NRC Form 366 (9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Sequoyah, Unit 1	0 5 0 0 0 3 2 7	1 OF 10

TITLE (4) Control Room Emergency Ventilation System Single Failure Criteria Violated Due To A Design Error Which Could Result In Exceeding Allowable Dose To Operators

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 7	1 0	8 7	8 7	0 3 9	0 4	0 5	1 3	8 8	Sequoyah, Unit 2	0 5 0 0 0 3 2 8
										0 5 0 0 0

OPERATING MODE (9): 5

POWER LEVEL (10): 0 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
20.405(a)(1)(i)	50.36(c)(1)	XX 50.73(a)(2)(v)	73.71(c)
20.405(a)(1)(ii)	50.36(c)(2)	XX 50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (AREA CODE)	
D. P. Siska J. A. Naik, Plant Operations Review Staff	6 1 5	8 7 0 - 6 8 6 2

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE) XX NO

EXPECTED SUBMISSION DATE (15): MONTH DAY YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On July 10, 1987, with units 1 and 2 in mode 5 (cold shutdown), it was determined that the potential existed for a single failure of the main control room (MCR) normal pressurization system, when operating during a control room isolation (CRI) actuation, to violate General Design Criteria (GDC)-19 of 10 CFR 50 Appendix A, "Control Room." A malfunction in the controller of the operating normal pressurization fan could result in the Control Building (CB) pressure of the lower floors exceeding the pressure in the MCR thereby allowing unfiltered, potentially radioactive air to leak into the MCR. In addition, a single failure of the operating normal pressurization fan suction damper in the closed position could result in a lower than designed pressure in the CB lower floors, thereby causing excessive outleakage from the MCR and the inability of the control room emergency ventilation system (CREVS) to maintain the MCR habitability zone at greater than or equal to +0.125 inch water-gauge pressure. TVA has subsequently performed extensive testing of CREVS and identified other deficiencies that could affect CREVS operability. Because of these deficiencies, the dose to MCR personnel following a postulated design basis accident would have exceeded the dose calculated in Final Safety Analysis Report, Section 15.5.3, and could have exceeded the dose requirements of GDC-19. The cause of these deficiencies has been determined to be inadequate design and testing of CREVS. As a result, TVA has deenergized the MCR normal pressurization system, and implemented several modifications that have resulted in substantially improved CREVS operation. On January 22, 1988, CREVS was returned to operable status. To ensure long-term CREVS operability, TVA has implemented a design change to allow an increase in the amount of makeup flow used by CREVS to pressurize the MCR. In addition, a comprehensive study will be performed to evaluate the current design of the CB ventilation system and recommend the changes necessary to ensure long-term operability of this system.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

DESCRIPTION OF EVENT

This LER is being revised to provide additional information with respect to the corrective action TVA has taken to prevent recurrence of this event. In addition, this revision makes changes to the dates in which the long-term corrective actions will be completed.

On July 8, 1987, with units 1 and 2 in mode 5 (0 percent power, 3 psig, 134 degrees F and 0 percent power, 0 psig, 128 degrees F, respectively), Mechanical Test personnel performed Surveillance Instruction (SI)-144.2, "Control Room Emergency Ventilation Test." On July 10, 1987, following a second performance of SI-144.2, it was determined that the potential existed for a single failure of the MCR normal pressurization system (EIIS Code VI), when operating during a control room isolation (CRI) actuation, to violate General Design Criteria (GDC)-19 of 10 CFR 50 Appendix A, "Control Room." GDC-19 requires the MCR to be designed with adequate radiation protection for personnel during an accident condition. At 1808 EST on July 10, 1987, both trains of CREVS were declared inoperable, and action statement "b" of Technical Specification (TS) LCO 3.7.7 was entered. At 1900 EST, an event notification was made in accordance with 10 CFR 50.72, paragraph b.2.iii.

