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November 30, 1984
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Office of Nuclear Reactor Regulation
Attn: John F. Stolz, Chief
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Stolz:

Three Mile Island Nuclear Station Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Control Room Habitability (III.D.3.4. NUREG 0737)
Results and Conclusions of Failure Mode and Effects Analysis

In response to a previous commitment (letter of April 30, 1984), GPU Nuclear Corporation contracted Impell Corporation to perform a Failure Mode and Effects Analysis (FMEA) for the TMI-1 Control Building Ventilation System (CBVS).

Acceptance Criteria for single failure were established such that no single active component failure of the CBVS would jeopardize the Control Room Habitability requirements for radiation and chlorine gas hazards. These requirements were based on the guidelines provided in General Design Criterion 19 and Regulatory Guides 1.78 and 1.95. (See Attachment 1) The results, recommendations and GPUN response are detailed in Attachment 2.

The initial conclusions based on the results of the FMEA indicate that no major modification to the CBVS will be required.

GPUN plans to perform tests, as described in Attachment-2 in order to verify our initial conclusions, and evaluations of results by March 1, 1985.

Sincerely,

H. D. Hukill
Director, TMI-1

HDH/MI/RAS/kds
cc: R. J. Conte
Attachments

A003
1/1

Attachment 1

Acceptance Criteria
Control Building Ventilation System
Failure Mode and Effects Analysis (FMEA)

A. The acceptance criteria for the FMEA are based on the guidelines provided in General Design Criterion 19 and Regulatory Guides 1.78 and 1.95 for radiation and chlorine hazards.

1. For the protection against radiation hazard, the integrated whole body dose shall not exceed 5 Rem or other body exposure equivalents for the duration of the accident.

2. For the protection against chlorine hazard, the chlorine concentration within the control room should not exceed 15 ppm within 2 minutes of the instant the operators become aware of the chlorine release.

3. The single failure of any component of CBVS shall not jeopardize the control room habitability.

B. To satisfy the above acceptance criteria the following conservative system performance objectives were established. These performance objectives are based on the radiation and toxic gas hazards analysis performed for control room habitability. They were utilized as a screening tool. Single failures which did not meet these objectives were further analyzed to confirm that the acceptance criteria was still met.

1. Radiation Hazard

Single failure of any CBVS component shall not:

1.1 Allow inflow of unfiltered air to the control room. (This is conservative since analysis shows that the integrated whole body dose will be within acceptable limits with inflow of 2650 cfm of unfiltered air for 30 minutes.)

1.2 Allow more than 12000 cfm filtered inflow to the emergency envelope. (The emergency envelope is comprised of control building floor elevations 322', 338-6", and 355' excluding the hallway areas.) This value is the upper limit at which the integrated dose or other equivalent exposure limit to the operator is calculated to be exceeded after 30 days.

1.3 Allow the positive pressure requirement of the control room to be compromised by inhibiting intake flow to less than 3000 cfm or breach the emergency envelope pressure boundary.

2. Chlorine Hazard

2.1 The failure of any single active component shall not compromise the 2 minute time interval, from the instance of alarm actuation, required for donning the emergency air breathing equipment by control room operators.

Attachment 2

Results and Conclusions of FMEA Study

The FMEA evaluated a total of 122 Control Building Ventilation System (CBVS) components to determine if the control room habitability acceptance criteria of Attachment 1 are met. All but six of the 122 (CBVS) components unconditionally satisfied the acceptance criteria and performance objectives. The remaining six components are discussed below. The acceptability of these single failures by test will verify the suitability of the CBVS design.

A. Radiation Hazard

I. System Recirculation Damper, AH-D-36

1. FMEA Results

1.1 This damper should open fully on a high radiation signal. Failure to do so does not provide a recirculation flow path. Since the leakage through AH-D-39 (intake damper), when the system is in recirculation mode is 3000 cfm, a failure of AH-D-36 will not compromise the minimum flow requirement. With no flow through AH-D-36 (leakage only), the inleakage through AH-D-39 will rise but there will not be sufficient pressure developed by the fan to result in an inleakage of greater than 12000 cfm. However, analysis show that minor duct deformation may occur if the emergency fan is allowed to run continuously with both AH-D-36 and AH-D-39 dampers closed. Minor duct deformation does not effect system operability.

