CONTROL ROOM HABITABILITY STUDY

FOR

DRESDEN UNITS 2 AND 3

COMMONWEALTH EDISON COMPANY

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CONTROL ROOM HABITABILITY STUDY

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1.0 INTRODUCTION

A study is being conducted of the Dresden Units 2 and 3 control room habitability during toxic gas releases, radioactive gas releases, and direct radiation resulting from design basis accidents (DBAs). The study includes a survey of potential onsite and offsite sources of toxic chemical hazards which could jeopardize control room habitability, along with an analysis of control room doses resulting from a DBA loss-of-coolant accident (LOCA). The study is intended to satisfy the requirements for control room habitability as provided in Item III.D.3.4 of NUREG 0737, Clarification of TMI Action Plan Requirements. A copy of NUREG 0737, Item III.D.3.4 is provided as Appendix A.

The following report summarizes the results of the study. The analysis of the onsite and offsite toxic chemical survey is provided in Section 3.0. The analysis of the radiological calculations is provided in Section 4.0. The recommended design modifications that address those results are included in Section 5.0. A response to the "Request for Information Required for Control Room Habitability Evaluation," as contained in Attachment 1 to Item III.D.3.4 of NUREG 0737, is provided as Appendix B.

2.0 EXISTING DESIGN

The Dresden Units 2 and 3 control room and its associated HVAC equipment room are located in the turbine building at elevations 534' and 549', respectively. The HVAC system for Units 2 and 3 also services the Units 2 and 3 computer room (elevation 517') and miscellaneous offices (elevation 534'). Return air is recirculated through the supply air handling unit or exhausted to the outside as conditions require. Mixed return air and outside air are filtered. The air handling unit has a hot water heating coil and a direct expansion cooling coil. Steam humidifiers are located in the ducts. When activated by smoke sensors, the HVAC system switches automatically to a purge mode with 100% outside air.

The Dresden Unit 1 control room is located in the turbine building at elevation 534', adjacent and open to the Units 2 and 3 control room.

3.0 TOXIC CHEMICAL SURVEY

3.1 OVERVIEW

A survey for potentially toxic chemicals stored or transported onsite or within a 5-mile radius offsite of Dresden Units 2 and 3 was conducted in accordance with the criteria outlined in NUREG 0737, Item III.D.3.4. The following discussion provides the survey methods, analysis methods and results, and conclusions of the toxic chemical survey.

3.2 ONSITE SURVEY METHODOLOGY

The onsite survey was conducted to identify chemicals stored within the plant boundary. A list of potentially toxic onsite chemicals is provided in Table C-1 of Appendix C. The results of the onsite survey analysis are provided in Section 3.5 below.

3.3 OFFSITE SURVEY METHODOLOGY

The offsite survey was conducted to identify chemicals stored or transported within a 5-mile radius of the Dresden site. Fixed industrial, municipal, and bulk storage facilities, as well as pipeline companies, local farms, and businesses, were contacted regarding the chemicals they stored. Chemicals transported by barge, rail, and highway were also addressed. For Dresden, commodities transported on the Illinois River; Elgin, Joliet, and Eastern Railway; Illionis Gulf Central Railroad; Atcheson, Topeka, and Santa Fe Railway; Baltimore and Ohio Railroad; and the I-55 and I-80 interstate highways were considered. In accordance with Regulatory Guide 1.78, only chemicals transported with a minimum shipment frequency of 10 per year by highway, 30 per year by rail, and 50 per year by barge were considered.

A survey of chemicals stored at, or transported to or from, fixed facilities was conducted by individually contacting each facility. Although most of the requests for information received responses, a few facilities chose not to respond because of proprietary concerns. A listing of the firms contacted and associated potentially toxic chemicals, as well as a listing of facilities that did not respond, is provided in Table C-2 of Appendix C.

A survey of barge traffic on the Illinois River was performed using Reference 1 (see Appendix C). This reference provides a record of yearly tonnage of a given commodity category shipped on a given section of the river. For this survey, the section from the mouth of the Illinois River to Lockport, Illinois was used. Conservatively, all barge traffic into, out of, within, and through this section is assumed to pass by Dresden. Shipment frequency was determined by dividing the yearly tonnage shipped by an average barge size of 2,500 tons (reference Appendix C). This methodology is conservative because it assumes only one barge per shipment, while normal shipments may contain as many as four barges (Reference 3.2). Table C-3 of Appendix C lists the chemicals whose shipment frequencies exceed 50 shipments per year.

Unlike the Reference 1 information on barge traffic, there is no centralized source of meaningful data on railway and highway commodity traffic which is applicable to this survey. Data on railway traffic were obtained by individually contacting each of the railroads discussed above. As noted in Appendix C, some information on commodity traffic by rail was not available. Data on highway commodity traffic was obtained by requesting information on chemicals transported to/from facilities within or near the 5-mile radius. This area includes chemical plants, bulk storage facilities, farms, and other chemical users/producers. While these sources cannot provide a complete listing of the regional highway traffic, they are the only known source of information and therefore the only data available for evaluation. Tables C-4 and C-5 of Appendix C provide a listing of potentially toxic chemicals transported by railway and highway, respectively.

The results of the offiste survey analysis are provided in Section 3.5.

3.4 ANALYSIS METHODOLOGY

The analysis of survey results was modeled to conform to Regulatory Guide 1.78, which discusses the requirements and guidelines to be used for determining the toxicity of chemicals in the control room following a postulated accident. The guidelines for determining the toxicity of a given chemical include shipment frequencies, distance from source to site, and general properties of the chemical such as vapor pressure and toxicity limit.

Three types of standard limits are considered in defining hazardous concentrations. The first limit is the toxicity limit, which is the maximum concentration that can be tolerated for 2 minutes without physical incapacitation of an average human. If the toxicity limit is not available for a given chemical, a second limit called the short-term exposure limit (STEL) is used. STEL is defined as the maximum concentration to which workers can be exposed for 15 minutes without suffering from irritation, tissue damage, or narcosis leading to accident proneness or reduction of work efficiency. The third limit is the threshold limit value (TLV), defined as the concentration below which a worker may be exposed 8 hours a day, 5 days a week without adverse health effects.

The threshold limit values, the short-term exposure limits, and the toxicity limit are taken from the following references.

1. Threshold Limit Values for Chemical Substances and Physical Agents in the Work Room Environment with Intended Changes for 1980. ACGIH Manual, P.O. Box 1937, Cincinnati, Ohio 45201

2. Physical and Toxic Properties of Hazardous Chemicals Regularly Stored and Transported in the Vicinity of Nuclear Installations, Committee on the Safety of Nuclear Installations of the Organization for Economic Cooperation and Development, Nuclear Energy Agency, Paris, March 1976

3. Hazardous Chemical Data, CHRIS, Department of Transportation, Coast Guard, October 1978

The models developed to calculate the concentration of toxic chemicals in the control room in the event of an accidental spill are consistent with the models described in NUREG 0570. These include a consideration of the following factors:

a. There is a failure of one container of toxic chemicals being shipped on a barge, tank car, or tank truck releasing all of its contents to the surroundings. Instantaneously, a puff of that fraction of the chemical which would flash to a gas at atmospheric pressure is released. The remaining chemical is assumed to spread uniformly on the ground and evaporate as a function of time due to the heat acquired from the sun, ground, and surroundings. Further, no losses of chemicals are assumed to occur as a result of absorption into the ground, cleanup operations, or chemical reactions.

b. A spill from a railroad tank car is assumed to spread roughly over a circular area. Similarly, a spill occurring on the highways is also assumed to spread over a circular area.

c. The initial puff due to flashing, as well as the continuous plume due to evaporation, is transported and diluted by the wind to impact on the control room inlet. The atmospheric dilution factors are calculated using the methodology of Regulatory Guide 1.78 and NUREG 0570, with partial building wake effects conservatively considered.

d. To determine which chemicals need monitoring, the control room ventilation systems were assumed to continue normal operation for the analysis. The chemical concentrations as a function of time were calculated and the maximum levels determined. These were compared to the toxicity limits. Wherever the toxicity limits were not available, STEL values and TLVs published by the American Conference of Governmental and Industrial Hygienists (ACGIH) were used in lieu of toxicity limits.

e. Concentrations were calculated as a function of time following the accident to compare with the published toxicity limits, STEL values, and TLVs.

f. When the concentration in the control room did not exceed the toxicity limit within 2 minutes after detection by odor, operator action to isolate the control room was assumed. In such cases, monitors are not employed in the control room air intake. Where toxicity limits are not available, STEL values were used in lieu of toxicity limits.

The control room ventilation system is designed as discussed in Section 2.0. At present, there are no toxic chemical monitors installed to isolate the control room. Therefore, it was assumed that the ventilation system operates continuously at the design flowrates throughout the duration of the accident.

3.5 ONSITE/OFFSITE RESULTS

The onsite chemicals listed in Table C-1 were analyzed and evaluated based on a fresh air intake of 2,000 cfm and no isolation. The analysis shows that none of the chemicals stored onsite poses a problem with regard to control room habitability.

