

WISCONSIN PUBLIC SERVICE CORPORATION
KEWAUNEE NUCLEAR POWER PLANT

UPDATED CONTROL ROOM HABITABILITY EVALUATION REPORT

PROJECT 834878 - CRHB

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Prepared by:

E. M. Megahed

E. M. Megahed

R. A. Cullotta

R. A. Cullotta

G. V. Schwab

G. V. Schwab

Approved by:

R. P. Berzins 2/22/89

R. P. Berzins

Project Mechanical Engineer

8903090012 890228
PDR ADOCK 05000305
P PDC

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1.0 SUMMARY

The Control Room Ventilation System, designated for the Kewaunee Nuclear Power Plant as the Control Room Air Conditioning (ACC) System, was re-evaluated for meeting the recommended habitability and design criteria of a, b, and c below. Deviations to that criteria are listed herein.

- a. Standard Review Plan 6.4, Control Room Habitability System, Revision 2, dated July, 1981.
- b. K. G. Murphy and K. M. Campe, "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Design Criterion 19", 13th AEC Air Cleaning Conference, August 1974.
- c. NUREG-0737, "Clarification of TMI Action Plan Requirements", Item III.D.3.4, Attachment 1, "Information Required for Control Room Habitability Evaluation", November, 1980.

Extensive performance testing of the Control Room Ventilation System was conducted in January, 1988. The system was tested in various post-accident operating modes, as well as normal operating modes. The evaluation of the control room habitability, therefore, reflects the as-tested system performance and observations made during the tests.

The evaluation of the habitability systems identified four deviations, which are as follows:

Deviation 1: ACC System outside air intakes design does not meet missile protection criterion.

Solution: No action, since air intakes are redundant and missile protection was not a requirement when plant was built.

Deviation 2: Dampers ACC-3A and ACC-3B do not meet single failure criteria due to both dampers being interlocked with a single damper ACC-2. Failure of ACC-2 to close or a spurious opening, if closed, will prevent both ACC-3A and ACC-3B from opening, which will result in loss of both redundant post-accident recirculation trains.

Solution: Four alternative solutions have been identified in resolution of this deviation as depicted in Section 3.5. An engineering evaluation will be performed to determine which alternative is to be implemented.

Deviation 3: The control room radiation monitor R23, which is used for automatic actuation of safety related function, i.e., control room Train A outside air isolation, is a QA Type 3/3 component.

Solution: Provide Train A Safety Injection signal for this automatic actuation function.

Deviation 4: The dampers that may require repair post-accident do not fully comply with the requirements of Appendix A of SRP 6.4, Acceptance Criteria for Valve or Damper Repair Alternative.

Solution: No action, since SRP 6.4 did not exist when plant was built. These dampers, however, do meet the intent of Appendix A.

The Control Room Ventilation System was evaluated for single failure criteria to determine if a single failure of an active component can preclude the system from performing its post-accident function. Complete information on this analysis is covered in Section 3.0.

Radiological evaluation for the habitability of the control room was performed to demonstrate that doses to the control room personnel resulting from the design basis accident are within the limits specified in General Design Criterion 19 of Appendix A to 10 CFR Part 50. Complete information on this analysis is covered in Section 4.0.

Control room habitability was evaluated to determine if any on-site postulated release of hazardous chemicals could result in exceeding the toxicity limits specified in Regulatory Guide 1.78. Complete and specific information on the evaluation is covered in Sections 5.0.

Section 6.0 provides the 1981 control room habitability evaluation for any off-site accidents that could result in release of hazardous chemicals where the toxicity would exceed the limits specified in Regulatory Guide 1.78. The release of hazardous chemicals due to off-site accidents was not re-evaluated, since the recent NRC concerns with regards to control room habitability did not indicate any concern for off-site chemical releases.

2.0 HABITABILITY SYSTEMS

The control room habitability systems include radiation shielding, isolation, redundant air filtering, cooling and ventilation system, radiation monitoring and personnel support. These habitability systems are provided to permit occupancy of the control room during normal operation and during design basis accident (DBA) conditions. These systems are given detailed description in applicable sections of the Updated Safety Analysis Report (USAR).

2.1. Functional Design

The design of the control room complex employs several systems and provisions to ensure habitability for a prescribed period following a DBA. The habitability systems and provisions include:

- Shielding
- Control Room Ventilation System
- Food, Water, Medical Supplies
- Kitchen and Sanitary Facilities

2.2. Design Requirements

2.2.1. Shielding

The radiation exposure of control room personnel through the duration of any one of the postulated DBA's discussed in Section 14 of the USAR shall not exceed the guideline values in General Design Criterion 19 of Appendix A, 10 CFR Part 50.

2.2.2. Control Room Ventilation System

Control Room occupancy post-DBA is based on 10 people.

The ventilation system is designed to maintain the control room at a maximum dry bulb temperature of 85°F and design maximum relative humidity of 40 percent.

The ventilation system is designed to maintain the control room at a positive pressure relative to the adjacent areas during normal operation. Upon a safety injection signal and/or high radiation detection, the control room is automatically isolated and 100 percent recirculation occurs. This action minimizes

the possibility of contaminants entering the control room.

The control room ventilation system is designed to seismic category I requirements.

2.2.3. Food, Water, Medical Supplies

A supply of food, consisting of 150 dehydrated meals, is maintained in the control room. An unlimited supply of potable water is provided. Basic medical supplies are provided.

2.2.4. Kitchen and Sanitary Facilities

Kitchen and sanitary facilities including toilets, washrooms, and lockers are provided within the emergency zone.

2.3. System Description

A flow diagram of the control room ventilation system, which serves the Control Room Emergency Zone (CREZ), is shown in Figures 1 and 2. The CREZ includes the control room, shift supervisor's office, kitchen, sanitary facility, computer room, CAS room, relay room, and mechanical equipment room. The normal and emergency flows shown in these figures, and as stated below, are the system design flows. The system provides redundant (two 100% capacity) air conditioning and filtered recirculation capability.

During normal operation the air conditioning system recirculates 13,450 cfm from the control room, relay room, shift supervisor's office, CAS room, computer room, and mechanical equipment room. This air is mixed with 2500 cfm of outside air, and the mixture is drawn through either control room A/C unit, which then supplies a total of 15,950 cfm to same areas, and in addition, the kitchen and sanitary facility. The ventilation air for the kitchen and sanitary facility is exhausted to the auxiliary building exhaust. Excess return air (2200 cfm) is exhausted to the Turbine Building. The A/C unit contains atmospheric dust filters, a cooling coil and a fan. The fan discharges to the CREZ after passing through the heating coil. The system is designed for year-around operation with temperature and humidity control. The air conditioning units are used under normal as well as emergency conditions.

The post-accident fan/radiological filter units are designed to perform two functions. They recirculate air within the CREZ, or receive outside air upstream of filters for purging of the control room, if required. The fan/radiological filter units are only used during emergency situations.

Upon a safety injection signal and/or high radiation detection at the air conditioning unit discharge, the following occurs:

- a. The Control Room Emergency Zone is automatically isolated from all outside air supply.
- b. The ventilation system is automatically re-aligned to the 100 percent recirculation mode.

The control room fan/recirculation filter cleanup feature recirculates 2500 scfm emergency zone atmosphere air. The cleanup feature draws recirculation air through radiological filter elements, and discharges to the inlet of the air conditioning units. The emergency zone is isolated and maintained at essentially atmospheric pressure during the duration of the accident. The ventilation system has the provisions for purging the emergency zone, if required, by manually re-positioning the system dampers from panel mounted control switches.

2.4. System Configuration and Essential Features

The ventilation system consists of redundant outside air intakes, 15,600 cfm air conditioning units and 2500 cfm fan/filter recirculation units. The filter recirculating units contain radiological filters. HEPA filter elements are capable of handling a nominal flow rate of 1000 scfm each. The filter medium is cased in stainless steel, is water and fire resistant, and complies with UL Standard UL-586.

The charcoal absorbers employ impregnated carbon beds of 2" depth that provide a minimum residence time of 0.25 seconds. The carbon is activated and impregnated for trapping radioiodine, both elemental and in the form of organic compounds.

The filter assemblies and associated air handling equipment are designed to seismic Category I and Quality Assurance Type 1 requirements. The control room atmosphere cleanup feature is capable of delivering the design flow rate of 2500 cfm with all filters at their maximum anticipated pressure drop.

The air conditioning unit houses the cooling coil which is supplied by chiller packages for the purpose of cooling and humidity control of the air stream directed to the conditioned spaces. Heating requirements are accomplished with hot water from the auxiliary building hot water converter.

The control room ventilation isolation dampers are capable of closing fully in 4 seconds or less after receipt of an isolation signal. Table 1 provides a listing of the isolation dampers along with various damper data, including damper leakage rates and damper closing times.

In the event of a loss of power under either normal operating or accident conditions, Class 1E power is supplied to all safety-related electrically powered motors and controls associated with the air conditioning and cleanup unit. Essential lighting in the control room also receives power from this source. In addition, DC batteries provide power for emergency lighting in the control room.

Protection against smoke in the emergency zone is provided by a smoke detector whose output signal is used to realign the ventilation system for 100 percent makeup. Should the control room become uninhabitable due to fire, safe shutdown of the reactor can be achieved from the "Appendix R" Dedicated Shutdown Panel (DSP) and local actions as defined by the Appendix R design.

2.5. Design Evaluation

2.5.1. Ventilation System Performance

Performance testing of the Control Room Ventilation System was conducted in January, 1988. The tests showed that for the normal operating mode the Control Room Emergency Zone (CREZ) is maintained between -0.1 to +0.3 "WC relative to the various adjacent areas and the atmosphere; for the post-accident recirculation mode the CREZ is maintained between -0.13 to +0.05 "WC relative to the various adjacent areas and the atmosphere. From the test results and observations during these tests, and subsequent calculations for isolation damper leakage, a gross inleakage rate of 200 cfm is predicted, equivalent to 0.094 volume changes per hour, which includes 10 cfm for opening and closing of doors.

The fresh air dampers ACC-1A/1B and ACC-5 inleakage, bypassing the filter trains, was measured to be 34 cfm at a differential pressure of 1.65 "WC, with both redundant sets of dampers closed. Based on this measured data, and assuming identical leakage characteristics for these dampers, a calculation was performed for bypass leakage assuming a single failure of one of the redundant dampers to close, i.e., leakage through ACC-1A/1B with ACC-5 open and leakage through ACC-5 with ACC-1A/1B open, with a 1.65" WC differential in both cases. The largest of the two leakages calculated is with ACC-5 open (83 cfm), which was then used in determining the gross inleakage rate. Similarly, the inleakage through the exhaust isolation dampers ACC-20 and ACC-21 was predicted by calculations based on measured data, and included in the gross inleakage rate.

The above pressure range in the CREZ for the post-accident recirculation mode includes both one train and two train operation of the post-accident recirculation fans in conjunction with either A/C fan 1A or A/C fan 1B. The pressure range is essentially the same for one or two recirculation fan operation. There is, however, a slight difference in the pressure range as to which A/C fan is operating. Based on this, it appears that the inleakage into the CREZ will be essentially the same for one or two recirculation fan operation, and hence, two filter trains running will not result in any higher control room dose than that with one filter train running; in fact, two filter trains will provide more rapid cleanup of the control room atmosphere which will result in lower dose than that with one filter train running.

2.5.2. Cleanup and Shielding

The control room cleanup subsystem and the control room shielding design basis assumptions are those of Regulatory Guide 1.4. The airborne fission product source term in the reactor containment following the postulated accident is assumed to leak from the containment at the design leak rate for the first 24 hours after the accident and at one-

half of that value thereafter. Mixing in the building wake, in which the control room and its ventilation intake are presumed to be immersed for the duration of the post-accident phase, is also assumed. The concentration of radioactivity which is postulated to surround the control room emergency zone boundary after the postulated accident is evaluated as a function of the fission product decay constants, the containment spray system effectiveness, the containment leak rate, the shield building cleanup subsystem, and the meteorology for each period of interest. The assessment of the amount of radioactivity within the control room takes into consideration infiltration of outside air and the effectiveness of the control room cleanup system.

The analysis performed demonstrates that doses to control room personnel resulting from the design basis accident are less than the dose limits specified by General Design Criterion 19. The control room area is thus continuously habitable under any foreseeable condition of operation. Complete and specific information on control room dose analysis is covered in Section 4.0.

2.5.3. Ventilation System Reliability

The control room ventilation system, including the cleanup feature, is designed to maintain a habitable environment and to ensure operability of components in the control room. The redundant 100 percent capacity active components are on separate Class 1E AC power supplies to assure that this system would be operable following a loss of offsite power.

A single failure analysis of active components has been performed, which identified two deviations (deficiencies). After these deviations are corrected, no single failure of an active component could preclude the ACC System from performing its post-accident function. Complete and specific information on the single failure analysis is covered in Section 3.0.

2.5.4. Hazardous Chemicals

The habitability of the control room has been evaluated to determine if any on-site or off-site related accidents could lead to a release of hazardous chemicals whose toxicity would exceed the limits specified in Regulatory Guide 1.78. The evaluation determined that any release of the identified hazardous chemicals will not pose a threat to the habitability of the control room. Complete and specific information on the evaluation for each of the identified hazardous chemical releases is covered in Sections 5.0 and 6.0.

2.6. Testing And Inspection

The control room ventilation system is periodically tested for the following.

1. Pressure drops across HEPA filters and charcoal adsorbers.
2. Automatic initiation of the system on high radiation and safety injection signals.
3. In-place filter testing - DOP tests for HEPA filters and halogenated hydrocarbon tests for charcoal filters.
4. Laboratory tests for activated carbon in the charcoal filters.
5. Ten hour run of each post-accident recirculation train per month.

For additional testing details and test results acceptance requirements see KNPP Technical Specifications 3.12 and 4.17.

3.0 SINGLE FAILURE ANALYSIS OF ACTIVE COMPONENTS

3.1 Single Failure Evaluation Basis

To assess the capability of the Control Room Air Conditioning (ACC) System to perform its post-DBA functions, given a single failure of an active component, a single failure analysis has been performed. This evaluation specifically addresses the design basis accidents that produce a Safety Injection (SI) signal. Other events that may require control room isolation have also been considered and are briefly discussed in Section 3.5.

The immediate post-DBA functions of the ACC System are as follows:

1. Control Room Emergency Zone (CREZ) isolation, which consists of isolation of outside air intakes and isolation of all other ventilation paths connected to other systems and/or areas external to the CREZ.
2. Post-accident recirculation and cleanup of CREZ environment.
3. Initiate cooling of the CREZ environment for equipment operability and personnel comfort.

For the post-accident fresh air addition function of the ACC System, which is not required until a relatively long period of time after the design basis LOCA, credit is taken for damper repair. Likewise, credit is taken for damper repair where a failure of a damper may result in loss of cooling to the CREZ, since temperature escalation is also a relatively long term event. In accordance with Appendix A of SRP 6.4, Acceptance Criteria for Valve or Damper Repair Alternative, no credit may be taken for manual correction (damper repair) during the first two hours after the accident.

All active components, including automatic actuation signal initiating devices, required to fulfill the immediate post-DBA functions are to have QA Type classification for functional operability of QA Type 1. The dampers, for which credit may be taken for manual correction, may have a lower QA Type classification for functional operability, i.e., QA Type 2 or QA Type 3.

3.2 Single Failure Analysis

The component/damper automatic actuation signals for the ACC System are shown in Table 3. This table also

identifies the associated safeguards power train for each component/damper. All the immediate post-DBA functions, except closure of the outside air intake dampers ACC-1A and ACC-1B, are initiated by the respective safeguards train Safety Injection (SI) signal. ACC-1A and ACC-1B closure is from the control room radiation monitor R23, which is located in the air supply duct on the A/C fan discharge (see Figure 2). ACC-1A and ACC-1B are assigned to safeguards Train A, which is a redundant pair to the isolation dampers ACC-2 and ACC-5 assigned to safeguards Train B. The initiation of ACC-1A and ACC-1B closure is upon detection of radioactivity level in the ventilation ductwork. This delay in outside air intake isolation is considered in the control room dose analysis discussed in Section 4.0.

A detailed analysis of single failure modes is presented in Table 2. This analysis identifies one deficiency; the failure of ACC-2 to close or a spurious opening, if closed, will prevent both ACC-3A and ACC-3B from opening. This will result in loss of both redundant post-accident recirculation trains. The cause of this is the electrical interlocking of both redundant dampers ACC-3A and ACC-3B via limit switches on a single damper ACC-2. The limit switches, one for each of the redundant dampers, have to prove ACC-2 closed, which then provides a permissive for ACC-3A and ACC-3B to open upon the respective safeguard train actuation signal. For the alternative solutions available in resolving this deficiency see Section 3.5.

