NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
THE HARTFORD ELECTRIC LIGHT COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

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July 1, 1981

Docket Nos. 50-213
50-245
50-336
A01379

RECEIVED
JUL 13 1981
U.S. NUCLEAR REGULATORY COMMISSION

Mr. Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

References:
(1) D. G. Eisenhut letter to All Operating Plants and Applicants for Operating Licenses and Holders of Construction Permits, dated October 31, 1980; forwarding NUREG-0737.
(2) W. G. Counsil letter to D. G. Eisenhut, dated December 15, 1980.
(3) W. G. Counsil letter to D. G. Eisenhut, dated December 81, 1980.
(4) W. G. Counsil letter to D. G. Eisenhut, dated July 1, 1981. (Docket No. 50-213)
(5) W. G. Counsil letter to D. G. Eisenhut, dated July 1, 1981. (Docket No. 50-336)
(6) W. G. Counsil letter to D. G. Eisenhut, dated May 20, 1981.
(7) W. G. Counsil letter to H. R. Denton, dated December 31, 1979.
(8) D. M. Crutchfield letter to W. G. Counsil, dated May 7, 1980.
(9) W. G. Counsil letter to D. G. Eisenhut, dated June 4, 1981.
(10) T. J. Dente letter to D. G. Eisenhut, dated July 1, 1981.
(11) W. G. Counsil letter to D. G. Eisenhut, dated June 10, 1980.
(12) W. G. Counsil letter to D. G. Eisenhut, dated October 31, 1980.
(13) D. B. Waters letter to D. G. Eisenhut, dated May 22, 1981.
(14) W. G. Counsil letter to R. A. Clark, dated March 18, 1981.

Gentlemen:

Haddam Neck Plant
Millstone Nuclear Power Station, Unit Nos. 1 and 2
Post TMI Requirements - Response to NUREG-0737

Drawings To:
Reg File - 1cy
BC - 5cys
Aperture Card Dist

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Via Reference (1), the NRC Staff identified those items in the TMI Action Plan, NUREG-0660, which have been approved by the Commission for implementation. Most of the items in NUREG-0737 have previously been addressed in References (2) and (3); however, a number of these items require submittal of additional information at this time. Accordingly, Connecticut Yankee Atomic Power Company (CYAPCO), on behalf of the Haddam Neck Plant, and Northeast Nuclear Energy Company (NNECO), on behalf of Millstone Unit Nos. 1 and 2, are docketing this submittal in response to the Reference (1) request. Enclosures 1, 2, and 3, for the Haddam Neck Plant and Millstone Unit Nos. 1 and 2, respectively, address those items which require a submittal at this time. Also included with each enclosure is an index identifying the items addressed in this document.

The only item requiring a submittal which is not addressed in the Enclosures to this letter is Item II.B.1, Reactor Coolant System Vents. References (4) and (5) provide the information required for this Action Plan Item for the Haddam Neck Plant and Millstone Unit No. 2, respectively. Therefore, this item is not addressed by this submittal.

We trust you will find this information responsive to the Reference (1) request.

Very truly yours,

CONNECTICUT YANKEE ATOMIC POWER COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

W. G. Counsil

W. G. Counsil
Senior Vice President

Docket No. 50-213

Enclosure 1

Haddam Neck Plant

Post TMI Requirements - Response to NUREG-0737

July, 1981

Docket No. 50-213

Haddam Neck Plant

Index

Item No.	Description
II.D.1	Relief and Safety Valve Testing
II.E.4.1	Dedicated Hydrogen Penetrations
II.E.4.2	Containment Isolation Dependability
II.F.1.3	Containment Hi-Range Radiation Monitor
II.K.3.1	Auto PORV Isolation
II.K.3.5	Auto Trip of RCP's
III.D.3.4	Control Room Habitability

II.D.1 Relief and Safety Valve Testing

By letter dated July 1, 1981, R. C. Youngdahl transmitted the Interim Data Report for the EPRI PWR Safety and Relief Valve Test Program. This report summarizes the test data collected to date on relief and safety valves. The Haddam Neck Plant has Copes Vulcan Globe D-100-160 with Stellite plug relief valves and Crosby HB-BP-86 safety valves. Relief and safety valves representative of the above valves are being tested in the EPRI program. CYAPCO will submit evaluations and other plant specific data on a schedule consistent with the R. C. Youngdahl letter of December 15, 1980 and modified on July 1, 1981.

II.E.4.1 Dedicated Hydrogen Penetrations

Item II.E.4.1 of Reference (1) requires that plants using external recombiners or purge systems for combustible gas control of the containment atmosphere should provide containment penetration systems for external recombiner or purge systems that are dedicated to the service only, that meet the redundancy and single failure requirements of GDC 54 and 56, and that are sized to satisfy the flow requirements of the system.

The systems used for combustible gas control at the Haddam Neck Plant were discussed in Reference (7). In Reference (8), the Staff concluded that the systems described in Reference (7) meet the requirements for dedicated penetrations, and are acceptable.

II.E.4.2 Containment Isolation Dependability

Position 7 of Item II.E.4.2 of Reference (1) requires that containment purge and vent valves automatically close on a high radiation signal.

The Haddam Neck Plant uses a purge and vent system to reduce airborne activity prior to commencement of refueling or other shutdown operation. Normal Operating Procedure NOP 2-13-5 requires that the 42-inch purge valves and the 8-inch purge bypass valves be closed before containment integrity can be established. These valves are not opened during any operational modes, as the Haddam Neck Plant Technical Specifications require that containment integrity be maintained during operational modes. There is a 3/4-inch line which may be used to vent the containment during operation to prevent pressure increases inside containment from exceeding the Limiting Condition for Operation. Since the Haddam Neck Plant is a four-loop plant which is licensed for three-loop operations, there have been times when work has been performed on the isolated loop inside containment during operation.

The use of the breathing air system increases the internal containment pressure, and the 3/4-inch vent line may be used to relieve this pressure. The flow rate for this line is about 10 SCFM. This line automatically isolates on receipt of a High Containment Pressure signal. This vent line has been used on less than five occasions in over 12 years of operation.

