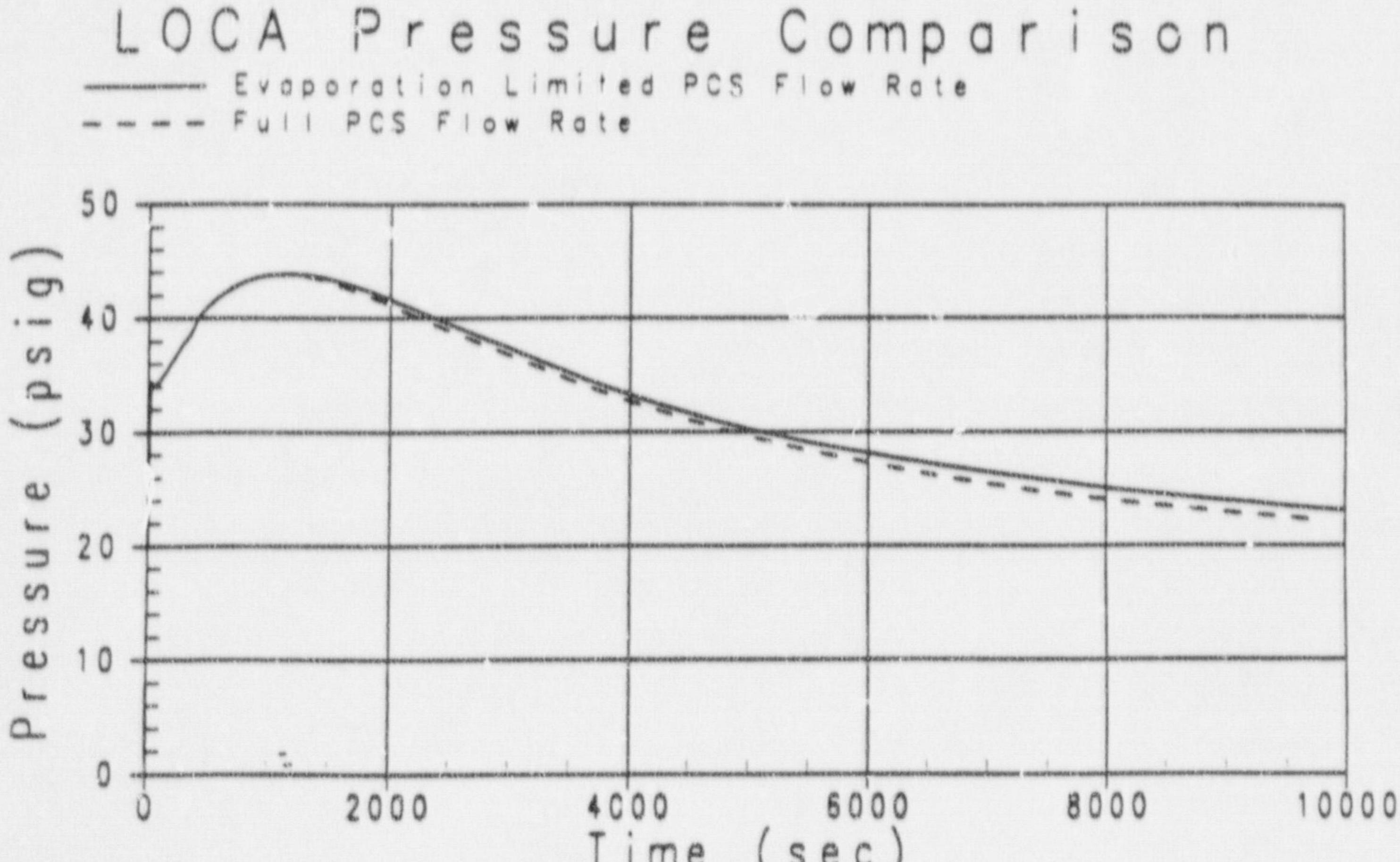


Figure 480.873-1

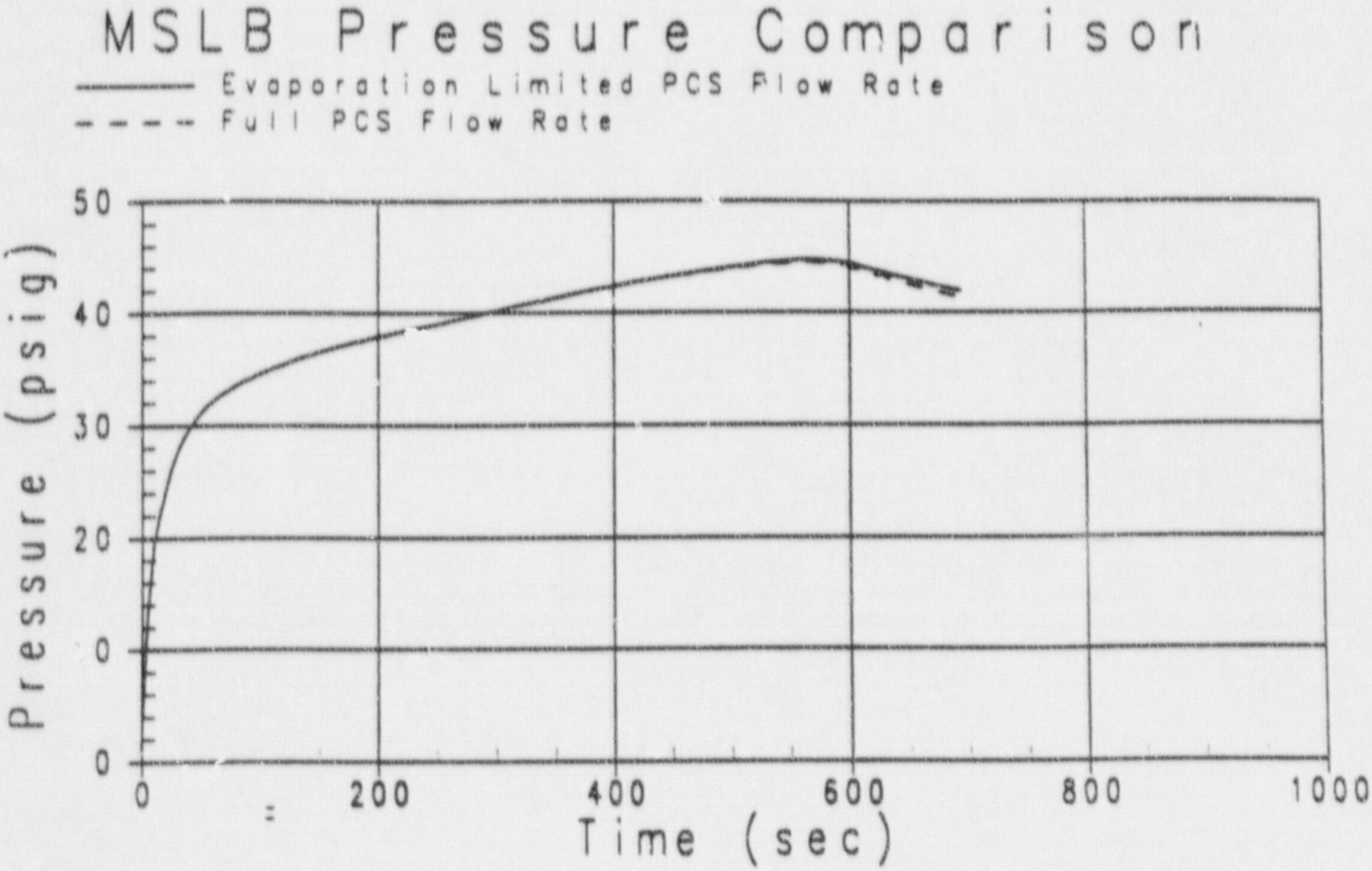


Figure 480.873-2

AP600

650.11F, Issue C-10 Effective Operation of Containment Sprays in LOCA (OITS #5973)
Revision 1

As discussed in NUREG-0933, Issue C-10 addressed the effectiveness of containment sprays to remove airborne radioactive material that could be present within the containment following a LOCA. This issue was expanded to include the possible damage to equipment located within the containment due to an inadvertent actuation of the sprays. This issue was resolved by SRP Section 6.5.2, "Containment Spray as a Fission Product Cleanup System," which references ANSI/ANS 56.3-1979, "PWR and BWR Containment Spray System Design Criteria.".