In order for the ACC System to perform the post-accident recirculation and cleanup function effectively, short circuiting of the recirculation flow via dampers ACC-5 and ACC-2, both of which are of safeguard Train B, is to be prevented. The following analysis supplements the Table 2 analysis by demonstrating that one of the dampers will close, given a single failure, to block the short circuit flow path.

The single failures and the associated analysis for each are:

1. Failure of SI Train B actuation signal - SI Train B signal closes both ACC-2 and ACC-5; however, in the absence of this signal, damper ACC-5 will close upon start of Post Accident Recirc. Fan 1A.
2. Failure of safeguard Train B power - Dampers ACC-2 and ACC-5 fail closed on loss of power, but receive power from both Train B (safeguard) and Train A (non-safeguard backup) through an automatic power

supply transfer relay. The dampers, therefore, may remain open on loss of Train B power, but both will close upon receipt of Train B SI signal.

3. Failure of ACC-2 or ACC-5 - If one of the dampers fails to close due to a local failure mechanism at the damper, the other damper will close.

Based on the above analysis, at least one damper, ACC-2 and/or ACC-5, is assured to close, given a single active failure, thus preventing short circuiting of the recirculation fan flow.

3.3 Damper Repair Alternative Evaluation

As permitted by Appendix A of SRP 6.4, credit is taken for manual correction (damper repair) to the ACC System for the following system functions:

1. Post-accident fresh air addition. (Note: Dose analysis, as discussed in Section 4.4, when assuming the CREZ is isolated on SI signal, will not require fresh air purging of the CREZ.)
2. Cooling of the CREZ environment for equipment operability and personnel comfort. Note that initiation of cooling of the CREZ environment is an immediate post-DBA function.

Dampers that may require damper repair are classified as (1) those requiring one-time positioning to the post-DBA position and (2) those requiring periodic re-positioning for fresh air addition post-DBA. A listing of these dampers is as follows:

1. Dampers requiring one-time positioning.

ACC-3A	Post-accident recirc. damper 1A
ACC-3B	Post-accident recirc. damper 1B
ACC-4	Control room recirc. isolation damper
ACC-5	Non-accident fresh air damper
ACC-15	Relay room supply damper
ACC-16	Relay room exhaust damper.

2. Dampers requiring periodic repositioning

ACC-1A	Aux Bldg. A/C intake damper
ACC-1B	Aux Bldg. vent intake damper
ACC-2	Filtered fresh air inlet damper

On loss of power, ACC-3A fails as-is and ACC-3B fails closed. For the fresh air addition mode of operation,

both of these dampers have to be closed. If one of the dampers has failed to the open position, ACC-3A can be closed via the handwheel on its limit torque operator, and ACC-3B can be made to fail closed by disconnecting power within the Control Room Ventilation Panel.

ACC-4 is a motor operated damper, fail closed on loss of power, but which receives power from both safeguard trains as described in Note 2 of Table 2; therefore, ACC-4 may have a power source to maintain this damper in open position. Should the failure be in the non-safeguard cable, the smoke detector or the actuator, the damper can be disconnected from the actuator and the damper blocked in the open position.

Dampers ACC-5, ACC-15 and ACC-16 are air actuated via an air solenoid valve. These dampers fail to their post-accident position on loss of air or loss of power. Therefore, if any of the dampers has failed to the undesired position, the damper can be made to fail to the post-accident position by disconnecting the air supply tubing locally at the damper. If the failure is in the actuator, the damper can be disconnected from the actuator and the damper blocked in the post-accident position.

The dampers in the second category are all motor operated dampers, fail closed on loss of power, but each receive power from both safeguard trains - it's respective train as depicted in Table 3 (safeguard) and the opposite train (non-safeguard backup) through an automatic transfer relay. These dampers, therefore, may have a power source for post-DBA operability. If the failure is in the non-safeguard cable or actuator, cable or actuator replacement will be required to make the damper operable from the control room for periodic repositioning.

The dampers in the above two categories do not fully comply with the requirements of Appendix A of SRP 6.4, that is, not all of them have the blade linkages external to the ductwork and not all of them have damper position indication in the control room; however, all these dampers have their actuators located external to the ductwork. Since SRP 6.4 did not exist when plant was built, and since the damper components most likely to fail, the actuators, are located external to the ductwork, these dampers are considered to be repairable. For those dampers that do not have control room position indications, damper position can be verified locally at the damper.

These dampers are located within the CREZ, the Control Room Ventilation Panel is located just outside the control room door, and the safeguard back-up power supplies for the category two dampers are located in the battery rooms. Therefore, radiological effects to the personnel performing damper repair is not of a significant concern.

3.4 Component QA Type Classification Review

All active components, including automatic actuation signal initiating devices, were reviewed for QA Type classification to verify that those required for the immediate post-DBA functions are classified as QA Type 1 for functional operability.

The following components were found not to be QA Type 1 for functional operability:

ACC-4	Control room recirc. isolation damper (QA2)
ACC-15	Relay room supply damper (QA2)
ACC-16	Relay room exhaust damper (QA2)
---	Shift supervisor's office temperature control damper (QA3)
R23	Control room radiation monitor (QA3)

Of the above, R23 is the only one required for the immediate post-DBA functions. For the alternative solutions available in resolving this deficiency see Section 3.5.

3.5 Conclusions

The ACC System meets the single failure criteria, given a failure of an active component, for the immediate post-DBA (those producing an SI signal) functions of CREZ isolation, post-accident recirculation, and initiation of CREZ cooling, with two exceptions. These two exceptions (deficiencies) are as follows;

1. The failure of ACC-2 to close or a spurious opening, if closed, will prevent both ACC-3A and ACC-3B from opening, which will result in loss of both redundant post-accident recirculation trains.
2. Control room radiation monitor R23, which is utilized to initiate automatic closure of the Train A outside air isolation dampers ACC-1A and ACC-1B, is classified as a QA Type 3/3 component. This function must be performed by a QA Type 1/1 component.

For the post-accident fresh air addition function, credit is taken for damper repair. Likewise, credit is taken for damper repair where a failure of a damper may result in loss of cooling to the CREZ, since temperature escalation is a sufficiently long term event. All dampers that may require repair were evaluated with respect to the requirements of Appendix A of SRP 6.4, Acceptance Criteria for Valve or Damper Repair Alternative, and determined that they meet the intent of Appendix A. It is assumed that these repairs can be made within reasonable time without recourse to formal procedures.

Other events that may require control room isolation have also been considered and determined to have sufficient redundancy/diversity for manual or automatic isolation of the CREZ. These events are as follows:

1. High Energy Line Break (HELB) outside containment - To preclude steam, and along with its potential radioactive contaminants, from entering the control room, the CREZ is isolated and the ventilation system placed in the recirculation/cleanup mode. These actions are performed automatically upon receipt of the steam exclusion signal. Complete Train A and Train B redundancy is provided as shown in Table 3.
2. Radwaste storage or fuel handling accident - An evaluation was performed, per NRC request, to assure control room habitability for a radwaste storage or a fuel handling accident concurrent with the loss of the in-line radiation monitor R23. The evaluation showed that there are other diverse features to alert the control room operator of an unusual occurrence so that he may take appropriate manual actions for isolating the CREZ and starting the post-accident recirculation filtering system. (Reference WPSC letter to NRC, C. W. Giesler to S. A. Varga, dated June 6, 1983.)
3. Hazardous chemical releases - The evaluation performed for both on-site and off-site hazardous chemical releases, as discussed in Sections 5.0 and 6.0, shows that any postulated chemical release will not pose a threat to the control room personnel, even in a non-isolated control room. Therefore, chemical detection and CREZ isolation is not required for the habitability of the control room.

There are several alternative solutions in resolution of the identified two single failure deficiencies. They are as follows:

DEFICIENCY 1 RESOLUTION ALTERNATIVES:

1. Rewire the power circuit for damper ACC-2 to provide a power disconnect switch within the Control Room Ventilation Panel, so that, whenever the reactor is critical, the system can be operated with the power for ACC-2 disconnected. (The existing power circuit has fuses, but they are located in the common circuit serving three dampers - ACC-2, ACC-5 and ACC-3B).
2. Remove the damper position interlocks between ACC-2 and ACC-3A/B that provide permissive for ACC-3A/B to open. The design intent of these interlocks was to prevent the dampers from stroking concurrently when switching between the recirculation and fresh air addition modes, thus preventing the potential for fresh air by-passing the post-accident filter units. The system test results of January, 1988 show that for the fresh air addition mode of operation the static pressure upstream of ACC-3A/B is higher than the static pressure downstream of ACC-3A/B, which indicates that there will not be any fresh air by-passing the filter units. This, however, should be verified by test for various possible modes of post-accident operation before implementing the removal of the interlocks.
3. Remove the damper position interlocks between ACC-2 and ACC-3A/B, and provide backdraft dampers at ACC-3A and at ACC-3B. These backdraft dampers will prevent the potential of fresh air by-passing the filter units during the damper stroking cycle whenever switching between the recirculation and fresh air addition modes.
4. Provide a motor operated damper in series with ACC-2, Train A powered, with automatic backup power from Train B, and trip closed on Train A SI and Steam Exclusion actuation signals.

DEFICIENCY 2 RESOLUTION ALTERNATIVES:

1. Upgrade R23, including its associated circuitry, to QA Type 1/1 requirements.
2. Provide Train A Safety Injection (SI) signal for automatic closure of dampers ACC-1A and ACC-1B.

An engineering evaluation of the Deficiency 1 resolution alternatives will be performed to determine the most practical and cost effective approach in resolution of this deficiency.

As for resolution of Deficiency 2, although either alternative will resolve this deficiency from the single failure perspective, the results of the control room dose analysis, as discussed in Section 4.4, requires that the control room be isolated immediately, i.e., without the isolation delay created by R23. Therefore, the resolution for Deficiency 2 is Alternative 2. A design change for implementing Alternative 2 has been initiated.

4.0 CONTROL ROOM DOSE ANALYSIS

4.1 Introduction

Radiological evaluation was performed to demonstrate that doses to the control room personnel resulting from the design basis accident are within limits specified in GDC 19 of Appendix A to 10 CFR Part 50.

The whole body gamma and beta skin doses due to exposure to noble gas radionuclides, and the thyroid dose due to inhalation of iodine radioisotopes are evaluated on the basis of source strength, atmospheric transport, and control room protection design features using the CARE computer program.

CARE (Calculated Accidental Release to the Environment of Fission Products) is the computer code, developed by NUS, used to calculate radiation doses (thyroid inhalation doses and whole body doses from submersion in a radioactive cloud) to plant personnel and the public due to a postulated release of core fission products from a nuclear facility to the atmosphere.

CARE accounts for the radioactive decay, leakage, holdup in barriers, removal by sprays, recirculation, dilution by the atmosphere, removal by filters, and determines the isotopic source activities in Curies of the isotopes at user specified times and locations.

Dose commitments were calculated using several time intervals to define the time-dependent parameters of the analysis. The time intervals and time-dependent parameters are given in Table 5. All other input parameters are given in Table 4.

Source terms used were consistent with Regulatory Guide 1.4. In the case of a LOCA, 100 percent of the noble gases and 25 percent of the iodides present in the reactor core are assumed to be released to the containment and are initially available for release to the atmosphere. The activities of each isotope of iodine, xenon, and krypton is calculated in terms of Curies released within each time interval. Core sources used as the basis for the analysis are shown in Table 6.

4.2 Analysis Model

The analysis model describing the activity release is shown in Figure 4. This figure illustrates the basic assumptions of the analysis. Credit is taken for the Shield Building annulus for holdup, decay, and

recirculation at appropriate times during the accident as determined by the Shield Building pressure transient analysis. The Shield Building annulus pressure transient is shown in Figure 5, and the corresponding annulus air discharge (exhaust) transient is shown in Figure 6.

This analysis shows that immediately following the accident, the Shield Building pressure increases due to containment shell expansion and heat transferred from the containment shell. Operation of one of the Shield Building Ventilation System's two redundant recirculation fans establishes a negative pressure at 6 minutes. During this period no credit is taken for the filtered exhaust of air by the Shield Building Ventilation System. Instead it is assumed that the Shield Building does not exist. From 0 to 6 minutes, 100% of the containment leakage is assumed to be released directly to the atmosphere without holdup or filtering.

After 6 minutes into the accident, the Shield Building filter becomes effective, but no credit for filter recirculation is taken. It is assumed that from 6 minutes on, 89% of the containment leakage is processed by the Shield Building Ventilation System. Of the remaining 11%, 10% is assumed to go to the Auxiliary Building Special Ventilation Zone where it is subject to processing by the Auxiliary Building Special Ventilation System and 1% is assumed to be released directly to the atmosphere. These leakage percentages are KNPP Technical Specification limits as defined in Technical Specification 4.4.b.6 and 4.4.b.7.

After 10 minutes, some credit is taken for Shield Building recirculation as determined by the Shield Building pressure transient analysis. During this final Shield Building mode, a portion of the activity is released via the Shield Building Vent and the rest is recirculated back into the Shield Building. The Shield Building release rate is doubled for conservatism by using an annulus participation factor of 0.5. This reduces the available Shield Building credit for holdup, decay and recirculation. The amount of Shield Building exhaust and recirculation for the time durations considered are shown in Table 5.

4.3 Analysis Input Parameters

4.3.1 Radiiodine Removal by Containment Spray

The time-dependent containment inventory was generated considering the effects of radiological decay and a conservative spray removal factor. To

assure accuracy and proper representation for the spray removal effectiveness, iodines were split into their prevalent species: 91% elemental, 4% organic, and 5% particulate per Regulatory Guide 1.4. Containment spray radioiodine removal coefficients and maximum decontamination factors were conservatively chosen for each species using the guidelines of Reference 11. (The maximum decontamination factor is the ratio of initial to final containment inventory after which spray is assumed to be ineffective.) Also, no credit for radioiodine spray removal was taken for the first 2.25 minutes, since this is the time required after the accident before full flow can be established at the containment spray nozzles. The following spray rates, decontamination factors, and spray durations, used in the analysis, are based on an initial 50% plate-out of halogens in the containment (25% available for release):

<u>IODINE SPECIES</u>	<u>SPRAY REMOVAL RATE, HR-1</u>	<u>MAXIMUM DF</u>	<u>SPRAY DURATION</u>
Elemental	10	100	27 min.
Organic	0	---	---
Particulate	.45	100	8 hr.

4.3.2 Atmospheric Dispersion

The atmospheric conditions were considered by determining the X/Q values during the accident time intervals. The term X/Q denotes the degree of dispersion of the activity as it is transported from the point of release to the receptor. The X/Q values were determined as described in Reference 6.

Occupancy factors have been utilized to provide further reduction in dose commitments. Other factors involved in this reduction are wind speed and wind direction. The total reduction factors at various time intervals are also given in Table 1 of Reference 6. Additional considerations for dose reduction were also taken into account.

4.3.3 Control Room Parameters

The key assumptions used in the analysis and documentation source from which they were obtained is given in Table 4. The model assumes that the

control room radioactivity gradually increases after initial isolation due to inleakage of 0.094 volumes per hour (equivalent to 200 cfm). Credit for this leak-tightness is taken after the time of control room isolation to provide a realistic determination of the integrated thyroid dose to personnel inside the control room over the duration of the accident. Two time frames for the control room isolation have been considered - immediate isolation and R23 delayed isolation - as follows:

1. Immediate isolation occurs when the fresh air dampers close on Safety Injection (SI) signal. This time is 5 seconds after the accident - 1 second for the SI signal to be produced and 4 seconds for the dampers to stroke closed. This time is less than the time it takes the radioactive cloud to reach the control room air intakes.
2. The R23 delayed isolation is when the Train B fresh air dampers fail to close on SI signal, and the isolation is then dependent on R23 detecting the presence of radioactivity in the control room ventilation system. This time is calculated to be 6.7 seconds from the time the radioactive cloud enters the control room - 2.7 seconds for the activity to reach the set-point of R23 and 4 seconds for the dampers to stroke closed. The dose due to the activity present in the control room during this first 6.7 seconds (prior to control room isolation) and the dose due to the initial activity trapped upon isolation as it gradually decays and is removed over the duration of the accident is calculated separately.

The whole body gamma and beta skin doses were calculated assuming a semi-infinite cloud. A geometry factor, as described in Reference 6, is used only for the whole body gamma dose. The geometry factor accounts for the ratio of infinite-to-finite cloud dose. It was determined that the dose contribution due to direct radiation through the control room walls due to other post-accident sources is negligible.