During normal operation, the Control Building (CB) normal pressurization fans (which have variable pitch blades to control air flow) supply approximately 8,200 cubic feet per minute (CFM) of outside air; 3,200 CFM to the upper CB floor (elevation 732) and 5,000 CFM to the lower CB floors (elevations 669, 685, and 706). All flow from the CB normal pressurization fans is unfiltered. Following a CRI, the system design requires the pressurization fan flow to be decreased from 8,200 CFM to approximately 3,000 CFM. In addition to the decrease in air flow, the CRI closes flow control dampers 31A - 105A and 31A - 106A, which isolates the unfiltered air flow to the MCR, and directs all normal pressurization air flow to the lower CB floors through the electrical board room air handling units (AHUs) on CB elevation 669 (see Figure 1). Also on a CRI, the emergency air cleanup fans start. Of the 4,000 CFM of flow supplied by the emergency air cleanup fans, 3,800 CFM is recirculation flow and 200 CFM is fresh makeup flow supplied by the CB emergency pressurization fans. The 200 CFM of fresh makeup flow is designed to maintain a minimum pressure in the MCR of +0.125 inches water-gauge (wg). All flow from the emergency air cleanup fans passes through high efficiency particulate absorber (HEPA) filters and charcoal adsorbers before entering the suction of the MCR AHUs.

A single failure of the normal pressurization fan's non-safety-related controller of fan blade pitch, initially documented on internal TVA Condition Adverse to Quality Report (CAQR) SQP 871226, could cause higher than designed flow rates from the operating normal pressurization fan. This high flow rate would increase the air flow to the electrical board room AHUs and cause higher than designed air pressures in the lower CB floors. Normal leakage around stairwell doors and wall penetrations could then result in unfiltered, potentially radioactive air entering the MCR habitability zone from the lower CB floors. Additional testing of the Control Building Ventilation System (CBVS) confirmed that the normal pressurization fans' air flow was, in fact, not adequately reduced following a CRI.

A second single failure, identified following the July 8, 1987 performance of SI-144.2 and documented on CAQR SQP 871226, involved the potential for the normal pressurization fan's suction damper to fail closed. This failure would terminate all air flow from the CB normal pressurization fan and cause a lower than designed pressure in the lower CB floors. This decreased pressure in the lower CB floors could cause increased outleakage from the MCR and result in the inability of CREVS to maintain the required +0.125 inch wg pressure in the MCR.

Also discovered during the July 8, 1987 performance of SI-144.2 and documented on CAQR SQP 871226 was the actual failure of the CREVS to maintain a positive pressure greater than or equal to +0.125 inches wg in the MCR habitability zone as required by TS Surveillance Requirement (SR) 4.7.7.e.3.

In addition to the deficiencies discussed above, CAQR SQP 871606 identified a previously unknown source of inleakage to the suction of the emergency air cleanup fan. This inleakage increased the amount of outside air being used by CREVS to pressurize the MCR. As illustrated in Figure 1, the spreading room supply fan and the emergency air cleanup fans take suction from the same section of ductwork in the mechanical equipment room. A CRI signal stops the spreading room supply fan and closes the spreading room supply fan's flow control dampers (31A-17 and 31A-102). In this configuration, operation of CREVS induces a substantial differential pressure across flow control dampers 31A-17 and 31A-102. This differential pressure causes a backflow of air from the spreading room, through the blade-type isolation dampers, through the idle spreading room supply fan, and into CREVS. This backflow serves as additional pressurization air for the CREVS and, until recent testing, was not identified. This additional pressurization air could increase the CREVS makeup flow above the 200 CFM limit allowed by TS SR 4.7.7.e.3 and invalidate the MCR dose calculations described in Final Safety Analysis Report (FSAR) Section 15.5.3.

Further testing of the CREVS in October, 1987, resulted in two additional deficiencies which were documented on CAQR SQP871657. The testing showed that the flow rates through some branches of the MCR AHU ductwork were lower than designed and could not be significantly increased with the existing ductwork configuration. The testing also showed higher than designed leak rates through two MCR doors that are adjacent to the Auxiliary Building. These deficiencies have an adverse impact on the ability of CREVS to maintain a +0.125 inch wg pressure in the MCR.

The above described conditions are applicable to both units 1 and 2 since the MCR habitability zone is common to both units.

CAUSE OF EVENT

This event was caused by an inadequate design of the Sequoyah Nucleer Plant (SQN) CBVS. A contributing cause of this event was the inadequate surveillance instructions that were in place to test the CREVS and verify that all performance requirements that affected CREVS ability to satisfy the TS SRs were met.

