GPU Nuclear

GPU Nuclear Corporation
Post Office Box 480
Route 441 South
Middletown, Pennsylvania 17057-0191
717 944-7621
TELEX 84-2386
Writer's Direct Dial Number:

April 30, 1984
5211-84-2099

Office of Nuclear Reactor Regulation
Attn: John F. Stolz, Chief
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Sir:

Three Mile Island Nuclear Station, Unit (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Control Room Habitability (III.D.3.4., NUREG 0737)

Due to your letter of December 28, 1983 and in subsequent conversations with members of your Staff, GPUN committed to providing additional information on the protection of control room personnel from on-site gaseous hazards of ammonium hydroxide, chlorine and radiation. Since the NRC has accepted our previous evaluations for off-site hazards, GPUN has undertaken testing and analysis during the first quarter of 1984 to determine the adequacy of the existing TMI-1 Control Building Ventilation System (CBVS) to protect control room personnel from these on-site gaseous hazards. The results of the evaluation indicate that the following modifications will adequately protect the control room operators: (See Attachment I for evaluation criteria)

A. To eliminate ammonium hydroxide as a hazard for control room operators in the event of a rupture of the ammonia tank, GPUN will construct a 2 ft. high dike around the 7000 gal. NH_4OH tank to provide a maximum surface area of 550 sq. ft. We anticipate completion of this modification by January, 1985. This modification will prevent the level of ammonium hydroxide from exceeding 100 ppm in the control room under the "worst" case meteorological conditions.

A046
1/1

In the interim, we have concluded that the probability of a tank rupture is sufficiently low as documented in our earlier submittal of July 16, 1982.

With regard to hazards associated with NH_4OH deliveries, during the time when TMI-1 was operating, there was only one delivery in a four year period. Although the probability of an accident associated with delivery is low, we will institute an administrative procedure to govern the movement of the truck to assure that the truck will remain as far away from the air intake structure as practical.

B. For the chlorine gas hazard, GPUN will install redundant chlorine detectors at the river water pump house and air intake structure. Issuance of the construction package is expected by March 1985, with installation dependent upon plant availability. GPUN will not install those detectors with known previous operation problems (such as the wick type). The specifications for the detection system are: 1) the chlorine detectors must respond within 10 seconds; 2) the signal from these detectors will isolate the CBVS, including fans and dampers required to isolate the CBVS; and 3) an additional signal from these detectors will provide an alarm and readout in the control room. These detector specifications will allow sufficient time for the operators to don emergency air breathing apparatus since the chlorine concentrations in the control room for the first 2 minutes after actuation of the alarm, will be essentially 0 ppm.

Similarly, as with deliveries of NH_4OH, GPUN will institute administrative procedures to control chlorine deliveries.

In the interim, prior to completion of the modification, we have concluded that the probability of a chlorine accident is sufficiently low for the chlorine hazard. We discussed this low likelihood in our earlier submittal of July 16, 1982.

C. For the radiation hazard, the evaluation indicated no need for additional modifications. The analysis revealed that the CBVS could have up to 12,000 cfm outside air inleakage without exceeding the maximum dose limitations. Furthermore, recent testing of the TMI-1 CBVS has demonstrated that the air inleakage past the main intake damper into the protected zone which includes the control room, was 3000 cfm nominal, in the emergency operating mode (100% recirculation). Under these conditions, the control room is under positive pressure.

Attachment II elaborates on the above by providing the assumptions, bases and conclusions of this recent evaluation.

We have provided in Attachment III, a brief description of the TMI-1 CBVS. Because the TMI-1 CBVS is unique, we feel this description will illustrate the salient features of the system that tend to mitigate the effects of any potential gaseous hazards, such as the length of the intake tunnel. The 455 foot long tunnel allows a significant time delay for the ingress of radiation and gaseous hazards.

Furthermore GPUN, as discussed with members of your Staff on April 19, 1984, will undertake a Failure Mode and Effects Analysis (FMEA) to confirm that no single active component failure could compromise the functions of the system to such an extent that the acceptance criteria for any of the three hazards is exceeded. Where appropriate, the analysis will take credit for operator action. The FMEA and the associated analyses will also indicate additional modifications, if any, that are required for the system to assure its operability under all design conditions. We anticipate completion of the FMEA by September, 1984. We will inform the NRC of the results and schedule of modifications, if any, by November, 1984.

Attachment IV provides a summary of the test results conducted on the TMI-1 CBVS where a positive pressure was maintained in the control building envelope which includes the control room. GPUN also plans to increase the leaktightness of the protected zone including the control room by adding seals and gaskets to the doors as long as the UL labeling of these fire doors are not compromised.

We trust that this information will provide you with the assurance that the TMI-1 control room operators can be adequately protected from gaseous hazards in accordance with the requirements of NUREG 0737 III.D.3.4.

Sincerely,

H. D. Hukill
VP - TMI-1

cc: J. Van Vliet
R. Conte

ATTACHMENT I

TMI-1 CONTROL ROOM HABITABILITY EVALUATION CRITERIA

An analysis of the habitability of the Three Mile Island Unit 1 control room has been performed by Pickard, Lowe & Garrick (PLG)* for radiological hazards posed by the design basis loss of coolant and fuel handling accident and for toxic gas hazards posed by ruptures of ammonium hydroxide and chlorine stored on site. These analyses were conducted using the guidance contained in SRP 6.4, and Regulatory Guides 1.4, 1.78 and 1.95. Where models were not given in these documents or were inappropriate due to particular design features at TMI Unit 1, appropriate and conservative models, described below, were used.

