TECHNICAL EVALUATION REPORT

REVIEW OF THE DESIGN AND OPERATION OF VENTILATION SYSTEMS FOR SEP PLANTS

(SEP, IX-5)

CONNECTICUT YANKEE ATOMIC POWER COMPANY
HADDAM NECK NUCLEAR POWER PLANT

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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

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1. INTRODUCTION

This review of the design and operation of ventilation systems at Haddam Neck Nuclear Power Plant is under Topic IX-5 of the Systematic Evaluation Program (SEP) and consists of the technical review and assessment of safety systems in light of changes in design conditions and criteria. The purpose of this review is to ascertain whether ventilation systems at the Haddam Neck plant have the capability to provide a safe environment for plant personnel under all modes of operation and whether all safety-related equipment can function properly to ensure safe shutdown of the reactor under normal and emergency conditions.

As background for this review, the SEP has been established to evaluate the safety of 11 of the older nuclear plants. Comparison of each plant against current licensing criteria is an important part of the SEP, with 137 selected topics being studied. Information for these studies is derived from a wide range of sources, including final safety analysis reports (FSARs), more recent drawings and system descriptions, and licensee submittals.

Information for this review included the above sources and elements of related SEP topics already reviewed for the Haddam Neck plant. Specifically, this report comprises a review of the Licensee's assessment [1] with emphasis upon ventilation of safety-related systems neccessary for safe shutdown [2,3].

2. REVIEW CRITERIA

In accordance with Nuclear Regulatory Commission (NRC) guidance for this evaluation, a ventilation system or portion thereof is considered essential to safety if it services systems or parts of systems that are necessary to ensure:

- o the integrity of the reactor coolant pressure boundary
- o the capability to shut down the reactor and maintain it in a safe condition
- o the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the guidelines of 10CFR100, "Reactor Site Criteria."

The criteria and guidelines used to determine if the ventilation systems meet the topic safety objectives are those provided in the following sections of the Standard Review Plan:

Section	Subject
9.4.1	Control Room Area Ventilation System
9.4.2	Spent Fuel Pool Area Ventilation System
9.4.3	Auxiliary and Radwaste Area Ventilation System
9.4.4	Turbine Area Ventilation System
9.4.5	Engineered Safety Feature Ventilation System.

In addition, applicable portions of related safety topic reviews were used where possible.

In accordance with NRC guidance, the following criteria (expressed in the form of questions to be determined) also were used to evaluate those heating, ventilation, and air conditioning (HVAC) systems or portions thereof that are relied upon to ensure the operation of safety-related equipment:

1. Whether a single active failure cannot result in loss of the system functional performance capability.
2. Whether the failure of a non-safety-related portion of a system will affect the performance of the essential portion of the system or will

result in an unacceptable release, as was defined during licensing review, of radioactive contaminants.

3. Whether the capability exists to detect the need for isolation and to isolate safety-related portions of the system in the event of failures or malfunctions, and the capability of the isolated system to function under such conditions.

4. Whether the ventilation systems (except for the control room) have the capability to direct ventilation air from areas of low radioactivity to areas of progressively higher radioactivity.

5. Whether both control room and engineered safety feature area HVAC systems have the capability to maintain temperature within the design parameters range for safety-related equipment.

6. Whether the engineered safety feature area ventilation s stem has the capability to circulate air to prevent accumulation of flammable or explosive fuel vapor mixtures from stored fuel.

3. RELATED SAFETY TOPICS

The scope of review for this topic was limited to avoid duplication of effort, since some aspects of the review are covered under related topics. These related topics are identified below. Each related topic report contains acceptance criteria and review guidance for its subject matter.

SEP Topic	Subject
II-2.A	Severe Weather Phenomena
II-3.B	Flooding Potential and Protection Requirements
II-4	Geology and Seismology
III-1	Classification of Structures, Components and Systems (Seismic and Quality)
III-2	Wind and Tornado Loadings
III-3	Hydrodynamic Loads
III-4	Missile Generation and Penetration
III-5.A	Pipe Break Inside Containment
III-5.B	Pipe Break Outside Containment
III-6	Seismic Design Considerations
VI-4	Containment Isolation System
VI-7.C	Independence of Onsite Power
VII-3	Systems Required for Safe Shutdown
VIII-2	Onsite Emergency Power Systems
IX-3	Station Service and Cooling Water
IX-6	Fire Protection
XV-20	Radiological Consequence of Fuel Damaging Accidents (Inside and Outside Containment)
TMI III.D.3.4	Control Room Habitability.