ANALYSIS OF EVENT

This event is being reported under 10 CFR 50.73, paragraphs a.2.v and a.2.vii.

The CREVS is designed such that during an accident, (1) the ambient air temperature does not exceed the allowable temperature for continuous duty rating of the equipment and instrumentation located within the MCR habitability zone, and (2) the radiation exposure to personnel occupying the MCR will remain within the requirements of GDC-19 of Appendix A to 10 CFR 50.

During mode 5 (cold shutdown) with both CREVS trains inoperable, action statement (b) of TS 3.7.7 was entered (i.e., no core alterations or positive reactivity changes). Compliance with the appropriate action statement significantly decreases the potential for any accident which could result in the release of radioactivity (e.g., the inadvertent drop of a spent fuel assembly). (Note that SQN LER 1-87078 documented a violation under action statement 3.7.7.b.) In addition, none of the previously described deficiencies had a significant effect on ability of the CBVS to provide the required heat rejection capabilities necessary to maintain the MCR habitability zone within the allowable temperature range.

If an accident occurred during power operation that resulted in large radiological releases, the potential existed for unfiltered, potentially radioactive air to enter the MCR habitability zone. TVA has evaluated the potential increase in radiological exposure that could have been received by MCR personnel if a design basis LOCA had occurred concurrent with the previously described deficiencies in the CREVS. This evaluation considered both the increased pressurization air (filtered) that leaked into the CREVS recirculation duct (from the spreading room) as well as unfiltered air that leaked into the MCR habitability zone from the lower CB elevations. The results of this dose evaluation (calculation B45 880212 237) showed that operation of either train of CREVS following a design basis LOCA would not have resulted in a violation of the whole body-gamma or beta-skin dose limits specified by GDC-19. Similarly, if train "B" of CREVS was used to pressurize the MCR following a LOCA, the inhalation (thyroid) dose to MCR personnel would have remained within the requirements of GDC-19. However, if train "A" of CREVS was operating for the duration of the accident, the inhalation dose to MCR personnel would have exceeded the GDC-19 limits by approximately 10 rem. The results of this evaluation are summarized below:

	Train A	Train B	GDC-19 Limits
Whole body-gamma	1.4 rem	1.5 rem	5.0 rem
Beta-skin	13.0 rem	13.7 rem	30.0 rem
Inhalation (thyroid)	39.8 rem	17.6 rem	30.0 rem

The dose evaluation model that was used to calculate the above MCR doses made several conservative assumptions. For example, the meteorological conditions that were assumed to exist at the time of the accident would be conservative 95 percent of the time. In addition, the radionuclide inventory that was assumed to be available for containment leakage was based on the assumptions in Regulatory Guide (RG) 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors." RG 1.4 assumes that of the entire core-fission product inventory, 100 percent of the noble gases and 50 percent of the iodines are immediately released to the containment atmosphere. The actual percentage of fission products that could be released to the containment would more likely be limited to that which had accumulated in the fuel pellet-cladding gap (i.e., approximately 10 percent of the core-fission product inventory). Hence, the RG 1.4 assumptions that were used for the above MCR dose analysis may result in a radiological source term which is as much as ten times higher than what would be expected.

Further, based on the results of industry and NRC sponsored tests that have been performed over the past several years, it has been shown that the evaluation models currently used to determine fuel performance during a LOCA (i.e., those based on 10 CFR 50, Appendix K) have been overly conservative. NRC recognized this conservatism and has published a proposed revision to Appendix K of 10 CFR 50 (52 FR 6334, dated March 3, 1987) which will allow utilities to perform more realistic LOCA analyses. An analysis under these guidelines would show even less fuel damage than the current SQN LOCA analysis. Thus, if a realistic assessment of the radiological source term was performed (i.e., an assessment based on the actual number of predicted fuel pin failures), the resultant MCR doses would be considerably lower than the values reported herein.