For the thyroid dose evaluation, the Iodine Protection Factor (IPF) defined by Reference 6 was used. The IPF is determined by calculating an equilibrium balance between iodine sources and losses within the control room. The IPF is defined

as the ratio of the integrated dose at the air inlet to the integrated dose due to filtered recirculation in the control room. The IPF is determined assuming filtered recirculation of 2500 cfm and an unfiltered bypass leakage component equal to 200 cfm.

4.4 Results

The analysis post-accident 30-day integrated control room LOCA dose, without fresh air purge, for the two time frames for control room isolation considered, are:

	DOSE (REM) WITH IMMEDIATE <u>ISOLATION</u>	DOSE (REM) WITH R23 DELAYED <u>ISOLATION</u>
Gamma Whole Body Dose =	1.9	1.9
Beta Skin Dose =	57.0	57.0
Thyroid Dose =	27.0	38.2

The thyroid dose for the R23 delayed isolation can be reduced to within GDC 19 limits by fresh air purging of the CREZ at 12 hr intervals. The sensitivity of the 30-day thyroid dose to CREZ inleakage for the two time frames for control room isolation considered, without fresh air purge, are shown in Figure 7. The gamma whole body and the beta skin doses are not dependent on the CREZ inleakage.

A conservative evaluation was performed to determine the thyroid and whole body doses received by control room operators during each of the other design basis accidents discussed in the KNPP USAR, Section 14.2. It was determined that the doses received from any of these accidents is smaller than the 30 day LOCA dose.

The requirements for protection of control room personnel against radiation are specified in General Design Criterion 19 of Appendix A, 10 CFR Part 50. According to this criterion, control room design should provide radiation protection such that control room personnel do not receive radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident. The thyroid and beta skin doses should be maintained at less than 30 rem.

In this analysis, the values for whole body dose and thyroid dose are below the limits of GDC 19. Although

the beta dose exceeds 30 rem for unprotected skin, credit for protective clothing and eye protection to reduce the dose to within 30 rem is allowed per Standard Review Plan 6.4 as long as the calculated dose is less than 75 rem.

Based on the above analysis results for the two time frames for control room isolation, the control room shall be isolated immediately, i.e., closure of the fresh air dampers on SI signal, which will eliminate the need for fresh air purging of the CREZ during the 30-day period following a LOCA. The frequency of purge, 12 hour intervals, required with the R23 delay is not practical.

5.0 STORAGE OF HAZARDOUS CHEMICALS ON-SITE

5.1 Habitability Evaluation Basis

To assess the control room habitability during and after a postulated release of hazardous chemicals on site, a habitability evaluation based on the criteria of Regulatory Guide 1.78 was conducted. Per Regulatory Guide 1.78, all chemicals stored on-site in quantities of 100 lb. or more were considered in the evaluation. Table 7, Hazardous Chemicals On-Site Weighing 100 lb. or more, was developed to identify these chemicals. Since chlorine gas is not stored on-site, Regulatory Guide 1.95 does not apply to this evaluation.

Table 7 identifies the chemical substance, the quantity of chemical stored, the chemical location, and distance to the Control Room Emergency Zone (CREZ). The chemicals' total assembly weight is the sum of several cylinders when they are manifolded. CREZ distance is given in the horizontal and vertical directions. The horizontal distance is the approximate straight line distance from the chemical storage tank to a point inside the control room where column rows 8 and Gw intersect. Vertical distance is the distance from the chemical tanks floor elevation to the relay room floor elevation which is the lowest elevation of the CREZ. Positive vertical distance indicates that the chemical is below the CREZ while negative vertical direction indicates that the chemical is above the CREZ.

Chemicals listed in Table 7 are stored in either the liquid or gas phase. The liquified gases will quickly become gases when exposed to atmospheric conditions. Vapors given off by liquid chemical spills are treated as gases. The chemical phase determines how the chemical could potentially reach the CREZ. Gases or vapors are transported through the plant by the ventilation systems, natural dispersion if the ventilation systems are idle, or may be pulled into the plant by the fresh air intakes. Liquids flow through the plant by either being pumped or runoff from a spill. The chemical phases and appropriate modes of transport are investigated in this evaluation.

5.2 Gas Phase Chemicals

The carbon dioxide fire suppression system is excluded from this discussion and is evaluated in subsections 5.4 and 5.5.

None of the gas phase chemicals have piping that penetrates the CREZ. Building ventilation systems where the gas phase chemicals are stored are not connected to the CREZ ventilation system. The ventilation systems will pull the gases/fumes from the spill area and dilute this side stream with the main stream ventilation flow. This main stream will then be discharged from the building through exhaust ductwork. Once exhausted, these chemicals gas/fumes concentrations would be further reduced and pose no threat to the control room operators.

The heating boiler propane cylinders and S.T.A. propane tanks are located at grade level outdoors. This is approximately 100 ft. horizontally and 70 ft. vertically below the control room air intakes. This distance is large enough to assure that the propane gas has been diluted sufficiently such that asphyxiation is not a concern.

The Simulator Building contains two carbon dioxide bottles for fire protection. This building is located approximately 600 ft. horizontally and 70 ft. vertically below the control room air intakes. This distance is large enough to assure that the carbon dioxide has been diluted sufficiently such that asphyxiation is not a concern.

5.3 Liquid Phase Chemicals

None of the liquid phase chemicals have piping that penetrates the CREZ. Spills are contained in the immediate tank area by curbs or carried away by the floor drain system. Liquified gases and spilled chemical fumes were covered in the previous section.

The caustic liquid tank is at elevation 642'-3", approximately 150 ft. horizontally from and 36 ft. above the relay room. The tank is surrounded by a six inch curb. Liquid that is not contained by the six inch curb will be carried away by floor drains to the sanitary sewer line.

The boric acid tank is located in the Auxiliary Building at elevation 626'-0", approximately 75 ft. from and 20 ft. above the relay room. The tanks are enclosed in a room with a floor drain that discharges to the waste holdup tank. Contents of the waste holdup tank are processed by the Waste Holdup System.

The chemicals in the water treatment area, sulfuric acid, hydrazine, boric acid, and caustic liquid, are at elevation 626'-0" approximately 170 ft. from and 20 ft.

above the relay room. Spilled liquids will be carried away by floor drains to the sanitary sewer line. A massive spill would cascade down the stairway between column rows HH and JJ to the basement floor where the floor drains will transport the chemical to the Turbine Building sump.

Liquid phase chemical spills below elevation 606'-0" will be collected in drain lines and sumps below the CREZ.

The drain systems will transport chemical spills to other systems for treatment, Waste Disposal System or SWPT ponds, or discharge the spills to the condenser circulating water discharge. In both cases, the chemicals can no longer effect the control room habitability.

5.4 Carbon Dioxide Fire Protection External to the CREZ

Liquified carbon dioxide is stored in the carbon dioxide fire protection tank. The storage tank is QA Type 1, seismically designed and seismically supported. It is located in the Turbine Building basement, elevation 586'-0", in an access controlled room without ventilation. This design encloses the large volume of CO₂ in a seismically designed tank and isolates it from other areas of the plant.

Carbon dioxide for fire protection is discharged by either automatic or manual actuation. All automatic releases are timed to increase the CO₂ concentration of a room to approximately one pound CO₂ to eight cubic foot of space and then stop CO₂ discharge. Any actuation of the system will open one of four master valves which alarms in the control room and activates the CO₂ master valve zone status light. The CO₂ fire protection system is also supervised and will give a trouble indication if a malfunction or disruption occurs within the circuitry. In addition, the tank has a local Hi/Lo pressure alarm. These alarms and controls constantly monitor the system to alert the operators to any malfunction or actuation so corrective action can be taken.

The Control Room Ventilation System is completely independent from the Turbine Building Ventilation and Auxiliary Building Ventilation systems. Therefore, the ventilation systems cannot transport discharged CO₂ to the CREZ. Carbon dioxide discharged from the fire protection system can enter the CREZ by either being pulled in by the control room outside air intakes or inleakage from CO₂ gases surrounding the CREZ.

Under normal conditions, the Control Room Ventilation System will be intaking fresh air from outside. Actuation of the CO₂ fire protection system will alarm in the control room and the "effected area" will be identified. If the discharge is controlled, a relatively small amount of CO₂ is released in a confined area. As the CO₂ is slowly removed from this area, its concentration is diluted by the air in the return ductwork to a level that will not effect personnel. An uncontrolled release could discharge a much larger quantity of CO₂. However, such a release would be diluted by dispersion in the Turbine Building. The six Turbine Building roof exhaust fans provide approximately 2.5 building air changes per hour and will quickly exhaust the CO₂. Assuming the maximum CO₂ concentration in the Turbine Building exhaust being pulled directly into the CREZ fresh air inlet (with no atmospheric dispersion), the CO₂ would be further diluted by the CREZ air to less than 2% concentration. At this concentration level, there is no hazard to the control room operators.

Under accident conditions, the Control Room Ventilation System will be in the recirculation mode. A controlled actuation of the CO₂ system is not a concern because of the small quantity of gas released, area of release is confined, and CO₂ will be diluted to safe levels as it is discharged. Uncontrolled releases have the potential to discharge large quantities of CO₂. However, any actuation of the CO₂ fire protection system will alarm in the control room and the "effected area" will be identified. An operator will investigate the CO₂ discharge and if necessary, manually isolate the system to stop the CO₂ flow. Since CO₂ is heavier than air, the discharged CO₂ will settle to the lowest Turbine Building elevation approximately twenty feet below the CREZ. With the outside air intakes closed, CO₂ can only pass into the CREZ by inleakage. Since the gas will be below the CREZ, CO₂ inleakage is not a concern.

5.5 Carbon Dioxide Fire Protection Within the CREZ

The relay room is protected by manual total flood CO₂ system. This system is manually initiated from the control room or locally outside the relay room double door on elevation 606'. Once initiated, the relay room vent supply and vent exhaust dampers will close, the CO₂ master valve at the CO₂ storage tank will open, and then the relay room CO₂ valve will open if both dampers are proven closed by a limit switch mounted on each damper. The relay room CO₂ valve is located external to the CREZ.

Both CO₂ valves are CO₂ operated by the upstream side pressure for the respective valve via a solenoid valve. Both valves fail closed on loss of CO₂ pressure; on loss of power, the master valve fails open and the relay room valve fails closed. The supply and exhaust dampers are air operated via a common solenoid valve. Both dampers fail open on loss of air or loss of power. The three solenoid valves are powered from a common safeguards Train A interruptable A-C power source.

The following analysis demonstrates that no single failure will result in flooding of the relay room with CO₂ post-accident:

1. Power failure - The CO₂ master valve will fail open; however, the relay room CO₂ valve will remain closed (fail closed on loss of power), thus blocking the CO₂ flow path to the relay room.
2. CO₂ pipe failure - Since the CO₂ piping in the relay room is not pressurized, and both CO₂ valves are external to the CREZ, pipe failure is of no concern for the habitability of the control room.

Based on the above, the system design is adequate, given a single failure, for preventing the release of CO₂ into the CREZ, thus preserving the habitability of the control room post-accident.

6.0 HAZARDOUS CHEMICALS OFF-SITE

A study was performed in 1981 to identify all stationary and frequent mobile sources of hazardous substances within five miles of the plant site. The area of study included the plant site boundaries but excluded sources located within the security fence or immediately outside the security fence.

In order to correctly ascertain the type, size and location of sources of hazardous substances, personnel associated with federal, state, and local agencies were contacted along with personnel from several private organizations. A complete listing of the agencies and organizations contacted is presented in Table 8.

The results of the investigations are summarized below:

- There is no rail traffic in the study area.
- There is no water traffic hauling hazardous substances that pass through the study area.
- There are no significant stationary sources located in the study area that use, generate or store hazardous substances.
- Farmers in the study area do use anhydrous ammonia. Anhydrous ammonia is shipped within the study area in pressurized 1,000 gal. containers.
- The number of truck trips hauling hazardous wastes that pass through the study area are less than 10 per year.
- There have been no accidents in the study area (vehicular or stationary source) involving hazardous substances that have been reported to the State Regional Division of Emergency Government in the past three years.

In conclusion, the only shipments of hazardous substances within or through the study area are anhydrous ammonia shipments to area farmers and shipments of various hazardous substances shipped to the Kewaunee Nuclear Power Plant itself (refer to Section 5.0).

Based upon the occurrence of an accident taking place at the intersection of Wisconsin 42 and the plant road (a distance of approximately 0.3 miles from the control room), the only hazardous substance that could reach the toxicity limit inside the control room under adverse environmental conditions is anhydrous ammonia.

However, based upon the average daily traffic and the accident rate on the section of the highway in the study area, the probability of an accident occurring in the study area involving a truck carrying a hazardous substance is $0.50E-7$ per year.

Based on the above analyses, no design modifications are needed to mitigate the possible effects of hazardous chemical releases off-site.

In addition, per NRC request, a dispersion analysis was performed using the Regulatory Guide 1.78 method. The results showed the maximum ammonia concentration at the air intake to be less than the toxicity levels used in the Regulatory Guide. (Reference WPSC letter to NRC, C. W. Giesler to S. A. Varga, dated January 10, 1983.)

7.0 REVIEW OF SRP 6.4 CONTROL ROOM HABITABILITY SYSTEM

The format of this section is as follows: Each section of the Standard Review Plan 6.4 is presented and our response follows immediately.

I. AREAS OF REVIEW

The control room ventilation system and control building layout and structures, as described in the applicant's safety analysis report (SAR), are reviewed with the objective of assuring that plant operations are adequately protected against the effects of accidental releases of toxic and radioactive gases. A further objective is to assure that the control room can be maintained as the backup center from which technical support center personnel can safely operate in the case of an accident. To assure that these objectives are accomplished the following items are reviewed:

1. The zone serviced by the control room emergency ventilation system is examined to ascertain that all critical areas requiring access in the event of an accident are included within the zone (control room, kitchen, sanitary facilities, etc.) and to assure that those areas not requiring access are generally excluded from the zone.

RESPONSE: In compliance. The control room emergency zone (CREZ) includes the control room, shift supervisor's office, kitchen, sanitary facility, computer room, CAS room, relay room, and mechanical equipment room.

2. The capacity of the control room in terms of the number of people it can accommodate for an extended period of time is reviewed to confirm the adequacy of emergency food and medical supplies and self-contained breathing apparatus and to determine the length of time the control room can be isolated before CO₂ levels become excessive.

RESPONSE: Control room occupancy capacity during an emergency is 10 people. Adequate supply of emergency food and medical supplies are provided - see Section 2.2.3. Carbon Dioxide (CO₂) analysis is as follows:

Carbon dioxide (CO₂) concentration values and effects (Ref. 9) 0.6% by volume may be considered the threshold for physiological

effects, 1.0% by volume is an upper limit for long time periods, 3.0% by volume, maximum for 24 hour exposure, and 5.0% by volume is a maximum for 1 hour exposure.

The permissible stay time (period of occupancy) is expressed in the form of the equation of the ASHRAE Handbook and Product Directory 1974 Applications, Chapter 12, Page 12.8.

$$T = 0.04 \frac{V}{N}, \text{ where}$$

T = Time (hours) required to raise the CO₂ concentration to 3% by volume.

V = Net volume of CREZ, ft³

N = Number of occupants, 10

$$T = 0.04 \frac{127,600}{10} = 510.4 \text{ hours}$$

$$= 21.3 \text{ days}$$

Determination of stay time at 1.0% by volume and initial CO₂ concentration in control room of 0.03% by volume.

CO₂ production is 0.75 ft³/hr/person

Amount of CO₂ at 1% concentration is 1276.0 ft³

Initial amount of CO₂ = 0.0003 (127,600)
= 38.3 ft³

Allowable accumulation of CO₂ = 1276.0 - 38.3
= 1237.7 ft³

T = Time (hours) required to raise the CO₂ concentration to 1% by volume.

$$T = \frac{1237.7}{0.75 \times 10} = 165.0 \text{ hours} = 6.9 \text{ days}$$

Ten occupants could safely stay in the control room for seven (7) days with no ventilation before exceeding 1% by volume. In the unlikely

event the conditions prevent purging of the control room, the maximum stay time may be increased to 21 days.

The above stay times are based on no addition of fresh air by inleakage. Since 10 persons will produce CO_2 at the rate of $7.5 \text{ ft}^3/\text{hr}$ or $0.125 \text{ ft}^3/\text{min}$, an inleakage rate of only 12.5 cfm (100×0.125) will prevent the carbon dioxide level from exceeding 1% by volume. Since the CREZ inleakage is much higher than 12.5 cfm, fresh air purge will not be required for carbon dioxide.

3. The control room ventilation system layout and functional design is reviewed to determine flow rates and filter efficiencies for input into the analyses of the buildup of radioactive or toxic gases inside the control room, assuming a design basis release. Basic deficiencies that might impair the effectiveness of the system are examined. In addition, the system operation and procedures are reviewed.