4. TECHNICAL EVALUATION

4.1 CONTROL ROOM AREA VENTILATION SYSTEM (CRVS)

The primary function of the control room ventilation system (CRVS) is to provide a controlled environment for the safety and comfort of control room personnel and to ensure the operability of control room components during normal operating, anticipated operational transient, and design basis accident conditions. However, since the CRVS is being reviewed generically under TMI Item III.D.3.4, "Control Room Habitability," to ensure compliance with 10CFR50, Appendix A, "General Design Criteria for Nuclear Power Plants," Criterion 19, "Control Room," it is not evaluated in this report.

4.2 SPENT FUEL POOL AREA VENTILATION SYSTEM

The spent fuel pool area does not include equipment essential to safe plant shutdown and therefore the spent fuel pool area was reviewed only with respect to personnel safety as reflected in the criterion that air must be directed from areas of lower radioactivity to areas of progressively higher radioactivity and that failure will not result in unacceptable release of radioactive contaminants.

The Licensee described the basic ventilation system as follows [1]:

"The function of the spent fuel pool area ventilation is to maintain ventilation in the spent fuel pool equipment areas to permit personnel access and to control airborne radioactivity in the area during normal operation, anticipated operational transients, and following postulated fuel handling accidents.

Ventilation for the spent fuel building consists of two supply units, two filtered exhaust units, associated supply and exhaust ducting, and necessary controls. The ventilation flow paths are independent, in that exhaust unit F-16-1A exhausts the area supplied by supply unit F-26-1A and exhaust unit F-35-1A exhausts the area supplied by supply unit F-34-1A. Design flows are such that exhaust capacity exceeds supply capacity by 1000 CFM per supply/exhaust train, maintaining a small continuous infiltration into the SFB, ensuring that contamination is not released outside the building. In the event of high airborne contamination levels in the SFB, as measured by the primary vent stack radiation monitor (R-14), the supply units may be shutdown and exhaust diverted through a charcoal and particulate filter bank."

The spent fuel pool area ventilation system is designed to supply 12,000 cfm of filtered, tempered outside air, via supply unit F-26-1A, to the new fuel and spent fuel storage areas and exhaust the effluent to the primary stack at 13,000 cfm, via exhaust fan F-16-1A during normal operation. The air is directed first to the new fuel area and then across the spent fuel where it is exhausted through ports located around the periphery of the spent fuel pit. The decontamination area of the spent fuel building is ventilated by a system consisting of supply unit F-34-1A, exhaust unit F-35-1A and associated ducting, dampers, and controls. Supply unit F-34-1A provides 5000 cfm of either recirculated or tempered outside air to the decontamination area. Exhaust unit F-35-1A exhausts the decontamination area effluent to the stack at a rate of 6000 cfm. When F-35-1A is started, F-34-1A is shifted automatically, via electrical interlocks, to deliver 100% tempered outside air. Provisions are included in the spent fuel pool area ventilation system to exhaust the primary auxiliary building process line plenums, when the ventilation and purge system is shut down, via isolation damper VS-D-467 and F-16-1A.

In the event that high radiation levels are detected emanating from the spent fuel building, the effluent is diverted to charcoal filter FL-30-1A, consisting of a prefilter, particulate filter, and a charcoal filter. In addition, F-26-1A, F-34-1A, and F-35-1A are shut down. The flow through the filter is 4000 cfm.

Supply units F-26-1A and F-34-1A and exhaust unit F-35-1A are powered by motor control center (MCC) 2-1, which is energized by 480-V bus 4. This bus is not supplied by emergency 4160-V buses 8 or 9. Therefore, upon loss of offsite power, the fans will be deenergized. Exhaust unit F-16-1A is powered by MCC 8-1, which is energized by 4160-V bus 9 via 480-V bus 6. Thus, in the event of loss of offsite power, F-16-1A will be energized by emergency power.

Regarding the spent fuel pool area ventilation system design, the Licensee drew the following conclusions:

"Exhaust unit F-16-1A and its associated charcoal filtration which exhausts the new and spent fuel area is required to mitigate the off-site dose consequences of the fuel handling accident. Exhaust unit F-35-1A which exhausts the decontamination area is required by Normal Operating Procedure NOP 2.15-3 to be shut down during fuel handling operations. As can be seen, exhaust unit F-16-1A is subject to single active failure. Since there are no automatically operated dampers and the charcoal filter is manually lined up during fuel handling operations, the dampers provided are not subject to failure. In addition, emergency power is not provided to the various components of the spent fuel building ventilation system. In particular, exhaust unit F-16-1A will require emergency power in the event a final handling accident occurs in conjunction with a loss of normal offsite power.