The offsite chemicals that were considered were:

- o Chemicals stored at facilities
- o Chemicals transported in pipelines
- o Railroad traffic
- o Barge traffic
- o Highway traffic

a. <u>Chemicals Stored at Facilities, Chemicals Transported in Pipelines, and Railroad Traffic</u>

These three categories are considered as follows. Each of the chemicals was evaluated based on toxic, physical, and chemical properties. Some were eliminated based on Regulatory Guide 1.78 (Table C-2) criteria. The remaining chemicals were analyzed assuming a fresh air intake of 2,000 cfm to the air handling system and no isolation. At this flowrate, without isolation, the following chemicals exceeded the TLV and STEL in the control room: ammonia, vinyl acetate, ethylene oxide, hydrochloric acid, chlorine, hydrofluoric acid, acrylonitrile, formaldehyde, and methyl chloride. These are discussed below.

1) Ammonia

The odor threshold for this chemical is 50 ppm. The analysis showed that after sensing the odor, the operators would have less than 1 minute to manually isolate the control room and put on breathing apparatus before the concentration in the control room reached toxicity limit (100 ppm). Hence, it is recommended that it be monitored.

2) Ethylene Oxide

This chemical has an odor threshold of 50 ppm, which is also its TLV. The operators can smell it at this level, and the analysis showed that the rate of concentration rise in the control room was such that there would be sufficient time for the operators to put on the breathing apparatus (after manual isolation of the control room) before the concentration reached the toxicity limit. Therefore, this chemical does not need to be monitored.

3) Vinyl Acetate

Vinyl acetate exists in liquid form with a pleasant odor. The odor threshold is 0.12 ppm, which is much less than the TLV limit (10 ppm). The analysis showed that the operators would have ample time to sense the chemical and manually isolate the control room and put on the breathing apparatus before the concentrations reached the STEL. Based on this, it is concluded that vinyl chloride does not need to be monitored.

4) Hydrochloric Acid

Hydrochloric acid is shipped as a solution, and it was conservatively assumed that the solution was at its maximum strength (40%). The odor threshold is 1 to 5 ppm and the toxicity limit is 35 ppm. The analysis showed that the concentration rise is such that there would be sufficient time for the operators to sense the odor (at 5 ppm) and put on breathing apparatus after manually isolating the control room. Based on this, it is concluded that HCl need not be monitored.

5) Chlorine

The odor threshold for this chemical is 3.5 ppm. The analysis showed that the operators would have 135 seconds after sensing the presence of the chemical by odor and manually isolating the control room and putting on breathing apparatus before the concentrations reached the toxicity limit (15 ppm). Hence, it is concluded that it need not be monitored.

6) Hydrofluoric Acid

The odor threshold for hits chemical is 0.036 ppm. The analysis showed that the operators would have 687 seconds after sensing the presence of the chemical by odor and manually isolating the control room and putting on breathing apparatus before the concentrations reached the toxicity limit (32 ppm). Hence, it is concluded that it need not be monitored.

7) Acrylonitrile

The odor threshold for this chemical is 21.4 ppm. The analysis showed that the operators would have 250 seconds after sensing the presence of the chemical by odor and manually isolating the control room and putting on breathing apparatus before the concentrations reached the toxicity limit (40 ppm). Hence, it is concluded that it need not be monitored.

8) Formaldehyde

The odor threshold for this chemical is 0.8 ppm. The analysis showed that the operators would have 120 seconds after sensing the presence of the chemical by odor and manually isolating the control room and putting on breathing apparatus before the concentrations reached the toxicity limit (10 ppm). Hence, it is concluded that it need not be monitored.

9) Methyl Chloride

The odor threshold for this chemical has not been established and credit cannot be taken for operators to be capable of detecting its smell and isolating the control room manually. Analysis showed that the unstated control room concentrations rise rapidly and reach toxicity limit (125 ppm) within 2 minutes. Hence, it needs to be monitored.

b. Barge Traffic

There are six categories of barge traffic: sodium hydroxide, alcohols, benzene and toluene, basic chemicals, nitrogeneous fertilizer, and other fertilizers. In the event of a release, the chemicals would flow into the river and mix, being diluted; or be confined to the lower deck of the barge and be released at a slow rate. Some chemicals are soluble and this would further reduce the release rate.

1) Sodium Hydroxode and Alcohols

Sodium hydroxide and alcohols are chemicals whose boiling points are higher than ambient temperature. Sodium hydroxide has negligible vapor pressure at room temperature; therefore, it does not need to be considered. Alcohols are highly soluble in water. The odor threshold of alcohols is much lower than the TLV; therefore, they could be detected by smell and the control room could be manually isolated. The operators would have sufficient time to put on breathing apparatus before concentrations exceed the STEL in the control room.

2) Benzene and Toluene

Benzene and toluene are not shipped along the segment of the river near the Dresden station.

3) Basic Chemicals

This category is comprised of a large number of chemicals. The published information does not identify the chemicals by tonnage and number of shipments. The U.S. Army Corps of Engineers (responsible for compiling this data) was contacted to obtain the information on individual chemicals, and this information was not available. Due to the large number of chemicals (toxic and nontoxic) involved, it is felt that the actual number of individual shipments for toxic chemicals would not exceed the shipment frequency for barges given in Regulatory Guide 1.78. Therefore, basic chemicals were not analyzed.

4) Nitrogeneous and Other Fertilizers

This is a broad category; most of the fertilizers are in solid form and are not toxic gases. Ammonia is included in this category. As discussed above for other chemicals, the release of such fertilizers would be confined to the lower deck of the barge, and a large fraction coming in contact with water would be dissolved. Also, the offsite analysis of chemicals indicates that ammonia needs to be monitored, and therefore barge accidents involving ammonia are not specifically evaluated.

c. Highway Traffic

Highway traffic was considered as discussed in Section 3.3 of this report.

4.0 RADIOLOGICAL ANALYSIS

General Design Criterion 19, Standard Review Plan (SRP) 6.4, and NUREG 0737, Item III.D.3.4 require that adequate radiation protection exist to permit control room access and occupancy for the duration of a design basis accident (DBA). The radiological analysis, provided in Appendix D, considered the loss-of-coolant accident (LOCA) as the worst-case DBA and assumed main steam isolation valve (MSIV) leakage at technical specification limits. Although several natural mechanisms exist to reduce or delay radioactive release to the environment, as discussed in Appendix D, credit was taken only for iodine plateout on surfaces of the steam lines and condenser and radioactive decay prior to release. The analysis also assumed that the control room HVAC system was designed with the proposed modifications discussed in Section 5.3. A detailed discussion of the methodology and assumptions of the analysis, as well as the conservatism of the approach, is included in Appendix D.

The following results are 30-day integrated doses in the control room based on the intake of unfiltered outside air for 8 hours following the LOCA, and filtered outside air thereafter. The dose guidelines provided in SRP 6.4, Acceptance Criterion 8 are also provided for comparison purposes. The thyroid and skin doses consist of contributions from airborne radioactivity inside the control room. The whole-body dose consists of contributions from airborne radioactivity inside and outside the control room, as well as direct shine from activity within the reactor building above the refueling floor.

TOTAL CONTROL ROOM DOSES (Rem)

	Thyroid	Skin	Whole-Body
Dresden Units 2 and 3	1.50E+1	2.82	3.16E-1
SRP 6.4, Guidelines for Control Room	30	30	5

As evidenced by these results, the control room HVAC system, with the design modifications discussed in Section 5.3, meets the radiological protection requirements of General Design Criterion 19 and SRP 6.4.

5.0 PROPOSED HVAC DESIGN MODIFICATIONS

5.1 OVERVIEW

The following section presents proposed modifications to the existing control room HVAC system to meet the intent of NUREG 0737, Item III.D.3.4 and SRP 6.4, and to satisfy the requirements of General Design Criterion 19 regarding control room habitability following a radiological DBA. These modifications include the addition of a redundant system (train B) consisting of an air handling unit (AHU), return air fan, cooling system, associated piping, ducts, dampers, and appurtenances, and an air filtration unit (AFU) common to both air handling systems.

5.2 EMERGENCY ZONE

SRP 6.4 defines the boundaries for a control room emergency zone. Within this zone, the plant operators are adequately protected against the effects of accidental radiological gas and toxic gas releases. This zone also allows the control room to be maintained as the center from which emergency teams can safely operate in a design basis radiological release.

To satisfy this requirement, the following areas are included in the emergency zone.

a. Main control room for Units 1, 2, and 3, which includes all critical documents and reference files, and toilet and locker rooms for Unit 1

b. Computer room for Units 2 and 3

c. New HVAC equipment room, which houses the new train B system

Areas outside the emergency zone, which are normally serviced by the existing AHU system (train A), shall be isolated in emergency conditions. Support rooms such as the kitchen and offices are accessible to operators with the aid of breathing equipment. The existing HVAC equipment room is also not included in the emergency zone.

5.3 PROPOSED MODIFICATIONS

The proposed HVAC system design modifications are described below. Figure 1 provides a schematic of the proposed system.

a. The Unit 1 control room will receive cooling from the Units 2 and 3 main control room HVAC system.

b. Existing supply AHU train A, return air fan A, and all related ductwork will be utilized.

c. New supply AHU train B will be located in a new HVAC equipment room. AHU train B will be sized to supply the emergency zone as discussed in Section 5.2. Ducts from new AHU train B will be connected to the corresponding ducts of the existing air handling system. A suggested possible arrangement is outlined in Figure 1.

d. New return air fan B will return air to new supply AHU train B. New AHU train B will also have outside air of 2,000 cfm.

e. A new AFU, sized to accommodate 2,000 cfm, will be located in the new HVAC equipment room. This unit will consist of a prefilter, electric heating coils, high-efficiency particulate air (HEPA) filter, charcoal filters, HEPA filter, and two full-capacity fans. The AFU will be in compliance with Regulatory Guide 1.52.

f. A new 100%-capacity cooling system for train B will be installed in the new HVAC equipment room.

g. Bubbletight and low-leakage dampers will be used as shown in Figure 1.