Since both the 42-inch and 8-inch purge valves are closed during operation and since the 3/4 inch vent line is rarely used, the requirement to close these valves on receipt of a high radiation signal is unnecessary. As such, no modification is planned. This position has been previously documented in Reference (6).

II.F.1.3 Containment Hi-Range Radiation Monitor

Item II.F.1.3 of Reference (1) states that "in-situ calibration by electronic signal substitution is acceptable for all range decades above 10 R/hr. In-situ calibration for at least one decade below 10 R/hr shall be means of calibrated radiation source."

In-situ calibration by electronic signal substitution at the detector is not feasible or necessary for the following reasons:

1. Cable connections to detectors in containment are environmentally sealed and are not designed to be disassembled on a regular basis.

2. The required in-situ calibration for one decade below 10 R/hr by means of a calibrated radiation source will serve to functionally check the detector and the cables from the detectors to the indicating modules in the control room.

For the above reasons, CYAPCO intends to perform calibration by electronic signal substitution of the indicating modules in the instrument calibration facility rather than in-situ.

II.K.3.1 Auto PORV Isolation

As required by Item II.K.3.2 of Reference (1), a study was undertaken to determine the need for an automatic PORV isolation system at the Haddam Neck Plant; Via Reference (9), CYAPCO informed the Staff that the study performed by the Westinghouse Owners Group was applicable to the Haddam Neck Plant and constituted CYAPCO's response to Item II.K.3.2. As stated in Reference (9), CYAPCO has reviewed the study and concurs in the conclusions of the study in that an automatic PORV isolation system is not necessary to ensure safe operation of the Haddam Neck Plant. As such, no further work on Item II.K.3.1 is planned.

II.K.3.5. Auto Trip of RCP's

Implementation of this requirement has been deferred pending issuance of further Staff requirements. As such, no information is provided here.

HADDAM NECK PLANT

CONTROL ROOM HABITABILITY STUDY

1.0 INTRODUCTION

The purpose of this submittal is to satisfy the requirements delineated in Action Item III.D.3.4 of NUREG-0737, Control Room Habitability. The specific references and sources of information employed in this evaluation will be identified in the context of the evaluation.

2.0 EVALUATION

2.1 Information Required for Control Room Habitability Evaluation

Attachment 1 provides the information required to be submitted for independent evaluation.

2.2 Toxic Gas/Chemical Analysis

2.2.1 On-Site Chemical Storage

A complete review of the Haddam Neck site was performed to determine the types and quantities of chemicals considered to be hazardous in accordance with Regulatory Guides 1.78 and 1.95. Table 1 provides a complete listing of the various hazardous chemicals stored at the site, along with quantities and storage locations.

In accordance with the guidance provided by Regulatory Guides 1.78 and 1.95, and the methodology delineated in NUREG-0570, it was determined that the only chemical stored on site that has the potential to adversely affect control room personnel is sulfuric acid.

Attachment 2 and its associated appendix (Appendix 1 to Attachment 2) provides a detailed review of the potential accidents on-site involving these chemicals along with a summary of the results of this review.

2.2.2 Off-Site Manufacturing and Storage of Hazardous Chemicals

A review of the surrounding areas was performed. Based upon this review, no significant manufacturing or storage facilities of hazardous chemicals have been identified within a five (5) mile radius of the Haddam Neck Plant.

2.2.3 Transportation of Hazardous Chemicals

In the vicinity of the Haddam Neck Plant barge traffic on the Connecticut River and truck transportation on State Route 9, which is the major highway in this area, represent the modes of transportation that require consideration in the hazardous chemical evaluation.

The hazardous materials transported on State Route 9 are primarily gasoline, fuel oil, and propane. Considering State Route 9 is located at a distance of four (4) miles from the Haddam Neck Plant, that the maximum quantity normally transported by truck is 8,000 gallons and that all trucking of hazardous chemicals is done in accordance with state and federal "DOT" requirements, only the explosion of propane in transit on State Route 9 is considered to have the potential to adversely affect control room personnel.

Attachment 2 provides a detailed review of potential explosions of propane on State Route 9 in the vicinity of the Haddam Neck Plant.

The hazardous materials shipped in the vicinity of the Haddam Neck Plant on the Connecticut River are also primarily gasoline and fuel oil, to tank farms located in Portland, Wethersfield, Hartford, and East Hartford, Connecticut. Gasoline or fuel oil on the Connecticut River are not considered to represent a toxic gas or explosion hazard to control room personnel.

2.3 Radiological Accident

Attachment 3 provides a complete radiological evaluation of the Haddam Neck control room.

3.0 CONCLUSIONS

3.1.1 Toxic Chemicals

As a result of the information presented in this review, no hazard to control room personnel has been identified from on-site or off-site storage and transportation of hazardous chemicals; therefore, no modifications to the Haddam Neck control room will be required in this area.

3.1.2 Radiological Accident

Based upon the analysis of Attachment 3, modifications to the control room will be required to reduce control room operator doses to levels set forth in GDC 19 and SRP 6.4. These modifications include installation of filtration system and reducing unfiltered control room in-leakage. Figure IV provides a preliminary schematic of the proposed modifications.

3.2 Installation Schedule

NUREG-0737 requires an inservice date of January 1, 1983 for all control room modifications. A review of the necessary equipment lead times along with coincident plant refueling outages required to complete these modifications for the Haddam Neck Plant indicates that the implementation date of NUREG-0737 is not practicable. It is Connecticut Yankee Atomic Power Company's current intention to complete implementation by January 1, 1984.

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.

   The control room ventilation system is a recirculation type. In the event of a loss of coolant accident, the control room inlet and exhaust damper close and the control room ventilation fan trips, thus isolating the control room. No automatic isolation capability is included in the control ventilation system for a toxic gas release.

2. Control Room Characteristics:

   (a) Control Room Air Volume:

   This volume will be defined as all areas presently included in the control room ventilation system.

   Haddam Neck Control Room Air Volume: 71,800 ft^3

   (b) Control Room Emergency Zone:

   The below-listed areas are those presently included in the control room ventilation system.

   1. Control Room
   2. Observation Room
   3. Toilet
   4. Kitchen
   5. Computer Room
   6. Operating Engineers Office
   7. Central Alarm Station

   (c) Control Room Ventilation System Schematic:

   The attached drawing, labeled Figure I, is a schematic of the Haddam Neck control room ventilation system.