In conclusion, pending resolution of the above identified areas of concern during integrated assessment, the spent fuel area ventilation system can maintain ventilation in the spent fuel pool equipment area to permit personnel access and control radioactivity during normal operation, anticipated operational transients, and following postulated fuel handling accidents."

Independent review confirms the Licensee's conclusions regarding the capability to control radioactivity release to the outside environment. The supply air to the new fuel and spent fuel area is directed from areas of lower radioactivity to areas of higher radioactivity. The exhaust unit F-16-1A is susceptible to both hardware failure and loss of electrical power via loss of MCC 8-1.

An additional area of concern lies in the dependency on manual action for aligning the charcoal filter system to exhaust unit F-16-1A in the event that high radiation levels are detected in the spent fuel building. According to the Licensee's description of the ventilation system, a single radiation monitor is employed to monitor the spent fuel building effluent. Failure of this monitor could inhibit transfer of the normal effluent to the charcoal filter system since no alarm would be generated. Thus, the ventilation system appears to be vulnerable to single failures additional to that discussed by the Licensee in Reference 1.

4.3 AUXILIARY BUILDING AND RADWASTE AREA VENTILATION SYSTEMS

The auxiliary building and radwaste area ventilation systems provide ventilation for the primary auxiliary building (PAB) and the waste disposal building (WDB), respectively. The WDB contains no equipment essential to safe shutdown. Therefore, the WDB ventilation system was reviewed here only with respect to personnel safety as reflected in the criteria that air must be directed from areas of lower radioactivity, to areas of progressively higher radioactivity and that failure will not result in release of radioactive contaminants. The PAB houses engineered safety features including (a) the chemical and volume control systems, (b) the low pressure and high pressure pumps, and (c) the residual heat removal system. The ventilation of specific safety-related equipment is evaluated in later sections of the report. This section considers the overall PAB ventilation system.

Regarding the function of the PAB and WDB ventilation systems, the Licensee stated:

> "The heating and ventilation systems are provided for personnel and equipment protection from airborne radioactive contaminants and excessive thermal conditions. Air flow is controlled in the direction of greater contamination prior to final exhaust through the filtration system and remote ventilation stack."

4.3.1 Primary Auxiliary Building (PAB) Ventilation System

The Licensee described the PAB ventilation system as follows:

> "The primary auxiliary building is provided with both supply and exhaust ventilation to ensure proper air flow direction and remove the heat generated by the various equipment. Flow paths from all supply and exhaust units are interrelated to provide one common ventilation system for the primary auxiliary building. As stated previously, the design flow path is from areas of lower contamination to areas of higher contamination. This is accomplished by exhausting each compartment separately.
>
> The supply system consists of two supply units each of which is equipped with ventilation enclosure particulate filter, steam heating coil, outside air supply damper, and face and bypass damper along with all necessary ducting, supply registers, and controls. All control functions are electro-pneumatic. Both supply fans are powered from safety related

buses and therefore are capable of receiving power from the emergency diesel generators.

Discharge from the reactor containment purge is manually blocked by a butterfly valve and will normally be directed to the prefilter by a manually-operated damper. Discharge from the primary auxiliary building lower levels and the volume control tank cubicle enter the inlet side of the prefilters and can be directed to either prefilter by manually-operated stop dampers. The exhaust from the waste disposal building also enters the inlet to the prefilters and can be directed to either prefilter by manually-operated stop dampers.

When the containment is not being purged, air flows from the process line plenums, PAB, and the WDS will flow through the same prefilter and through the HEPA-HECA filters. During containment purging operations, air flow from the process line plenums and containment will flow through one prefilter and the HEPA-HECA filters, while air flow from the PAB and WDB flow through the prefilter and directly to the fan inlet plenum, bypassing the HEPA-HECA filters.

The exhaust and purge system exhausts air and noncondensibles from the primary auxiliary building, waste disposal building, reactor containment (during containment purge operations), and from various vented components connected to the two process line plenums."

The PAB ventilation system is designed to deliver filtered, tempered, outside air to all areas of the PAB and exhaust the effluent to the primary vent stack. Supply unit F-25-1A supplies 35,650 cfm of filtered, tempered, outside air to areas in the PAB located at elevation 21'6" and below. Supply unit F-36-1A supplies 27,250 cfm of filtered, tempered, outside air to PAB areas located at elevation 35'6". The ventilation and purge system is used to exhaust the PAB effluent to the primary vent stack.