RESPONSE: The information required for NRC's review is as follows:

Control room ventilation system diagram (See Figures 1 and 2).

Control room ventilation system functional design (see Section 2.0).

Control room ventilation system flow rates (See Figures 1 and 2).

Cleanup filter efficiencies are: Elemental Iodine - 90%, Organic Iodide - 90%, Particulate - 99%.

4. The physical location of the control room with respect to potential release points of hazardous airborne materials is reviewed. The layout of the control building is reviewed to assure that airborne materials will not enter the control room from corridors or ventilation ducts, etc.

RESPONSE: The information required for NRC's review is depicted in Table 7, Hazardous Chemicals On-Site Weighing 100 lb or more; Figure 3, Control Room Outside Air Intake Location Plan; USAR Figure 1.1-2, Physical Facilities Layout; and

USAR Figures 1.2-1 through 1.2-11, General Arrangements.

5. Radiation shielding provided by structural concrete is analyzed to determine the effectiveness of shielding and structure surrounding the control room. The control building layouts are checked to see if radiation streaming through doors or other apertures or from equipment might be a problem.

RESPONSE: The information required for NRC's review is depicted in USAR Figures 1.2-1 through 1.2-11, General Arrangements.

6. Independent analyses are performed to determine the radiation doses and toxic gas concentrations. Estimates of dispersion of airborne contamination are made in conjunction with the assigned meteorologist.

RESPONSE: The information required for NRC's independent analysis is depicted in Sections 4.0, 5.0 and 6.0.

II ACCEPTANCE CRITERIA

The specific criteria necessary to meet the relevant requirements of General Design Criteria 4, 5 and 19 and to assure that the control room habitability positions of item III.D.3.4 of NUREG-0737 are met are as follows:

1. Control Room Emergency Zone

The control room emergency zone should include the following:

- a. Instrumentation and controls necessary for a safe shutdown of the plant, i.e., the control room, including the critical document reference file,
- b. Computer room, if it is used as an integral part of the emergency response plan,
- c. Shift Supervisor's office, and
- d. Operators' washroom and the kitchen.

RESPONSE: In compliance, all of the above are within the control room emergency zone.

2. Ventilation System Criteria

The ventilation system is reviewed by ASB under SRP Section 9.4.1, "Control Room Area Ventilation System." The AEB reviewer ascertains from the ASB if the following system performance and availability criteria are met:

- a. Isolation Dampers - dampers used to isolate the control zone from adjacent zones or the outside must be leaktight. This may be accomplished by using low leakage dampers or valves. The degree of leaktightness should be documented in the USAR.

RESPONSE: Leaktightness in compliance. Documentation of leaktightness is not in the USAR, but is depicted in Table 1 of this report.

- b. Single Failure - a single failure of an active component should not result in loss of the system's functional performance. All the components of the control room emergency filter train will be considered active components. See Appendix A to this SRP for criteria regarding valve or damper repair.

RESPONSE: In compliance with exceptions. These exceptions and alternative corrective solutions are depicted in Section 3.0, Single Failure Analysis of Active Components, Subsection 3.5. Compliance will be achieved after the alternative solutions have been evaluated and the selected solutions implemented.

3. Pressurization Systems

Ventilation systems that will pressurize the control room during a radiation emergency should meet the following requirements.

- a. Systems having pressurization rates of greater than or equal to 0.5 volume changes per hour should be subject to periodic (every 18 months) verification that the makeup is $\pm 10\%$ of design value. During plant construction or after any modifications to the control room that might significantly affect its capability to maintain a positive pressure, measurements should be taken to verify that the control room is

pressurized to at least 1/8-inch water gauge relative to all surrounding air spaces while applying the design makeup air rate.

RESPONSE: Not applicable, system does not employ pressurization concept.

- b. Systems having pressurization rates of less than 0.5 and equal to or greater than 0.25 volume changes per hour should have identical testing requirements as indicated in (1), above. In addition, at the CP stage an analysis must be provided (based on the planned leaktight design features) that ensures the feasibility of maintaining 1/8-inch water gauge differential with the design makeup air flow rate.

RESPONSE: Not applicable, system does not employ pressurization concept.

- c. Systems having pressurization rates of less than 0.25 volume changes per hour should meet all the requirements for (2), above, except that periodic verification of control room pressurization (every 18 months) should be specified.

RESPONSE: Not applicable, system does not employ pressurization concept.

4. Emergency Standby Atmosphere Filtration System

The atmosphere filtration system is reviewed by ETSB under SRP Section 6.5.1. The ETSB will determine the credit for iodine removal for this system in accordance with the guidelines of Regulatory Guide 1.52 and will advise the AEB accordingly. Efficiencies for systems not covered by Regulatory Guide 1.52 will be determined on a case-by-case basis by ETSB.

RESPONSE: The filter efficiencies used for dose analysis are within the Kewaunee Technical Specification acceptance requirements for filter testing. These efficiencies are as given previously in response to SRP Subsection I.3.

5. Relative Location Of Source And Control Room

The control room inlets should be located considering the potential release points of

radioactive material and toxic gases. Specific criteria as to radiation and toxic gas sources are as follows:

- a. Radiation Sources - as a general rule the control room ventilation inlet should be separated from the major potential release points by at least 100 feet laterally and by 50 feet vertically. However, the actual minimum distances must be based on the dose analyses.

RESPONSE: The location of ventilation inlets does not comply with the general separation rules from the radiation source, See Figure 3, Control Room Outside Air Intake Location Plan; however, the analyzed post-accident dose to the control room operators is within GDC 19 limits.

- b. Toxic gases - The minimum distance between the toxic gas source and the control room is dependent upon the amount and type of the gas in question, the container size, and the available control room protection provisions. The acceptance criteria for the control room habitability system are provided in the regulatory positions of Regulatory Guide 1.78 with respect to postulated hazardous chemical releases in general and in Regulatory Guide 1.95 with respect to accidental chlorine releases in particular.

RESPONSE: The hazard to the control room operators from toxic gas releases, both on-site and off-site, has been evaluated and determined that any postulated release will not pose a threat to the habitability of the control room. Complete information on the evaluation is covered in Sections 5.0 and 6.0.

6. Radiation Hazards

The dose guidelines for evaluating the emergency zone radiation protection provisions are as follows:

- (1) Whole body gamma: 5 rem
- (2) Thyroid: 30 rem
- (3) Beta skin dose: 30 rem*

* Credit for the beta radiation shielding afforded by special protective clothing and eye protection is allowed if the applicant commits to their use during severe radiation releases. However, even though protective clothing is used, the calculated unprotected skin dose is not to exceed 75 rem. The skin and thyroid dose levels are to be used only for judging the acceptability of the design provisions for protecting control room operators under postulated design basis accident conditions. They are not to be interpreted as acceptable emergency doses. The dose levels quoted here are derived for use in the controlled plant environment and should not be confused with the conservative dose computation assumptions used in evaluating exposures to the general public for the purposes of comparison with the guideline values of 10 CFR Part 100.

In accordance with General Design Criterion 19, these doses to an individual in the control room should not be exceeded for any postulated design basis accident. The whole body gamma dose consists of contributions from airborne radioactivity inside and outside the control room, as well as direct shine from all radiation sources.

RESPONSE: The control room doses for the DBA are within the limits specified in GDC 19. For complete information on the dose analysis assumptions and results see Section 4.0.

7. Toxic Gases

Three exposure categories are defined: protective action exposure (2 minutes or less), short-term exposure (between 2 minutes and 1 hour), and long-term exposure (1 hour or greater). Because the physiological effects can vary widely from one toxic gas to another, the following general restrictions should be used as guidance: there should be no chronic effects from exposure; acute effects, if any, should be reversible within a short period of time (several minutes) without benefit of any measures other than the use of self-contained breathing apparatus.

The allowable limits should be established on the basis that the operators should be capable of carrying out their duties with a minimum of interference caused by the gas and subsequent

protective measures. The limits for the three categories normally are set as follows:

- a. Protective action limit (2 minutes or less) use a limit that will assure that the operators will quickly recover after breathing apparatus is in place. In determining this limit, it should be assumed that the concentration increases linearly with time from zero to two minutes and that the limit is attained at two minutes.
- b. Short-term limit (2 minutes to 1 hour): use a limit that will assure that the operator will not suffer incapacitating effects after a 1-hour exposure.
- c. Long-term limit (1 hour or greater): use a limit assigned for occupational exposure (40-hour week).

The protective action limit is used to determine the acceptability of emergency zone protection provisions during the time personnel are in the process of fitting themselves with self-contained breathing apparatus. The other limits are used to determine whether the concentrations with breathing apparatus in place are applicable. They are also used in those cases where the toxic levels are such that emergency zone isolation without use of protective gear is sufficient. Self-contained breathing apparatus for the control room personnel (at least 5 individuals) should be on hand. A six-hour onsite bottled air supply should be available with an unlimited offsite replenishment capability from nearby location(s). As an example of appropriate limits, the following are the three levels for chlorine gas:

Protective Action:	15 ppm by volume
Short-term:	4 ppm by volume
Long-term:	1 ppm by volume

Regulatory Guide 1.78 provides a partial list for protective action levels for other toxic gases

RESPONSE: Chlorine gas is not stored on-site, nor are there any shipments or storage facilities of chlorine gas off-site. Other toxic gases, both on-site and off-site, have been

investigated/evaluated per Regulatory Guide 1.78, and determined that they pose no threat to the control room operator. For detailed discussion see Sections 5.0 and 6.0.

III. REVIEW PROCEDURES

The reviewer selects and emphasizes aspects of the areas covered by this review plan as appropriate for a particular case. The judgment on areas to be given attention and emphasis in the review is based on an inspection of the material presented to see whether it is similar to that recently reviewed for other plants and whether items of special safety significance are involved.

1. Control Room Emergency Zone

The reviewer verifies that the control room emergency zone includes the areas identified in Subsection II.1 of this SRP section. The emergency zone should be limited to those spaces requiring operator occupancy. Spaces such as battery rooms, cable spreading rooms, or any other spaces not requiring continuous or frequent occupancy after a design basis accident (DBA) generally should be excluded from the emergency zone. Inclusion of these spaces may increase the probability of smoke or hazardous gases entering the emergency zone. They may also increase the possibility of infiltration into the emergency zone, thus decreasing the effectiveness of the ventilation system in excluding contamination. It is advantageous to have the emergency zone located on one floor, with the areas included in the zone being contiguous.

RESPONSE: In compliance, see response to SRP Subsection I.1.

2. Control Room Personnel Capacity

A control room designed with complete isolation capability from the outside air to provide radiation and toxic gas protection is reviewed to determine if the buildup of carbon dioxide could present a problem. The air inside a 100,000 cubic foot control room would support five persons for at least six days. Thus, CO₂ buildup in an isolated emergency zone is not normally considered a limiting problem.

RESPONSE: The CO₂ buildup for the Kewaunee CREZ is not a problem. The CREZ can remain isolated without fresh air purge for the entire duration of the post-DBA

period. For additional details see response to SRP Subsection I.2.

3. Ventilation System Layout And Functional Design

The reviewer evaluates the control room ventilation system in order to establish appropriate parameters to be used in the control room dose calculations. The review is coordinated with the ASB which evaluates the control room ventilation system design and performance in accordance with SRP Section 9.4.1. The procedures are as follows:

- a. The type of system proposed is determined. The following types of protection provisions are currently being employed for boiling water reactor (BWR) or pressurized water reactor (PWR) plants:
- (1) Zone isolation, with the incoming air filtered and a positive pressure maintained by the ventilation system fans. This arrangement is often provided for BWR's having high stacks. Air flow rates are between 400 and 4000 cfm.
 - (2) Zone isolation, with filtered recirculated air. This arrangement is often provided for BWR's and PWR's with roof vents. Recirculation rates range from 2,000 to 30,000 cfm.
 - (3) Zone isolation, with filtered recirculated air, and with a positive pressure maintained in the zone. This arrangement is essentially the same as that in (2), with the addition of the positive pressure provision.
 - (4) Dual air inlets for the emergency zone. In this arrangement, two widely spaced inlets are located outboard (on opposite sides) of potential toxic and radioactive gas sources. The arrangement guarantees at least one inlet being free of contamination, except under extreme no-wind conditions. It can be used in all types of plants. Makeup air supplied from the contamination-free inlet provides a positive pressure in the emergency zone and thus minimizes infiltration.
 - (5) Bottled air supply for a limited time. In this arrangement, a flow rate of 400 to 600 cfm is provided from compressed air containers for about one hour to prevent inleakage. It is used in systems having containments whose

internal atmospheric pressure becomes negative within an hour after a DBA (subatmospheric containments).

RESPONSE: The Kewaunee control room ventilation system is of the protection types (2) and (4).

- b. The input parameters to the radiological dose model are determined (see Item 5 below). The parameters are emergency zone volume, filter efficiency, filtered makeup air flow rate, unfiltered inleakage (infiltration), and filtered recirculated air flow rate.

RESPONSE: This information required for NRC's review is depicted in Table 4.0, Control Room Dose Analysis Input Parameters.

- c. The ventilation system components and the system layout diagrams are examined. The review will be coordinated with the ASB in particular if there are questions pertaining to the system design. ASB will determine if the system meets the single failure criterion as well as other safety requirements under SRP Section 9.4. Damper failure and fan failure are especially important. The review should confirm that the failure of isolation dampers on the upstream side of fans will not result in too much unfiltered air entering the control room. The radiation dose and toxic gas analysis results are used to determine how much unfiltered air can be tolerated.

RESPONSES: The ventilation system will meet single feature criteria after the two noted deficiencies have been corrected. The outside air isolation dampers are redundant, Train A and Train B, so that, given a single failure, at least one train of isolation dampers is assured to close. For complete analysis details see Section 3.0, Single Failure Analysis of Active Components.

- d. The following information may be used in evaluating the specific system types (see Reference 6 for further discussion):

- (1) Zone isolation with filtered incoming air and positive pressure. These systems may not be sufficiently effective in protecting against iodine. The staff allows an iodine protection

factor (IPF), which is defined as the time integrated concentration of iodine outside over the time-integrated concentration within the emergency zone, of 20 to 100 for filters built, maintained, and operated according to Regulatory Guide 1.52. An IPF of 100 requires deep bed filters. Such systems are likely to provide a sufficient reduction in iodine concentration only if the source is at some distance from the inlets. Thus, in most cases only plants with high stacks (about 100 meters) would meet GDC 19 with this system.

- (2) Zone isolation with filtered recirculated air. These systems have a greater potential for controlling iodine than those having one-through filters. IPF's ranging from 20 to over 150 can be achieved. These are the usual designs for plants having vents located at containment roof level. A system having a recirculation rate of 5000 cfm and a filter efficiency of 95% would be rated as follows:

<u>Infiltration (cfm)</u>	<u>IPF*</u>
200	25
100	49
50	96
25	191

*Within the range of interest, the iodine protection factor is directly proportional to recirculation flow rate times efficiency.

Infiltration should be determined conservatively. The calculated or measured gross leakage is used to determine the infiltration rate that will be applied in the evaluation of the radiological consequences of postulated accidents. This rate is determined as follows:

- (i) The leakage from the control room when pressurized to 1/8-inch water gauge is calculated on the basis of the gross leakage data. One-half of this value is used to represent the base infiltration rate. Component leak rates may be used to calculate gross leakage. (See for example, References 9 and 10.)

- (ii) The base infiltration rate is augmented by adding to it the estimated contribution from opening and closing of doors associated with such activities as the required by the plant emergency procedures. Normally, 10 cfm is used for this additional contribution.
- (iii) An additional factor that is used to modify the base infiltration rate is the enhancement of the infiltration occurring at the dampers or valves upstream of recirculation fans. When closed, these dampers typically are exposed to a pressure differential of several inch water gauge. This is accounted for by an additional infiltration contribution over the base infiltration at 1/8-inch water gauge.

The use of an infiltration rate that is based on calculation is acceptable except in the case where the applicant has assumed exceptionally low rates of infiltration. In these cases, more substantial verification or proof may be required. For instance, if an applicant submits an analysis that shows a gross leakage rate of less than 0.06 volume changes per hour, the reviewer would require that the gross leakage be verified by periodic tests as described in Regulatory Position C.5 of Regulatory Guide 1.95.

- (3) Zone isolation with filtered recirculated air and with a positive pressure. This system is essentially the same as the preceding one. However, an additional operational mode is possible. Makeup air for pressurization is admitted. It is filtered before entering the emergency zone. Pressurization reduces the unfiltered inleakage that is assumed to occur when the emergency zone is not pressurized. Assuming a filter fan capacity of 5000 cfm and a filter efficiency of 95%, the following protection factors result (flows in cfm).