Even if radioactive iodine concentrations in the MCR were higher than the level that had been originally predicted, System Operating Instruction (SOI)-55-OM-12, "XA-55-12B Annunciator Response," directs MCR personnel to don air packs and begin continuous radiation monitoring in the MCR when there is indication that activity levels in the MCR have exceeded certain levels.

Although the recent dose evaluation showed a thyroid dose that could have exceeded GDC-19 requirements, there were several analytical conservatisms inherent in that evaluation that were not fully representative of the actual SQN design and operating characteristics. Thus, TVA is confident that if a design basis LOCA had occurred concurrent with the previously described CREVS deficiencies, MCR personnel would not have received radiological exposures that exceeded GDC-19 limits.

CORRECTIVE ACTION

The following corrective actions have been completed, and CREVS has been returned to operable status.

To ensure that CREVS is adequately tested, SI-144.2 was revised on November 24, 1987, to include air inleakage testing of the MCR doors. This additional testing requirement ensures that unfiltered, potentially radioactive air does not leak into the MCR during CREVS operation.

To minimize the potential backflow through the spreading room fan and flow control dampers 31A-17 and 31A-102, TVA implemented Design Change Notice (DCN)-91 to separate the CREVS recirculation duct from the spreading room fan suction duct. Following a CRI, the CREVS now draws recirculation air from an independent point in the mechanical equipment room at CB elevation 732.

To preclude a single failure of the normal pressurization fan's controller from overpressurizing the CB lower floors during a CRI, TVA implemented DCN-51 as an interim measure. This DCN deenergized the CB normal pressurization fans and locked open their suction dampers and fan blade positioners. As a result, a flow path for outside air to the suction of the electrical board room (EBR) AHUs was maintained.

Following the implementation of DCN-51, it was determined that certain areas in the lower CB floors (elevations 669 and 685) had inadequate air supply flow rates (i.e., less than 90 percent of design). To resolve this deficiency, which is documented on CAQR SQP871658, TVA has implemented DCN-129. This DCN revised the design air flows in the lower CB floors and reduced the system pressure drops by modifying the existing ductwork configuration. To allow the EBR AHUs to remain in service while this DCN was being implemented, alternate air return flow paths to the EBR AHUs were established by removing an access door from the communications room return duct (elevation 669), opening both doors of the operating EBR AHU and removing a panel on the common EBR AHU air return plenum. Following the completion of DCN-129, the alternate return flow paths were closed off. As a result of implementation of this DCN, the air supply flow rates from the EBR AHUs are currently at a satisfactory level.

Since the implementation phase of DCN-129 effectively eliminated the flow path for outside air to the suction of the EBR AHUs (by removing panels on the subject AHUs), the pressure in the lower CB floors (elevations 685 and 706) could not be maintained at an acceptable level. To resolve this condition, a Field Change Request (FCR) to DCN-129 was approved to deenergize the CB battery room exhaust fans (CB elevations 669 and 706) and temporarily modify an access door in the battery room exhaust fan duct (elevation 669) to serve as a balance damper. As a result, outside air was being drawn in through the battery room exhaust fan duct and into the suction of the modified EBR AHUs. Thus, the EBR AHUs supplied some outside air (i.e., pressurization air) to CB elevation 685 which resulted in a positive pressure on this CB floor. The existence of normal leakage paths around stairwell doors and ceiling penetrations also resulted in a slightly positive pressure at CB elevation 706.

Following the completion of DCN-129, the access door in the battery room exhaust fan duct was returned to its original configuration, and the outside air for the EBR AHUs is now supplied through the CB normal pressurization fan ductwork. Also, the battery exhaust fans were returned to service.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

During the implementation of the previously described DCNs, TVA took extensive measures to locate and seal outleakage flow paths from the MCR and rebalance the air flow rates on CB elevation 732. Following a detailed measurement of air flows on CB elevation 732, it was discovered that approximately 19,000 CFM of air was being returned to the MCR AHUs through a return damper in the mechanical equipment room. Since the design flow through this damper was only 8,400 CFM (4,400 following a CRI), a slightly negative pressure existed in the mechanical equipment room. To correct this deficiency, TVA has implemented DCN-119 and DCN-143. DCN-119 removed the damper described above and replaced it with a balancing damper to limit the return flow through the damper to its specified design value. As designed, the implementation of this DCN resulted in a slightly positive pressure in the mechanical equipment room. However, to further improve the air flow conditions on CB elevation 732 and increase the pressure in the MCR following a CRI, TVA implemented DCN-143. DCN-143 added an air supply duct in the mechanical equipment room (from the MCR AHUs) to increase the pressure in that room, and installed sheet metal above MCR door C56 to reduce the amount of air being returned from the MCR to the mechanical equipment room. After this DCN was implemented and the air flows were rebalanced, it was determined that the pressures in the MCR and mechanical equipment room had increased slightly and were also more stable.