The ventilation and purge system includes two parallel prefilters, a high-efficiency particulate air (HEPA) filter, a high-efficiency charcoal absorber (HECA) filter, and two parallel fans, F-50-1A and F-50-1B. Ducting and dampers are provided for split system operation and for bypassing the HEPA-HECA filters. Each of the fans is rated to deliver the PAB effluent to the primary stack at a maximum flow rate of 52,000 cfm. The flow capacity of each of the two pre-filters and the HEPA-HECA filters is 52,000 cfm. Discharge from either prefilter is directed to the exhaust fans via a manual stop damper or to the HEPA-HECA filters via a manual stop damper and a motor-operated damper.

The flow capacity of the HEPA-HECA filters limits the fans to the split system mode or to single-fan operation, whereas HEPA-HECA filter bypass permits operation of the two fans at full-rated flow since each of the prefilters is rated at 52,000 cfm. F-50-1A is powered by 480-V bus 5, which is energized by 4160-V emergency bus 8, while F-50-1B is powered by 480-V bus 6, which is energized by 4160-V emergency bus 9. Thus, continued operation of the ventilation and purge system is assured in the event of a loss of offsite power.

Supply air from F-25-1A is delivered to the east and west ends of the PAB at elevation 21'6" and distributed to the various areas at this elevation and below via a network of supply ducts. Supply unit F-36-1A delivers the filtered, tempered, outside air at a rate ranging from a minimum of 3200 cfm to a maximum of 27,250 cfm to the various areas and rooms located at elevation 35'6" via a network of supply ducts. In addition, provisions are included for recirculating the air in the areas served by F-36-1A at flow rates up to 2400 cfm. Exhaust from the areas served by both F-25-1A and F-36-1A is drawn by a network of exhaust ducts by the ventilation and purge system and delivered to the primary stack. In the event the PAB ventilation system is shut down, effluent from process plenums, inlcuding exhaust from areas other than the PAB, is directed to the spent fuel building exhaust system filter via a cross-connect damper.

Both supply units, F-25-1A and F-36-1A, are powered by MCC 8, which is energized by 4160-V emergency bus 9 via 480-V bus 6. Thus, although protection is provided against loss of offsite power, both supply units would be disabled in the event MCC 8 or bus 6 is lost. Further, since each supply unit is dedicated to a separate level in the PAB, failure of either unit would result in loss of ventilation for the equipment located in the level served by the failed unit. Consequently, the unventilated equipment could malfunction due to overheating.

Regarding the loss of supply air to the PAB levels, the Licensee stated:

"The primary auxiliary building supply system is subject to a single active failure as a result of each supply fan being designated to supply a specific PAB level. The PAB exhaust system contains redundant full capacity fans and thus is not subject to the mode of failure. The normal position of the various remotely-operated control/isolation dampers is open, and as indicated above, these dampers will close on system trip functions as well as loss of control air.

In addition, the exhaust isolation dampers for exhaust fans F-50-1A and F-50-1B will close on various exhaust system functions. The position of the dampers is normally open. Therefore, since the damper actuators are motor operators the failure position upon loss of power (i.e. - fail as-is) will not inhibit the operation of the exhaust system.

The various failure modes discussed could result in a loss of supply air to the safety-related equipment contained within the PAB, however, there would be no loss of exhaust capability, thus providing portions of the building normal ventilation requirements. The impact of this loss on the ability of the equipment to perform its required safety function will be evaluated during integrated assessment."

4.3.2 Waste Disposal Building (WDB) Ventilation System

The Licensee described the WDB ventilation system as follows [1]:

"The waste disposal building ventilation system consists of a supply fan and exhaust ducting which employs the primary auxiliary building exhaust system. Supply unit F-51 is located in the stairwell area and draws outside air through a damper and plenum located on the east wall of the stairwell. A separate damper and ducting provides the capability for recirculation. Air is supplied at approximately 11250 cfm to each level of the building, the stairwell and to the pipe tunnel in the waste disposal building. Air is exhausted at 12350 cfm from the various rooms of the building, the stairwell, and the pipe tunnel. Exhausts are combined in a common duct which penetrates the primary auxiliary building wall, and joins the intake of the PAB ventilation system exhausts thereby passing through the previously-described prefilters and charcoal filters and is subsequently discharged to the primary vent stack by fans F-50-1A and F-50-1B. Exhaust air flow is measured by a flow indicator located in the WDB exhaust duct near the inlet to the PAB exhaust system."