For the radiation dose model, the Murphy-Campe model prescribed by SRP 6.4 was used for meteorological modeling for the Design Basis LOCA, using site data for the year July 1976 through June 1977 for input. The particular model used was that given in Section V-B.1.b of the Murphy-Campe paper for a diffuse source-point receptor situation. The model assumed for the fuel handling accident was the most conservative possible; the entire release was assumed to enter the control building ventilation system. Modeling of flow within the control room is not prescribed by Murphy-Campe, hence an intercompartmental flow model assuming three well-mixed compartments with provisions for filtration was developed. Also an energy dependent geometry factor is used instead of equation (9) of the Murphy-Campe method. It is assumed that no outside air infiltrates, since the wind direction would need to be considerably different (more than 45 degrees) to reach the control building instead of the intake structure which would effectively preclude it from reaching both at the same time. A filter efficiency of 90% for iodine was used in the analysis, even though tests indicated that the filters employed have efficiencies in excess of 99%.

The values for atmospheric dispersion were determined by Dr. James Halitsky (an acknowledged expert in the field of atmospheric dispersion and one of the authors cited in the Murphy-Campe paper). The value used for chlorine from the river water chlorinator is very close to the value from equation (5) of the Murphy-Campe paper when credit is taken for initial expansion of the chlorine puff (Regulatory Guide 1.78, Appendix B) and when averaging is done over the effective size of the intake vent (i.e., the crosswind cross-sectional area from which the intake flow is drawn). For the other two spill sites, the Unit 1 chlorinator and the ammonium hydroxide

*Pickard, Lowe and Garrick, Inc. has provided engineering consulting services to the electric power industry since 1956. PLG services include power plant performance and risk analysis, plant operations, and maintenance, nuclear fuel analysis and management, environmental monitoring and site analysis, and management consulting.

storage tank, the values calculated by Dr. Halitsky are somewhat lower than those calculated assuming that no buildings intervene. This is due to the fact that the plumes must pass over the tops of the service building (from the Unit 1 chlorinator) or the turbine building (from the ammonium hydroxide storage tank) and drop more than 30 meters to reach the intake vent. This substantially increases the dilution of the toxic gas.

For the river water chlorinator, the increasing wind speed serves to dilute the chlorine, but also decreases the time required for the plume to reach the intake tunnel structure. A critical question is thus whether the intake damper is able to close before the chlorine reaches it. These are the critical questions in determining if the operators will have the required two minutes to put on breathing equipment before a substantial amount of chlorine (15 ppm by volume) reaches the control room. To analyze both parts of this question, wind speeds of both 1.0 meter per second and 3.0 meters per second were used in the analysis. These are bounding wind speeds for westerly winds at TMI. For the river water chlorinator, a detector with 10 second delay time at the intake structure was assumed. In both cases, CBVS ventilation is turned off on a high chlorine signal, and alarms are activated to alert the operators. No detection is assumed for ammonia. A control building ventilation model assuming three well mixed compartments (at the three elevations) is used. No credit is taken for filtration.

The codes used in this analysis are all PLG proprietary. They are: HYDROS, for analyzing releases from large-break LOCAs; CRDOSE, for analyzing control room flows and doses; NH3VAP, for analyzing evaporation of ammonia from pools; CHLORVAP, for analyzing chlorine ruptures and evaporation; and CRCONI, for analyzing the behavior of a toxic gas in an intake tunnel and the resulting control building concentrations of the toxic gas.

TABLE 1

Chlorine Concentrations in TMI Unit 1
Control Room Two Minutes After Alarm Sounds

Spill Location	Detector Location	Wind Speed (m/s)	Concentration Two Minutes After Alarm Sound, parts per million
River Water Chlorinator	At Spill	1	0.0
River Water Chlorinator	At Spill	3	0.0
Unit 1 Chlorinator	At Intake	1	0.024
Unit 1 Chlorinator	At Intake	3	0.007

For all cases, detection in 10 seconds after the concentration reached is assumed, followed by the automatic shutdown of CBVS ventilation until operators have put on breathing apparatus. A 2400 cfm intake flow rate is estimated in the interim which reflects a flow with the Normal Supply fan running and dampers shut. This value is a conservative assumption due to the fact that the Normal Supply would be shutoff during isolation.

ATTACHMENT II

A. AMMONIUM HYDROXIDE HAZARD

BASES OF ANALYSIS:

- The Control Building Ventilation System (CBVS) was assumed to be in the normal mode of operation with 9 Air Changes/Hour (Economizer Mode). Normal Supply Fan (AH-E-17A or B) and Return Fan (AH-E-19A or B) are running and Intake Damper (AH-D-39), Elevation 306 Supply Damper (AH-D-28) and Exhaust Damper (AH-D-37) are open. Recirculation Damper (AH-D-36) is allowed to modulate.