(d) Infiltration Leakage Rate:

The infiltration leakage rate based upon both testing and calculation is estimated at 296 cfm.

(e) High Efficiency Particulate Air (HEPA) Filter and Charcoal Absorber Efficiencies:

The Haddam Neck control room ventilation system does not contain HEPA or charcoal filters.

(f) Closest Distance Between Containment and Air Intake:

Closest Distance = 70'

(g) Layout of Control Room, Air Intakes, Containment Building, and Chlorine, or Other Chemical Storage Facilities with Dimensions:

The attached drawing, labeled Figure II, provides a layout of the Haddam Neck site identifying the location of the air intake, containment building, sulfuric acid tank with associated dimensions.

The attached drawing, labeled Figure III, provides a layout of the Haddam Neck control room with associated dimensions.

(h) Control Room Shielding Including Radiation From Air Leakage From Penetrations, Doors, Ducts, Stairways, Etc.:

A control room shielding analysis is provided as Appendix 1 to this Attachment.

(i) Automatic Isolation Capability - Damper Closing Time Damper Leakage and Area:

Upon receiving a 4 psig containment pressure signal, the intake and exhaust dampers close and supply fan trip automatically.

Damper Closing Time:	7 seconds
Intake Damper Leakage:	20 cfm (calculated)
Intake Damper Area:	8 ft^2

(j) Chlorine or Toxic Gas (Local or Remote):

The Haddam Neck control room does not contain either local or remote toxic gas detectors.

(k) Self-Contained Breathing Apparatus Availability (Number):

The control room contains five (5) self-contained air packs with additional air bottles as well as self-contained air packs available at various designated sites in the plant.

(l) Bottled Air Supply (Hours):

The Haddam Neck control room contains eight (8) "J" size bottles at 300 ft^3 each. This volume will provide approximately a 26-hour supply for one person.

(m) Emergency Food and Potable Water Supply:

Normally sufficient food and water is maintained in the control room to support five (5) people for a period of five (5) days.

(n) Control Room Personnel Capacity (Normal and Emergency):
A normal shift consists of 7 individuals. During an emergency, an average of 10 with a maximum of up to 20 can be expected.

(o) Potassium Iodide Drug Supply:

A supply of 1,000 pills is maintained on site.

3. On-Site Storage of Chlorine and Other Hazardous Chemicals

(a) Total amount and size of container:

Table 1 (attached) provides a complete listing of all identified hazardous chemicals stored on site.

(b) Closest distance from control room air intake:

No chemicals have been identified as having the potential to adversely affect control room personnel.

4. Off-Site Manufacturing Storage or Transportation Facilities of Hazardous Chemicals

(a) Identify facilities within a five-mile radius:

No facilities within a five-mile radius have been identified.

(b) Distance from Control Room:

Since no facilities have been identified, this item is not applicable to the Haddam Neck Plant.

(c) Quantity of Hazardous Chemicals in One Container:

Since no facilities have been identified, this is not applicable to the Haddam Neck Plant.

(d) Frequency of Hazardous Chemical Transportation Traffic (Truck, Rail, and Barge):

This item was discussed in the preceding section.

5. Technical Specifications:

(a) Chlorine Detection System:

The Haddam Neck Plant does not utilize chlorine; therefore, this is not applicable.

(b) Control Room Emergency Filtration System Including the Capability to Maintain the Control Room Pressurization at 1/8" Water Gauge
Verification of Isolation by Test Signals and Damper Closure Times and Filter Testing Requirements:

The Haddam Neck Plant has no technical specifications applicable to control room ventilation systems.

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	HADDAM NECK PLANT	
CHEMICAL	QUANTITY	LOCATION
1. Sulfuric Acid	1500 gals	Acid storage tank; elevation 21'6" turbine building.
2. Sodium Hydroxide 50% by Weight	1500 gals	Elevation 21'6" turbine building.
3. Chloroethane	Negligible	N/A
4. Unisol	N/A	N/A
5. Hydrazine 35% by Weight (non-flammable)	Three 55 gal drums	Two in warehouse; one near acid storage tank; elevation 21'6" turbine building.

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	HADDAM NECK PLANT	
CHEMICAL	QUANTITY	LOCATION
6. Penetone Products	Penetone Products 28-55 gal drums	North side of warehouse outside of protected area.
7. Penetone Formula 2101	N/A	N/A
8. Ammonia 30% by Weight	Negligible	N/A
9. Acetone	Negligible	N/A
10. Nitrogen (Liquid)	Two 160 liter cylinders	East of machine shop in outside storage building.
11. Hydrogen	13,125 scf/month	Southeast corner of site.
12. Acetaldehyde	N/A	N/A
13. Acrylonitrile	N/A	N/A

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

CHEMICAL	HADDAM NECK PLANT	
	QUANTITY	LOCATION
14. Anhydrous Ammonia	N/A	N/A
15. Aniline	N/A	N/A
16. Benzene	N/A	N/A
17. Butadiene	N/A	N/A
18. Butenes	N/A	N/A
19. Carbon Monoxide	Negligible	N/A
20. Chlorine	N/A	N/A
21. Sodium Hypochlorite NaOCl 12½% by Weight	30,000 gals	Screenwall house.
22. Ethyl Chloride	N/A	N/A
23. Ethyl Ether	N/A	N/A
24. Ethylene Dichloride	N/A	N/A

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	HADDAM NECK PLANT	
CHEMICAL	QUANTITY	LOCATION
25. Ethylene Oxide	N/A	N/A
26. Fluorine	N/A	N/A
27. Formaldehyde	N/A	N/A
28. Helium	Ten 213 ft^3 bottles	Just west of reactor building.
29. Hydrogen Cyanide	N/A	N/A
30. Hydrogen Sulfide	N/A	N/A
31. Methanol	15 gals	Five in chemistry lab. Ten in warehouse.
32. Sodium Oxide	N/A	N/A
33. Sulfur Dioxide	N/A	N/A
34. Vinyl Chloride	N/A	N/A

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	HADDAM NECK PLANT	
CHEMICAL	QUANTITY	LOCATION
35. Xylene	Negligible	N/A
36. Phosphoric Acid 60% by Weight	N/A	N/A
37. Ureaformaldehyde	N/A	N/A
38. Halon	Seven 322 # bottles	Switchgear.
	One 40# bottle	Records storage area.
39. Carbon Dioxide - CO_2	38-100# bottles	Cable vault.
	12-100# bottles	PAB charcoal filters.
	12-65# bottles	Turbine building.
	74-65# bottles	East of machine shop in outside storage building.