In a May 28, 1993, letter, Westinghouse stated that the AP600 design does not include a containment spray system for removal of airborne radioactive materials in the containment. Section 15.6.5.3 of the SSAR provides the details of the accident source term and mitigation techniques for the AP600 design. Status: Since issuance of the DSER, Westinghouse has committed to provide containment spray capability for mitigation of beyond design-basis-accidents. However, the design details have not been provided to the staff (Note: The design details have subsequently been provided by Westinghouse in draft form by letter NSD-NRC-97-5329, dated September 17, 1997). Therefore, this issue remains open until the design is submitted to the staff and the staff has the opportunity to evaluate the design.

Response:

The containment spray in the AP600 is provided to mitigate beyond design basis accidents. It is not credited in design basis safety analyses. Issue C-10 was revised in SSAR Revision 17, subsection 1.9.4.2.2 to note that the AP600 does not have a *safety-related* containment spray system. SSAR Revision 17 includes the SSAR changes identified in Letter DCP/NRC1039, dated September 17, 1997 to incorporate the nonsafety-related containment spray. Please note that the spray header shown on a separate sheet 4 of figure 9.5.1-1 in the markup was incorporated into sheet 3 of the SSAR figure.

The water for the containment spray is from the fire protection system. The source of the water in the fire protection system is the raw water system which provides the following water treatment before water is delivered to the fire water storage tanks: 1) ultraviolet pretreatment to kill biological organisms and disinfect the water, 2) addition of sodium hydroxide to maintain a pH of 5.8 to 7.5, 3) coagulation and clarification, and 4) filtration to remove silt and debris. No additional additives are added to the water for the containment spray.

Westinghouse actions on this item are complete.

SSAR Revisions:

NONE. The SSAR revisions were incorporated in SSAR Revision 17.

Question: 720.440F (OITS # 6178) Revision 1

Passive Containment Cooling System

Flooding of the PCS annulus due to plugging of the upper annulus drains is the only PRA-postulated mechanism for the failure of PCS cooling. The probability of plugging is minimized in the design by including two 100 percent drains, and a weekly surveillance of the annulus floor and drains to identify and eliminate debris that can potentially plug the drains. WEC has credited this surveillance in the PRA but has not incorporated it in the Technical Specifications. This is Open Item 720.440F.

Response:

Flooding of the PCS annulus due to plugging of the upper annulus drains is modeled in the AP600 PRA and was assigned a failure probability of 1.0E-04 per demand. In the PRA model, a weekly surveillance interval was considered. The technical specifications, on the other hand, specify surveillance every two years. In addition, the specific drain configuration has changed since the Level 2 PRA was revised in September 1996. As was modeled in the PRA, Revision 8, the drains were located in the floor of the annulus. However, the two 100 percent drain openings are now located in the side wall of the shield building with screens provided to prevent entry of small animals into the drains.

The fact that the surface area of the drains is vertical makes them less susceptible to clogging due to build-up of randomly collected debris, as compared to a configuration with horizontal floor drains. Thus, the drain configuration is more resistant to random plugging than a horizontal floor drain configuration, and would have a smaller failure probability. On the other hand, the technical specification surveillance interval is a factor of 100 above the assumed surveillance used in the PRA model. This change is deemed to have a negative effect compared to the PRA modeling assumption of a weekly surveillance. However, in the PRA failure probability estimate, no attempt was made to tie the estimated failure probability to the surveillance interval. A relatively conservative value of 1.0E-04 per demand was used. There is no systematic drain plugging mechanism envisioned. Thus, the demand failure rate is similar to a "shock failure" mode postulated in common cause failure (CCF) models. There is no need to revise this demand probability due to the revised drain configuration. However, the uncertainty in the failure rate increases due to the increased surveillance interval. The results of sensitivity studies performed to address this uncertainty for the PCS failure probability are summarized below:

PCS Failure Probability	LRF	Containment Effectiveness	LRF/CDF
0.0001 (base case)	1.82E-08	89.2 %	10.8 %
0.001	1.84E-08	89.1 %	10.9 %
0.01	1.97E-08	88.3 %	11.7 %
0.1	3.33E-08	80.3 %	19.7 %
1.0	1.69E-07	0.0 %	100 %

From the sensitivity analysis, it can be seen that a 10-fold increase in the PCS failure probability has negligible effect on large release frequency (LRF). Thus, if one looks at the upper uncertainty range of PCS failure probability with a factor of 10 increase, the LRF change would be negligible. This provides us the confidence to retain the original CCF estimate of 1.0E-04 per demand for the PCS drains to randomly plug.