1.2 Damper AH-D-36 does not have any position indicator lights or any other direct means of communicating damper position status to the control room operators. Thus, alternate means are required to alert the operator to the failure of damper AH-D-36 to open so manual corrective action can be taken.

2. GPUN Plans

2.1 GPUN plans to modify the operating procedure to have the operator check the Flow recorder (FR-271) indication during actuation of the emergency fan (AH-E-18A&B, Fig. 1). A low flow indication will alert the operator that the CBVS is not functioning properly. The initial correction action will be to check if AH-D-36 has failed to open. Manual corrective action will be taken if the damper fails to open.

The CBVS components are tested each month per TMI-1 Technical Specifications (Tech Spec No. 3.15) to assure proper operation of the CBVS system. The routine testing of CBVS thus provide a high degree of confidence in system operation and its physical condition.

II System Exhaust Damper AH-D-37

1. FMEA Results

2.1 This damper should close fully on a high radiation signal. Failure to do so would result in an unsealed flow path into the emergency envelope. This failure is considered a breach in the emergency envelope and creates a potential for unfiltered air to enter the envelope.

Evaluation of the system configuration and component design features indicate that the failure of this damper to close will not have an adverse impact on the ability of the CBVS to maintain the control room at a positive pressure with respect to the outside. The fact that the emergency fans are located directly above control room will insure that even in this worst case configuration, the emergency fans will be able to supply the control room with sufficient inlet air to maintain a positive pressure. In addition, all air drawn in past AH-D-37 by the emergency fan will pass through the emergency filter bank before exhausting into the control room eliminating the possibility of any unfiltered air entering the control room due to the failure of AH-D-37 to close.

1.2 Damper AH-D-37 does not have any position indicator lights or any other direct means of communicating damper position status to the control room operators. However, if it's failure does not jeopardize control room habitability there is no need to add unnecessary control room indications or alarms.

2. GPUN Plans

2.1 GPUN plans to perform a test to confirm that the control room pressure will remain positive with this damper open. Positive results of this test will support the conclusion that no modifications are necessary and that the control room habitability requirements are not jeopardized by the failure of this damper.

III Control Access Area Isolation Damper AH-D-28

1. FMEA Results

1.1 This damper should close on high radiation signal to isolate the emergency envelope from the remainder of the CBVS. Failure to do so would not isolate these two areas from each other and would permit an air exchange between them. If the system is in recirculation mode with this damper failed open, the emergency envelope pressure boundary would be breached and potential for unfiltered air to enter the envelope exists.

The failure of this damper to close will not have an adverse impact on the ability of the CBVS to maintain the control room at a positive pressure with respect to the outside. The fact

that the emergency fans are located directly above the control room will insure that even in this worst case configuration, the emergency fans will be able to supply the control room with sufficient inlet air to maintain a positive pressure. In addition, all air drawn in past AH-D-28 by the emergency fan will pass through the emergency filter bank before exhausting into the control room eliminating the possibility of any unfiltered air entering the control room due to failure of AH-D-28 to close.

1.2 Damper AH-D-28 has a position indicating light in the control room.

2. GPUN Plans

2.1 GPUN plans to perform a test to confirm that the control room pressure will remain positive with this damper open. Positive results of this test will support the conclusion that no modifications are necessary and that the control room habitability requirements are not jeopardized by the failure of this damper.

IV Normal Duty Fan Intake Damper AH-D-41A&B

1. FMEA Results

1.1 This damper should close upon trip of the normal duty fan. The failure of this damper to close and the starting of the emergency fan/filter train would cause reverse flow through Fan AH-E-17.