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	HADDAM NECK PLANT	
CHEMICAL	QUANTITY	LOCATION
39. CONTINUED		
40. Nitrogen (Gas)	32-300 scf bottles	East of machine shop in outside storage building.
41. Argon (Gas)	Nine 300 scf bottles	East of primary access building outside.
42. Dimethyl-Amine	Five 300 scf bottles	East of machine shop in outside storage building.
43. Sulfur Hexafluoride	Three 300 scf bottles	East of machine shop in outside storage building.

APPENDIX 1 TO ATTACHMENT 1

CONTROL ROOM SHIELDING ANALYSIS

A. Location and Description

The Haddam Neck control room is located in the northeast corner of the turbine building on the 59'6" level. The control room's southeast corner is 125 feet west and 22.5 feet north of the containment center. The thickness of the floors, ceiling, and walls is given in the Table of Assumptions for the Haddam Neck Plant.

B. Criteria

All source terms are consistent with NUREG 0588, and include: 100% of the core noble gas inventory and 50% of the core inventory of iodines in the containment air; 50% of the core iodines and 1% of the core solid fission product inventory in the water sources. Specific source strengths are from TID-14884.

C. Methodology

Three sources of radiation were considered in determining the CY control room dose. They are:

1. Direct shine from the containment;
2. Immersion dose from airborne activity concentrations outside the control room;
3. Sky shine dose from the containment.

The direct shine dose contribution was computed using the QAD-P5F point kernel computer code. The containment source was broken up into five source regions. Four regions modeled the containment free air volume and one region was used to model plate-out. Each volume region was modeled by 27,000 source points and the plate-out source by 13,500 source points. The entire containment source was modeled by 121,500 source points distributed into an eight energy gamma spectrum. A concrete density of 2.24 gm/cm^3 was assumed for the containment as well as for the control room shielding. The ground below grade (21') was also assumed to have a 2.24 gm/cm^3 density. The density of air was assumed to be .0012 gm/cm^3. The immersion dose from airborne activity concentration outside of the control room was calculated using a combination of the TACT-III (Reference 2) and QAD-P5F computer codes. The total 30 day integrated whole body dose, unreduced by shielding, was obtained using the TACT-III computer code. The TACT-III computer code uses a semi-infinite cloud dose model to compute the unshielded dose, so a shielding factor was defined using the QAD-P5F computer code. The shielding factor was obtained by dividing the unreduced semi-infinite cloud dose rate at time $t = 0$ by the highest shielded dose rate within the control room at $t = 0$. Since the gamma spectrum would soften over time due to decay of the high energy gamma emitters, this shielding factor is very conservative.

There are nine pentrations in the Central Alarm Station (CAS). These are 4 inch circular holes which allow access for computer cabling. The streaming due to these penetrations has been taken into account in the calculation of the immersion dose.

The sky shine contribution at this distance from the containment has been shown to be negligible compared to the direct shine contribution.

D. Results

CONTROL ROOM

INTEGRATED 30-DAY WHOLE BODY DOSES, REM

HADDAM NECK

Source	Dose
Direct Shine	0.093
Immersion	0.531
Sky Shine	Negligible
Total	0.624

E. Conclusions

The analysis of the Haddam Neck control room shielding shows that the 30-day whole body dose for the control room is 0.624 rem. This was calculated using very conservative methods and assumptions; therefore, this dose is expected to be an upper bound on the dose to the control room after any incident.

It should be recongized that the total whole body dose cannot be determined until the final design details of the ventilation systems are complete and the dose from airborne sources within the control room are calculated, however, the doses computed here from sources outside the control room are well within the guidelines of General Design Criteria 19 of Appendix A to 10CFR, part 50 and are therefore acceptable.

HADDAM NECK PLANT - DBA ASSUMPTIONS

ASSUMPTION	BASIS
1. Power Level = 1825 MWt	Tech Specs.
2. Core Inventory	TID-14844
3. Core Release Fractions: 50% of equilibrium iodine activity 100% of equilibrium noble gas activity	NUREG-0588
4. Iodine Form: 91% elemental 5% particulate 4% organic	Reg. Guide 1.4
5. Containment Air Recirculation Flow Rate	Tech. Specs. = 50,000 cfm
6. Containment Air Recirculation Unit Filter Efficiencies: 95% particulate 99% elemental 30% organic	D. C. Switzer letter to D. L. Ziemann dated March 21, 1978
7. Fan Operability: fan at t = 0 min. 2 fans at t = 14 mins.	D. C. Switzer letter to D. L. Ziemann dated March 21, 1978
8. Containment Leak Rate: .18%/day ≤ 24 hours .09%/day > 24 hours	Tech Specs.
9. X/Q's at control room: (0-8) hr = 5.85×10^{-3} sec/m^3 (8-24) hr = 4.11×10^{-4} sec/m^3 (24-96) hr = 1.52×10^{-4} sec/m^3 (96-720) hr = 4.09×10^{-5} sec/m^3	D. C. Switzer letter to D. L. Ziemann dated March 21, 1978
10. Containment Volume = 2.23×10^{6} ft^3	FDSA
11. RHR System Leakage = 3 liters/hr.	Tech. Specs.
12. RHR System Imitation Time = 15 min. post LOCA	
13. RHR System Dilution = 148,000 gallons	FDSA
14. Containment Shielding Dimensions: Walls = 4.5 feet Crane Wall = 3 feet Dome = 2.5 feet	FDSA
15. Control Room Shielding: North and East Walls = 20 inches South, West, and interior walls = 16 inches Floor = 14 inches Ceiling = 22 inches	FDSA
16. Shortest distance to containment surface: = 57 feet	FDSA

ATTACHMENT 2

HADDAM NECK PLANT
HAZARDOUS CHEMICAL/MATERIAL ANALYSIS

1.0 EVALUATION OF POTENTIAL ACCIDENTS

In this attachment the potential effects of accidental releases of hazardous materials identified as having the potential to effect control room habitability are briefly discussed and summarized. These effects are calculated in accordance with NRC guidelines. The potential accidents stem from possible explosions from flammable materials or toxic clouds of materials that may be accidently released outside of the control room.