Supply unit F-51 is powered by MCC 9, which is energized by 480-V bus 4 and is not supplied by emergency power. Thus, in the event of a loss of offsite power, the WDB ventilation system would be disabled. However, since the effluent from this building is exhausted via the PAB ventilation exhaust system, loss of the WDB ventilation supply system due to loss of offsite power is mitigated by the use of the PAB ventilation exhaust system, which is redundantly powered by onsite emergency power sources.

Regarding loss of the WDB ventilation system due to single-active failures, the Licensee stated [1]:

> "The waste disposal building does not contain any safety-related equipment. As previously discussed, the exhaust from this area is handled by the PAB exhaust system and is thus subject to the above failure modes [of the primary auxiliary building ventilation system]. The supply system contains a single fan and associated air-operated dampers and, therefore, is subject to a single active failure condition as well as loss of air and power.
>
> Based upon this information, a failure of the supply system would result in the building exhaust continuing to function through PAB exhaust and associated filtration. Therefore, it has been determined that the subject ventilation system can suitably maintain the building environment to permit personnel access, control airborne activity, and provide adequate cooling and heating for equipment contained within the building during normal as well as anticipated abnormal operation of equipment in the building."

Independent review confirms the Licensee's statement regarding susceptibility of the WDB ventilation supply system to single-active failures. As stated above, the ventilation system is not redundantly powered nor is it powered via an emergency bus. Although only a single supply unit, with associated manually operated dampers, is employed and is thus susceptible to single-active failure as well as to loss of offsite power, the fact that the PAB ventilation exhaust system is used appears to be sufficient to meet the ventilation requirements for the WDB. Also, since the effluent from the various areas and rooms is exhausted to a common duct, the criterion regarding direction of air movement from areas of lower radioactivity to areas of higher radioactivity also appears to be met by the WDB supply and exhaust provisions.

4.4 TURBINE AREA VENTILATION SYSTEM

The Licensee described the turbine area ventilation system as follows:

> "The turbine area ventilation system services all areas of the turbine building with the exception of the lubrication oil storage room and service boiler room. The lubricating oil storage room ventilation

consists of a centrifugal exhaust air fan which removes air and fumes from the oil rooms as well as drawing air into the room thorugh screened openings equipped with fire dampers. Ventilation for the service boiler room is provided by a roof ventilator. Outside supply air, and combustion air enter through open steel doors during the summer; a hooded envelope intake around the stack provides for combustion air in the winter.

The turbine room and auxiliary bay warm weather ventilation is provided by a combination natural and forced ventilation system. Louvered supply openings at the base of the west wall provide natural ventilation air, which is supplemented by fans providing the forced ventilation air. Continuous roof ventilators on the turbine room roof exhaust all the heated ventilation air. Forced ventilation air supply is required due to the limited area available for ventilation supply openings.

Air flow through the building is accomplished primarily by the stack effect resulting from the difference in elevation between supply and exhaust openings and the addition of heat to the air. This flow is supplemented by the air introduced into the building by the supply fans. The average stack height is approximately 90 feet. The design difference between supply and exhaust air is 20°F.

For greatest effectiveness, the air supplied to the turbine and auxiliary bay areas is introduced beneath the equipment, where possible. It is allowed to rise alongside the equipment, thus absorbing the heat released.

Openings in the operating floors for stairs and equipment removal and around heaters and piping relieve air from the lower level of the turbine building to the operating floor. From here, the air is exhausted by the roof ventilators."

The review of heating and ventilation drawings 16103-24017, sheets 1, 2, and 3, for the turbine area disclosed that a total of 10 fans are employed for ventilating the various areas and equipment rooms of the turbine area. Power to these fans is supplied by MCC 3-1, which is energized by 480-V bus 7. This bus is not supplied by either emergency bus. Thus, loss of offsite power results in shutdown of the turbine area ventilation system. It is to be noted that effluent from the turbine area is exhausted directly to the atmosphere. Thus, the criterion regarding the flow of air from areas of lower radioactivity to areas of higher radioactivity also was not a necessary consideration for this system.

Regarding the turbine area ventilation system, the Licensee concluded:

"The turbine building does not contain equipment which is considered essential to safe shutdown of the plant...it is our judgment that safety grade ventilation is not required, thus the turbine area ventilation is adequate as designed."