Makeup Air	Recir. Air	IPF (Assuming No Infiltration)	IPF (Assuming Infiltration*)
400	4600	238	159

750	4250	128	101
1000	4000	96	80

*Normally 10 cfm infiltration is assumed for conservatism. This flow could be reduced or eliminated if the applicant provides assurance that backflow (primarily as a result of ingress and egress) will not occur. This may mean installing two-door vestibules or equivalent.

The makeup flow rate should have adequate margin to assure that the control room will be maintained at a pressure of at least 1/8-inch water gauge. The applicant should indicate that an acceptance test will be performed to verify adequate pressurization. If the makeup rate is less than 0.5 volume changes per hour, supporting calculations are required to verify adequate air flow. If the makeup rate is less than 0.25 volume change per hour, periodic verification testing is required in addition to the calculations and the acceptance test.

A question that often arises is whether "pressurization" or "isolation and recirculation" of the control room is to be preferred. Which design gives the lowest doses depends upon the assumptions as to unfiltered inleakage. Isolation limits the entrance of noble gases (not filterable) and, in addition, it is a better approach when the accident involves a short-term "puff release". If filtration is 25 cfm or less, "isolation" would be best in any event.

A second question related to the first involves the method of operation. The following possibilities have been considered:

- (i) Automatic isolation with subsequent manual control of pressurization.
- (ii) Automatic isolation with immediate automatic pressurization.

The first is advantageous in the case of external puff releases. Simple isolation would minimize the buildup of the unfilterable noble gases. It would also protect the filters from excessive concentrations in the case of chlorine release. However, the second method does guarantee that infiltration (unfiltered) is reduced to near zero immediately upon

accident detection. This would be beneficial in the case where the contamination transport path to the emergency zone is mainly inside the building. Method (i) should be used in the case of a toxic gas release and either method (i) or (ii) should be used in the case of a radiological release, provided GDC 19 can be satisfied. A substantial time delay should be assumed where manual isolation is assumed, e.g., 20 minutes for the purpose of dose calculations.

- (4) Dual air inlets for the emergency zone. Several plants have utilized this concept. The viability of the dual inlet concept depends upon whether or not the placement of the inlets assures that one inlet will always be free from contamination. The assurance of a contamination free inlet depends in part upon building wake effects, terrain, and the possibility of wind stagnation or reversal. For example, in a situation where the inlets are located at the extreme edges of the plant structures (e.g., one on the north side and one on the south side), it is possible under certain low probability conditions for both inlets to be contaminated from the same point source. Reference 6 presents the position for dealing with the evaluation of the atmospheric dispersion (X/Q values) for dual inlet system.

With dual inlets placed on plant structures on opposite sides of potential radiation release points (e.g., containment building), and capable of functioning with an assumed single active failure in the inlet isolation system, the following considerations may be applied to the evaluation of the control room X/Q's:

- (i) Dual inlet designs without manual or automatic selection control - Equation (6) of Reference 6 may be used with respect to the least favorable inlet location to estimate X/Q's. The estimated values can be reduced by a factor of two (2) to account for dilution effects associated with a dual inlet configuration. This is based upon the dilution derived from drawing in equal amounts of clean and

contaminated air through two open inlets.

(ii)

Dual inlet designs limited to manual selection control - Equation (6) of Reference 5 may be used with respect to the more favorable inlet location to estimate the X/Q's. The estimated value can be reduced by a factor of 4 to account for dilution effects associated with a dual inlet configuration and the relative probability that the operator will make the proper inlet selection. The reduction factor is contingent upon having redundant radiation detectors within each air inlet. The reduction factor is based on the judgment that trained control room operators, in conjunction with radiation alarm indication, will select and close the contaminated air inlet.

(iii)

Dual inlet designs with automatic selection control features - Equation (6) of Reference 6 may be used with respect to the more favorable inlet location to estimate the X/Q's. The estimated values can be reduced by about a factor of 10 to account for the ability to select a "clean" air inlet. The actual factor may be somewhat higher if the inlet configuration begins to approach the remote air inlet concept such that the probability of having one clean air inlet is relatively high. Plant configuration and meteorological conditions should be used as the principal basis for reduction factors greater than 10. The reduction factor of 10 or more is contingent upon having redundant detectors in each inlet and the provision of acceptable control logic which would be used in the automatic selection of a clean air inlet.

Because damage to the ducting might seriously affect the system capability to protect the operators, the ducting should be seismic

Category I and should be protected against tornado missiles. In addition, the number and placement of dampers must be such as to assure both flow and isolation in each inlet assuming one single active component failure (see Appendix A for information on the damper repair alternative). The location of the intakes with respect to the plant security fence should also be reviewed.

- (5) Bottled air supply for a limited time. In some plant designs the containment pressure is reduced below atmospheric within one hour after a DBA. This generally assures that after one hour significant radioactive material will not be released from the containment. Such a design makes it feasible to maintain the control room above atmospheric pressure by use of bottled air. Periodic pressurization tests are required to determine that the rated flow (normally about 300 to 600 cfm) is sufficient to pressurize the control room to at least 1/8-inch water gauge. The system is also required to be composed of several separate circuits, one of which is assumed to be inoperative to account for a possible single failure. At least one non-redundant, once-through filter system for pressurization as a standby for accidents of long duration is also desirable.

Compressed air bottles should be protected from tornado missiles or internally-generated missiles and should be placed so as not to cause damage to vital equipment or interference with operation if they fail.

RESPONSE: The control room ventilation system employs System Types (2) and (4). A gross inleakage rate of 200 cfm is used, which consists of infiltration, isolation damper leakage, and 10 cfm for opening and closing of doors. (Refer to Section 2.5.1 for our determination of the infiltration, rate.)

Dual inlet designs limited to manual selection control is employed.

4. Atmosphere Filtration Systems

ESTB evaluates the iodine removal efficiency of the atmosphere filtration systems under SRP Section 6.5.1,

determines the appropriate credit to be given and advises the AEB reviewer.

RESPONSE: Atmosphere cleanup system is designed so that it will operate after the DBA and retain radioactive materials after the DBA. Filter efficiencies used for the control room dose analysis are as depicted in Table 4.

5. Relative Location of Source and Control Room

The SAB will identify all potential sources of toxic or otherwise potentially hazardous gases as described in SRP Section 2.2. The SAB will provide to the AEB the findings of its toxic gas estimates for use in the control room habitability analysis. There are three basic categories: Radioactive sources, toxic gases such as chlorine, and gases with the potential for being released inside confined areas adjacent to the control room.

a. Radiation Sources

The LOCA source terms determined from the AEB review in accordance with Appendix A to SRP Section 15.6.5 are routinely used to evaluate radiation levels external to the control room. The dispersal from the containment or the standby gas treatment vent is determined with a building wake diffusion model. This model is discussed in Reference 6. Contamination pathways internal to the plant are examined to determine their impact on control room habitability. Other DBA's are reviewed to determine whether they might constitute a more severe hazard than the LOCA. If appropriate, an additional analysis is performed for the suspect DBA's.

RESPONSE: The most severe radiological hazard to the control room operator is LOCA, which has been analyzed as discussed in Section 4.0. All other radiological accidents as addressed in the USAR are less severe.

b. Toxic Gases

The SAB will review and identify those toxic substances stored or transported in the vicinity of the site which may pose a threat to the plant operators upon a postulated accidental release. The method used to determine whether the quantity or

location of the toxic material is such as to require closer study is described in Regulatory Guide 1.78. This guide also discusses the methods for analyzing the degree of risk and states, in general terms, the various protective measures that could be instituted if the hazard is found to be too great. In the case of chlorine, specific acceptable protective provisions have been determined.

In summary, the following provisions or their equivalent are required for the emergency zone ventilation system:

- (1) quick-acting toxic gas detectors
- (2) automatic emergency zone isolation
- (3) emergency zone leaktightness
- (4) limited fresh air makeup rates and
- (5) breathing apparatus and associated bottled air supply.

The best solution for a particular case will depend on the toxic gas in question and on the specific ventilation system design.

RESPONSE: Off-site toxic gas releases were evaluated to pose no threat to the habitability of the control room. See response to SRP Subsection II.7; see also Section 6.0.

c. Confined Area Releases

The reviewer studies the control building layout in relation to potential sources of radiation and toxic gases inside the control building or adjacent connected buildings. The following is considered:

- (1) Storage locations of CO₂ or other firefighting materials should be such as to eliminate the possibility of significant quantities of the gases entering the emergency zone. The review will be coordinated with the Chemical Engineering Branch (CMEB).

RESPONSE: On-site toxic gas releases were evaluated to pose no threat to the habitability of the control room. See response to SRP Subsection II.7; see also Section 5.0.

- (2) The ventilation zones adjacent to the emergency zone should be configured and balanced to preclude air flow toward the emergency zone.

RESPONSE: In compliance during normal mode of operation; during emergency mode of operation the control room ventilation employs the isolation with recirculation concept.

- (3) All pressurized equipment and piping (e.g., main steam lines and turbines) that could cause significant pressure gradients when failed inside buildings should be isolated from the emergency zone by multiple barriers such as multiple door vestibules or their equivalent.

RESPONSE: In compliance. The consequences of postulated pipe failures outside containment have been analyzed and reported in Appendix 10A of the USAR.

6. Radiation Shielding

Control room operators as well as other plant personnel are protected from radiation sources associated with normal plant operation by a combination of shielding and distance. The adequacy of this type of protection for normal operating conditions is coordinated with the RAB. To a large extent the same radiation shielding (and missile barriers) also provides protection from DBA radiation sources. This is especially true with respect to the control room walls which usually consist of at least 18 inches of concrete. In most cases, the radiation from external DBA radiation sources is attenuated to negligible levels. However, the following items should be considered qualitatively in assessing the adequacy of control room radiation shielding and should be coordinated with the RAB who will be requested to provide assistance as necessary.

- a. Control room structure boundary. Wall, ceiling, and floor materials and thickness should be reviewed. Eighteen inches to two feet of concrete or its equivalent will be adequate in most cases.
- b. Radiation streaming. The control room structure boundary should be reviewed with respect to penetrations (e.g., doors, ducts, stairways). The potential for radiation streaming from accident

sources should be identified, and if deemed necessary, quantitatively evaluated.

- c. Radiation shielding from internal sources. If sources internal to the control room complex are identified, protective measures against them should be reviewed. Typical sources in this category include contaminated filter trains, or airborne radioactivity in enclosures adjacent to the control room.

Evaluations of radiation shielding effectiveness with respect to the above items should be performed using simplified analytical models for point, line, or volume sources such as those presented in Reference 11 and 12. If more extended analysis is required, analytical support from the RAB should be requested. The applicant's coverage of the above items should also be reviewed in terms of completeness, method of analysis, and assumptions.

RESPONSE: The analyzed post-accident dose to the control room operators is within GDC 19 limits. For detailed discussion see Section 4.0.

7. Independent Analyses

The applicant is required to calculate doses to the control room operators. Independent analyses are made by the AEB because of the diversity of control room habitability system designs and the engineering judgment involved in their evaluation. Using the approach indicated in Reference 6, the source terms and doses due to a DBA are calculated. The source terms determined by the AEB's independent analysis of low population zone LPZ doses for a LOCA are used. The methods and assumptions for this calculation are presented in Appendix A to SRP 15.6.5. The control room doses are determined by estimating the X/Q from the source points to the emergency zone using meteorological input supplied by the assigned meteorologist, by determining the credit for the emergency zone's protection features, and by calculating the dose. Table 6.4-1 is a form which may be used to summarize the information that is needed for the control room dose calculation. The effective X/Q's are used for calculating the doses. The dose is then compared with the guidelines of GDC 19. If the guideline values are exceeded, the applicant will be requested to improve the system. In the event that other DBA's are expected to result in doses comparable to or higher than the LOCA, additional analyses are performed. The limiting accidents are compared with Criterion 19.

RESPONSE: The information required for the NRC's independent analysis is depicted in Section 4.0.

8.0 INFORMATION REQUIRED FOR CONTROL ROOM HABITABILITY EVALUATION (ATTACHMENT 1 TO Item III.D.3.4 OF NUREG 0737)

- (1) Control-room mode of operation, i.e., pressurization and filter recirculation for radiological accident isolation or chlorine release.

RESPONSE: Radiological Accident: Concept used is isolation with filtered recirculation.

Chemical Release: Chlorine gas is not stored on-site, nor are there any shipments or storage facilities of chlorine gas off-site.

- (2) Control-room characteristics

- (a) Control room air volume

RESPONSE: Control room consists of: control room, toilet, kitchenette, CAS room, computer room and shift supervisor's office.

The air volume of control room is:

$$V_1 = 47,000 \text{ ft}^3$$

- (b) Control room emergency zone (V_t) consists of control room (V_1), relay room (V_2) and mechanical equipment room (V_3).

RESPONSE: 1) Air volume of relay room is:

$$V_2 = 51,700 \text{ ft}^3$$

- 2) Air volume of mechanical equipment room is:

$$V_3 = 28,900 \text{ ft}^3$$

- 3) Control room emergency zone total volume:

$$\begin{aligned} V_t &= V_1 + V_2 + V_3 \\ &= 47,000 + 51,700 + 28,900 \\ &= 127,600 \text{ ft}^3 \end{aligned}$$

(c) Control room ventilation system schematic with normal and emergency air-flow rates.

RESPONSE: See Figures 1 and 2, Control Room Ventilation System Diagram.

(d) Infiltration leakage rate

RESPONSE: Gross in-leakage rate is 200 cfm (0.094 volume changes per hour), which consists of infiltration (80 cfm), isolation damper leakage (110 cfm), and opening/closing of doors (10 cfm).

(e) High efficiency particulate air (HEPA) filter and charcoal absorber efficiencies.

RESPONSE: See Table 4, Control Room Dose Analysis Parameters.

(f) Closest distance between containment and air intake.

RESPONSE: See Figure 3, Control Room Outside Air Intake Location Plan.

(g) Layout of control room, air intakes, containment building, and chlorine, or other chemical storage facility with dimensions.

RESPONSE: Control Room Outside Air Intakes: see Figure 3.

Chemical Storage Locations: See Table 7.

(h) Control room shielding including radiation streaming from penetrations, doors, ducts, stairways, etc.

RESPONSE: See USAR Figures 1.2-1 through 1.2-11, General Arrangements.

(i) Automatic isolation capability - damper closing time, damper leakage and area.

RESPONSE: See Table 1, Control Room Ventilation Isolation Damper Data.

(j) Chlorine detectors or toxic gas (local or remote)

RESPONSE: No chlorine or toxic gas detectors provided, nor are they required. See response to SRP Subsection II.7.

(k) Self-contained breathing apparatus availability (number)

RESPONSE: Four (4) MSA Air Packs are stored in the control room.

(l) Bottled air supply (hours supply)

RESPONSE: Each Air Pack is equipped with a 1/2 hour air supply bottle, and in addition, eight spare bottles are kept on hand in the control room. Furthermore, there are 150 additional bottles available on site, and there is on-site capability for bottle refill.

(m) Emergency food and potable water supply (how many days and how many people)

RESPONSE: A supply of food, consisting of 150 dehydrated meals, is maintained in the control room. An unlimited supply of pottable water is provided.

(n) Control Room personnel capacity (normal and emergency)

RESPONSE: Normal: 4

Max. emergency: 10

(o) Potassium iodide drug supply

RESPONSE: Supply of potassium iodide is available in the control room.

(3) Onsite storage of chlorine and other hazardous chemicals:

(a) Total amount and size of container

RESPONSE: See Table 7, Hazardous Chemicals On-Site Weighing 100 lb or more.

(b) Closest distance from control room air intake

RESPONSE: See Table 7, Figure 3, and USAR Figures 1.2-1 through 1.2-11.

- (4) Offsite manufacturing, storage, or transportation facilities of hazardous chemicals.

- (a) Identify facilities within a 5-mile radius.

RESPONSE: See Section 6.0, Hazardous Chemicals Off-Site.

- (b) Distance from control room.

RESPONSE: See Figure 3, Control Room Outside Air Intake Location Plan, and USAR Figure 1.1-2, Physical Facilities Layout.

- (c) Quantity of hazardous chemicals in one container.

RESPONSE: See Section 6.0, Hazardous Chemicals Off-Site.

- (d) Frequency of hazardous chemical transportation traffic (truck, rail, and barge).

RESPONSE: See Section 6.0, Hazardous Chemicals Off-Site.

- (5) Technical specifications (refer to standard technical specifications)

- (a) Chlorine detection system.

RESPONSE: Chlorine is not stored on site.

- (b) Control room emergency filtration system including the capability to maintain the control room pressurization at 1/8-inch water gauge, verification of isolation by test signals and damper closure times, and filter testing requirements.