5.4 MODIFIED SYSTEM OPERATION

For normal conditions, the AHU train A system will operate as discussed in Section 2.0.

For an emergency condition, as determined by radiation monitors in the reactor building ventilation manifold, system operation will be as follows. Within 8 hours, the bubbletight isolation dampers will isolate the normal outside air intake to the AHUs and all ventilation zones which are not mentioned in Section 5.2 above. The outside air damper to the new AFU will be remote manually opened and an AFU fan will begin supplying filtered air to one AHU train. The return air fan will route the return air to the associated AHU train. Barring component failures in the operating AHU train, the system will continue to operate in this manner for the duration of the emergency.

On failure of airflow in the operating AHU train system, that train is automatically isolated and the redundant train is energized. Outside air will be supplied to the redundant AHU train by an AFU fan in this operating mode. The return air fan will route the return air to the associated AHU.

In the event that toxic gases are detected as discussed in Section 3.5 of this report, all outside air intakes and all ventilation zones which are not mentioned in Section 5.2 will be isolated. The AHU will supply 100% recirculated air to the emergency zone.

6.0 RECOMMENDATIONS

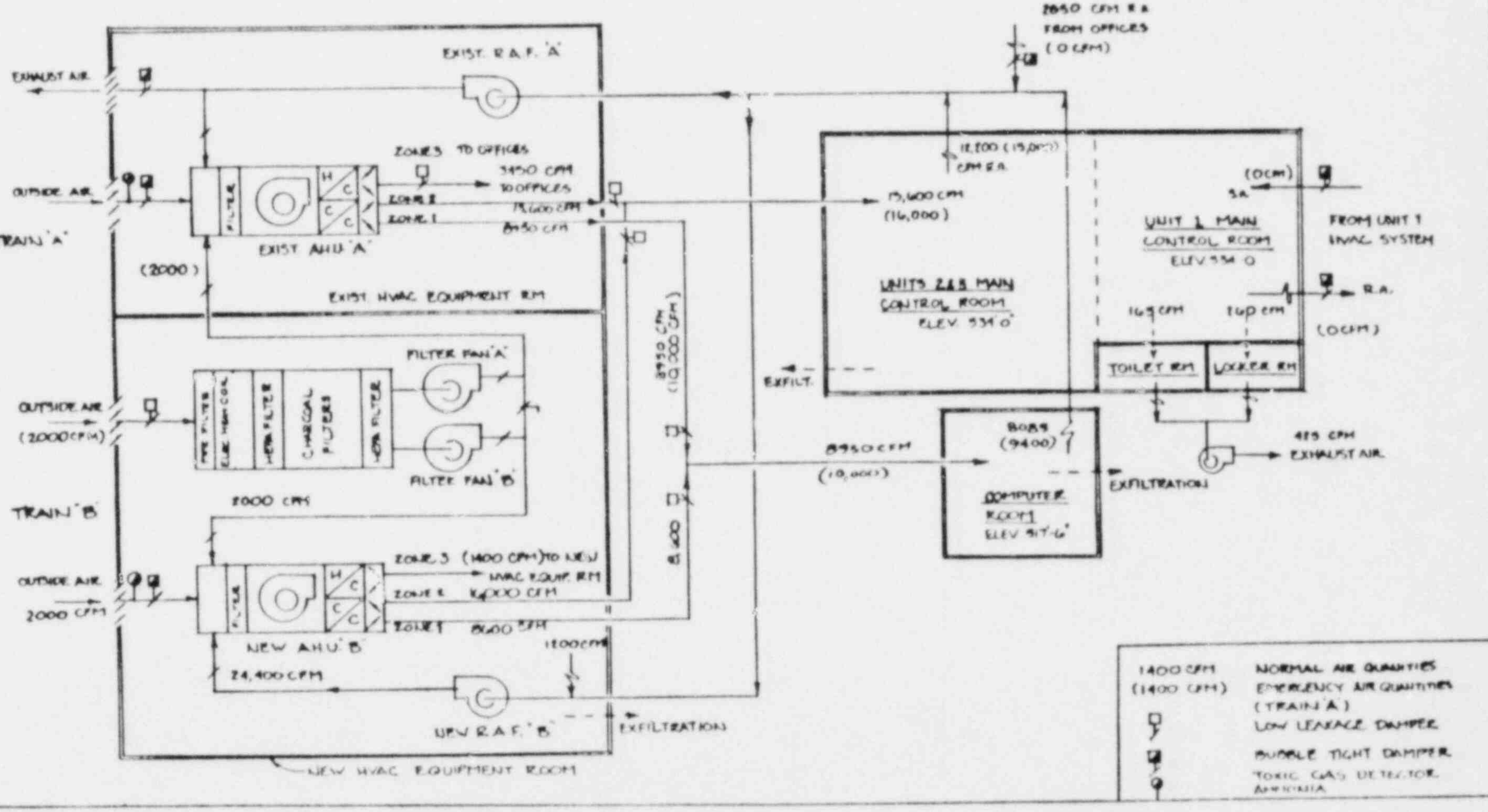
Based on the results of the radiological analysis, it is recommended that the control building HVAC system design incorporate the modifications discussed in Section 5.3.

Based on the results of the toxic gas analyses, it is recommended that a monitor be added to the fresh air intake to detect ammonia. The system should incorporate automatic isolation of the fresh air intake upon detection of ammonia.

DRESDEN FIGURE 1

CONTROL RM HVAC SCHEMATIC

REVISION:	0	1
DATE	8/20/81	10/12/81



APPENDIX A

NUREG 0737, ITEM III.D.3.4

CONTROL ROOM HABITABILITY REQUIREMENTS

III.D.3.4 CONTROL-ROOM HABITABILITY REQUIREMENTS

Position

In accordance with Task Action Plan item III.D.3.4 and control room habitability, licensees shall assure that control room operators will be adequately protected against the effects of accidental release of toxic and radioactive gases and that the nuclear power plant can be safely operated or shut down under design basis accident conditions (Criterion 19, "Control Room," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50).

Changes to Previous Requirements and Guidance

There are no changes to the previous requirements.

Clarification

(1) All licensees must make a submittal to the NRC regardless of whether or not they met the criteria of the referenced Standard Review Plans (SRP) sections. The new clarification specifies that licensees that meet the criteria of the SRPs should provide the basis for their conclusion that SRP 6.4 requirements are met. Licensees may establish this basis by referencing past submittals to the NRC and/or providing new or additional information to supplement past submittals.

All licensees with control rooms that meet the criteria of the following sections of the Standard Review Plan:

2.2.1-2.2.2	Identification of Potential Hazards in Site Vicinity
2.2.3	Evaluation of Potential Accidents;
6.4	Habitability Systems

shall report their findings regarding the specific SRP sections as explained below. The following documents should be used for guidance:

(a) Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of Regulatory Power Plant Control Room During a Postulated Hazardous Chemical Release";

(b) Regulatory Guide 1.95, "Protection of Nuclear Power Plant Control Room Operators Against an Accident Chlorine Release"; and,

(c) 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.

Licensees shall submit the results of their findings as well as the basis for those findings by January 1, 1981. In providing the basis for the habitability finding, licensees may reference their past submittals. Licensees should, however, ensure that these submittals reflect the current facility design and that the information requested in Attachment 1 is provided.

(3) All licensees with control rooms that do not meet the criteria of the above-listed references, Standard Review Plans, Regulatory Guides, and other references.

These licensees shall perform the necessary evaluations and identify appropriate modifications.

Each licensee submittal shall include the results of the analyses of control room concentrations from postulated accidental release of toxic gases and control room operator radiation exposures from airborne radioactive material and direct radiation resulting from design-basis accidents. The toxic gas accident analysis should be performed for all potential hazardous chemical releases occurring either on the site or within 5 miles of the plant-site boundary. Regulatory Guide 1.78 lists the chemicals most commonly encountered in the evaluation of control room habitability but is not all inclusive.

The design-basis-accident (DBA) radiation source term should be for the loss-of-coolant accident LOCA containment leakage and engineered safety feature (ESF) leakage contribution outside containment as described in Appendix A and B of Standard Review Plan Chapter 15.6.5. In addition, boiling-water reactor (BWR) facility evaluations should add any leakage from the main steam isolation valves (MSIV) (i. e., valve-stem leakage, valve seat leakage, main steam isolation valve leakage control system release) to the containment leakage and ESF leakage following a LOCA. This should not be construed as altering the staff recommendations in Section D of Regulatory Guide 1.96 (Rev. 2) regarding MSIV leakage-control systems. Other DBAs should be reviewed to determine whether they might constitute a more-severe control-room hazard than the LOCA.

In addition to the accident-analysis results, which should either identify the possible need for control-room modifications or provide assurance that the habitability systems will operate under all postulated conditions to permit the control-room operators to remain in the control room to take appropriate actions required by General Design Criterion 19, the licensee should submit sufficient information needed for an independent evaluation of the adequacy of the habitability systems. Attachment 1 lists the information that should be provided along with the licensee's evaluation.