This review team concurs with the Licensee's conclusion. Since no equipment essential to safe shutdown is housed in the turbine area, partial or complete loss of the ventilation system will not adversely impact safe shutdown capability. Further, no impact on personnel safety regarding buildup of unacceptable radioactivity levels due to system malfunctions is expected since effluent is normally exhausted directly to the atmosphere.

4.5 ENGINEERED SAFETY FEATURES VENTILATION SYSTEM

4.5.1 Cable Vault Ventilation System

Regarding the function and design of the cable vault ventilation system, the Licensee stated:

"The cable vault ventilation system services both the above-grade electrical equipment and subgrade cable vault. The safety equipment contained within this area consists of MCC-7, as well as the various safety-related cables and associated electrical penetrations.

The ventilation system for this area is comprised of a 100% outside air supply ventilation unit F-31-1A, which consists of a particulate filter face and bypass damper and heating coil. This unit supplies approximately 4000 cfm during operation. In addition, a roof exhaust fan F-32-1A draws air from the cable vault and electrical penetration area and discharges it to atmosphere at approximately 4000 cfm. Both the exhaust and supply fans are powered from safety buses and, therefore, are capable of receiving power from the emergency diesel generator. The supply unit face and bypass damper are pneumatically operated."

Supply unit F-31-1A and exhaust unit F-32-1A are both powered by MCC 7, which is energized by 4160-V emergency bus 9 via 480-V bus 6. Thus, the cable vault ventilation system is protected against loss of offsite power. However, loss of MCC 7 would result in shutdown of the ventilation system with possible failure of safety-related equipment housed in the cable vault due to loss of cooling.

Regarding the susceptibility of the cable vault ventilation system to single-active failures, the Licensee concluded:

> "Based upon the above summary, our review has concluded that the cable vault supply and exhaust fans are subject to a single active failure. In addition, in the event of a loss of instrument air to the supply air dampers, the supply air capability will be lost until corrective action can take place. Pending resolution of the above-identified areas of concern during integrated assessment, it is our conclusion that the cable vault ventilation can maintain the environment in this area at conditions so as to ensure reliable operation of safety-related equipment and permit personnel access during design basis accidents."

Independent review supports the Licensee's conclusion regarding loss of the ventilation system due to single-active failure of the system components and loss of instrument air to the supply air dampers. An additional area of concern requiring resolution is the potential for shutdown due to loss of the motor control center powering both the supply and exhaust units.

4.5.2 Auxiliary Feedwater Pump Room

The Licensee made the following statement concerning ventilation of the auxiliary feedwater system [1]:

> "The steam-driven auxiliary feedwater pumps and their associated valves and controls are contained within a separate building on the west side of the containment structure. No ventilation is presently provided. On the basis of extensive experience with this system involving periods of use during normal operation and testing, reliable operation of all equipment has been demonstrated. Based on this experience, it is our conclusion no ventilation is required."

Supporting documentation concerning the capability of the auxiliary feedwater system components to perform satisfactorily without ventilation was not furnished. It is suggested that the Licensee provide documentation to support the conclusions drawn.

4.5.3 Emergency Diesel Generator Rooms

The Licensee provided the following description of the ventilation system for the emergency diesel generators [1]:

"There are two emergency diesel generator rooms each of which contains an emergency diesel generator and its associated auxiliary systems, controls, and switchgear. The ventilation system for each room is comprised of an outside air intake penthouse located on the roof of each building, a 25000 cfm exhaust fan which exhausts directly outside, and an 1800 cfm transfer fan and associated duct work located in the area which contains the generator switchgear to ensure adequate ventilation in this area. Each exhaust fan is started automatically upon start of the corresponding diesel generator. In addition, the power for each fan is supplied from the associated diesel generator."

The Licensee made the following statement concerning the potential for single-active failures in the diesel generator ventilation system and the associated consequences:

"Based upon the above summary, our review had concluded that the emergency diesel generator room exhaust fan is subject to a single active failure, however, the short-term effect of loss of the exhaust will not result in a loss of a diesel generator. However, in the long term, the loss of exhaust could result in overheating of the diesel generator and its associated electrical and auxiliary equipment. Pending resolution of the above-identified areas of concern during integrated assessment, it is our conclusion that the emergency diesel generator room ventilation system can maintain the environment in this area at suitable conditions so as to ensure reliable operation of the emergency diesel generator and its associated auxiliary systems and electrical equipment."