RESPONSE: For Control Room Post-Accident Recirculation (Emergency Filtration) System Technical Specification see Kewaunee Technical Specifications 3.12 and 4.17.

9.0 REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missiles Design Bases."
2. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems and Components."
3. 10 CFR Part 50, Appendix A, General Design Criterion 19, "Control Room".
4. NUREG-0737, "Clarification of TMI Action Plan Requirements," Item III.D.3.4, "Control Room Habitability," November 1980.
5. Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Absorption Units of Light-Water-Cooled Nuclear Power Plants."
6. K. G. Murphy and K. M. Campe, "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Design Criterion 19," 13th AEC Air Cleaning Conference, August 1974.
7. Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release."
8. Regulatory Guide 1.95, "Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release."
9. S. H. Dole, Environmental Requirements for Extended Occupancy of Manned Satellites, ASME paper No. 59-AV-12, March, 1959.
10. Regulatory Guide 1.4, Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident, Revision 2.
11. WASH 1329, A Review of Mathematical Models for Predicting Spray Removal of Fission Products in Reactor Containment Vessels, June 15, 1974.
12. ANSI/ANS 58.9 - 1981, Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems.

TABLE 1

CONTROL ROOM VENTILATION ISOLATION DAMPER DATA

<u>DAMPER NO.</u>	<u>POWER SOURCE</u>	<u>FUNCTION</u>	<u>CFM</u>	<u>SIZE (INCHES)</u>	<u>AREA (SQ.FT.)</u>	<u>LEAKAGE Δ P OF 4" W.G. (CFM)</u>	<u>QA TYPE</u>	<u>FAILURE MODE</u>	<u>CLOSING TIME (SECONDS)</u>
ACC-1A	SAFEGUARD Train A	ISOLATION OF O.A. TO CONTR. RM. HVAC	2500	36 X 12	3.00	31.5	1	FC	4
ACC-1B	SAFEGUARD Train A	ISOLATION OF O.A. TO CONTR. RM. HVAC	2500	24 X 18	3.00	31.5	1	FC	4
ACC-2	SAFEGUARD Train B	PURGE POST-ACC O.A. TO CONTR. RM. HVAC	2500	18 X 18	2.25	23.6	1	FC	3.5
ACC-5	SAFEGUARD Train B	ISOL OF NORMAL O.A. TO CONTR. RM. HVAC	2500	24 X 18	3.00	31.5	1	FC	3
ACC-10	SAFEGUARD Train B	ISOL OF NORMAL EXH FROM CONTR. RM. HVAC (TOILET & KITCHEN)	300	14 X 5	0.49	5.1	1	FC	2.5
ACC-11	SAFEGUARD Train A	(SAME FUNCTION AS ACC-10)	300	14 X 5	0.49	5.1	1	FC	2.5
ACC-20	SAFEGUARD Train A	ISOL OF NORMAL RELIEF FROM CONTR. RM. HVAC TO TURB BLDG.	2200	24 X 18	3.00	31.5	1	FC	3
ACC-21	SAFEGUARD Train B	(SAME FUNCTION AS ACC-20)	2200	24 X 18	3.00	31.5	1	FC	3

NOTE: Damper leakages are based on K-450 specification requirement of "not-to-exceed" 10 cfm/sq ft at 4" WC; vendor tests showed leakages to be within specification limits. Damper closure times are taken from the vendor "operational checkout certification" sheets.

SINGLE FAILURE MODE ANALYSIS

<u>No.</u>	<u>COMPONENT</u>	<u>FAILURE MODE</u>	<u>RESULTING LOCAL EFFECTS</u>	<u>INHERENT SELF-REGULATING MEASURES</u>	<u>REMARKS</u>
1.	A/C fans	One fan fails	Loss of one 100% capacity fan and associated chilled water pump and chiller	Redundant fan will auto start with its associated pump and chiller upon trip of the other fan	Fans are interlocked to permit only one fan to run
2.	Chilled water pumps and chillers	One pump and/or its associated chiller fails	The associated A/C fan will trip	Redundant fan will auto start with its associated pump and chiller upon trip of the other fan	Pump auto starts on fan start, and chiller auto starts on pump start
3.	Post accident recirc. fans	One fan fails	Loss of one 100% capacity post accident filter train	Redundant post accident recirc fan and filter trains	
4.	Post accident recirc. dampers (ACC-3A & ACC-3B)	One damper fails to open	None	Redundant parallel dampers	The respective recirc. fan must be running for the damper to open Need ACC-2 closure permissive for either ACC-3A or 3B to open
5.	Outside air intake dampers (ACC-1A & ACC-1B)	Either damper fails to close	None	Redundant dampers ACC-2 and ACC-5 will auto close to isolate outside air	

SINGLE FAILURE MODE ANALYSIS

<u>No.</u>	<u>COMPONENT</u>	<u>FAILURE MODE</u>	<u>RESULTING LOCAL EFFECTS</u>	<u>INHERENT SELF-REGULATING MEASURES</u>	<u>REMARKS</u>
6.	Filtered fresh air inlet damper (ACC-2)	Damper fails open	With respect to CREZ isolation: None With respect to CREZ cleanup: Dampers ACC-3A and ACC-3B will not open, which will cause the <u>loss of both redundant</u> post-accident recirc. trains	Redundant dampers ACC-1A and ACC-1B will auto close <u>Deficiency</u>	See Note 1
7.	Non-accident fresh air damper (ACC-5)	Damper fails to close	With respect to CREZ isolation: None With respect to CREZ cleanup: None	Redundant dampers ACC-1A and ACC-1B will auto close Closure of this damper is not a permissive for any of the CREZ components	See Note 1
8.	Control room recirc. isolation damper (ACC-4)	Damper fails closed	Loss of unfiltered air return path to both A/C fans, which will result in partial loss of cooling for the entire CREZ	Temp escalation is a relatively long term event	ACC-4 auto closes upon smoke detection in air return path See Note 2

SINGLE FAILURE MODE ANALYSIS

<u>No.</u>	<u>COMPONENT</u>	<u>FAILURE MODE</u>	<u>RESULTING LOCAL EFFECTS</u>	<u>INHERENT SELF-REGULATING MEASURES</u>	<u>REMARKS</u>
9.	Exhaust to Aux Bldg vent stack isolation dampers (ACC-10 & ACC-11)	One damper fails to close	None	Redundant in-series dampers	
10.	Exhaust to Turb Bldg isolation dampers (ACC-20 & ACC-21)	One damper fails to close	None	Redundant in-series dampers	
11.	Relay Room CO ₂ isolation dampers (ACC-15 and ACC-16)	One or both dampers fail closed	Loss of cooling to Relay Room	Temp escalation is a relatively long term event	
12.	Shift Supervisors Office temperature control damper	Damper fails closed	Loss of cool air supply to the office	This office is not required for control room operation nor does it contain any safety related equipment	The door between the Control Room and the office is normally open, which will allow the return duct to pull Control Room air through the office

SINGLE FAILURE MODE ANALYSIS

<u>No.</u>	<u>COMPONENT</u>	<u>FAILURE MODE</u>	<u>RESULTING LOCAL EFFECTS</u>	<u>INHERENT SELF-REGULATING MEASURES</u>	<u>REMARKS</u>
13.	A/C fan disch backdraft dampers	Damper on idle fan fails open	Reverse flow thru idle fan (short circuit) will result in partial loss of cooling for the entire CREZ	Temp escalation is a relatively long term event	See Note 3
		Damper on running fan fails to open	Loss of cooling for the entire CREZ	Temp escalation is a relatively long term event	See Note 3
14.	Post accident recirc. fan inlet backdraft dampers	One damper fails to open	Loss of one 100% capacity post accident filter train	Redundant post accident recirc. fan and filter trains	

SINGLE FAILURE MODE ANALYSIS

- Note 1: In order for the ACC System to perform the post-accident recirculation and cleanup function effectively, short circuiting of the recirculation flow via dampers ACC-5 and ACC-2 is to be prevented. An analysis which demonstrates that one of these dampers will close, given a single failure, is presented in Subsection 3.2.
- Note 2: Damper ACC-4 fails closed on loss of power, but receives power from both Train A (safeguard) and Train B (non-safeguard backup) through an automatic power supply transfer relay. Therefore, given a single failure as the loss of one of the safeguards power sources, the damper will remain open.
- Note 3: In order to re-establish cooling for the CREZ, the operator has to shut down the running A/C fan, which will then auto start the idle fan.

TABLE 3

SYSTEM AUTO ACTUATION SIGNALS

	<u>FAIL</u> <u>POSIT</u>	<u>POWER</u> <u>TRAIN</u>	<u>SI</u>	<u>BO</u>	<u>STM</u> <u>EXCL</u>	<u>R23(A)</u>	<u>R13(A)</u> <u>R14(B)</u>
<u>ISOLATION DAMPER CLOSURE SIGNALS</u>							
ACC-1A	FC	A			A	A	
ACC-1B	FC	A			A	A	
ACC-2	FC	B	B		B	A	
ACC-5	FC	B	B		B	A	
ACC-10	FC	B	B		B		B
ACC-11	FC	A	A		A		A
ACC-20	FC	A	A		A		A
ACC-21	FC	B	B		B		B

COMPONENT START OR DAMPER OPEN SIGNALS

A/C FAN 1A		A	A	A			
A/C FAN 1B		B	B	B			
Recirc. Fan 1A		A	A	A	A	A	
Recirc. Fan 1B		B	B	B	B	B	
ACC-3A	FAI	A	A		A	A	
ACC-3B	FC	B	B		B	B	

- NOTES:
- A - Safeguards Train A
 - B - Safeguards Train B
 - FC - Fail Closed
 - FAI - Fail As-Is
 - SI - Safety Injection Signal
 - BO - Blackout Signal
 - ACC-5 also closes upon start of either recirc. fan
 - A/C fans are interlocked to permit only one fan to run
 - Chiller pump auto starts upon respective A/C fan start
 - Chiller auto starts upon respective chiller pump start

CONTROL ROOM DOSE ANALYSIS PARAMETERS

<u>PARAMETER</u>	<u>VALUE</u>	<u>REFERENCE SOURCE</u>
Reactor Power Level	1683 MWt.	102% of 1650 MWt USAR Sect. 14.3.2
Isotopic Core Inventory	See Table 6	Source Terms for Exxon Fuel
Containment Free Volume	1.32E+06 ft. ³	USAR Sect. 5.2.1
Shield Building Annulus Volume	3.74E+05 ft. ³	USAR Sect. 5.2.2
Shield Building Participation Factor	0.5	See Note 1
Auxiliary Building Volume	1.0 ft. ³	See Note 2
Containment Leakage Rate		TS 4.4.a.6.a, and Reference 10
0-24 hours	0.5%/day	
1-30 days	0.25%/day	
Containment Spray Rate		Reference 11
Elemental	10/Hr	
Organic	0/Hr	
Particulate	.45/Hr	
X/Q's	See Table 5	Reference 6
Breathing Rates	See Table 5	Reference 14
Shield Building Exhaust Rate	See Table 5	Calc 611.1170.M1
Shield Building Recirc. Rate	See Table 5	Calc 611.1170.M1
Shield Building Control Room, and Zone SV Filter Efficiencies		TS 3.6.b.3, TS 3.12.c, and Reference 5
Elemental	.90	
Organic	.90	
Particulate	.99	
Control Room Emergency Zone Volume	1.276E+5 ft. ³	Calc. S-B01-ACC-001
Control Room Recirculation Rate	2500 cfm	Sect. 2, this report

CONTROL ROOM DOSSE ANALYSIS PARAMETERS

<u>PARAMETER</u>	<u>VALUE</u>	<u>REFERENCE SOURCE</u>
Control Room Inleakage	200 cfm	Sect. 8, this report
Diameter of Containment	120 ft.	Design Drawings (S-214)
Distance, Containment to Center of the Control Room	75 ft.	Design Drawings (A-208)
Containment Inventory Available For Release		Reference 10
Nobles	100%	
Halogens	25%	
Iodine Species Split		Reference 10
Elemental	91%	
Organic	4%	
Particulate	5%	

Note 1: Arbitrary value to account for non-uniform mixing in the shield building annulus.

Note 2: Arbitrary value assigned to simulate a condition of no holdup.

TABLE 5

CONTROL ROOM DOSE ANALYSIS PARAMETERS v.s. TIME

AFTER LOCA TIME PERIOD	CONTAIN- MENT LEAKAGE/ DAY	SHIELD BLDG. EHHAUST (CFM)	SHIELD BLDG. RECIRC. (CFM)	CONTAIN- MENT		X/Q SEC/M3	BREATHING RATE M3/SEC	RELEASE PATHS		
				SPRAY HR-1 ELE ¹	PAR ²			THRU SHIELD BLDG.	THRU AUX. BLDG.	UN- FILTERED
0-2.25 min	0.5%	----	----	--	---	2.93E-03	3.47E-04	0%	0%	100%
2.25-6 min	0.5%	----	----	10	.45	2.93E-03	3.47E-04	0%	0%	100%
6-10 min	0.5%	4700	0	10	.45	2.93E-03	3.47E-04	89%	10%	1%
10-15 min	0.5%	4000	600	10	.45	2.93E-03	3.47E-04	89%	10%	1%
15-20 min	0.5%	3200	1400	10	.45	2.93E-03	3.47E-04	89%	10%	1%
20-27 min	0.5%	3000	1600	10	.45	2.93E-03	3.47E-04	89%	10%	1%
27 min-8 hr.	0.5%	3000	1600	0	.45	2.93E-03	3.47E-04	89%	10%	1%
8 hr.-24 hr.	0.5%	3000	1600	0	0	1.73E-03	1.75E-04	89%	10%	1%
24 hr-4 days	0.25%	3000	1600	0	0	6.74E-04	2.32E-04	89%	10%	1%
4 days- 30 days	0.25%	3000	1600	0	0	1.93E-04	2.32E-04	89%	10%	1%

1 ELE = Elemental Species of Iodine

2 PAR = Particulate Species of Iodine

TABLE 6

ISOTOPIC CORE INVENTORY

Activity in the Core for Design Basis LOCA
At the Kewaunee Nuclear Power Plant for Exxon Fuel

- ° End of Cycle conditions, 850 days of operation at 1683 MWt.
- ° Fuel assembly exposure of 49,000 MWD/MTU
- ° ORIGIN computer code was used to determine isotopic composition and activity (curies).