- The Unit 1 7000 gallon Ammonium Hydroxide Tank is full when the spill occurs (See Figure 1 for location).

- A dike surrounding the Unit 1 tank limiting the evaporation surface area to a maximum of 575 square feet is assumed. The dike height of 2' is sufficient to completely contain the 7000 gallons within the tank.

- The Unit 2 Ammonium Hydroxide Tank is assumed to be empty (See Figure 1 for location).

- The worst case meteorological conditions resulting in the highest ammonia concentration were used.

RESULTS:

Figure 2 graphically depicts the results of the analysis using the normal operation system configuration and worst case meteorological conditions. The acceptance criteria requirements of 100 ppm for 30 minutes, or 500 ppm for 10 minutes, are not exceeded in the Control Room with the utilization of a Dike around the Unit 1 tank, and the Unit 2 tank drained.

REQUIRED MODIFICATIONS:

- The TMI-1 Ammonium Hydroxide Tank will be provided with a seismic reinforced concrete dike, approximately 8" thick, that will have a volume capacity of 7000 gallons or greater. The dike will be sized to limit the evaporation surface area to a maximum of 550 square feet.

- The TMI-2 Ammonium Hydroxide tank will be drained.

- Administrative procedure governing the movement of the truck delivering ammonium hydroxide will be implemented to assure that it remains as far away from the Air Intake Structure as practical.

B. RADIATION

BASIS OF ANALYSIS:

- The worst case design basis radiation release accident (LOCA) was used in the analysis for determining integrated dose. The ES signal resulting from the LOCA automatically shuts off/closes the Normal Supply Fan (AH-E-17A or B), Return Fan (AH-E-19A or B), Intake Damper (AH-D-39), Elevation 306 Supply Damper (AH-D-28), and Exhaust Damper (AH-D-37), and thus, isolates the Control Room. The Emergency Supply Fans (AH-E-18A or B) and Return Fan (AH-E-19A or B) used for ventilation recirculation and Damper (AH-D-36) are manually operated by the operator prior to unfiltered radiation reaching the system. The Intake outside air flow during Emergency mode operation was determined to be 3000 cfm during system tests made 4/10/84 and 4/11/84 (See Attachment IV).

- The analysis used 4 shift rotation (8 hr/shift).

- Positive Pressure in the Emergency Envelope is maintained and filter efficiency is 90% during the 30 day period.

RESULTS:

Figures 3, 4, and 5 graphically depict the integrated dose for the 4 shift operator rotation. The first shift of operators experience the highest 30 day integrated dose. The analysis indicates that up to 12,000 cfm outside air inleakage would not exceed the maximum dose limitations for the first shift operators. The outside air inleakage during testing of 4/10/84 with the system operating in Emergency mode equalled 3000 cfm (See Attachment IV).

MODIFICATIONS:

None required based on the above analysis.

C. CHLORINE

BASIS OF ANALYSIS:

- A Chlorine detection system will be installed that automatically shuts off/closes Normal Supply Fans (AH-E-17A or B), Return Fans (AH-E-19A or B), Intake Damper (AH-D-39), Elevation 306 Supply Damper (AH-D-28) and Exhaust Damper (AH-D-37). Recirculation Damper (AH-D-36) is automatically opened. The Chlorine detection system will be comprised of redundant detectors at the River Water Pump House (RWPH) Chlorinator House (See Figure 1 for location), and the Air Intake Structure.

- The detectors will initiate the above actuations and alarm in the control room within 10 seconds after the spill/release.
- The Control Room Operator will don Emergency Air Breathing Apparatus prior to activating the Emergency Recirculation Mode at which time the outside air inleakage will equal 3000 cfm.
- The outside air inleakage prior to Emergency Mode activation is equal to 2400 cfm (estimated with all dampers shut and supply fans running). This represents a conservative estimate of flow in that the supply fan is shutoff with the isolation signal.
- Worst case meteorological conditions were assumed.
- A Damper closing time of 10 seconds was assumed.

RESULTS:

For all wind speeds coincident with worst case meteorology, there is essentially 0 ppm of chlorine concentration in the Control Room 2 minutes after alarm signal.

MODIFICATIONS:

- Install redundant chlorine detectors at RWPH Chlorinator House and the Air Intake Structure with required isolation between safety-related and non-safety related positions of the overall system. This also includes cabling for alarms and fan/damper interlocks with the Chlorine Detection System.

ATTACHMENT III

The TMI-1 CBVS has unique features that quantitatively and qualitatively enhance the protection of Control Room Operators. The simplified flow diagram (Figure 6) depicts the fail safe positions of the emergency boundary envelope dampers. Intake (AH-D-39), Exhaust (AH-D-37), and Elevation 306 Supply (AH-D-28) dampers all fail in the closed position. Recirculation damper (Ah-D-36) fails in the open position. These failed positions represent the isolation/recirculation mode of the CBVS.

The Air Intake tunnel is 455 feet long which provides a long residence time for any gas entering the Air Intake Structure. Coupling this feature with the bends and louvers in the openings on all sides of the Air Intake Structure, released gases will have to traverse a long and winding course, resistant to wind forces during system isolation.

Due to the geometric arrangement of the Control Building, Air Intake Structure, and Radiation source (See Figure 1), the arrival of radioactive gas at these points at the same time is precluded. The Control Building and Air Intake Structure are 350 feet and 70^{o} azimuthally apart.