TVA has evaluated the above described modifications to the CB ventilation system and verified that there is sufficient air flow to all CB elevations. This evaluation has also verified that these changes do not invalidate the seismic category 1 classification of the CB AHUs, nor do they adversely affect the system design as described in section 9.4 of the Final Safety Analysis Report (FSAR).

On January 22, 1988, SI-144.2 was successfully completed (using 200 CFM of outside air to pressurize the MCR), and CREVS was returned to operable status. To provide greater long-term reliability, ECN-7336 has been implemented to increase the allowable CREVS makeup flow from 200 CFM to a maximum of 1,000 CFM. Increasing the makeup flow to a maximum of 1000 CFM ensures that CREVS will be able to maintain a + 0.125 inch wg pressure in the MCR even if there is an unanticipated degradation in the MCR habitability zone pressure boundary.

As described above, TVA has taken extensive corrective actions to return CREVS to operable status. To determine if additional modifications to the CBVS configuration are appropriate, a comprehensive study of the CBVS design will be performed. This study will document potential improvements to the CBVS design (including the return of the normal pressurization system to service) and provide recommendations to enhance the overall CBVS performance.

* U.S.GPO:1986-0-624-538/455

In addition, although applicable SIs have documented compliance of the Emergency Gas Treatment System (EGTS) and the Auxiliary Building Gas Treatment System (ABGTS) with applicable FSAR and TS requirements, a design review of these TS-required ventilation systems will also be performed. This review will determine if any of the findings from the CBVS study can be applied to either the EGTS or the ABGTS to enhance the operation of these systems.

Thus, although substantial data exists to evince the CBVS, EGTS, and ABGTS are capable of performing their design safety functions, TVA has decided to take additional measures to enhance the overall operation of these TS-required ventilation systems. However, since the aforementioned studies of the CBVS, EGTS, and ABGTS are considered by TVA to be long-term enhancements of these systems, they are not scheduled to be complete until November 1, 1989.

As described previously, the primary cause of this event was an inadequate design of the SQN CBVS. To improve the design process TVA uses for its nuclear plants and to prevent recurrence of this event, TVA has completely reorganized the design and engineering groups since the original CBVS design was approved. In addition to the reorganization, TVA has issued Nuclear Engineering Procedures (NEP)-5.1 "Design Output"; NEP-5.2, "Review"; and NEP-5.5, "Engineering Requirements Specifications." These procedures provide the necessary control over TVA nuclear plant design requirements that did not exist at the time the original CBVS design was approved.

ADDITIONAL INFORMATION

There have been two previously reported occurrences where an inadequate design could have resulted in both trains of a TS-required ventilation system being inoperable - SQRO-50-327/84011 and 87036.

COMMITMENTS

A design study of the CBVS, EGTS, and ABGTS will be performed to determine if additional improvements can be made to enhance the performance of these TS-required ventilation systems. TVA expects these studies will be complete by November 1, 1989.