<u>ISOTOPE</u>	<u>ACTIVITY</u>	<u>ISOTOPE</u>	<u>ACTIVITY</u>
I-129	1.60	Kr-88	2.98×10^7
I-131	4.84×10^7	Kr-89	3.71×10^7
I-132	6.87×10^7	Xe-131m	3.50×10^5
I-133	9.04×10^7	Xe-133	8.99×10^7
I-134	1.03×10^8	Xe-133m	2.19×10^6
I-135	8.00×10^7	Xe-135	1.74×10^7
Kr-85	5.02×10^5	Xe-135m	2.42×10^7
Kr-85m	1.06×10^7	Xe-137	8.77×10^7
Kr-87	2.04×10^7	Xe-138	8.45×10^7

TABLE 7

HAZARDOUS CHEMICALS ON-SITE WEIGHING 100 LB OR MORE

CHEMICAL	STORAGE CONTAINERS			WEIGHT (lb)		LOCATION			CONTROL ROOM EMERGENCY ZONE DISTANCE	
	NUMBER	CYLINDER	MANIFOLD	PER	TOTAL	BUILDING	ELEVATION	COLUMNS ROWS	HORIZONTAL	VERTICAL
				CONTAINER	ASSEMBLY					
BORIC ACID (12%)	2	4000 GAL	YES	35000	70000	AUXILIARY	626'-0"	6-H-J	75	-20
BORIC ACID (5000 PPM)	2	500 GAL	YES	4375	8750	AUXILIARY	626'-0"	1-2-6-GS	200	-20
CARBON DIOXIDE	2	K	YES	75	150	SIMULATOR	606'-0"		600	0
CARBON DIOXIDE	1	TANK	N/A	15000	15000	TURBINE	586'-0"	7-8-A-B	140	20
CAUSTIC LIQUID	1	5000 GAL	N/A	58400	58400	AUXILIARY	642'-3"	2-3-JJ-KK	150	-36
CAUSTIC LIQUID	1	300 GAL	N/A	3500	3500	AUXILIARY	626'-0"	2-FI-LL	170	-20
CAUSTIC LIQUID STANDPIPE	1	300 GAL	N/A	3500	3500	AUXILIARY	586'-0"	5-6-H	80	20
DICHLORODIFLUOROMETHANE	3	FC	NO	145	145	AUXILIARY	606'-0"	1S-1-66-HH	200	0
FERRIC SULFATE	1	55 GAL	N/A	2000	2000	TURBINE	586'-0"	1-2-A-B	245	20
FREON	8	FC	NO	145	145	AUXILIARY	606'-0"	1S-1-66-HH	200	0
HALON	2	TANK	YES	90	180	TSC	606'-0"	11-12-F	75	0
HALON	2	TANK	YES	90	180	TSC	606'-0"	11-12-F	75	0
HALON	2	TANK	YES	232	464	WISE ANNEX	619'-1"	4-5-R-D	220	-19
HALON	2	TANK	YES	232	464	WISE ANNEX	606'-0"	4-5-R-D	220	0
HYDRAZINE (30%)	5	55GL DRUM	NO	475	475	AUXILIARY	626'-0"	1-2-6-GS	170	-20
HYDRAZINE - AFW	1	50 GAL	N/A	435	435	AUXILIARY	626'-0"	1-6-GS	200	-20
HYDRAZINE - BOILER	1	100 GAL	N/A	870	870	AUXILIARY	626'-0"	1-6-GS	200	-20
HYDRAZINE - CONDENSATE	1	100 GAL	N/A	870	870	AUXILIARY	626'-0"	1-6-GS	200	-20
LIQUID NITROGEN	1	GP45	N/A	270	270	AUXILIARY	606'-0"	1-66-HH	200	0
LIQUID NITROGEN	1	GP45	N/A	270	270	AUXILIARY	642'-3"	6-7-GW	50	-36
LIQUID NITROGEN	1	GP45	N/A	270	270	TSC	586'-0"	10-11-F	55	20
LIQUID PETROLEUM GAS	10	FX	NO	105	105	AUXILIARY	606'-0"	1S-1-66-HH	200	0
LIQUID PROPANE	2	FX	YES	200	400	OUTSIDE	606'-0"	1-1S-LL	220	0
LIQUID PROPANE	1	FX	N/A	100	100	TSC	586'-0"	10-11-G	40	20
NITROGEN	12	T	YES	22	264	AUXILIARY	606'-0"	1S-1-HH	200	0
NITROGEN	12	T	YES	22	264	AUXILIARY	606'-0"	1S-1-66-HH	200	0
NITROGEN	12	T	YES	22	264	AUXILIARY	606'-0"	1S-1-66-HH	200	0
NITROGEN	12	T	YES	22	264	AUXILIARY	606'-0"	1S-1-66-HH	200	0
NITROGEN	12	T	YES	22	264	AUXILIARY	606'-0"	1S-1-66-HH	200	0
NITROGEN	12	T	YES	22	264	AUXILIARY	606'-0"	1-1S-6S-66	200	0
POLYHSPINAT & POLYACRYLT	1	100 GAL	N/A	840	840	TURBINE	586'-0"	7-8-B	140	20
PROPANE	4	FX	NO	100	100	AUXILIARY	606'-0"	1S-1-66-HH	200	0
PROPANE - S.T.A. TRAILER	1	500 GAL	N/A	2100	2100	OUTSIDE	606'-0"	1S-1'S-T-L	220	0
SODIUM HYPOCHLORITE (12%)	1	5000 GAL	N/A	48800	48800	TURBINE	586'-0"	4-5-A-B	165	20
SODIUM HYPOCHLORITE (12%)	1	100 GAL	N/A	1000	1000	TURBINE	586'-0"	1-2-A-B	240	20
SODIUM SULFATE BRINE	1	19000 GAL	N/A	160000	160000	AUXILIARY	586'-0"	1-JJ-KK	190	20
SULFURIC ACID (98%)	1	300 GAL	N/A	4600	4600	AUXILIARY	626'-0"	2-FI-LL	170	-20
SULFURIC ACID (98%)	1	5000 GAL	N/A	48000	48000	AUXILIARY	586'-0"	1-JJ-KK	200	20

TABLE 8

ORGANIZATIONS CONTACTED
(HAZARDOUS CHEMICALS OFF-SITE)

FEDERAL

U.S. ENVIRONMENTAL PROTECTION AGENCY (Regional Office)

U.S. COAST GUARD (Regional and Local Office)

INTERSTATE COMMERCE COMMISSION (Regional Office)

STATE

WISCONSIN TRANSPORTATION COMMISSION

WISCONSIN DEPARTMENT OF NATURAL RESOURCES (State and
Regional Offices)

WISCONSIN STATE PATROL

WISCONSIN DEPARTMENT OF TRANSPORTATION

WISCONSIN DIVISION OF EMERGENCY GOVERNMENT

LOCAL

KEWAUNEE COUNTY EMERGENCY PREPAREDNESS

CITY OF MANITOWOC

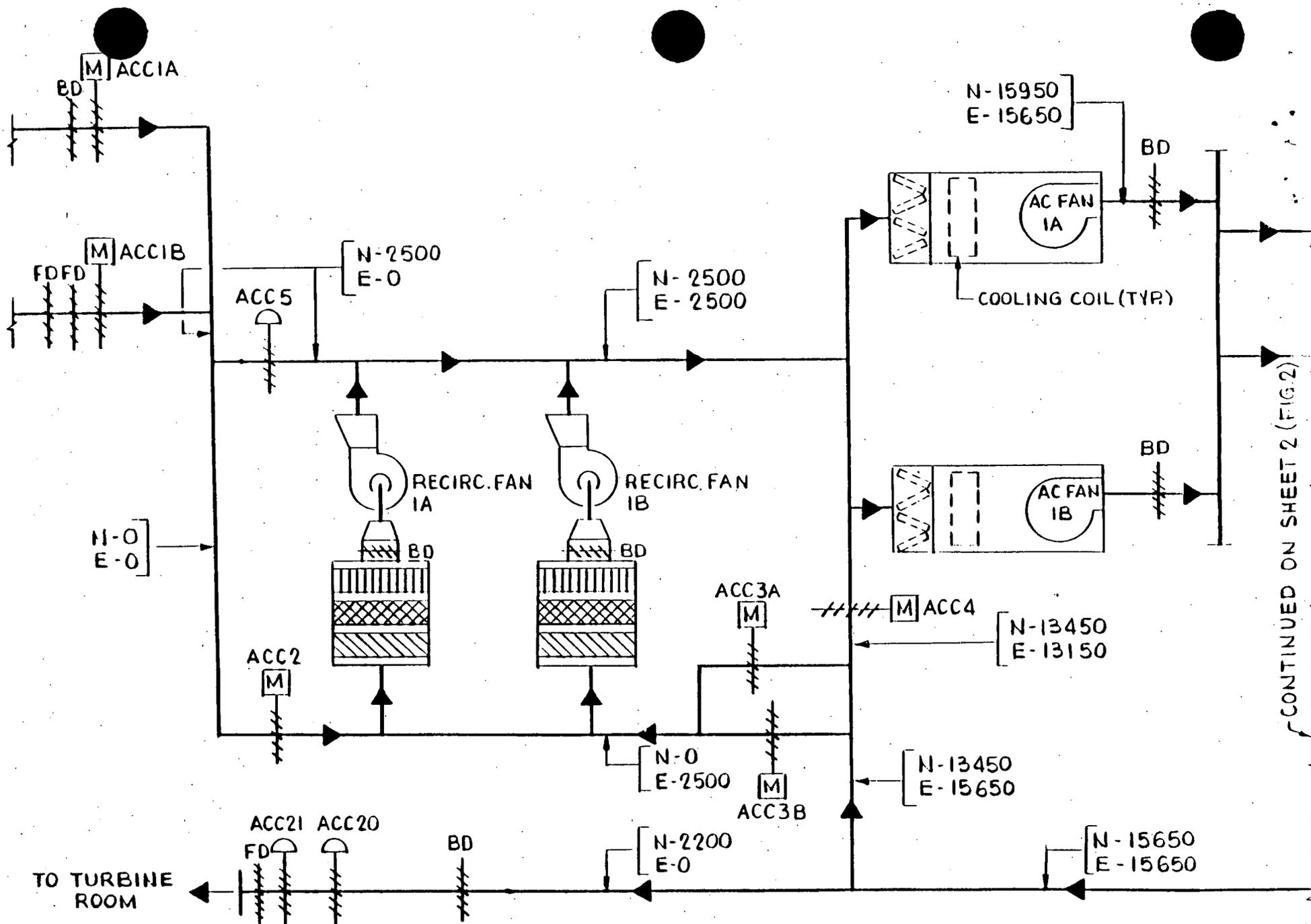
PRIVATE

WHITELAW FARM COOP.

MANITOWOC FARM COOP.

WASTE MANAGEMENT INC. (Corporate and Regional Offices)

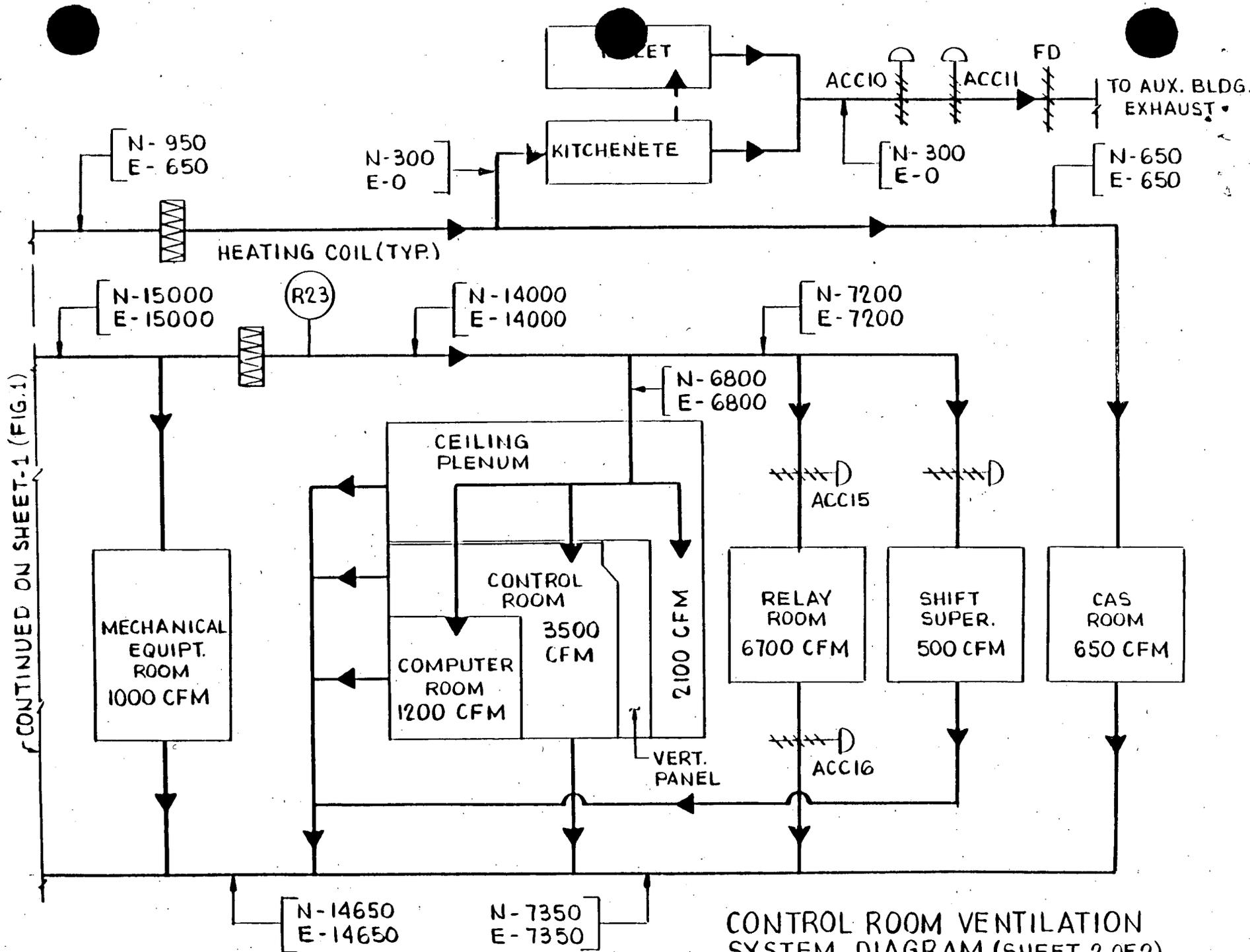
WISCONSIN PUBLIC SERVICE CORPORATION



N - NORMAL FLOW (CFM)
 E - EMERGENCY FLOW (CFM)
 BD - BACKDRAFT DAMPER
 FD - FIRE DAMPER

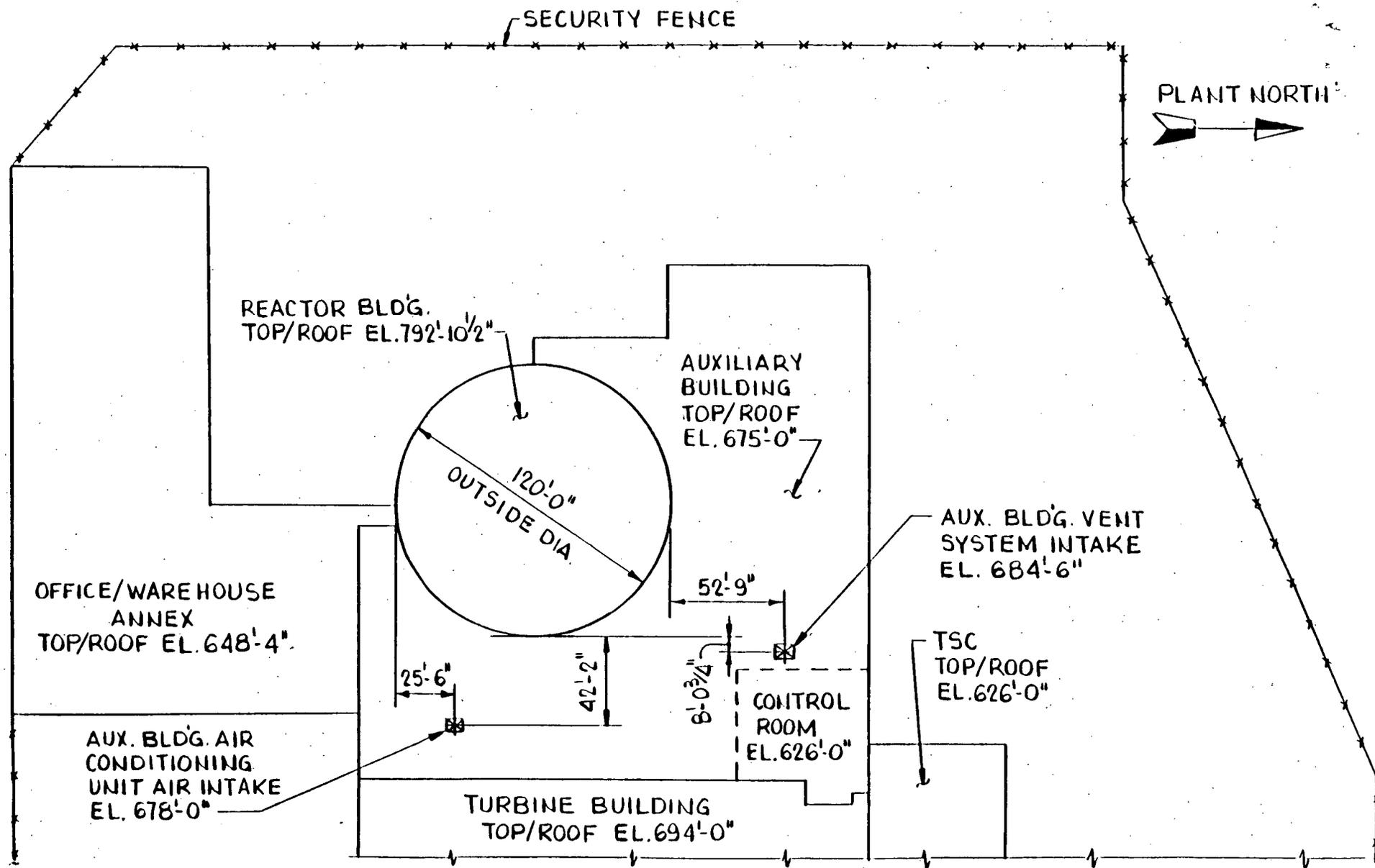
CONTROL ROOM VENTILATION
 SYSTEM DIAGRAM (SHEET 1 OF 2)