The approach and specific procedures for the various calculations are contained in Appendix 1 to this attachment.

1.1 Potential for Explosions

Gaseous propane is a flammable material which has an explosive potential. An accidental release of propane will form a cloud that can drift toward a plant and explode, provided its concentration is within the flammability limits.

Propane is a commodity which is commonly transported on highways in the vicinity of the Haddam Neck Plant. As previously indicated, the major highway in the area of the Haddam Neck Plant is approximately four (4) miles from the site. Considering the guidelines provided in Regulatory Guide 1.91, and above the distance, transportation of propane will not pose a problem to the Haddam Neck Plant.

1.2 Toxic Chemicals -- On Site

As previously discussed in Section 2.2.1 of this submittal, the only chemical stored on site at the Haddam Neck Plant that has been identified as having the potential for adversely affecting control room personnel is sulfuric acid.

1.2.1 Sulfuric Acid

Sulfuric acid is stored on site at the Haddam Neck Plant. The table below shows the amount stored and distance to the control room intake plenum.

Amount	Distance to Control Room Intake Plenum
1500 gal	287 ft. (87.5 m)

Concentration levels calculated at the control room intake were based on the following general conditions:

total tank failure; ambient temperature - 38°C
continuous release of material; worst-case meteorological conditions; spill radius - 13.4 m.

Because of the low volatility of sulfuric acid the calculated concentration is very low. The concentration would be 2.1×10^{-5}mg/m^3.

This is considerably below the H_2SO_4 toxicity limit of 2 mg/m^3 (Regulatory Guide 1.78). Therefore, failure of H_2SO_4 storage tank at the Haddam Neck Plant site poses no threat to control room personnel.

2.0 METHODOLOGY FOR H_2SO_4

2.1 Sulfuric Acid

Because sulfuric acid (98% concentration) is relatively nonvolatile, no flashing into an H_2SO_4 cloud was assumed. Therefore, Equation 1 did not apply. Equation 3 was used to calculate vapor pressure: an ambient temperature of 311°K and pure H_2SO_4 was assumed (rather than 98% aqueous) to assure conservatism of the approximateion. Equation 4 was used to calculate the H_2SO_4 evaporation rate, which provides the source emission rate for Equation 2. The evaporation computations were based on the following calculated inputs: spill area, vapor pressure, and equivalent dike diameter. The Hd term was calculated for laminar flow. Ambient temperature and wind speed were assumed to be 38°C andlm/sec. The spill area was calculated, since there is no diking at the Haddam Neck Plant. The calculational method was based on a procedure contained in NUREG 0570 which assumes a spill thickness of one (1) cm when the ground conditions are such that the use of Equation 5 is precluded. On this basis, the area of the spill was calculated as 567.8 m^2. This resulted in an initial H_2SO_4 plume width (yo) of 5.54 meters. The evaporation rate was calculated as .3311 ug/sec and the calculated concentration, 21×10^{-6} mg/m^3 at the Haddam Neck Plant air intake.

APPENDIX 1 TO ATTACHMENT 2

APPROACHES AND SPECIFIC PROCEDURES FOR CALCULATING AFFECTS FROM ACCIDENTAL RELEASES OF SULFURIC ACID, AMMONIA, AND CHLORINE

1.0 APPLICABLE EQUATIONS

A number of equations are applicable for calculating the effects of the above materials. All those used in this analysis are summarized in NUREG 0570, and are presented below.

- Gaussian Puff Equation

$$\chi(x, y, z, h) = \frac{Q}{(2\pi)^{3/4}\sigma_{XI}\ \sigma_{YI}\ \sigma_{ZI}} \cdot \exp\left\{-\frac{1}{2}\left[\frac{x^2}{\sigma_{XI}^2} + \frac{y^2}{\sigma_{YI}^2}\right]\right\}$$

$$\cdot \left\{\exp\left[-\frac{1}{2}\ \frac{(z-h)^2}{\sigma_{ZI}^2}\right] + \exp\left[-\frac{1}{2}\ \frac{(z+h)^2}{\sigma_{ZI}^2}\right]\right\} \qquad ①$$

Where χ = concentration (g/m^3)

Q = source strength (g) = m_{vo}

$\sigma_{XI}, \sigma_{YI}, \sigma_{ZI}$ = adjusted standard deviations of the puff concentration in the horizontal along-wind (X), horizontal cross-wind (Y), and vertical cross-wind directions (Z), respectively (m).

x, y, z = distances from the puff center in the X, Y, and Z directions, respectively (m). z is also the effective above-ground elevation of the receptor, e.g., the fresh-air intake of a control room.

h = effective above-ground elevation of the source.

To account for the initial volume of the puff, it is assumed that:

$$\sigma_{XI}^2 = \sigma'^2_{XI} + \sigma_o^2$$

$$\sigma_{YI}^2 = \sigma'^2_{YI} + \sigma_o^2$$

$$\sigma_{ZI}^2 = \sigma'^2_{ZI} + \sigma_o^2$$

$$\sigma_{XI}^2 = \sigma_{YI}^2$$

and letting $x = x_o - ut$

$$\sigma_o = \left[m_{vo}/(2^{1/2}\, \pi^{3/2}\, \rho_v)\right]^{1/3}$$

where

σ_o = initial standard deviation of the puff (m)

σ'_{XI}, σ'_{YI}, σ'_{ZI} = standard deviation of puff concentration in the X, Y and Z directions, respectively (m)

m_{vo} = mass of the instantaneously released puff (g)

ρ_v = density of the puff (g/m^3)

x_o = ground distance between the source of spill and receptor (m)

u = wind speed (m/sec)

t = time after release (sec)

- Gaussian Plume Equation

$$\chi(x,y,z,h) = \frac{Q'}{2\pi u\sigma_Y \quad \sigma_Z} \exp\{(-\frac{y^2}{2\sigma_y^2})\}\{\exp[-\frac{(z-h)^2}{2\sigma_Z 2}] + \exp[-\frac{(z+h)^2}{2\sigma_Z 2}]\}\} \quad ②$$

where

σ_Y, σ_Z = standard deviations of the plume concentration in the Y and Z directions, respectively (m)

Q' = continuous source strength (g/sec)

y is also modified to account for initial plume size as is done in Equation 1.