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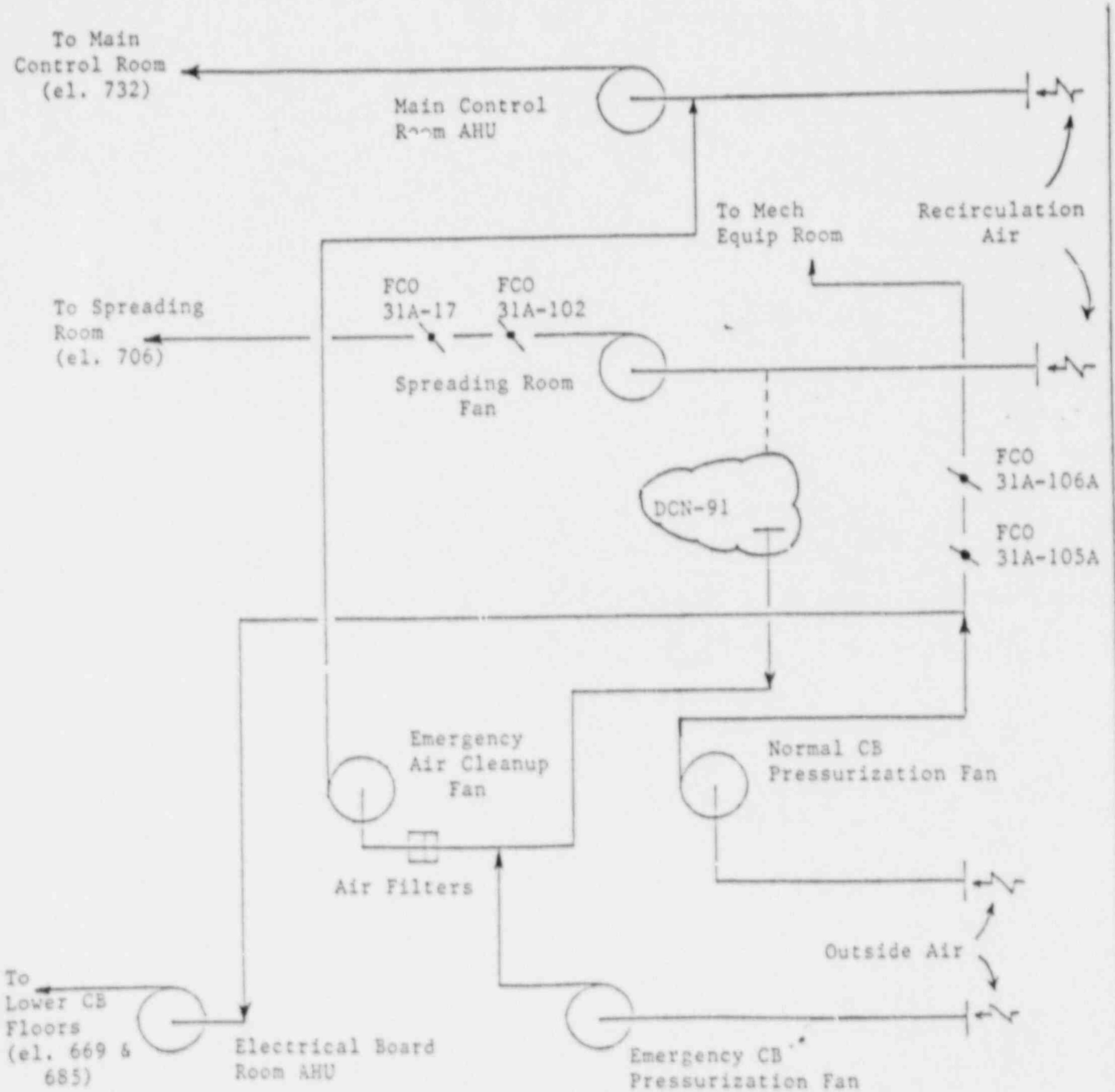

FIGURE 1: SIMPLIFIED CONTROL BUILDING VENTILATION SCHEMATIC

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May 13, 1988

U. S. Nuclear Regulatory Commission
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Gentlemen:

TENNESSEE VALLEY AUTHORITY - SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2 - DOCKET NOS. 50-327 AND 50-328 - FACILITY OPERATING LICENSE DPR-77 AND DPR-79 - REPORTABLE OCCURRENCE REPORT SQRO-50-327/87039 REVISION 4

The enclosed revised licensee event report provides additional information with respect to the corrective action TVA has taken to prevent recurrence of the event described herein. This revision also makes changes to the dates in which long-term corrective actions will be accomplished. This event was originally reported in accordance with 10 CFR 50.73, paragraphs a.2.v and a.2.vii, on August 7, 1987 and revised on November 27, 1987, February 4, 1988, and February 25, 1988.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

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