The CBVS is monitored via the H&V control panel in the Control Room. Each of the Normal Supply Fans (AH-E-17A/B), Emergency Supply Fans (AH-E-18A/B) and Return Air Fans (AH-E-19A/B) has an indicator of the operational status. Intake Damper (AH-D-39), Exhaust Damper (AH-D-37), and Recirculation Damper (AH-D-36) position are combined for indication of Normal or Recirculation Mode. Elevation 306 Supply Damper (AH-D-28) is separately monitored for status (open/shut conditions). Intake Damper (AH-D-39) open or closed position is also indicated on the ESAS panel in the control room.

ATTACHMENT IV

SUMMARY OF TEST RESULTS

Tests were conducted on April 10 and 11, 1984, during the 11:00 pm to 7:00 am shift for the Control Building Ventilation System (CBVS) to establish the following:

1. Outside air leakage past the main damper at the intake air tunnel with CBVS operating in Emergency mode.

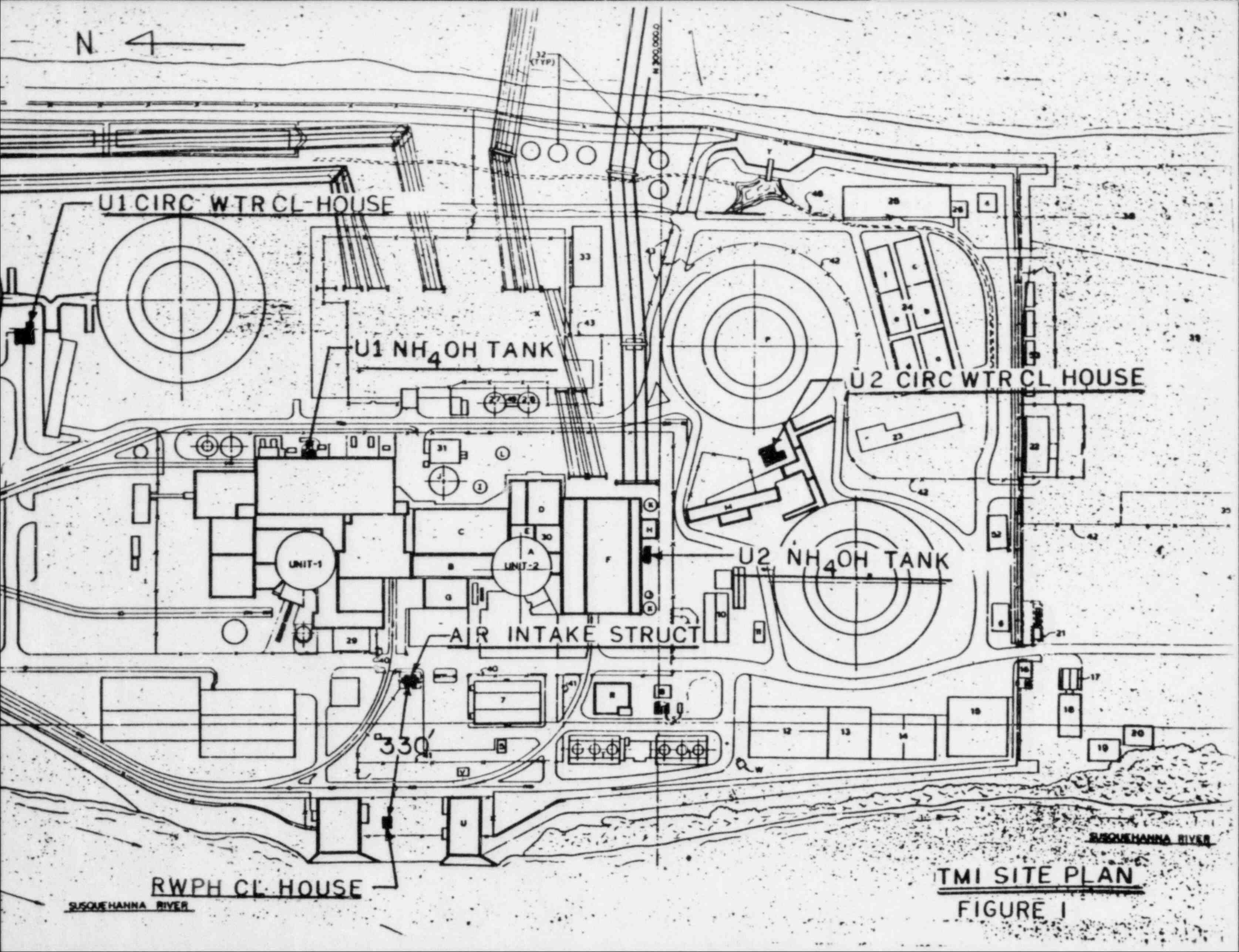
2. Minimum volume of outside air required to achieve positive pressure in the Control Building protected zone envelope.

The test results were as follows:

1. With the system operating in Emergency Mode (100% recirculation), one Emergency Supply Fan (AH-E-18A or B) and one Return Air Fan (AH-E-19A or B) operating, dampers AH-D-39, AH-D-28 and AH-D-37 closed and Damper AH-D-36 opened, the flow of outside air past AH-D-39 was 3000 cfm nominal.