Applicability

This requirement applies to all operating reactors and operating license applicants.

Implementation

Licensees shall submit their responses to this request on or before January 1, 1981. Applicants for operating licenses shall submit their responses prior to issuance of a full-power license. Modifications needed for compliance with the control-room habitability requirements specified in this letter should be identified, and a schedule for completion of the modifications should be provided. Implementation of such modifications should be started without awaiting the results [illegible] staff review. Additional needed modifications, if any, identified by t[illegible]f during its review will be specified to licensees

Type of Review

A postimplementation review will be performed.

Documentation Required

By January 1, 1981 licensees shall provide the information described in Attachment 1. Applicants for an operating license shall submit their responses prior to full-power licensing.

Technical Specification Changes Required

Changes to technical specifications will be required.

References

NUREG-0660, Item III.D.3.4.

Letter from D. G. Eisenhut, NRC, to All Operating Reactor Licensees, dated May 7, 1980.

III.D.3.4. ATTACHMENT 1, INFORMATION REQUIRED FOR CONTROL-ROOM HABITABILITY EVALUATION

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

(2) Control-room characteristics

(a) air volume control room

(b) control-room emergency zone (control room, critical files, kitchen, washroom, computer room, etc.)

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

(d) infiltration leakage rate

(e) high efficiency particulate air (HEPA) filter and charcoal adsorber efficiencies

(f) closest distance between containment and air intake

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

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

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

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

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

(l) bottled air supply (hours supply)

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

(n) control-room personnel capacity (normal and emergency)

(o) potassium iodide drug supply

(3) Onsite storage of chlorine and other hazardous chemicals

(a) total amount and size of container

(b) closest distance from control-room air intake

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

(a) identify facilities within a 5-mile radius;

(b) distance from control room

(c) quantity of hazardous chemicals in one container

(d) frequency of hazardous chemical transportation traffic (truck, rail, and barge)

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

(a) chlorine detection system

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

APPENDIX B

NRC-REQUESTED INFORMATION REQUIRED

FOR

CONTROL ROOM HABITABILITY EVALUATION

The following list of responses corresponds directly to the items requested by Attachment 1 to NUREG 0737, Item III.D.3.4. The responses reflect the modified control room HVAC system design as discussed in Section 5.3 of this report.

Item	Response
1	Upon detection of high airborne radioactivity in the reactor building ventilation manifold, the control room HVAC system will enter the emergency mode of operation within 8 hours. In this mode, normal makeup and selected return air ducting are remote manually isolated and the control room emergency zone is pressurized by once-through makeup air passing through an emergency filter unit. Upon detection of high ammonia concentrations in the control room HVAC fresh air intake, the system will automatically be switched to the isolation/recirculation mode of operation. In this mode, the operators will put on breathing apparatus until the toxic chemical concentrations are reduced to below safe levels. Upon operator detection of vinyl acetate, ethylene oxide, and hydrochloric acid, the system will be manually placed in the isolation/recirculation mode of operation. In this mode of operation, the operators will put on breathing apparatus until the toxic chemical concentrations are reduced to below detectable levels.
2	Control Room Characteristics a. Control room air volume: The air volume of the control room emergency zone is approximately 132,000 cubic feet, including 104,000 cubic feet for the main control room. b. Control room emergency zone: The control room emergency zone includes the main control room for Units 1, 2, and 3; computer room for Units 2 and 3; toilet and locker rooms for Unit 1; and the new HVAC equipment room. c. Control room ventilation system schematic: Figure 1 of this report provides a proposed ventilation system schematic for the control room emergency zone indicating normal and emergency airflows.

Item	Response

d. Infiltration leakage rate: Infiltration leakage into the control room is negligible because the control room will be maintained at a positive pressure with respect to adjacent rooms during both normal and emergency conditions. For emergency conditions, makeup air will be limited to a maximum of 2,000 scfm. Backflow infiltration is assumed to be 10 scfm.

During isolation/recirculation conditions, infiltration is initially negligible because the control room will be at a positive pressure at the time of system isolation. Infiltration following isolation is conservatively assumed to be 105 cfm following system isolation.

e. HEPA filter and charcoal adsorber efficiencies: The HEPA filters in the emergency filtration train are rated at 99.97% efficiency in removing particulates of 0.3-micron size and larger. The charcoal filters in the emergency filtration train are rated at 99% efficiency for removal of elemental and organic iodine.

f. Closest distance between containment and air intake: The Units 2 and 3 control room HVAC system intake (elevation 549') is located approximately 162 feet from the closest wall of the secondary containment reactor building. Additionally, the standby gas treatment system (SGTS) exhaust to the main chimney for Units 2 and 3 is located approximately 444 feet laterally and 278 feet above the HVAC system intake.

g. Layout: A layout drawing showing the relative location of the control room, HVAC system intake, toxic gas monitors, turbine building, SGTS main chimney, and the containment is shown in attached Figure B-1.

h. Control room shielding: The control room design consists of poured-in-place reinforced concrete with 6-inch floor and ceiling slabs and 18- to 27-inch walls. The radiation streaming effect in the control room is considered negligible during normal operation and provides a 30-day integrated whole-body dose of 101 mRem post-LOCA. Refer to FSAR Section 12.2 for further details.

i. Automatic isolation capability, damper information: Isolation of the normal makeup air intake takes approximately [illegible] seconds. The makeup air intake and exhaust damper will be bubbletight with an area of 25 square feet each and a leakage factor of zero. Office zone duct will be isolated with bubbletight dampers with a leakage factor of zero for the return air, and a low leakage type damper for the supply air. The Unit 1 control room HVAC supply and return ducts will be isolated with bubbletight dampers.

Item | Response

j. Chlorine or toxic gas detectors: A toxic gas detector will be provided for ammonia.

k, l. Self-contained breathing apparatus availability and bottled air supply: Five self-contained breathing apparatus are available in the control room, each with a 20-minute air supply. A manifolded bottled air system is currently being installed. The system is capable of supplying air to four people for 8 hours or five people for 6-1/2 hours.

m. Emergency food and potable water supply: The control room area contains food provisions sufficient to supply at least five people for a week. Adequate water is also available near the control room.

n. Control room personnel capacity: During normal operation, the control room will contain five people. [illegible] emergency conditions, the personnel capacity will be limited to five people by the bottled air system capabilities.

o. Potassium iodide supply: A supply of potassium iodide is available in the plant.

3 Onsite Storage of Chlorine and Other Hazardous Chemicals

Refer to Table C-1 of Appendix C for this information.

4 Offsite Manufacturing, Storage, or Transportation Facilities of Hazardous Chemicals

Refer to Tables C-2 through C-5 of Appendix C for this information.

5 Technical Specifications

a. Chlorine detection system: Because no chlorine detection system exists at the present time, no technical specification has been written for it. The technical specification will be reviewed and revised, as necessary, to address the proposed modifications.

b. Control room emergency filtration system: Because no control room emergency filtration system exists at the present time, no technical specification has been written for it. The technical specifications will be reviewed and revised, as necessary, to address the proposed modifications.