A single-active failure of the exhaust unit of either diesel generator room will eventually cause the loss of the associated generator. The Licensee, however, does not define short and long term. Since failure of a diesel generator causes loss of all safety system trains associated with the failed diesel, loss of a diesel generator room ventilation system can have a significant impact on extended safety system operation under emergency conditions. It is to be noted that no single-active failure will result in loss of ventilation for both diesel generators. The reviewers concur with the action being taken by the Licensee to resolve the above-described concern.

4.5.4 Intake Structure Ventilation System

The Licensee provided the following description of the intake structure ventilation system [1]:

"The intake structure ventilation system is addressed as a result of this building containing the service water pumps which are considered safety related. The ventilation for the screenwell house is provided by air flow through wall louvers, as well as open doors during warm weather. The air is exhausted by a gravity roof ventilator. The chlorination room has a propeller exhaust fan available for ventilation as required. The mechanisms which act to preclude any rapid heat buildup are as follows: the service water pipes will contain cool river water which act as heat sinks and, as previously indicated, the room is not air tight thus allowing for cooling as a result of infiltration. In addition, if a system failure should occur, opening of the intake structure doors is an alternative to provide a sufficient flow of air to ensure adequate equipment cooling."

Regarding the ventilation system design, the Licensee concluded:

"Based upon the above review, the system as designed will ensure reliable operation of the safety-related equipment in this area as well as permit personnel access during design basis accidents."

The reviewers concur with the Licensee's conclusion concerning the ventilation system. The system as described above appears to satisfy the requirements of Criteria 1 and 2 listed in Section 2 of this report.

4.5.5 Switchgear Room Ventilation System

Regarding the design and function of the switchgear room ventilation system, the Licensee stated [1]:

"The switchgear room ventilation system services all electrical equipment located in the switchgear room. This area contains various safety-related switchgear as well as the plant batteries. The ventilation of this area is comprised of centrifugal supply and exhaust fans F-6-1A and F-44-1A, respectively, and associated intake exhaust and distribution duct work and dampers. Thermostatic controls pneumatically modulate the outside exhaust and return air dampers to control the switchgear room temperature. The battery room area of the switchgear room is equipped with a separate 100 cfm exhaust fan to provide continuous ventilation in the vicinity of the batteries thus precluding any buildup of hydrogen. All of the above exhaust and supply units are powered from safety-related buses and, therefore, are capable of receiving power from the emergency diesel generator."

A review of the service building ventilation system drawing, 16103-24061, disclosed that exhaust fan F-1-1A, which provides ventilation for the battery room, exhausts the air from the battery room at a flow rate of 1000 cfm as opposed to the 100 cfm stated above by the Licensee. This error should be corrected by the Licensee.

Supply fan F-6-1A and exhaust fans F-44-1A and F-14-1A are all indicated, in drawing 16103-30004, as being powered by MCC 6, which is energized by 4160-V emergency bus 9 via 480-V bus 6. Thus, although protection is provided against loss of offsite power, loss of MCC 6 would result in shutdown of the ventilation system for the switchgear room and possible failure of the equipment contained therein.

Regarding the potential for single-active failures in the ventilation system and the associated consequences, the Licensee stated:

> "Based upon the above summary, our review has concluded that the switchgear/battery room exhaust and supply fans are subject to a single active failure. In addition, in the event of a loss of instrument air to the various control dampers, the supply and exhaust capability will be lost until corrective action can take place. Pending resolution of the above-identified areas of concern during the integrated assessment for Haddam Neck, it is our conclusion the cable vault ventilation can maintain the environment in this area at conditions so as to ensure reliable operation of the various safety-related equipment and permit personnel access during both normal operations and design basis accidents."

This review team concurs with the Licensee's conclusions regarding loss of ventilation due to single active failure of the system components and loss of instrument air to the various control dampers. However, it is not clear how the cable vault ventilation system would provide adequate ventilation for the switchgear room in the event of loss of its dedicated ventilation system as stated above by the Licensee. It is suggested that the Licensee provide a detailed analysis to support this conclusion. An additional area of concern requiring resolution is the potential for shutdown due to loss of the motor control center powering the three fans which comprise the ventilation system for the switchgear room.

4.5.6 <u>Cable Spreading Area Ventilation System</u>

The Licensee made the following statement concerning the ventilation system for the cable spreading area [1]:

"Ventilation for the cable spreading area is provided by the service building ventilation system. The system consists of various roof exhaust units and corresponding venting as well as associated exhaust duct work. In the advent of loss of ventilation to the cable spreading area, sufficient open area as well as open venting is provided to preclude overheating of this area, thus ensuring reliable operation of the various safety cables located in the cable-spreading area. Based upon the above review, it is our conclusion that a safety-grade ventilation system is not required for this area."