2. With the system operating in Emergency mode (100% recirculation) as in Item 1, the pressure in various areas within the protected zone was measured. Positive air pressures with respect to the area outside the protected zone were obtained in all areas except in Engineered Safeguard Actuation System Panels room at Elevation 338', with 4000 cfm nominal outside air coming into the system from intake tunnel.

FIGURES



TMI SITE PLAN

FIGURE 1

FIGURE 2

TMI-1 CONTROL ROOM

RUPTURES OF THE UNIT 1 AMMONIUM HYDROXIDE STORAGE TANK

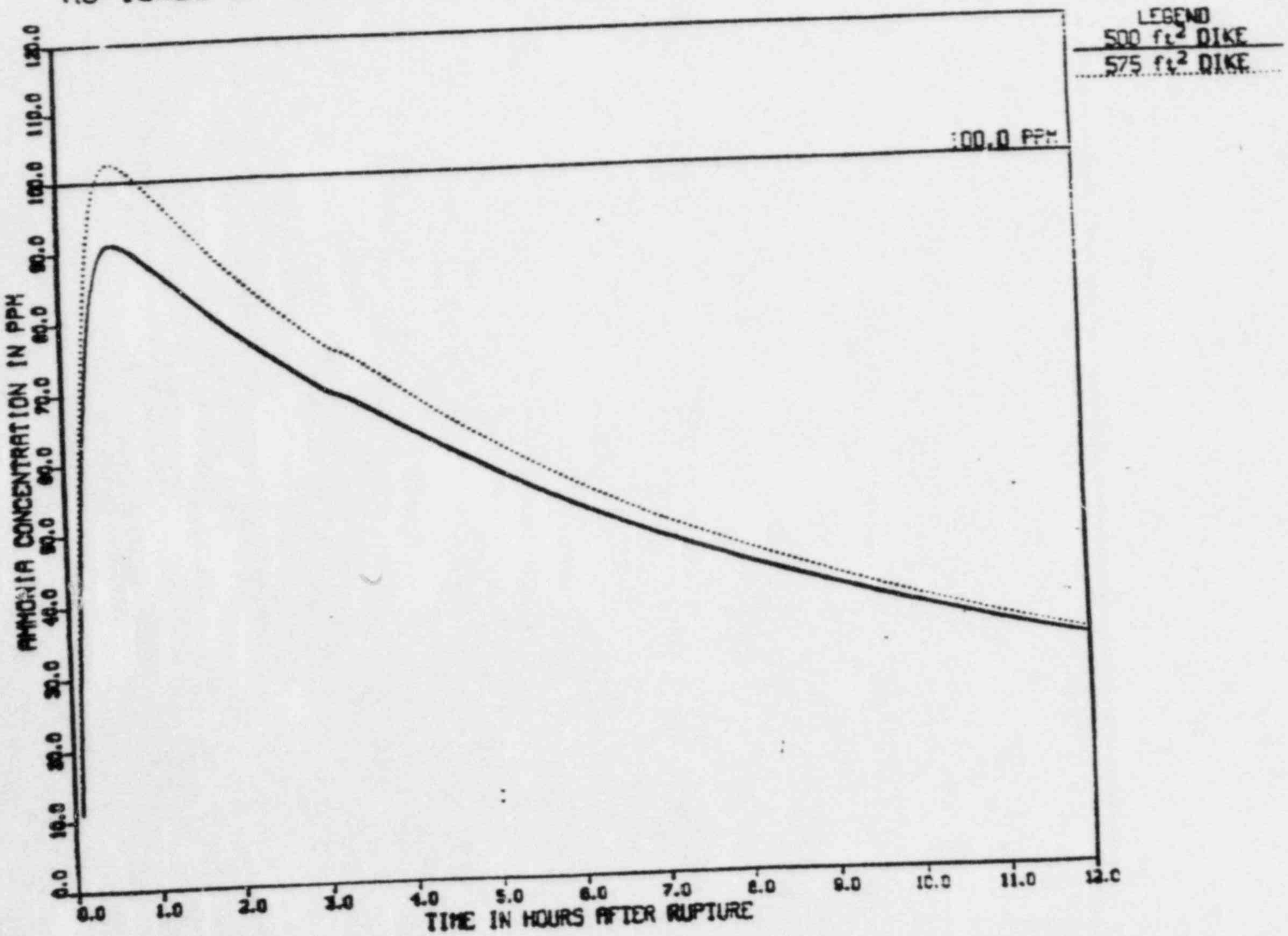