As a conclusion, the AP600 PRA model estimate of failure for PCS horizontal drains to plug due to CCF is acceptable to represent the current AP600 design where the vertical drains with screens to prevent small animals from entering the annulus drains are inspected every two years. Thus, the plant risk is not affected by the design change or inspection times. Moreover, the uncertainty in the LRF is insensitive to a factor of 10 (even a factor of a 100) increase in the PCS failure probability, as demonstrated above.

Supplemental Question - Received via email from D.C. Scaletti to B.Rarig 1/8/98

In response to RAI 720.440F (OITS #6178), concerning the failure probability of the PCS (and the TS inspection interval) based on the upper annulus drains, Westinghouse has redesigned the PCS drains. Instead of being on the upper annulus horizontal floor, they are now located above the upper annulus floor elevation. Therefore, there will be an accumulated pool of water occupying the PCS air annulus region (while not stated in the submittal, I believe that the pool height will be about 1 foot, reducing the turning region to 5 feet in height).

Westinghouse needs to address the impact of this pool (which could be as cold as 40F) on the PCS performance, the air circulation rate. In addition, the holes in the shield building need to be addressed as they represent "leakage" into the air annulus region not previously considered.

Response to Supplemental Question:

The external PCS annulus drains are designed to limit the maximum depth of the pool of water, such that the distance from the bottom of the baffle to the top of the pool is at least five feet. The maximum pool level would be reached at 1902 seconds based on the fact that a pool 1 foot deep in the annulus occupies a volume of 1902 cubic feet (based on a 139 foot outside diameter and a 130 foot inside diameter for the annulus) and the PCS initial flow rate of just under 1 cubic foot per second.

The following discussion addresses 1) the effect of the pool on unrecoverable losses in the air flow path; 2) the effect of a cold pool on the temperature of air flowing through the annulus; and 3) the potential for the drain paths to affect buoyant air flow via leakage.

1) the effect of the pool on unrecoverable losses in the air flow path:

The effect of the pool on unrecoverable losses in the air flow path is negligible since the annulus riser flow area is 412 square feet and the downcomer flow area is 1490 square feet, as compared to the entrance area between the downcomer and riser of 2488 square feet with a six foot high opening and 2073 square feet with water partially blocking one foot of the annulus entry opening. The velocity through the entry area from the downcomer to the annulus is low and a rounded wall attachment exists at the bottom of the baffle, resulting in a form loss coefficient nearly equal to zero (Reference 720.440F-1, Section 4). With no pool, the downcomer-to-riser entrance area is 6 times the riser flow area, and with a one foot deep pool, the entrance area is still 5 times the riser flow area.

Therefore, even with the pool present, the velocity through the entrance area is still low, and the rounded wall entry will lead to a negligible loss through this region.

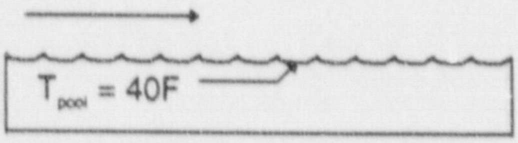
2) the effect of a cold pool on the temperature of air flowing through the annulus:

The presence of a cold pool and its effect on the buoyancy driven cooling of containment is negligible. Cooling by the pool could reduce the temperature of air flowing through the annulus. The effect can be bracketed by considering cooling of the minimum air flow rate through the annulus during periods where the containment is rejecting heat from the shell outer surface. Reference 720.440F-2, Figure 4-128, shows the air mass flow rate through the annulus calculated by the Evaluation Model for a LOCA. The figure shows that the external shell has begun to significantly heat up at about the same time that the external water is credited in the model, or about 337 seconds, when the air mass flow rate is at 120 lbm/sec. The figure also shows that as the containment shell continues to increase in temperature and evaporated steam is added to the flow, the air flow increases to reach a relatively steady value of 350 lbm/sec out to 5000 seconds. The influence of a cold pool on the temperature of the air would be maximized by considering the lower value of 120 lbm/sec of air flow.

The potential cooling effect of a pool of 40F water can be conservatively estimated by assuming
a) an air velocity across the pool equal to the annulus velocity – the actual velocity across the pool is 1/5 to 1/6 of the annulus velocity,
b) the maximum temperature difference of 120F air and 40F water.