FIGURE - 1



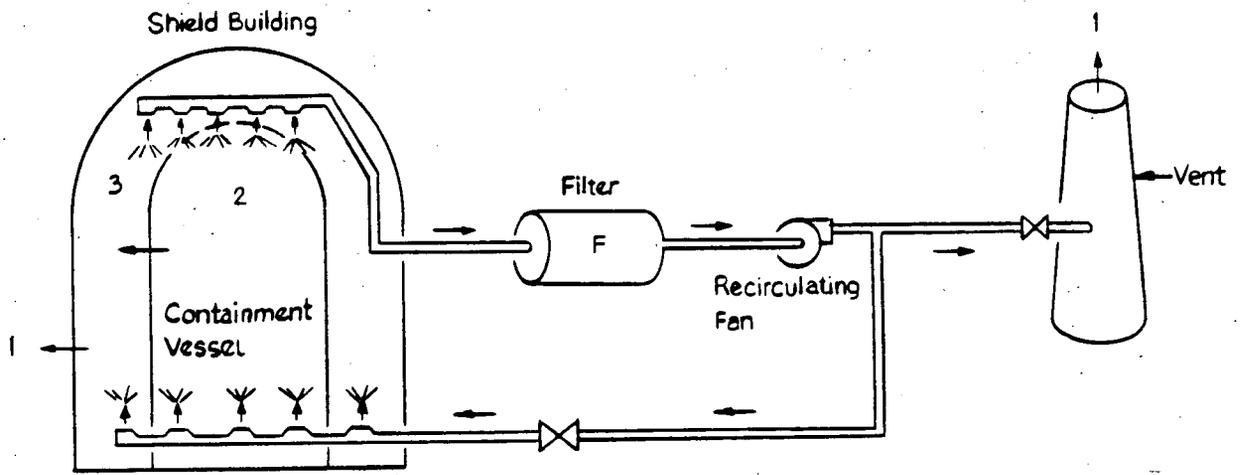
CONTINUED ON SHEET-1 (FIG.1)

CONTROL ROOM VENTILATION
SYSTEM DIAGRAM (SHEET 2 OF 2)
FIGURE-2

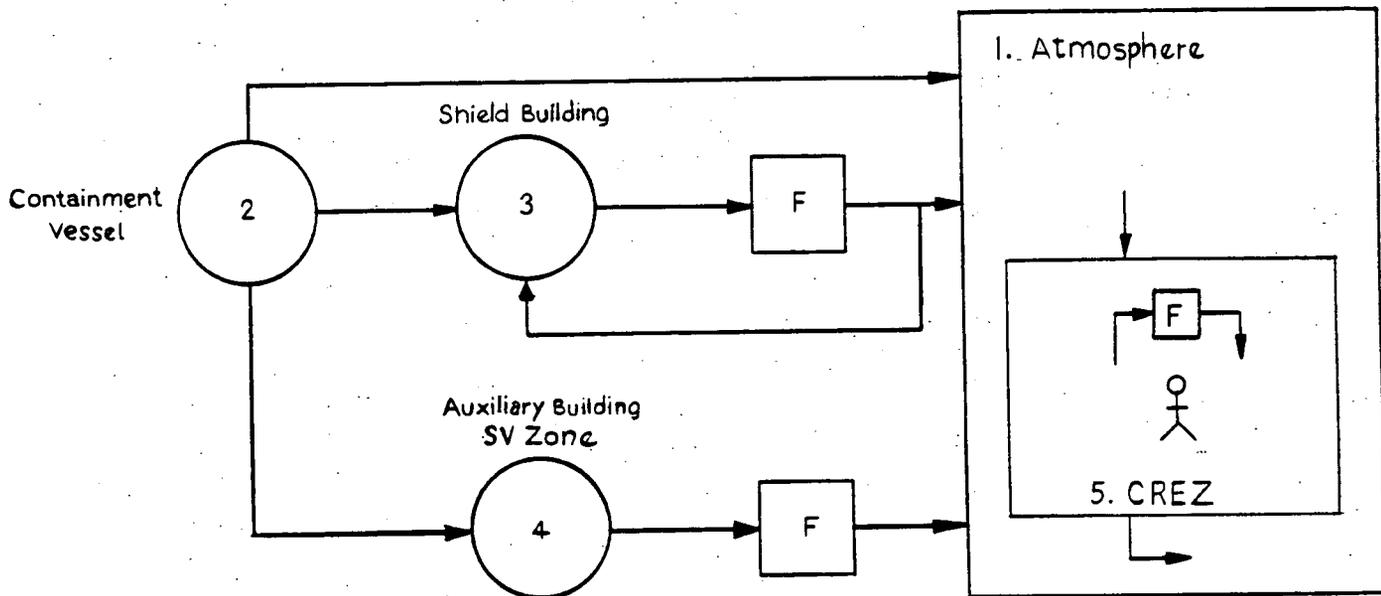


CONTROL ROOM OUTSIDE AIR INTAKE LOCATION PLAN

FIGURE-3



System Schematic



Analytical Model

Regions

1. Atmosphere
2. Containment Vessel
3. Shield Building
4. Auxiliary Building Special Ventilation (SV) Zone
5. Control Room Emergency Zone (CREZ)

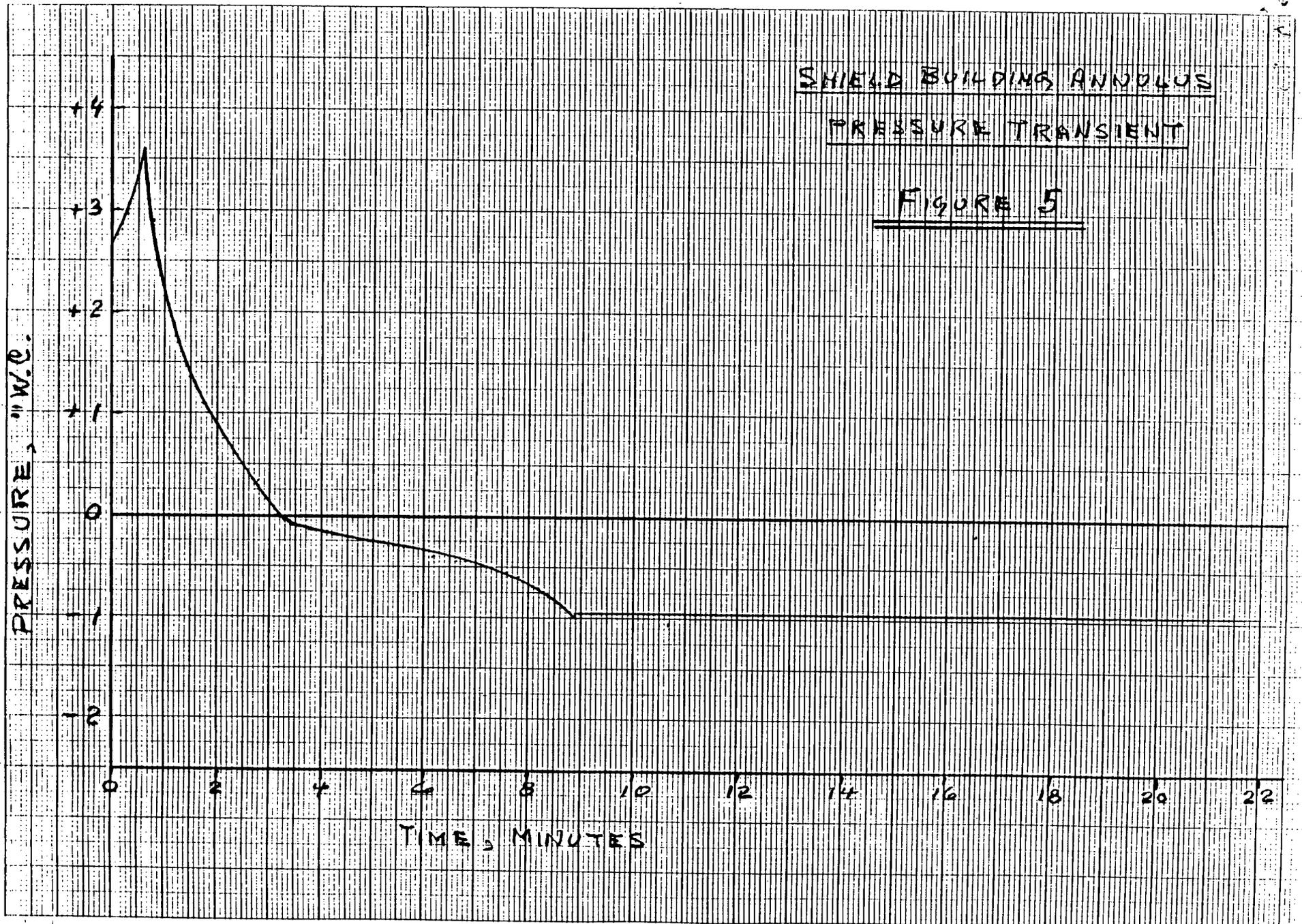
CONTROL ROOM DOSE ANALYSIS MODEL DIAGRAM

Figure 4

SHIELD BUILDING ANNULUS

PRESSURE TRANSIENT

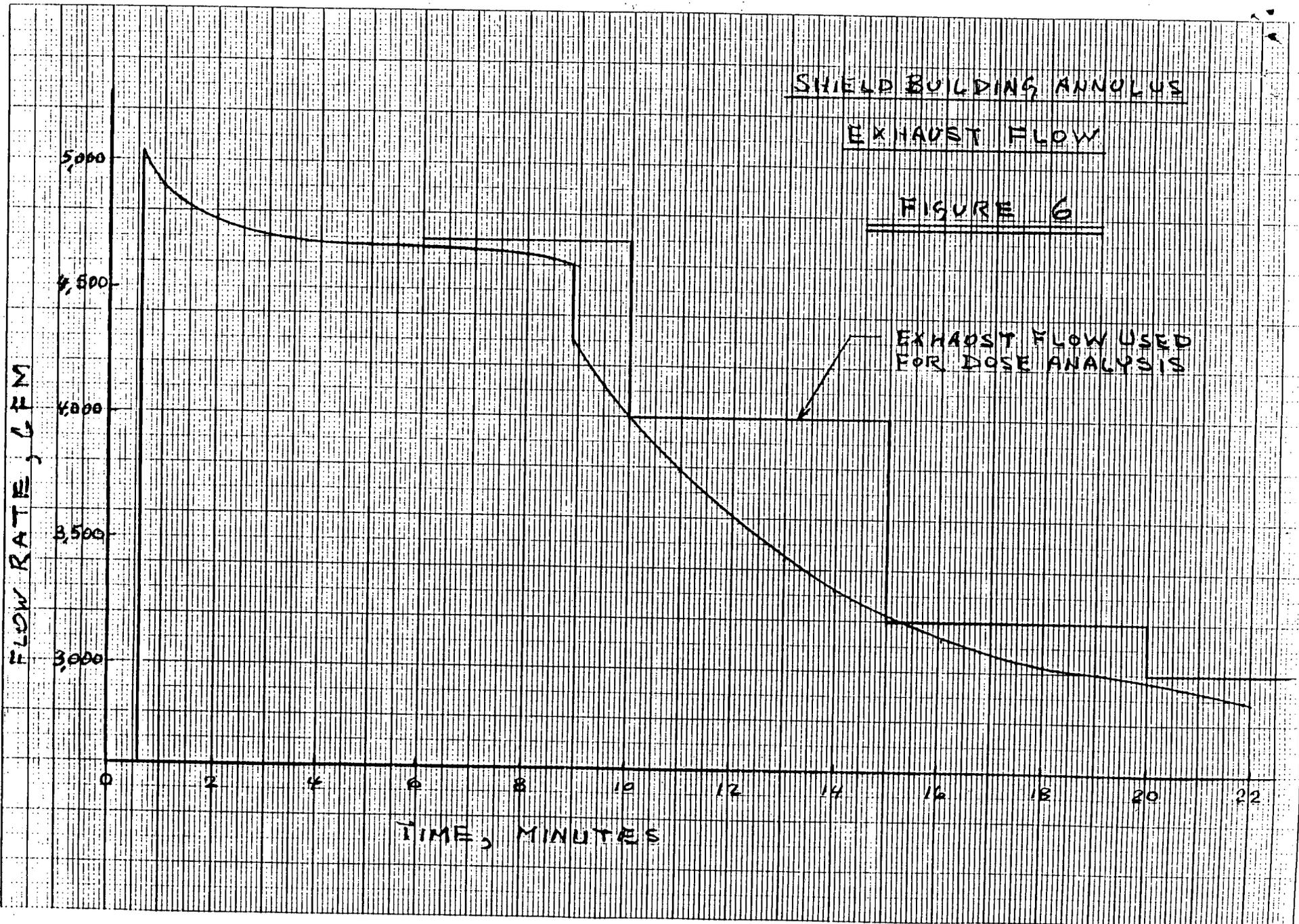
FIGURE 5



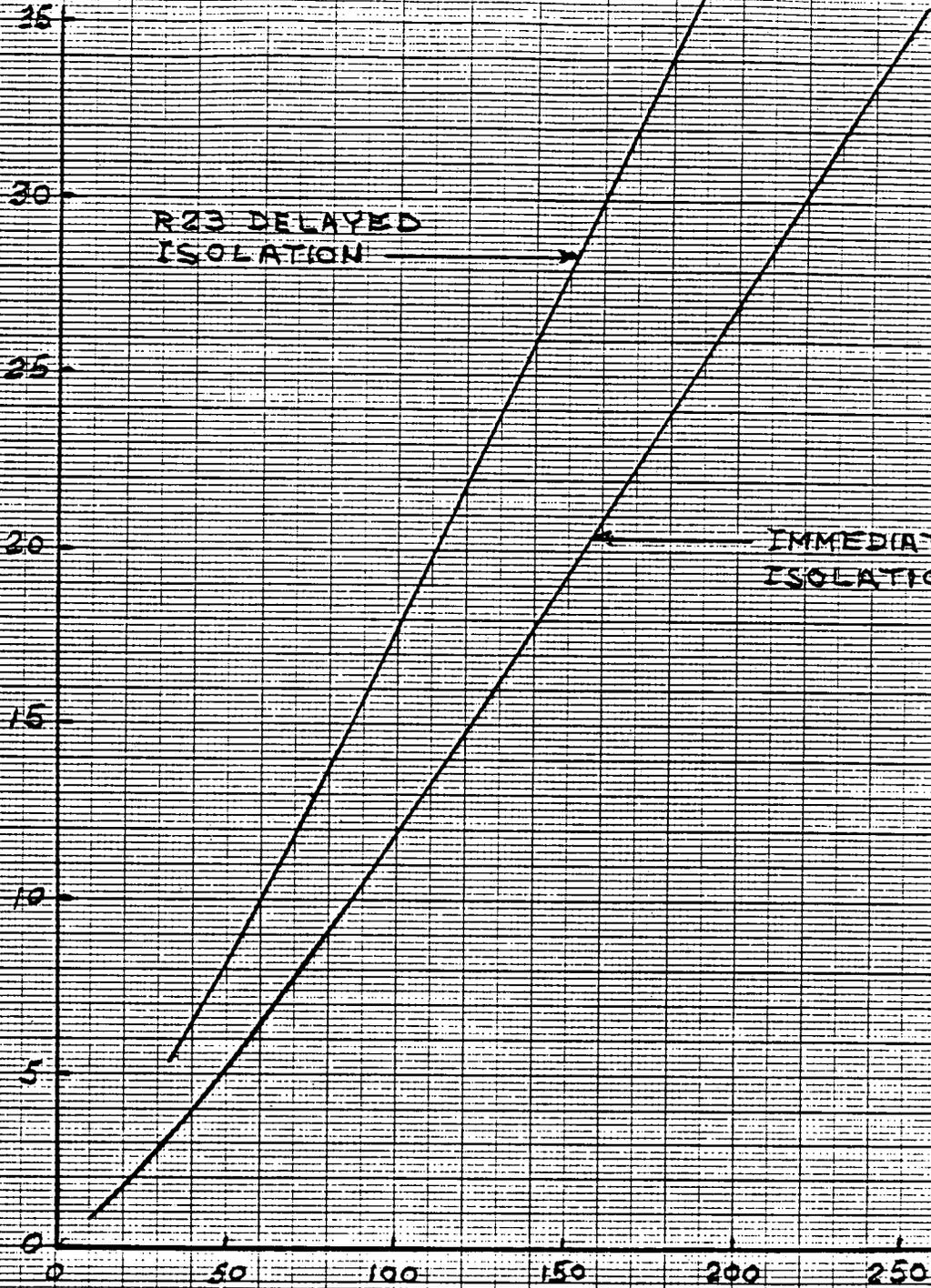
SHIELD BUILDING ANNULUS

EXHAUST FLOW

FIGURE 6



THYROID DOSE, REM



CREZ INLEAKAGE, CFM

SENSITIVITY OF 30-DAY THYROID

DOSE TO CREZ INLEAKAGE

FIGURE 7