Evaluation of the direction of air flow during this failure indicate that even though some flow may recirculate back through the normal fan, the control room will remain at a positive pressure without the possibility of unfiltered air being introduced.

2. GPUN Plans

2.1 GPUN plans to perform a test to confirm that the control room pressure will remain positive with this damper open. Positive results will assure the acceptance criteria are satisfied and that no modifications are required.

V Normal Duty Supply Fans AH-E-17A&B

1. FMEA Results

1.1 This fan should trip on the high radiation signal. In the event of the single failure of the motor starter this fan will not shut down. Failure to do so would result in unfiltered air entering the control room. If, in addition, the operator were to start either of the emergency fans, the high intake flow criteria would be violated.

1.2 Fan status indication lights are in the control room.

2. GPUN Plans

2.1 Current operating procedure requirements have the operator verify that the normal fan is shut off prior to actuating the emergency fan. The verification is accomplished by the normal fan status indicator within the control room.

GPUN plans to modify the operating procedure that in case the fan (AH-E-17A&B) failed to trip on the high radiation alarm the control room operator would take manual action to trip the normal fan and start the emergency fan.

The operator will have a minimum of 30 minutes to shut off the fan. This is ample time to go to the MCC and trip the breaker if required. Once tripped the operator would be allowed the option of starting either train of emergency fan.

In addition to the fact that manual action can be taken to stop fans AH-E-17A&B, periodic testing will confirm that the probability of failure of these fans to stop is low. The CBVS components are tested each month to assure proper operation of all the CBVS components. This testing provides a high degree of confidence in system operation and its physical condition.

VI Radiation Monitoring Detectors

There is one radiation detector monitoring the control room to isolate the emergency envelope in the event of high radiation. This arrangement constitutes a single failure of a device which could potentially adversely impact the CBVS. A further evaluation was conducted to see if diverse signals could be expected to isolate the CBVS or alert operators to the need to isolate manually.

There are several radiation monitors which alarm in the control room in the event of any radiation release in the plant or onsite. The control room is automatically isolated on an Engineered Safeguards (ES) actuation which would more than likely precede any radiation release which has the potential to reach the control building air intake. Based on the above, GPUN has concluded that the likelihood of not isolating the emergency envelope when required for protection against a radiation hazard is negligible.

B. Chlorine Hazard

Based on the analysis, assuming worst case initial conditions and any single failure, it would take more than two minutes from the time high chlorine alarm is initiated in the control room until chlorine will enter the control room envelope. There will be sufficient time for personnel in the control room to don emergency breathing apparatus. Single failures identified in the FMEA analysis will not reduce this minimum time below the acceptance criteria stated in Attachment 1.