T_{air} = 120F
P_{air} = 14.7 psia

V_{air} = 15 ft/sec



Total width of pool = 4.5 feet

Using the approach recommended by Holman (Reference 720.440F-3), and assuming unit depth into the paper in the above figure, the following calculation gives an upper bound cooling rate due to the pool.

$T_{boundary\ layer}$ = (120+40)/2 = 80F

Cp = 0.24 Btu/lbm-degF
ρ = 0.0735 lbm/cu.ft.
μ = 0.1241×10^{-4} lbm/sec-ft
Pr = 0.71
k = 0.015 Btu/hr-ft-degF

$Re_L = (\rho v_{air} L)/\mu = 4x10^5$

Since Re_{crit} for flow across a flat plate is $5x10^5$, the heat transfer will be laminar. Since the total heat transfer coefficient for laminar flow across a flat plate is equal to twice the heat transfer coefficient at x = L, the total Nusselt number, Nu_L is given by

$Nu_L = 2Nu_{x=L} = 2 [0.332 Pr^{1/3} Re_L^{1/2}] = 375$

Now the total average heat transfer coefficient, h, is given by

$Nu_L = hL/k = 375$

Therefore, a conservatively high value for h is 1.3 Btu/hr-sq.ft.-degF.

Using a pool surface area of 1902 square feet and a temperature difference of 80F, the cooling rate of the pool is estimated to be less than 55 Btu/sec.

To put pool cooling into perspective it is useful to compare the pool cooling rate to the energy removal rate by the PCS, approximately 37000 Btu/sec. The pool cooling is < 0.2% of the energy delivered to the riser annulus by the PCS. Thus, the effect of the cooling due to the annulus pool water is judged a negligible energy sink.

The effect of pool cooling on the annulus air temperature and thus its buoyancy can be bracketed by considering the maximum cooling rate and the minimum air flow: $\Delta T_{air,max}$ = (55 Btu/sec)/(120 lbm/sec)/(0.24 Btu/lbm-degF) = 1.7F. The density effect of such a decrease in the air temperature entering the annulus is small compared to the total density change in the riser annulus, which is due to both sensible heating of the air and the addition of low molecular weight steam. The effect of the temperature change alone on density is related to the absolute temperature change, which is [1- (459.7+118.3)/(459.7+120.0)]*100 < 0.3%. Since the density change is very small and is only effective over a few feet at the bottom of the annulus, and since the velocity is related to the square root of the density change over a given height, the effect on buoyancy driven air flow is negligible.

It should also be noted that the cool, 40F, PCS water applied to the AP600 containment would provide improved energy removal relative to the DBA Evaluation Model which assumes the PCS water is applied at 120F.

3) the potential for the drain paths to affect buoyant air flow via leakage:

Any ambient air flow coming into the downcomer through drain paths near the bottom of the annulus would only provide additional cool air at the bottom of the annulus. Baffle leakage paths, from the downcomer to the riser at an elevation near the top of the downcomer, are modeled in the Evaluation Model because of the potential for short circuiting of the annulus flow. Because of the geometry and location of the drains, there would be no short circuiting of the annulus flow.

It is concluded that the presence of a pool up to one foot in depth in the external PCS annulus has a negligible impact on PCS performance.

References:

720.440F-1 Stewart and A.T. Pieczynski, "Tests of Air Flow Path for Cooling the AP600 Reactor Containment," WCAP-13328, 1992, Westinghouse Electric Company

720.440F-2 WCAP-14407, Rev. 1, "WGOTHIC Application to AP600," July 1997

720.440F-3 J.P. Holman, Heat Transfer, Third Ed., McGraw-Hill Book Company, New York, 1972, pp 148-154.

SSAR Revision: None.

PRA Revision:

The following change on page 40-2 of PRA Chapter 40, Passive Containment Cooling, will be made in PRA Revision 11: **[note the redline/strikeout of the changes below were provided in Rev. 0 response to this open item; no changes have been made as a result of this Rev. 1 response]**