Drawing 16103-24061 shows that exhaust fan F-5-1A is dedicated to the cable spreading area and exhausts the air from this area at a flow rate of 10,000 cfm. Although loss of F-5-1A results in loss of the dedicated exhaust fan, the ventilation flow diagram (drawing 16103-24061) indicates a large number of openings to the cable spreading area through which supply air can be provided and exhausted via other service building fans. It was noted that, among the large complement of supply and exhaust fans (approximately 23) comprising the service building ventilation system (2), 14 fans, including F-5-1A, are powered by MCC 6, which is energized by 4160-V emergency bus 9 via 480-V bus 6. Sufficient information was not available to determine the power source for the remaining fans from the drawings provided for this review. However, it can be seen that loss of MCC 6 could severely impact the service building ventilation capability and possibly result in excessive thermal conditions in the cable spreading area. This review team concurs with the Licensee that loss of the dedicated cable spreading area exhaust fan would be compensated for by the remaining building fans. However, it is suggested that the Licensee determine the actual impact that loss of MCC 6 would have on the building ventilation system.

5. CONCLUSIONS

The Haddam Neck plant ventilation systems satisfy all NRC acceptance criteria except as indicated below.

5.1 AUXILIARY AND RADWASTE AREA VENTILATION SYSTEMS

5.1.1 Primary Auxiliary Building Ventilation System

In additional to the single-active failures in the PAB ventilation system identified by the Licensee, including loss of ventilation to a specific PAB area due to supply unit failure, the evaluation disclosed that both supply units would be shut down if the power source via MCC 8 were to fail. Thus, potential exists for loss of safety-related equipment housed in the PAB due to loss of ventilation resulting from power loss as well as from single fan unit malfunctions.

5.2 ENGINEERED SAFETY FEATURES VENTILATION SYSTEMS

5.2.1 Cable Vault Ventilation System

The Licensee concluded that the supply and exhaust fans are subject to single-active failures and that loss of instrument air to the supply air dampers will inhibit delivery of supply air to the cable vault. The evaluation disclosed that both the supply and exhaust fans are powered by MCC 7. Thus, loss of MCC 7 would result in shutdown of the cable vault ventilation system with possible failure of safety-related equipment housed in the cable vault area.

5.2.2 Auxiliary Feedwater Pump Room Ventilation

The Licensee stated that, based on extensive experience with the auxiliary feedwater system, no ventilation is required for this system. Documentation to support this conclusion should be provided by the Licensee for review and evaluation.

5.2.3 Emergency Diesel Generator Room Ventilation System

Single-active failures in the diesel generator ventilation system that could result in a diesel generator failure in the long term were identified by the Licensee. Although no single-active failure in the ventilation system was found that could cause both diesels to fail, the Licensee stated that resolution of the concern regarding loss of a single diesel due to ventilation failure is planned during integrated assessment.

5.2.4 Switchgear Room Ventilation System

In addition to single-active failure susceptibility among the three fans serving this area and identified by the Licensee as requiring resolution, the evaluation disclosed that loss of MCC 6, which powers all three fans, would result in shutdown of the switchgear room ventilation system. This could result in failure of safety-related equipment, including vital buses and batteries, housed in this room. The Licensee stated that sufficient ventilation would be provided by the cable vault ventilation system however, it is not clear how the cable vault ventilation would provide the required ventilation. The Licensee should provide documentation to support this conclusion.

5.2.5 Cable Spreading Area Ventilation System

The Licensee concluded that adequate ventilation would be provided to the cable spreading area via the various service building supply and exhaust fans if the dedicated cable spreading area exhaust fan failed. The evaluation disclosed that more than half of the service building fans were powered by one motor control center, MCC 6. Thus, loss of MCC 6 could result in a significant loss of service building ventilation capability. The Licensee should determine the actual impact of MCC 6 failure, particularly on the cable spreading area.

6. REFERENCES

1. Safety Assessment Report, SEP Topic IX-5, Ventilation Systems, Haddam Neck Nuclear Power Plant December 14, 1981

2. SEP Topic VII-3, "Electrical, Instrumentation and Control Features of Systems Required for Safe Shutdown - Haddam Neck Nuclear Station," April, 1981

3. Final Safety Analysis Report through Amendment No. 20, Haddam Neck Plant Connecticut Yankee Atomic Power Company