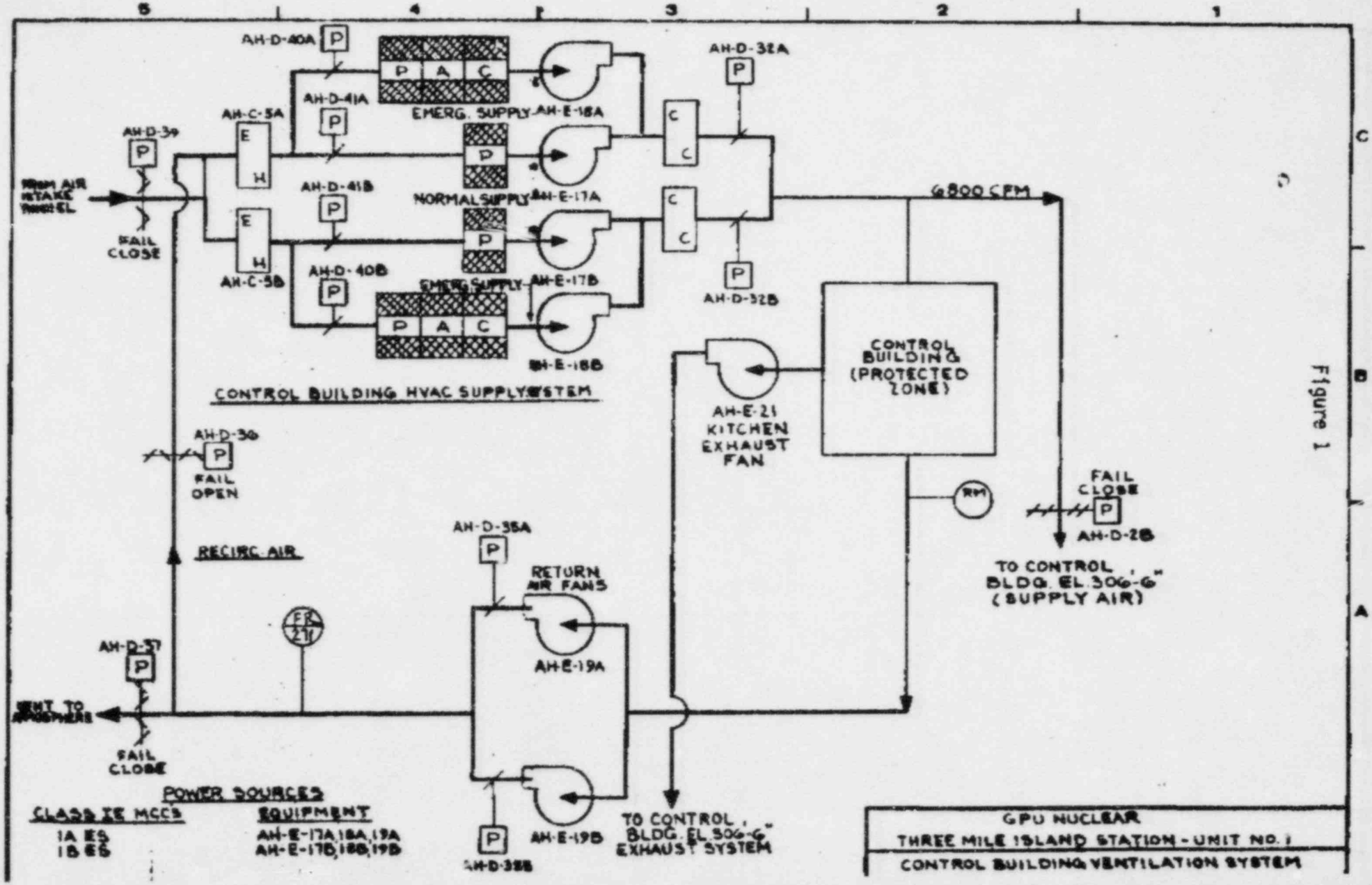
AH-D-40A
AH-D-41A
AH-C-5A
AH-D-39
FROM AIR INTAKE TUNNEL EL
FAIL CLOSE
AH-D-41B
AH-C-5B
AH-D-40B
EMERG. SUPPLY
AH-E-18A
NORMAL SUPPLY
AH-E-17A
EMERG. SUPPLY
AH-E-17B
AH-E-18B
AH-D-32A
AH-D-32B
6800 CFM
CONTROL BUILDING (PROTECTED ZONE)
AH-E-21 KITCHEN EXHAUST FAN
CONTROL BUILDING HVAC SUPPLY SYSTEM
AH-D-36
FAIL OPEN
RECIRC AIR
AH-D-35A
RETURN AIR FANS
AH-E-19A
AH-E-19B
AH-D-32B
AH-D-37
VENT TO ATMOSPHERE
FAIL CLOSE
FAIL CLOSE
AH-D-28
TO CONTROL BLDG. EL 306'-6" (SUPPLY AIR)
TO CONTROL BLDG. EL 306'-6" EXHAUST SYSTEM
POWER SOURCES
CLASS 1E MCC'S
1A ES
1B ES
EQUIPMENT
AH-E-17A, 18A, 19A
AH-E-17B, 18B, 19B
GPU NUCLEAR
THREE MILE ISLAND STATION - UNIT NO. 1
CONTROL BUILDING VENTILATION SYSTEM

Figure 1