> There are two ***100 percent*** drains in the ~~floor of the annulus~~ ***vertical wall of the shield building.*** ~~Weekly~~ Surveillance of these ***drains*** is performed ***every two years***. One drain is sufficient to prevent overflowing of the passive containment cooling system to block the air inlet.
>
> The probability, q(PC), of failure of the PC event tree node due to the drain plugging is considered to be a rare event due to the following considerations:
>
> - The annulus is shielded from random accumulation of debris that may potentially plug the drains.
> - ***The drains are located on the shield building vertical wall above the annulus floor, and have screens to prevent small animals from entering the drains.***
> - ~~Surveillance is performed often enough, once a week, to remedy any plugging potential.~~
>
> There are no data on this failure mode. Even if it is assumed that both drains will plug once during the plant lifetime, the failure probability would be 5E-04 per week, for a 40-year plant lifetime. ~~If the weekly surveillance is omitted or it misses the failure mode with a probability of 0.01 per surveillance opportunity, the probability of the failure continuing into a second week would be 5E-06.~~
>
> Based on the rarity of this failure mode and engineering judgement, a failure probability of .0001 is assigned to the PC node, given that a core damage event has occurred.
>
> q(PC) = 1E-04.

Figure 40-2 of PRA Chapter 40, Passive Containment Cooling, will be revised in PRA Revision 11 as shown on the next page.

Question: 720.441F (OITS #6179) Revision 1

Reactor Cavity Flooding System:

The IRWST injection squib valves are diverse from the containment recirculation squib valves. Diversity between these valves is specified in SSAR Section 6.3.2.2.8.9, but the criteria for confirming that diversity has been achieved is not provided. This needs to be addressed by ITAAC. This is Open Item 720.441F.

Response:

As stated in SSAR subsection 6.3.2.2.8.9, the IRWST injection squib valves are diverse from containment recirculation squib valves because they are designed to different design pressures. The following discussion, taken from AP600 PRA subsection 12.5.1, further explains the diversity:

> "The squib valves in the recirculation lines are normally in a different environment than the squib valves in the injection lines. The injection line valves have reactor coolant system pressure on one side and the pressure head of the IRWST on the other side. These valves are designed to withstand and open under this type of load.
>
> The recirculation squib valves have the head of the IRWST on one side and the containment atmosphere pressure on the other side. These valves do not have to support the reactor coolant system pressure, nor do they have to open under such conditions"

Thus, the IRWST injection squib valves are designed to withstand high pressure of approximately 2500 psig whereas the recirculation squib valves are designed for a lower pressure of approximately 150 psig. Because these two sets of squib valves are designed to withstand different design pressures, the thickness of some of the valve components and the size of the propellant charges are different. Because of these differences, the IRWST injection squib valves are diverse from the recirculation squib valves.

Because diversity is derived from the difference in design pressures and operating conditions, there is no need for an ITAAC.

NRC Follow-on Question (from Enclosure 6 of NRC letter dated January 7, 1998):

The IRWST injection squib valves are claimed to be diverse from the containment recirculation squib valves because they are exposed to and designed to open against different system pressures. As such, the thickness of some of the valve components and the size of the propellant charges are different. Although the difference in the valve design pressure provides some degree of diversity, other failure mechanisms could affect both valves, such as: (1) failure of the valve actuation signal or power supply, (2) maintenance or surveillance errors, particularly if maintenance is performed by the same crew, and (3) failure of the propellant charges due to defects in the chemical composition or environmental/aging effects, particularly if charges from the same supplier and batch are used in both valves. Additional mechanisms or administrative controls to minimize the potential for such common cause failure modes should be identified.

Response to follow-on question:

1. Common cause failure (CCF) of the actuation signal and the actuation power supply for these squib valves is treated separately in the PRA. The possibility of such a CCF occurring is quantified in the PRA. Note that DAS actuates these valves such that CCF of the PMS does not fail either the IRWST injection or the containment recirculation squib valves. Also note that the power supply for these squib valves is the Class 1E dc power supply.

2. CCF maintenance errors on squib valves are considered incredible because of the simplicity of squib valves which require very little / infrequent maintenance and because of the effectiveness of continuity in-service testing. Maintenance errors on AOVs or MOVs which are more complicated valves and require more frequent and extensive maintenance are more probable than maintenance errors on squib valves.

3. CCF of the propellant and environmental / aging effects are also considered incredible. This concern is similar to a concern over CCF of all MOVs caused by bad grease or environmental / aging effects. Such basic elements of components are not considered as credible CCF and are not typically considered within traditional PRA CCF analysis.

Given the above, additional mechanisms or administrative controls to minimize the potential for such common cause failure modes is not necessary.

Revisions:	SSAR	None.
	PRA	None.
	ITAAC	None.