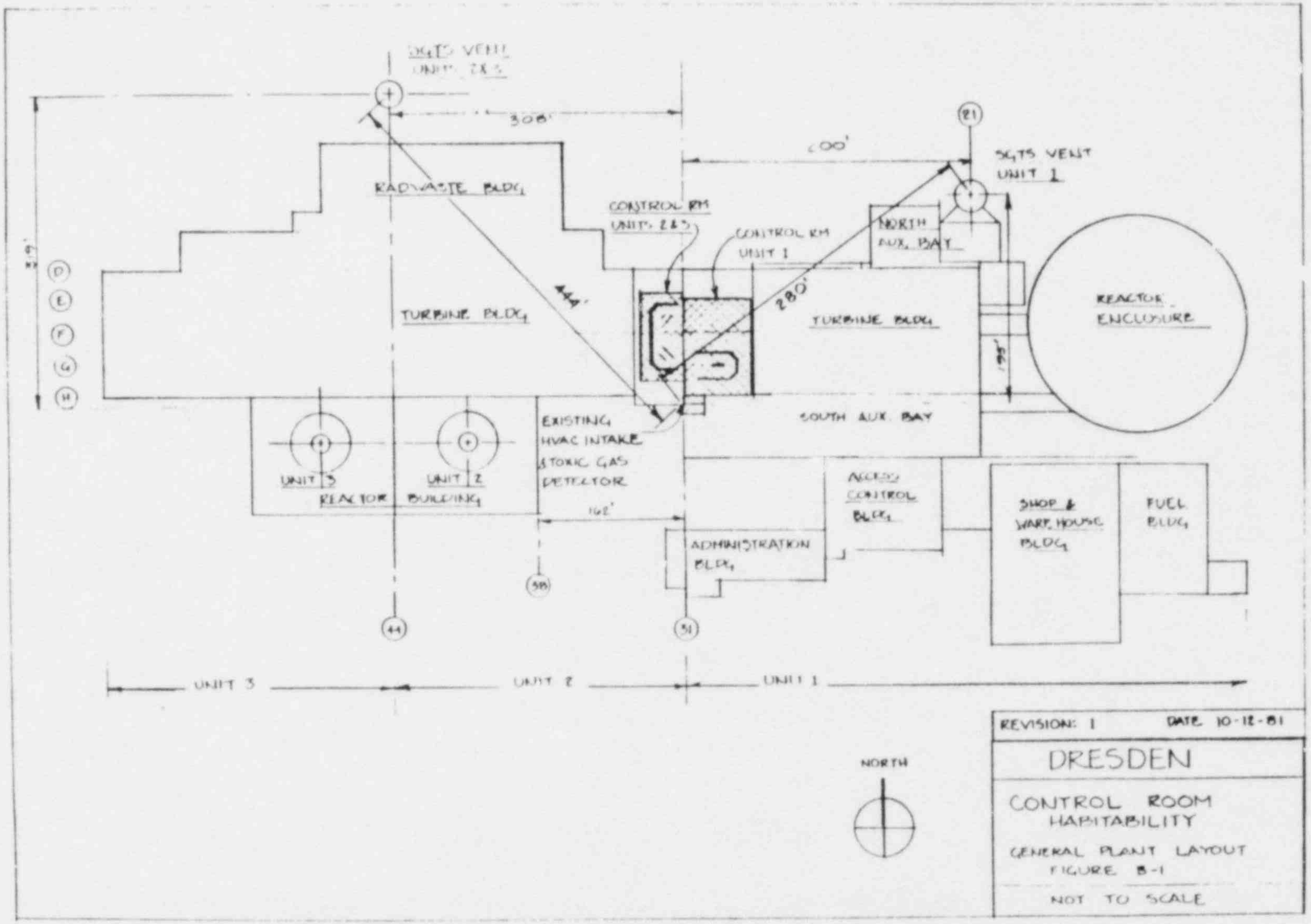

SGTS VENT UNITS 2&3
308'
600'
SGTS VENT UNIT 1
81
RADWASTE BLDG
CONTROL RM UNITS 2&3
CONTROL RM UNIT 1
NORTH AUX. BAY
TURBINE BLDG
444'
280'
TURBINE BLDG
REACTOR ENCLOSURE
SOUTH AUX. BAY
EXISTING HVAC INTAKE & TOXIC GAS DETECTOR
UNIT 3
UNIT 2
REACTOR BUILDING
162'
ACCESS CONTROL BLDG
SHOP & WARE HOUSE BLDG
FUEL BLDG
ADMINISTRATION BLDG
D
E
F
G
H
38
44
51
UNIT 3
UNIT 2
UNIT 1
NORTH
REVISION: 1
DATE 10-12-81
DRESDEN
CONTROL ROOM HABITABILITY
GENERAL PLANT LAYOUT FIGURE B-1
NOT TO SCALE

TABLE C-1

POTENTIALLY TOXIC CHEMICALS STORED WITHIN THE DRESDEN SITE BOUNDARY

Chemical	Quantity[1]	Location
Ammonium nitrate	2,000 gal.	Decontamination area
Caustic soda	4,200 gal.	Turbine building (D1)
Carbon dioxide	7.5 tons	Turbine building (D3)
Carbon dioxide	4 tons	Behind laundry (D1)
Halon 1301	400 ft^3	Turbine building (D2)
Hydrogen	35,000 scf	Between discharge canal and filter building
Hydrogen	130,000 cu ft at 2,640 psi	Same as above, only in truck
Nitrogen liquid	8,000 gal.	Between reactor building Unit 3 and records storage building
Nitrogen, liquid	500,400 cu ft at 15 psi	Same as above, only in truck
Polyacrylic acid	6,000 gal.	In building near crib house (D1)
Sodium hydroxide	10,000 gal.	Turbine building (D3)
Sodium hydroxide	500 gal.	Radwaste building
Sodium hydroxide	250 gal.	Turbine building (D2)
Sodium hydroxide	250 gal.	Turbine building (D3)
Sodium hydroxide	3,600 gal.	In truck next to above tanks of sodium hydroxide
Sodium hypochlorite	36,000 gal.	Underground
Sodium hypochlorite	4,000 gal.	In truck next to tank above
Sulfuric acid	5,000 gal.	Turbine building (D1)
Sulfuric acid	5,000 gal.	Outside turbine building (D3)
Sulfuric acid	500 gal.	Radwaste building
Sulfuric acid	250 gal.	Turbine building (D2)
Sulfuric acid	250 gal.	Turbine building (D3)

(1) Wherever multiple containers of the same chemical are stored in close proximity, the quantity of the largest container is provided.

TABLE C-2

POTENTIALLY TOXIC CHEMICALS STORED AT FIXED FACILITIES WITHIN A 5-MILE RADIUS OF DRESDEN[1]

Facility[2]	Distance (miles)	Chemical	Quantity[3,5]
Airco	2.40	Carbon dioxide (pipeline)	24/.4
	2.40	Carbon dioxide	50 gal.
	2.40	Chlorithane	500 tons at 200 psi
Alumax-Mill	2.85	Argon, liquid	600,000 ft^3 [4]
	2.85	Chlorine	1 ton
	2.85	Nitrogen, liquid	73,000 ft^3
A.P. Green Refractory	1.95	Monoaluminum phosphate	1,500 gal.
		35% phosphoric acid (technical grade)	3,200 gal.
		Propane	5,000 gal.
Armak	3.70	Acrylonitrile	210,000 lb
	3.70	Anhydrous ammonia	150,000 lb
	3.70	Fatty amines	750,000 lb
	3.70	Formaldehyde	110,000 lb
	3.70	Hydrogen	110 ft^3
	3.70	Isopropol alcohol	136,000 lb
	3.70	Methyl chloride	200,000 lb
	3.70	Nitrogen, liquid	1,200 scr
	3.70	Quaternery chlorides	180,000 lb
	3.70	Natural gas (pipeline)	6[5]
	3.70	Nitrogen (compressed) (pipeline)	3[5]
	3.70	Hydrogen (pipeline)	6[5]
Bols farm	0.85	Anhydrous ammonia	2 tons
Cardox	3.50	Carbon dioxide	400 tons
	2.45	Carbon dioxide (pipeline)	12/2.5[5]
	3.50	Carbon dioxide (pipeline)	20/0.4[5]

Table C-2 (continued)

Facility[2]	Distance (miles)	Chemical	Quantity[3,5]
Collins Station	4.95	Argon	300 ft^3 [4]
	4.95	Ammonium hydroxide	6,000 gal.
	4.95	Carbon dioxide	50 ton
	4.95	Helium	224 ft^3 [4]
	4.95	Nitrogen	224 ft^3 [4]
	4.95	Propane, liquid	100 lb[4]
	4.95	Sodium hydroxide	15,000 gal.
	4.95	Sodium hypochloride	3,000 gal.
	4.95	Sulfuric acid	15,000 gal.
Durkee Foods	3.15	Nitrogen	800,000 ft^3
	3.15	Hydrogen	1,750,000 ft^3
	3.15	Sodium hydroxide	250,000 lb
	3.15	Sulfuric acid	200,000 lb
	3.15	Anhydrous ammonia	10,000 lb
	3.15	Gasoline	500 gal.
	3.15	No. 6 fuel oil	60,000 gal.
	3.15	Therminol 66	60,000 gal.
	3.15	Chlorine	
Dolinger farm	1.50	Anhydrous ammonia	2 tons
Dow Chemical		No information was provided	
Dravo-Mechling	4.25	Uran	1,000,000 gal.
Exxon Chemical Americas Exxon Company, USA		No information was provided	
General Electric	0.60	Nitric acid (62%)	5,350 gal.
	0.60	Sodium hydroxide (50%)	5,920 gal.
Hydrocarbon Transport (pipeline)	2.00	Butane	6[5]
	4.00	Butane	10[5]
	4.00	Butane	10[5]
	4.00	Ethane	10[5]
	2.00	Isobutane	6[5]
	4.00	Isobutane	10[5]
	4.00	Isobutane	10[5]
	4.00	Natural gas	10[5]
	4.00	Natural gas	10[5]
	2.00	Propane	6[5]
	4.00	Propane	10[5]
	4.00	Propane	10[5]

Table C-2 (continued)

Facility[2]	Distance (miles)	Chemical	Quantity[3,5]
Minooka wastewater treatment	4.65	Chlorine	150 lb
Midwestern Gas Transmission (pipeline)	4.00	Natural gas	30
Mobil Chemical		No information was provided	
Mobil Oil		No information was provided	
Natural Gas Pipeline (pipeline)	1.40	Natural gas	30
	1.10	Natural gas	36
Northern Illinois Gas Company	2.45	Diethanol amine	55 gal.
	2.45	Diethylene glycol	5,500 gal.
	2.45	Hydrogen	8,000 ft^3
	3.70	Hydrogen (pipeline)	6[5]
	3.70	Natural gas (pipeline)	6[5]
	3.70	Nitrogen, compressed (pipeline)	3[5]
	2.45	Nitrogen, liquid	8,900 gal.
	2.45	Metyl alcohol	10,000 gal.
	2.45	Petroleum naphtha	160,000 barrels
	2.45	Potassium nitrate	80 lb
	2.45	50% sodium hydroxide	6,600 gal.
	2.45	Sodium hypochlorite	55 gal.
	2.45	93% sulfuric acid	6,600 gal.
Northern Petrochemical		No information was provided	
Reichhold Chemical		No information was provided	
Shady Oaks Trailer Park Waste Water Facility	4.90	Chlorine	150 lb

(1) Includes pipelines.
(2) This list includes only those facilities with potentially toxic chemicals, or those from which no information was received.
(3) Wherever multiple containers of the same chemical are stored at the same facility, the quantity of the largest container is provided.
(4) Standard type gas bottles
(5) Quantities for pipelines are expressed as pipe diameter (inches)

TABLE C-3

POTENTIALLY TOXIC CHEMICALS TRANSPORTED ON BARGES WITHIN A 5-MILE RADIUS OF DRESDEN[1]

Chemical Category[2]	Yearly Shipment (tons)
Alcohols	335,612
Basic chemicals	1,730,666
Nitrogenous fertilizers	720,819
Other fertilizers	403,482
Sodium hydroxide	293,228

(1) Data are based on barge traffic along the Illinois River from the mouth of the Illinois River to Lockport, Illinois, 0.35 mile from the Dresden site. The source of the information is Waterborne Commerce of the U.S., U.S. Army Corps of Engineers, 1978 (latest edition).