- Equation for Obtaining Vapor Pressure

(Handbook of Chemistry and Physics)

$$\text{Log } P = (-0.2185\ A/K) + B \qquad (3)$$

where:

P = vapor pressure (mm Hg)

K = temperature (°K)

A = molar heat of vaporization (cal per gram-male)

B = constant of integration

Values of A and B are given in the above reference.

• Calculation of Evaporation Rates

$$(dm_v/dt) = h_d \, M \, \text{[illegible]} \, (P_s - P_a)/R_g \, (T_a + 273) \qquad (4)$$

where, for a laminar flow

$$h_d = 0.664 \, \frac{D}{L} \, (Re)^{1/2} \, (Sc)^{1/3}$$

and for a turbulent flow

$$h_d = 0.037 \, \frac{D}{L} \, (Re)^{0.8} \, (Sc)^{1/3}$$

Re = Reynold number = $L \, u \, \rho/\mu$

Sc = Schmidt number = $\mu/D\rho$

L = characteristic length (cm)

μ = viscosity of air (g/cm sec)

M = molecular weight of the liquid (g/mole)

P_s = saturation vapor pressure of the liquid at temperature Ta (mm Hg)

P_a = actual vapor pressure of the liquid in air (mm Hg)

h_d = mass transfer coefficient (cm/sec)

R_g = universal gas constant

D = diffusion coefficient (cm^2/sec)

u = wind speed (cm/sec)

ρ = density of air (g/cm^3)

• Calculation of Spill Size

$$A(t) = \pi \{ r_o^2 + 2t [\frac{gV_o}{\pi} \frac{(\rho_\ell - \rho)}{\rho_\ell}]^{1/2} \} \quad (5)$$

and $V_o = \pi r_o^3$

where

r_o = initial radius of the spill (cm)

g = gravitational constant = 981 (cm/sec^2)

V_o = volume of the spill (cm^3)

ρ_ℓ = density of the liquid or gas (g/cm^3)

ρ = density of air (g/cm^3)

t = time (sec)

• Calculation of Concentration at Air Intake and Within Control Room

The concentration, Co, at the outside air intake at time t_i is:

$$C_o(t_i) = m_{v,\,puff}(\chi/Q)_{t_i} + (dm_v/dt)_{t_i,\,plume}(\chi/Q') \quad (6)$$

The concentration build-up inside control room C_r in g/m^3, at time t_i is:

$$C_r(t_i) = C_r(t_{i-1}) + [C_o(t_i) - C_r(t_{i-1})]\,[1 - \exp(-WT/V_r)] \quad (7)$$

where $T = t_i - t_{i-1}$

W = air flow rate in control room (m^3/sec)

V_r = control room air space (m^3)

T = time duration (sec)

ATTACHMENT 3

HADDAM NECK PLANT CONTROL ROOM

RADIOLOGICAL EVALUATION

I. General

A radiological analysis is given below based on the conceptual ventilation system design described in section 3.

II. Methodology

A. Activity

The dose analysis was based on the actual amount of activity which enters the control room via supply fans, doors and other inleakage paths. Filtration of iodine by the control room ventilation system was factored in the calculation. The activity distribution model is based on the following assumptions:

1. activity entering the control room is instantaneously mixed in the control room volume.
2. airflow into the control room = airflow out of the control room.
3. activity is instantaneously transported to the control room air intake immediately after release from the control volume.

The rate of change of activity in the control room is based on the following production and loss equation:

$$\begin{pmatrix}\text{rate of change}\\ \text{of activity in}\\ \text{control room}\end{pmatrix} = \begin{pmatrix}\text{rate at which}\\ \text{activity is}\\ \text{input}\end{pmatrix} - \begin{pmatrix}\text{rate at which}\\ \text{activity is}\\ \text{removed}\end{pmatrix}$$

The differential-equation which describe the time dependent change of activity is:

$$\frac{dA_{cr}(t)}{dt} = C_{At}(t) \times TR_I - (\lambda_{di} + \lambda_{c_{2i}} + \lambda_{L_2})A_{cr}(t) \qquad (1)$$

where: $\frac{dA_{cr}(t)}{dt}$ = rate of change of activity in the control room with respect to time

$C_{At}(t)$ = concentration of activity (Ci/m^3) in the atmosphere outside the control room at time = t

TR_I = rate at which air is being admitted into the control room (m^3/hr).

λ_{d_i} = decay constant for isotope i (1/hr)

λc_{2i} = internal control room removal constant by internal recirculated flow thru filters (1/hr) for isotope i.

λ_{L_2} = removal rate by outleakage from control room (1/hr)

$A_{cr}(t)$ = activity (Ci) in the control room at time = t

The equation which expresses the activity outside the control room from containment or RHR leakage is:

$$C_{at}(t) = \lambda_{L_{1j}} A_i(0)\ X/Q_j e^{-(\lambda_{d_i} + \lambda_{c_{1_{ij}}} + \lambda_{L_{1j}})t} \qquad (2)$$

where: $\lambda_{L_{1j}}$ = containment leakrate or RHR leakage (1/HR) during time step j.

$A_i(0)$ = initial activity of isotope in the containment atmosphere or RHR system.

X/Q_j = atmospheric dispersion coefficient during time period j.

$\lambda_{c1_{ij}}$ = removal coefficient for containment air recirculation fans for isotope i and time period j for containment release

= 0.0 for RHR system

After substituting equation 2 into equation 1 and integrating equation 1, we obtain:

$$A_{cr}(t) = \frac{\lambda_{L_{1j}} A_i(0)\ X/Q_j\ TR_j e^{(\lambda_{di} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}}{\lambda_{c_{1_{ij}}} + \lambda_{L_{ij}} - \lambda_{c_{2_{ij}}} - \lambda_{L_{2_j}}}$$

$$\times (1-e)^{-(\lambda_{c_{1_{ij}}} + \lambda_{L_j} - \lambda_{c_2} - \lambda_{L_{2_j}})t} + A_{cr}(0)e^{-(\lambda_{di} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}$$

where: all parameters are as defined previously.