FIGURE 3

TMI-1 CONTROL ROOM DURING DESIGN BASIS LOCA

THIRTY DAY BETA SKIN DOSE

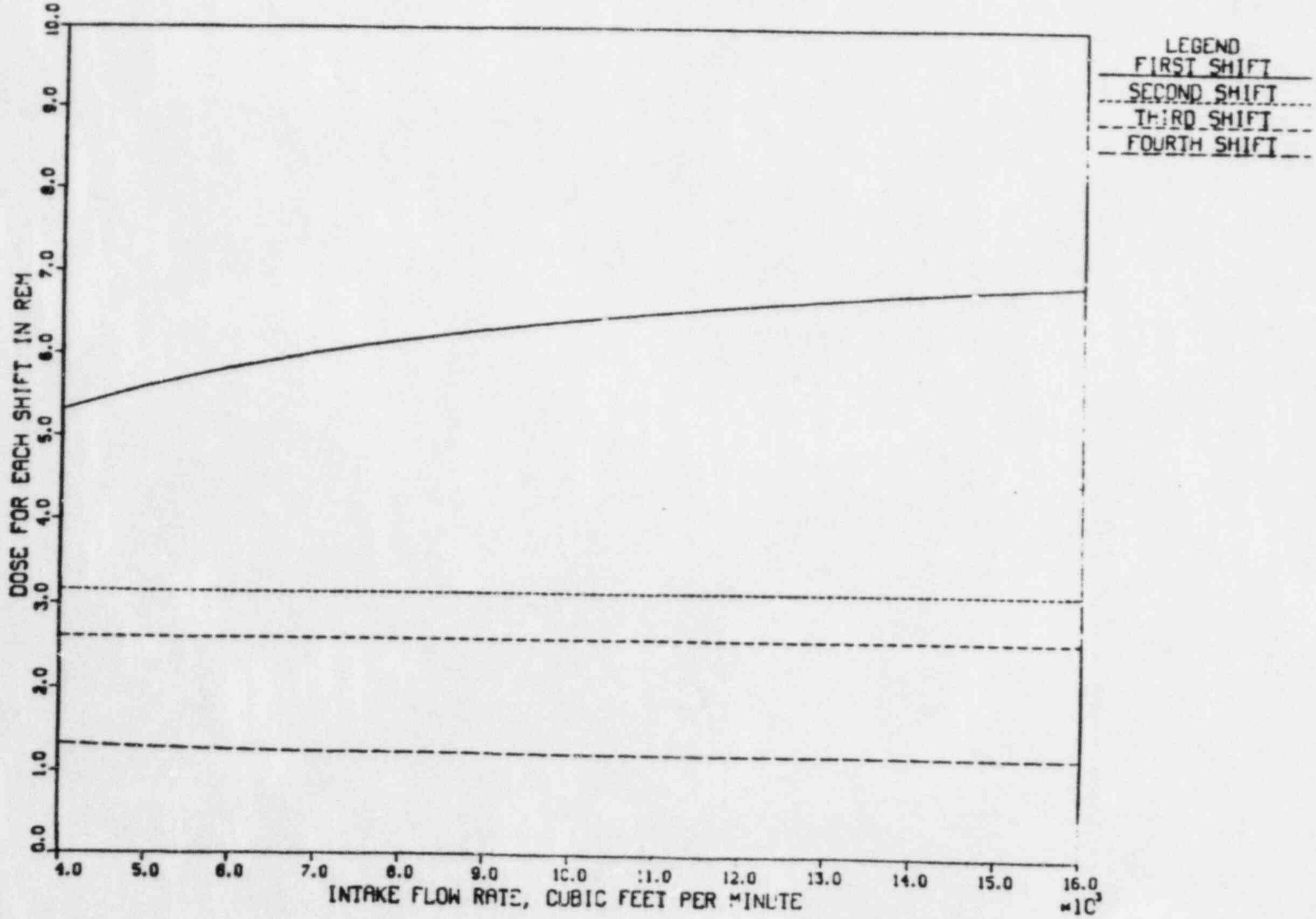


FIGURE 4

TMI-1 CONTROL ROOM DURING DESIGN BASIS LOCA

THIRTY DAY GAMMA WHOLE BODY DOSE

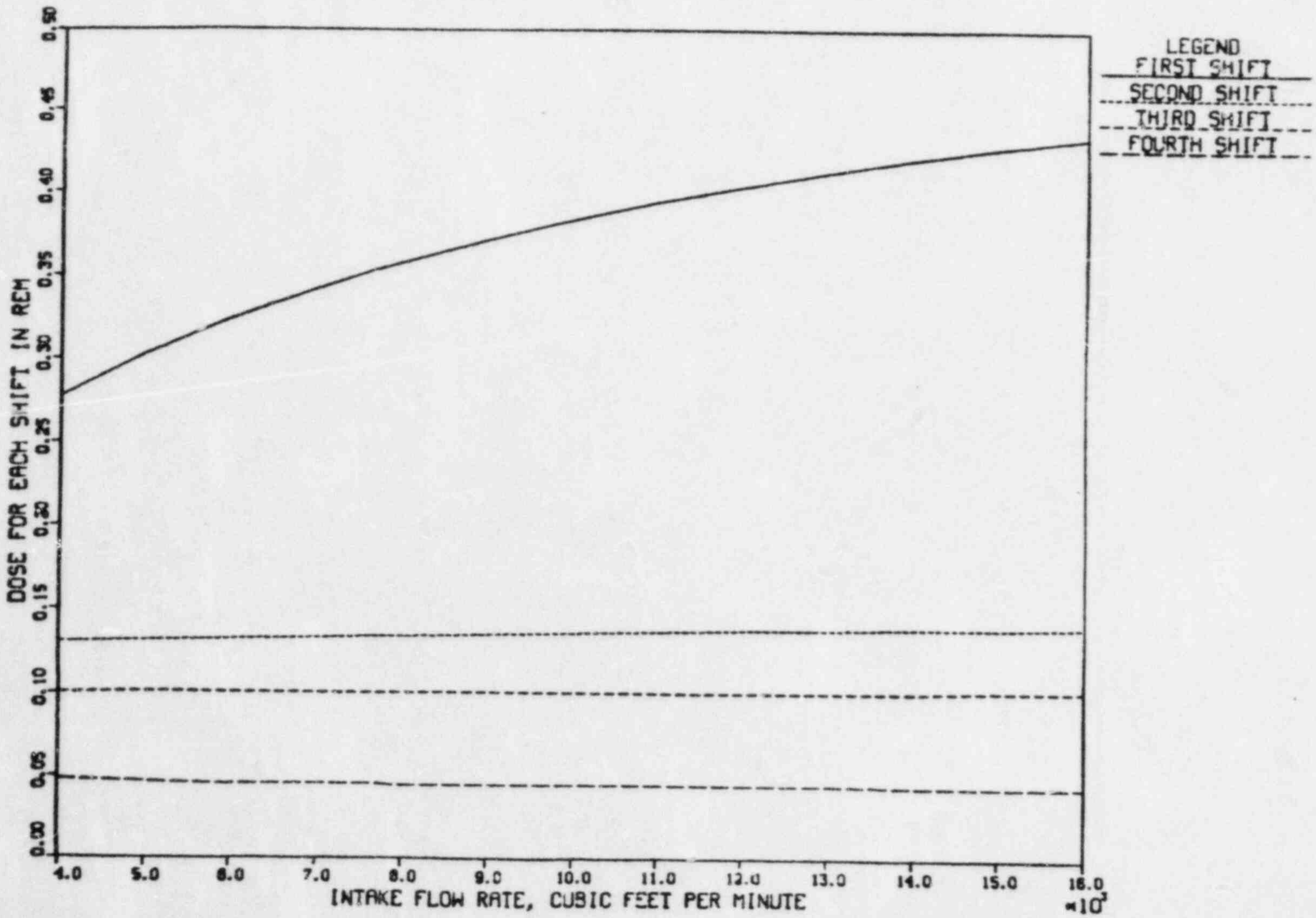