(2) The chemical categories listed above are those which were determined to pass by the Dresden site with a minimum frequency of 50 times per year. Shipment frequencies were calculated using a 2,500-ton barge capacity.

TABLE C-4

POTENTIALLY TOXIC CHEMICALS TRANSPORTED ON RAILROADS WITHIN A 5-MILE RADIUS OF DRESDEN[1]

Railroad	Distance (miles)	Chemical	Quantity of Individual Container (tons)
Atcheson, Topeka, and Santa Fe	4.00	No information was provided	
Baltimore and Ohio	3.70	No information was provided	
Elgin, Joliet, and Eastern	2.45	Anhydrous ammonia	81
	2.45	Carbon dioxide	79
	2.45	Ethylene	84
	2.45	Ethylene oxide	89
	2.45	Hydrochloric (muriatic) acid	97
	2.45	Liquified petroleum gas	75
	2.45	Vinyl acetate	96
	1.45	Alkaline corrosive liquid	76
	1.45	Resin solution	94
	1.45	Styrene monomer, inhibited	98

Table C-4 (continued)

Railroad	Distance (miles)	Chemical	Quantity of Individual Container
Illinois Gulf Central	4.00	Acrylonitrile	20,600 gal.
		Alkanesulfonic acid	20,000 gal.
		Butane	33,000 gal.(2)
		Butyl acetate	20,000 gal.
		Butyl alcohol	20,000 gal.
		Chlorine	33,000 gal.(2)
		Denatured alcohol	20,000 gal.
		Ethylene oxide	20,000 gal.
		Formaldehyde	20,000 gal.
		Heptane	20,000 gal.
		Hexane	20,000 gal.
		Hydrochloric acid	20,000 gal.
		Isobutane	33,000 gal.(2)
		Liquified petroleum gas	33,000 gal.(2)
		Petroleum naptha	20,000 gal.
		Potassium hydroxide	20,000 gal.
		Propylene oxide	20,000 gal.
		Sodium hydroxide	20,000 gal.
		Sulfuric acid	20,000 gal.
		Toluene	20,000 gal.
Transported on the Elgin, Joliet, and Eastern by Armack	1.44	Acrylonitrile	140,000 lb
		Anhydrous ammonia	165,000 lb
		Fatty amines	140,000 lb
		Formaldehyde	140,000 lb
		Methyl chloride	120,000 lb

(1) The chemicals listed above pass by the Dresden site with a minimum frequency of 30 times per year.

(2) This is the amount of gas in liquid gallons.

TABLE C-5

POTENTIALLY TOXIC CHEMICALS TRANSPORTED ON HIGHWAYS WITHIN A 5-MILE RADIUS OF DRESDEN[1]

Highway	Distance (miles)[2]	Chemical	Quantity[3]
Collins Road	1.95	Monoaluminum phosphate	13,333 lb
		85% phosphoric acid	26,667 lb
Durkee Foods	4.00	Nitrogen	40,000 lb
		Hydrogen	10,000 lb
		Sodium hydroxide	45,000 lb
		Sulfuric acid	45,000 lb
		Anhydrous ammonia	4,000 lb
		Gasoline	5,500 lb
		No. 6 fuel oil	45,000 lb
		Therminol 66	36,000
		Chlorine	2,250
Lorenzo Road	3.00	Ammonium hydroxide	3,000 gal.
		Argon	224 ft^3 (4)
		Carbon dioxide	36,000 lb
		Nitrogen	224 ft^3
		Propane	100 lb (4)
		Sodium hydroxide	3,500 gal.
		Sodium hypochloride	3,000 gal.
		Sulfuric acid	3,000 gal.
State Route 6	2.00	Argon	450,000 ft^3 (5)
		Anhydrous ammonia	40,000 lb
		Carbon dioxide	17 tons
		Fatty amines	45,000 lb
		Formaldehyde	46,000 lb
		Hydrogen	8,000 ft^3
		Isopropol alcohol	41,000 lb
		Nitrogen	600,000 ft^3
		Quaternery chlorides	46,000 lb
		Sodium hydroxide	48,000 lb
		50% sodium hydroxide	3,500 gal.
		93% sulfuric acid	3,500 gal.

(1) The chemicals listed above pass by the Dresden site with a minimum frequency of 10 times per year. Refer to Section 3 of this report for further discussion of this subject.
(2) Closest potential approach of the transport vehicle to the Dresden site on a given highway.
(3) Wherever multiple container sizes of the same chemical are transported on a given highway, the quantity of the largest container is provided.
(4) Standard type gas bottles
(5) This is the volume of gas each liquid would have at standard temperature and pressure.

TABLE C-6

REFERENCES

1. Waterborne Commerce of the United States, 1978, U.S. Army Corps of Engineers

2. Telephone conversation between B. Burdick and R. MacLauchlin, U.S. Army Corps of Engineers, 9/14/81 (3320)

3. Telephone conversation between B. Burdick and K. Salo, Dow Chemical, 9/30/81 (3478)

4. Telephone conversation between D. Semon and J. Labeda, Liquid Air Corporation of North America, 9/9/81 (3297)

5. Telephone conversation between D. Semon and J. Quinn, Fisher-Kalow, 9/18/81 (3405)

6. Telephone conversation between D. Semon and R. Wawrznyiak, Alexander Chemical, 9/18/81 (3404)

7. Telephone conversation between D. Semon and P. Hackett, Liquid Air Corporation of America, 9/25/81 (3399)

8. Telephone conversation between D. Semon and C. Desanty, Airco, 7/22/81, 8/24/81 (3022, 3223)

9. Letter from Alumax, 8/11/81 (3153)

10. Telephone conversation between D. Semon and W. Burch, Alumax, 8/18/81 (3184)

11. Letter from A.P. Green Refractory, 8/31/81 (3263)

12. Telephone conversation between D. Semon and B. Gielisk, A.P. Green Refractory, 10/5/81 (3524)

13. Letter from Armack, 8/31/81 (3254)

14. Telephone conversation between D. Semon and K. Brandmire, Armack, 10/12/81 (3519)

15. Telephone conversation between D. Semon and L. Bols, farm, 7/21/81 (3012)

16. Telephone conversation between D. Semon and W. Carmack, Cardox, 7/22/81, 8/24/81, 9/21/81 (3023, 3222, 3367)

17. Telephone conversation between D. Semon and R. Wine, Collins Station, 7/15/81, 7/20/81 (2980, 3015)

18. Telephone conversation between D. Semon and R. Still, Collins Station, 7/20/81 (3014)

19. Telephone conversation between D. Semon and J. Dollinger, farm, 7/22/81 (3021)

20. Telephone conversation between B. Burdick and P. Ottison, Dravo-Mechling, 9/21/81 (3357)

21. Telephone conversation between B. Burdick and R. Cardillo, Exxon Chemical Americas, 9/24/81 (3386)

22. Letter from General Electric, 8/17/81 (3189)

23. Telephone conversation between D. Semon and D. Stuman, Hydrocarbon Transport, 8/24/81, 9/28/81 (3225, 3441)

24. Telephone conversation between D. Semon and M. Young, Mid-America Pipeline, 8/10/81, 9/14/81, 10/2/81 (3124, 3346, 3518)

25. Telephone conversation between D. Semon and D. McCoy, Minooka Wastewater Facility, 7/13/81 (2966)

26. Telephone conversation between D. Semon and C. Cassidy, Midwestern Gas Transmission, 8/24/81, 9/28/81 (3221, 3442)

27. Letter from Midwestern Gas Transmission, 8/25/81 (3237)

28. Letter from Mobil Chemical, 9/22/81 (3393)

29. Letter from Natural Gas Pipeline Company of America, 9/11/81 (3353)

30. Letter from Northern Illinois Gas, 9/2/81 (3325)

31. Telephone conversation between D. Semon and E. Gruber, Northern Illinois Gas, 10/5/81 (3521)

32. Telephone conversation between D. Semon and C. Hendrickson, Northern Illinois Gas, 10/5/81 (3522)

33. Telephone conversation between B. Burdick and J. Basil, Reichhold Chemical, 9/8/81 (3280)

34. Letter from Elgin, Joliet, and Eastern Railway, 8/21/81 (3214)

35. Telephone conversation between D. Semon and T. Bray, Elgin, Joliet, and Eastern Railway, 9/25/81 (3403)

36. Telephone conversation between B. Burdick and T. Bray, Elgin, Joliet, and Eastern Railway, 9/25/81 (3396)

37. Letter from Illinois Central Gulf Railroad, 8/17/81 (3262)

38. Telephone conversation between M. Dunn and C. Bossard, Illinois Central Gulf Railroad, 10/2/81 (3443)

39. Telephone conversation between D. Semon and J. Mendalbaum, U.S. Interstate Commerce Commission, 8/19/81 (3188)

40. Telephone conversation between B. Burdick and J. Nalevanko, Materials Transportation Bureau, Department of Transportation, 8/12/81 (3151)