The integrated activity (Ci - Hrs) can be obtained by integrating the above equation with respect to time.

$$A_{I_{cr}}(t) = \int_0^t A_{cr}(t)\,dt$$

$$A_{I_{cr}}(t) = \frac{\lambda_{L_{1j}} A_i(0)\ X/Q_j\ TR._j}{(\lambda_{c1_{ij}} + \lambda_{L_{ij}} - \lambda_{c_{2_{ij}}} - \lambda_{L_{2_j}})} \left[- \frac{e^{-(\lambda_{di} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}}{(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})} \right.$$

$$+ \frac{e^{-(\lambda_{c_{1_{ij}}} + \lambda_{L_{1j}} + \lambda_{d_i})t}}{(\lambda_{c_{1_{ij}}} + \lambda_{L_{1_j}} + \lambda_{d_i})} + \frac{1}{(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})}$$

$$- \left. \frac{1}{(\lambda_{c_{1_{ij}}} + \lambda_{L_{ij}} + \lambda_{d_i})} \right] + \frac{A_{cr}(0)(1-e)^{-(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}}{(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})}$$

B. Dose Calculation

1. General

The dose calculation was based on 18 isotopes, 5 of which were iodines and 13 noble gas. Activity levels were based on equilibrium core levels and were obtained using the methodology employed in TID-14844. Thyroid, whole body, and skin dose conversion factors were obtained from Regulatory Guide 1.109, Revision 1.

2. Thyroid

The thyroid dose was computed using the following equation:

$$D_{thy} = \sum_{j=1}^{n} \frac{BR}{V} \sum_{i=1}^{n} IA_{cr_{ij}}(t) \times DCF_i$$

where: BR = breathing rate = 3.47×10^{-4} in^3/sec

DCF_i = adult thyroid dose conversion factor for isotope i (rem/Ci inhaled)

V = control room volume (m^3)

$IA_{cr_{ij}}(t)$ = integrated activity (Ci-Hrs) from isotope i during time period j.

3. **Whole Body**

The whole body dose was based on activity concentrations which exist in the control room. A semi-infinite cloud dose was obtained using the dose conversion factors from Regulatory Guide 1.109, Revision 1. Since the control room personnel are in a less than infinite cloud source, a correction factor was based on assuming an average gamma energy of .77 MeV for noble gas at t = 0 after the accident. The correction factor was determined using the following equation:

$$PF = \frac{D\gamma_{\infty}}{D\gamma_R} = \frac{\int_0^{\pi 2}\int_0^{\frac{\pi}{2}}\int_0^{\infty} \frac{S_v e^{-\mu R}}{4\pi R^2}\, B(\mu R)\, DCF\, R^2\, dR\, \sin\phi\, d\phi\, d\theta}{\int_0^{2\pi}\int_0^{\frac{\pi}{2}}\int_0^{R} \frac{S_v e^{-\mu R}}{4\mu R^2}\, B(\mu R)\, DCF \mu R^2\, dR\, \sin\phi\, d\phi\, d\theta}$$

where: S_v = volume source (MeV/cm^3-sec)

μ = attenuation coefficient for air

R = distance from dose point to incremental volume dV

$B(\mu R)$ = buildup factor for air

DCF = dose conversion factor $\left(\frac{\text{mRem-Hr}}{\text{MeV/cm}^2\text{-sec}}\right)$

$R^2 dR \sin\phi d\phi d\theta$ = volume increment

$$PF = \frac{1097}{V^{.338}}$$

Therefore, the whole body dose to control room operators is:

$$Dose_{WB} = \frac{\text{Semi Infinite Cloud Dose}}{PF}$$

4. **Beta Dose**

The beta dose was calculated using the semi-infinite cloud dose model based on the concentration of activity in the control room. This method is appropriate because of the relatively short range of beta particles in air.

A computer code CRADLE (Reference 3) was developed to implement the methodology discussed in this section.

III. Assumptions

Since final design parameters have not yet been determined the following assumptions have been made regarding the ventilation system.

1. Normal ventilation system isolation assumed to be 10 seconds.
2. Control room unfiltered air inleakage is assumed to be 100 cfm. CYAPCo proposes to tighten the control room to significantly reduce inleakage (see Section 3).
3. Makeup air requirements are assumed to be 8000 cfm filtrated makeup for 9 minutes every 2 days.
4. Control room bypass damper leakage is assumed to be 10 cfm.
5. Control room ventilation system recirculation flow is assumed to be 8000 cfm.

It is also assumed that significant release of fission products from the fuel does not occur until one minute after pipe rupture. Therefore, we have made the following assumptions with regard to fission product release.

Core Release:

25% core iodine activity @ t = 1 minute
100% core noble gas activity @ t = 1 minute

All other assumptions are consistent with our March, 1978 Technical Specification Change submittal (Reference 2) and are summarized in Table 2A.

IV. Results

Table 2B lists the results which were calculated for the 30 day dose to control room operators. Also listed in Table 2B are the results of the shielding analysis which was transmitted in Reference 1. The resulting whole body dose from the direct sources outside the control room have been added to the whole body dose from activity concentrations inside the control room.

V. Conclusion

Based on the results given in Table 2, the proposed conceptual design will be sufficient to reduce the control room operator doses to levels below the criteria set forth in GDC19 and SRP6.4.