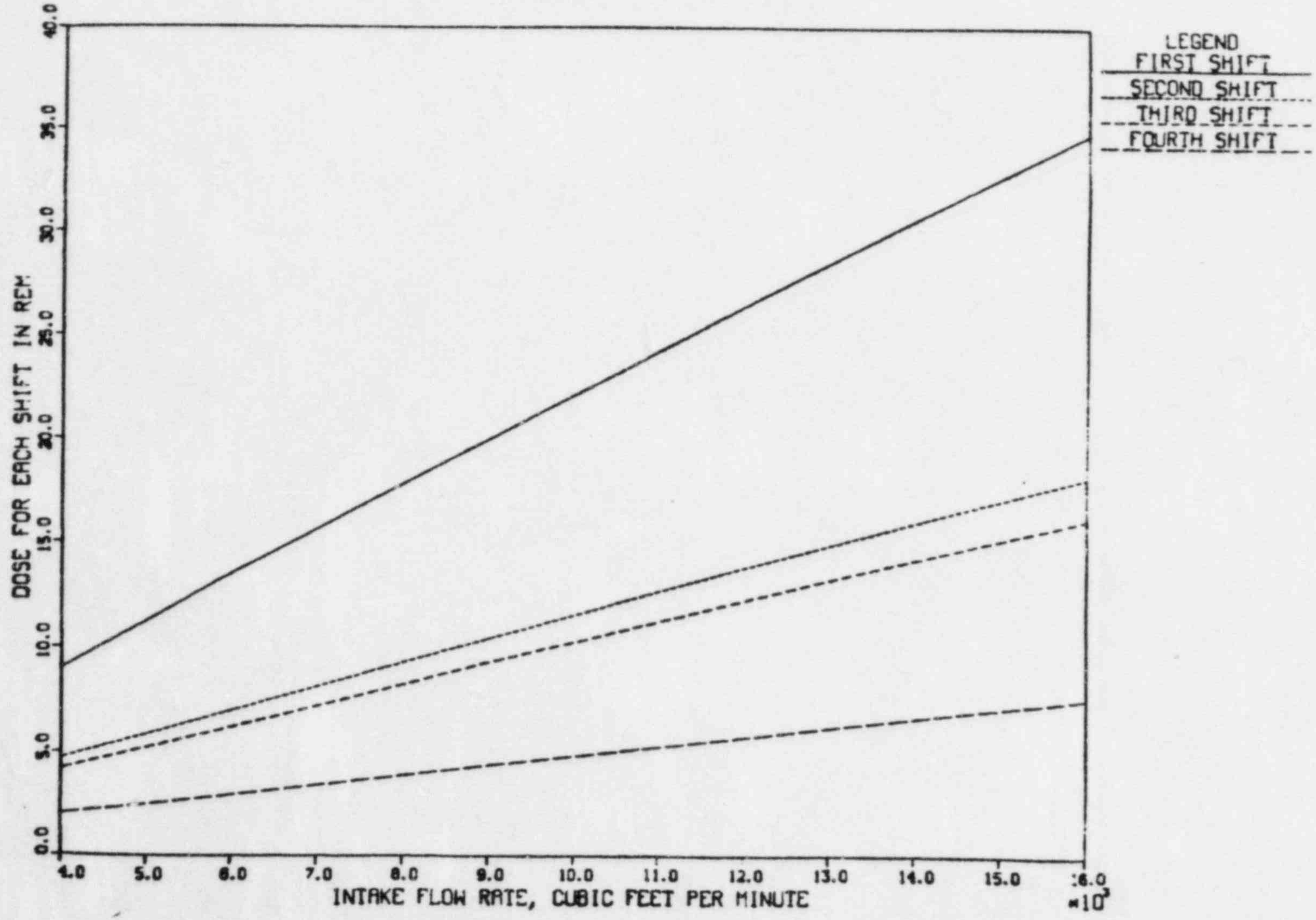
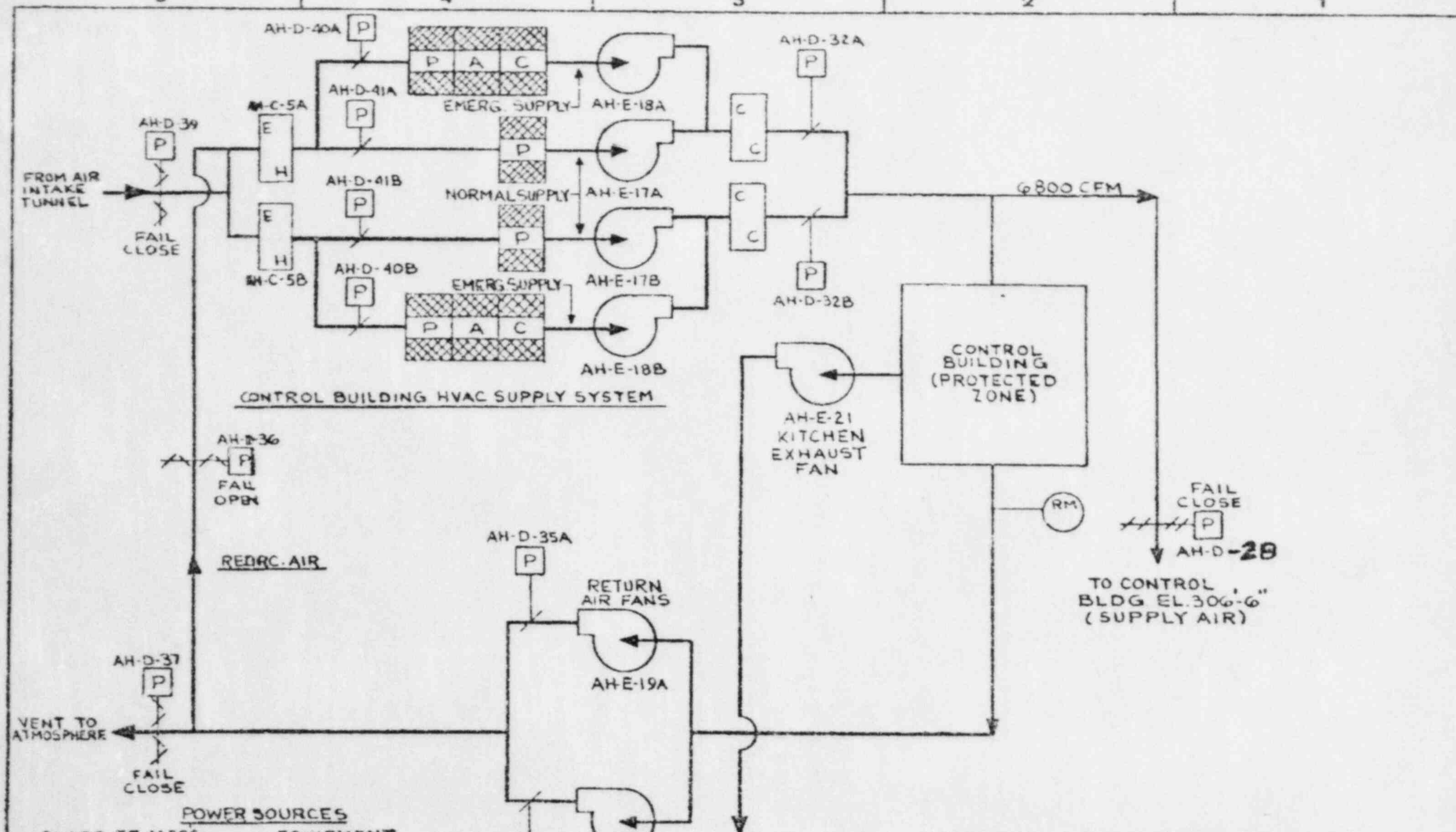


FIGURE 5

TMI-1 CONTROL ROOM DURING DESIGN BASIS LOCA

THIRTY DAY THYROID DOSE





GPU NUCLEAR
THREE MILE ISLAND STATION - UNIT NO. 1
CONTROL BUILDING VENTILATION SYSTEM
(EXISTING CONFIGURATION)