41. Telephone conversation between D. Semon and R. Powell, Shady Oaks Park, 7/14/81 (2963)

42. Telephone conversation between D. Semon and R. Kraus, Union Carbide, 8/18/81, 10/5/81 (3185, 3523)

43. Telephone conversation between D. Semon and L. Rapp, Bob Rapp's Dock, 7/15/81 (2972)

44. Telephone conversation between B. Burdick and R. Craig, Baltimore and Ohio Railroad, 8/17/81, 9/1/81 (3179, 3248)

45. Telephone conversation between B. Burdick and W. Brodsky, Atcheson, Topeka, and Santa Fe Railroad, 9/8/81 (3274)

46. Telephone conversation between D. Semon and G. Wimberly, Durkee Foods, 10/26/81 (3527)

47. Letter from Mobil Oil Corporation, 8/21/81 (3199)

48. Letter from Northern Petrochemical Company, 8/19/81 (3201)

49. Telephone conversation between B. Burdick and D. Harmer, Dow Chemical, 9/18/81 (3359)

50. Telephone conversation between D. Semon and John Gann, Calgon, 11/13/81 (3609)

APPENDIX D

RADIOLOGICAL ANALYSIS

FOR

CONTROL ROOM HABITABILITY

FOLLOWING A DBA-LOCA

A. INTRODUCTION

The following analysis was performed in accordance with the guidance of NUREG 0737, Item III.D.3.4 to determine compliance with the radiological requirements of General Design Criterion 19 and Standard Review Plan (SRP) 6.4. The loss-of-coolant accident (LOCA) was considered in the analysis to be the radiological design basis accident (DBA). Furthermore, main steam isolation valve (MSIV) leakage at the technical specification limit was assumed for the analysis.

The results of this analysis are considered conservative. Several natural mechanisms will reduce or delay the radioactivity prior to release to the environment. However, credit was taken only for iodine plateout on surfaces of the steam lines and condenser and radioactive decay prior to release. These mechanisms are discussed in Section E.

B. METHODOLOGY

The guidelines given in SRP 6.4 (Reference 1) and Regulatory Guide 1.3 (Reference 2) have been used with the exception of the X/Q for the control room and plateout of iodines during transportation within pipes. Realistically, the components of main steam lines and the turbine-condenser complex, though nonsafety grade, would remain intact following a DBA-LOCA. Therefore, plateout of iodines on surfaces of main steam lines and the turbine-condenser complex is expected. Atmospheric dispersion factors are based on the Halitsky Methodology from Meteorology and Atomic Energy 1968, as discussed in Section D.

C. ASSUMPTIONS AND BASES

Regulatory Guide 1.3 has been used to determine activity levels in the containment following a DBA-LOCA. Activity releases are based on a containment leakage rate of 1.6% per day. Table D-1 lists the assumptions and parameters used in the analysis and dose point locations. The majority of the containment leakage will be collected in the reactor building and exhausted to the atmosphere through the 99% efficient SGTS filters as an elevated release from the main stack. However, there are certain release pathways from the containment which will bypass the SGTS filters. The bypass leakage has been quantified by assuming that all MSIVs leak at the technical specification limit of 11.5 scfh per main steam line. Based on this assumption, a total leakage for all steam lines together would be 46 scfh (0.7667 scfm).

Radioactivity leaking past the isolation valves could be released through the outboard MSIV stems into the steam tunnel, or continue down the steam lines to the stop valves and into the turbine-condenser complex. Leakage into the steam tunnel is exhausted by the SGTS filtration system, thus eliminating it as a bypass pathway. Leakage down the steam lines is subject to plateout and delay within the lines. Reference 3, Section 5.1.2 discusses iodine removal rates which can be applied to calculate plateout on the piping and turbine condenser surfaces. Elemental and particulate iodine decontamination factors of over 100 can be calculated for small travel distances and large travel times down the steam lines, considering the small volumes of leakage which leak past the valves.

The credit for plateout and holdup within steam lines and the turbine-condenser complex has been taken by dividing them into three different volumes. The first volume consists of steam lines between the inboard and outboard isolation valves, the second volume consists of steam lines between the outboard isolation valves and the turbine stop valves, and the third volume includes the steam lines after the turbine stop valves and the turbine-condenser volume complex. Conservatively, failure of an inboard isolation valve in one main steam line has been considered. The activity leaking from the primary containment travels through, and mixes well within, each volume prior to release to the environment from the turbine-condenser complex. The removal rate for iodine due to plateout within each volume is based on the estimated surface area and the methodology given in Reference 3, Section 5.1.2. These removal rates are only applied to elemental and particulate iodines. The removal of organic iodine through plateout is not considered. It was assumed that the bypass leakage is collected in the steam line turbine-condenser volume complex from which it will leak at 1% of the turbine-condenser volume per day. This leak rate is consistent with the assumptions used for the control rod drop accident in SRP 15.4.9 (Reference 4). This assumption is conservative, because the volumetric leakage out of the condenser would be approximately the same as the inleakage and the 1% leak rate per day out of the turbine-condenser volume is higher than the leak rate into the steam lines from the drywell. Furthermore, the bypass leakage will be cooling and condensing as it travels down the lines.

Leakage within the turbine building would be exhausted by the heating, ventilating, and air conditioning (HVAC) system if it were working. Additional plateout on ductwork, fans, and unit coolers would further minimize the iodine releases. Should the HVAC system not be working, then any bypass leakage would tend to collect in the building and be subject to additional decay and plateout. Leakage from the turbine building into the control room is minimized by the separate HVAC systems and by maintaining the interconnecting doors in their normally closed positions.

The control room pressurization system ensures that leakage is from the protected area towards the other parts of the building, further minimizing the possibility of contaminating the protected areas. A positive pressure is maintained in the main control room by introducing 2,000 cfm of outside air through a 99% efficient filtration system.

The activity which enters the main control room may be the result of bypass leakage, standby gas treatment system (SGTS) exhaust in the outside air, or both, depending on wind direction. Because of the locations of these sources with respect to the control room HVAC intake, it is possible for the intake to be exposed to activity from both sources at the same time. Because the SGTS exhaust is elevated, the concentrations from this source at the intake will be less than those due to bypass leakage. This analysis conservatively assumes that the activity concentration at the intake is due to concurrent bypass leakage and chimney releases for the duration of the event.

D. ATMOSPHERIC DISPERSION FACTOR (X/Q)

The following discussion is an explanation of the reasons for the use of the Halitsky X/Q methodology and a value of $K_c = 2$, instead of the Murphy methodology (Reference 5) which SRP 6.4 suggests as an interim position.

Historically, the preliminary work on building wake X/Q's was based on a series of wind tunnel tests by J. Halitsky, et al. Halitsky summarized these results in Meteorology and Atomic Energy in 1968 (Reference 6). In 1974, K. Murphy and K. Campe of the NRC published their paper based on a survey of existing data. This X/Q methodology, which presented equations without derivation or justification, was adopted as the interim methodology in SRP 6.4 in 1975. Since then, a series of actual building wake X/Q measurements have been conducted at Rancho-Seco (Reference 7) and several other papers have been published documenting the results of additional wind tunnel tests.

In Reference 5, Murphy suggested the following equation for the calculation of X/Q

$$X/Q = K_c/AU$$

where

$K_c = K + 2$

$K = 3/(S/d)^{1.4}$

A = Cross-sectional area of the building

U = Wind speed

This formulation was derived from the Halitsky data in Figure 37 of Reference 5 from Murphy's paper. The Halitsky data were from wind tunnel tests on a model of the EBR-II rounded (PWR type) containment and the validity of the data was limited to $0.5<s/d<3$ (Reference 6, Section 5.5.5.2). The origin and reason for the +2 in K + 2 is not known. All other formulations use K only, and for the situation where K is less than 1, the use of K + 2 imposes an unrealistic limit on the X/Q.

For the Dresden plant, the building complex is composed of square-edged buildings and not a round-topped cylindrical containment as was used in the Halitsky experiments. For an HVAC intake located near the south wall of the control building at elevation 549'-0", the intake will be subject to a building wake caused by a combination of the reactor building and the turbine building for any bypass leakage escaping from the turbine building. There will be no reactor building bypass leakage because the building is kept at a negative pressure by the SGTS which exhausts to the main chimney.

Because the Murphy methodology could not be applied, a survey of the literature was undertaken. It was found that the Halitsky wind tunnel test data (Reference 6, Section 5.5.5) conservatively overestimated K_c values "by factors of up to possibly 10." Given this conservatism, it was felt that the use of a reasonable K_c value from the Halitsky data on square-edged buildings should be acceptable. A review of Figure 5.27 from M&AE (Reference 6) resulted in K_c values in the 0.5 to 2 range. A value of $K_c = 2$ was chosen to get a X/Q for the control room. A building cross-sectional area of 1,550 m^2 was conservatively used. This corresponds to a projected area of one reactor building above grade. The use of a 1,550 m^2 area is very conservative because both the reactor buildings are adjacent to each other and the combined projected area would be larger than the value used. Information from other sources, as indicated below, has also shown that this should be a conservative value.

1. In a paper by D.H. Walker (Reference 8), control room X/Q's were experimentally determined for floating power plants in wind tunnel tests. Different intake and exhaust combinations were considered. Using the data for intake 6 and stack A exhaust (Reference 8), X/Q values of 1.77×10^{-5} and 2.24×10^{-5} were found after adjusting the wind speed from 1.5 m/sec to 1 m/sec. These values are approximately two order-of-magnitudes lower than the conservatively calculated value for Dresden.

2. In a wind tunnel test by P.N. Hatcher (Reference 9), a model industrial complex was used to test dispersions due to a wake. Data obtained from these tests show that K_c has a value less than 1, and decreases as the test points are moved closer to the structure. In a study to determine optimum stack heights, R.N. Meroney and B.T. Yang (Reference 10) show that for short stacks (6/5 of building height), K_c reaches a value of approximately 0.2 and decreases closer to the building. They concluded that the Halitsky methodology was "overly conservative." These recent experimental tests show that $K_c = 2$ used to determine the X/Q for Dresden is a conservative estimate by at least a factor of 2 and possibly by 10 or more.

3. Field tests were made on the Rancho-Seco facility (Reference 7), and X/Q values were obtained. The data indicate that the use of $K_c = 2$ is conservative.

It was concluded that sufficient data and field tests exist to give a reasonable assurance that the chosen X/Q is a conservative one, over and above the conservatism implied by using the fifth percentile wind speed and wind direction factors. Based on the above discussion, the following equation is used in the calculation of X/Q values.

$$X/Q = 2/AU$$

E. MECHANISMS FOR REDUCING IODINE RELEASES

The following mechanisms could result in significant quantities of iodine being removed before they are released to the environment. However, numerical credit for the plateout mechanisms is the only credit taken in the calculation of radiological consequences.

1. DRYWELL SPRAYS, SUPPRESSION POOL TO AIR PARTITIONING, AND CONDENSATION EFFECTS

Though manually operated, the drywell sprays will reduce the iodine source term if actuated. Even without the spray system, condensation will occur in the drywell and suppression chamber.

The iodines in the air and suppression pool are expected to reach equilibrium due to this phenomenon. Because the iodines have a preference to stay in water due to the equilibrium partition factor of over 400 established by the physical conditions in the containment, the iodines available for release by air leakage will be reduced significantly. In addition, recent investigations after TMI (NSAC-14, Workshop on Iodine Releases in Reactor Accidents) have indicated that the iodine release assumption may be excessively conservative. Most of the iodine may be released as cesium iodide instead of elemental iodine. The cesium iodide has a much higher solubility and ability to plateout than elemental iodine.

2. PLATEOUT

Although there is an implied factor of 2 iodine plateout in Regulatory Guide 1.3 source term, experimental evidence and the experience at TMI indicates that significantly larger plateout factors are common. The plateout removal constant used in this analysis is based on the lowest deposition velocity quoted in Reference 3. The other data quoted in Reference 7 indicate that the deposition velocities could be higher by a factor of 4, which would tend to increase the plateout.

3. REMOVAL THROUGH VALVES AND LEAKAGE HOLES

Because the bypass leakage paths are through minute holes in valves and valve seats, the leakage will be subjected to filtration effects. Larger particulates could tend to plug the leak paths (Reference 11).

4. CONDENSATE WITHIN PIPES

Condensation will occur within the pipes when the pipes cool down to ambient temperature. This could result in removal of iodines and particulates from the gas phase.

F. RESULTS

The calculated radiation doses are given in Table D-2 and are found to be within the guidelines of General Design Criterion 19 and SRP 6.4.

REFERENCES

1. Standard Review Plan 6.4, Habitability Systems, Rev 1

2. Regulatory Guide 1.3, Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling Water Reactors, Rev 2, June 1974

3. NUREG/CR-009, "Technilogical Basis for Models of Spray Washout of Airborne Contaminants in Containment Vessels," A.K. Posta, R.R. Sherry, P.S. Tam, October 1978

4. Standard Review Plan 15.4.9, Spectrum of Rod Drop Accidents (BWR), Rev 1

5. 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

6. D.H. Slade, ed., Meteorology and Atomic Energy, TID 24190 (1968)

7. G.E. Start, J.H. Cate, C.R. Dickson, N.R. Ricks, G.H. Ackerman, and J.F. Sagendorf, "Rancho-Seco Building Wake Effects on Atmospheric Diffusion," NOAA Technical Memorandum, ERL ARL-69 (1977)

8. D.H. Walker, R.N. Nassano, M.A. Capo, 1976, "Control Room Ventilation Intake Selection for the Floating Nuclear Power Plant," 14th ERDA Air Cleaning Conference

9. R.N. Hatcher, R.N. Meroney, J.A. Peterka, and K. Kothari, 1978, "Dispersion in the Wake of a Model Industrial Complex," NUREG 0373

10. R.N. Meroney and B.T. Yang, 1971, "Wind Tunnel Study on Gaseous Mixing Due to Various Stack Heights and Injection Rates Above an Isolated Structure," FDDL Report CER 71-72RNM-BTY16, Colorado State University

11. H.A. Morewitz, R.P. Johnson, C.T. Nelson, E.V. Vaughan, C.A. Guderjahn, R.K. Hillard, J.D. McCormack, and A.K. Posta, "Attenuation of Airborne Debris from Liquid-Metal Fast Breeder Reactor Accident," Nuclear Technology, Volume 46, December 1979

TABLE D-1

LOSS-OF-COOLANT ACCIDENT
PARAMETERS TABULATED FOR POSTULATED ACCIDENT ANALYSES

	Design Basis Assumptions	
I. Data and Assumptions Used to Estimate Radioactive Source from Postulated Accidents		
A. Power level, MWt	2,527	
B. Burnup	NA	
C. Fission products released from fuel (fuel damaged)	100%	
D. Iodine fractions		
Organic	0.04	
Elemental	0.91	
Particulate	0.05	
II. Data and Assumptions Used to Estimate Activity Released		
A. Primary containment leak rate, %/day	1.6	
B. Volume of primary containment, cu ft	2.75E+5	
C. Secondary containment release rate, %/day	100	
D. Leak rate through MSIV, scfh	11.5	
E. Number of main steam lines	4	
F. Leak rate from turbine condenser complex, %/day	1.0	
G. Volume and surface area (all four steam lines)	Ft^3	Ft^2
Between inboard and outboard MSIV	176	470
Outboard and turbine stop valves	761	1,693
Turbine condenser complex	1.7E+5	6.5E+5
H. Deposition velocity for iodines, cm/sec		
Particulate	0.012	
Elemental	0.012	
Organic	0.0	
I. Valve movement times	(See Note)	
J. SGTS adsorption and filtration efficiencies, %		
Organic iodines	99	
Elemental iodine	99	
Particulate iodine	99	

Table D-1 (continued)

		Design Basis Assumptions	
III.	**Dispersion Data, sec/m^3**		
A.	Control room wake X/Q for time intervals of	Bypass Leak	SGTS (Chimney)
	0 to 2 hours	1.29E-3	7.0E-4*
	2 to 8 hours	1.29E-3	6.45E-6
	8 to 24 hours	7.61E-4	3.81E-6
	1 to 4 days	4.84E-4	2.42E-6
	4 to 30 days	2.13E-4	1.07E-6

*0 to 2 hour fumigation conditions assumed according to Regulatory Guide 1.3

		Design Basis Assumptions
IV.	**Data for Control Room**	
A.	Volume of control room, ft^3	1.04E+5
B.	Filtered intake, cfm	2,000
C.	Efficiency of charcoal adsorber, %	99
D.	Efficiency of HEPA, %	99.9
E.	Unfiltered inleakage, cfm	10
F.	Recirculation flowrate	0.0
G.	Occupancy factors:	
	0 to 1 day	1.0
	1 to 4 days	0.6
	4 to 30 days	0.4

Note: The MSIV movement times are not applicable to the analysis because the valves will close before any significant fuel failures occur. The control room HVAC intake valve movement times are not applicable because the calculated doses assume an unfiltered outside air intake of 2,000 cfm for the first 8 hours post-LOCA.

TABLE D-2

DBA-LOCA RADIOLOGICAL CONSEQUENCES

CONTROL ROOM	Doses (Rem) Thyroid	Skin	Whole-Body
1. Bypass Leakage			
a. Activity inside control room	3.04	4.77E-1	1.55E-2
b. Plume shine	--	--	2.03E-3
c. Direct shine	--	--	1.01E-1
2. Stack Release			
a. Activity inside control room	1.20E+1	2.35	1.75E-1
b. Plume shine	--	--	1.98E-2
TOTAL CONTROL ROOM DOSES	1.50E+1	2.82	3.16E-1

Note: The values provided above represent 30-day integrated doses. The doses are calculated assuming an unfiltered outside air intake of 2,000 cfm for the first 8 hours post-LOCA. At 8 hours, the control room operators are assumed to remote manually activate the charcoal filtration unit.