TABLE 2A

Assumption — **Basis**

1. Core Thermal Power Level = 1825 Mwt

2. Activity Released: (See Section III)

Time Period	Fraction Core Release from Containment	
	Iodines	Noble Gas
1 minute	.25	1.0

3. CAR Fan Initiation Times — Reference 1

   1 fan at t = 1 minute
   2 more fans at t = 15 minutes

4. CAR Fan Flowrate:

   50,000 cfm/fan — Reference 1

5. CAR Fan Filter Efficiencies: — Reference 1

elemental	99
organic	30
particulate	95

6. Containment Leakrate: — Reference 1

   < 24 hours, .18%/day
   > 24 hours, .09%/day

7. Containment Volume = 2.23×10^6 ft^3 — FDSA

8. Control Room X/Q's: — Reference 4

Time Period	Containment (sec/m^3)	RHR (sec/m^3)
(0-8) hr	5.15E-3	4.48E-3
(8-24) hr	3.57E-3	2.76E-3
(24-96) hr	1.36E-3	8.98E-4
(96-720) hr	2.96E-4	7.37E-5

TABLE 2A (Continued)

	Assumption	Basis
9.	RHR System Leakage = 3 liters/hr	Reference 1
10.	RHR System Initiation = 15 minutes	Reference 1
11.	RHR System Dilution = 148,000 gallons	Reference 1
12.	Inventory Available for Release From RHR = 25% of core iodine	Reference 1
13.	Iodine Partition Factor = 0.1	SRP 15.6.5
14.	Dose Conversion Factors (Thyroid, Beta)	Reg. Guide 1.109, Revision 1
15.	Control Room Volume = 71,779 ft^3	Attachment 1
16.	Control Room Iodine Filter Efficiencies: elemental = 95% organic = 95% particulate = 95%	Assumed Values
17.	Control Room Recirculation Flow Through Filter = 8000 cfm	Assumed Value
18.	Normal Ventilation System Flowrate = 1500 cfm	Attachment 1
19.	Normal Ventilation System Isolation = 10 seconds	Attachment 1
20.	Control Room Damper Bypass Leakage = 10 cfm	Assumed Value
21.	Control Room Unfiltered Inleakage = 100 cfm	Assumed Value
22.	Make up Air Requirements: 8000 cfm filtered makeup for 9 minutes every 2 days	Assumed Value

TABLE 2B

Organ	Ventilation System Dose (rems)		Direct Dose From Sources Outside Control Room (rems)(Ref. 1)	Total Dose (rems)
	Containment Contribution	RHR Contribution		
Thyroid	20.1	7.7	---	27.8
Whole Body	1.4	<< 1	0.6	2.0
Skin	24.2	<< 1	---	24.2

REFERENCES

1. Letter from W. G. Counsil to Darrell G. Eisenhut transmitting Haddam Neck Plant, Millstone Nuclear Power Station Units I and II Post-TMI Requirements, Implementation of NUREG-0737, December 31, 1980.

2. Letter from D. C. Switzer to D. L. Ziemann, and Attachments 1 and 2, March 21, 1978.

3. Miller, D. W., CRADLE computer code, "Control Room Accident Dose Level Evaluations." Revision 1, February, 1981.

4. Murphy, K. G., and Campe, K. M., "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Design Criterion 19," presented at the 13th AEC Air Cleaning Conference.

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Docket No. 50-245

Enclosure 2

Millstone Unit No. 1

Post TMI Requirements - Response to NUREG-0737

July, 1981

Docket No. 50-245

Millstone Unit No. 1

Index

Item No.	Description
11.D.1	Relief and Safety Valve Testing
11.E.4.2	Containment Isolation Dependability
11.F.1.3	Containment Hi-Range Radiation Monitor
11.K.3.14	Isolation Condenser Modification
11.K.3.25	Effect of Loss of Alternating Current Power on Pump Seals
111.D.3.4	Control Room Habitability

11.D.1 Safety/Relief Valve Testing

Reference (10) transmitted the preliminary data from the generic Safety/Relief Valve Test Program undertaken by the BWR Owners Group. A preliminary review of the generic BWR Safety/Relief Valve Test Program results demonstrates that the valves tested, which are representative of the valves installed at Millstone Unit No. 1, satisfied the acceptance criteria for operability. Therefore, based upon this preliminary review, the operational adequacy of the Safety/Relief Valves at Millstone Unit No. 1 has been demonstrated

11.E.4.2 Containment Isolation Dependability

At Millstone Unit No. 1, the drywell and torus may be vented or purged through either of two lines. The 18-inch lines are used almost exclusively for inerting and de-inerting the containment. Technical Specification 3.7.A.6 requires that the containment atmosphere oxygen concentration be reduced to less than 5% by weight within the 24 hour period subsequent to placing the reactor in the run mode. De-inerting may commence 24 hours prior to a shutdown. Therefore, since the 18-inch valves are only allowed to be open for these short durations and remain closed when containment integrity is required, there would be no appreciable increase in safety by requiring that these valves automatically close on a high radiation signal. These valves auto-isolate on high drywell pressure or low reactor water level.

The two-inch lines are opened periodically to maintain the 1.0 psid pressure differential between the drywell and the torus and to control drywell oxygen concentration. Procedures require that exhaust from these lines be directed to the Standby Gas Treatment System. Effluent to the stack is continuously monitored so that if exhaust from the two-inch lines were inadvertantly directed to the stack, it would automatically be directed to the Standby Gas Treatment System if high radiation were detected. Since vent exhaust is directed to Standby Gas Treatment System, these lines do not provide an open path from the containment to the atmosphere. As clarified in telephone conversations between NRC Staff and representatives of General Electric and the BWR Owners Group, the high radiation signal should close any line that provides an open path from the containment to the environment. Therefore, this requirement does not apply to the two-inch vent valves.

NNECO has concluded that the signals used for containment isolation are redundant and diverse and are adequate to ensure the safe operation of Millstone Unit No. 1. As such, no modifications to the containment isolation signals are planned.

11.F.1.3 Containment Hi-Range Radiation Monitor

Item 11.F.1.3 of Reference (1) states that "in-situ calibration by electronic signal substitution is acceptable for all range decades above 10 R/hr. In-situ calibration for at least one decade below 10 R/hr shall be by means of calibrated radiation source."

In-situ calibration by electronic signal substitution at the detector is not feasible or necessary for the following reasons:

1. Cable connections to detectors in containment are environmentally sealed and are not designed to be disassembled on a regular basis.

2. The required in-situ calibration for one decade below 10 R/hr by means of a calibrated radiation source will serve to functionally check the detector and the cables from the detectors to the indicating modules in the control room.

For the above reasons, NNECO intends to perform calibration by electronic signal substitution of the indicating module in the instrument calibration facility rather than in-situ.

11.K.3.14 Isolation of Isolation Condensers on High Radiation

The Millstone Unit No. 1 isolation condenser system design does not presently automatically isolate on high radiation in the steam line nor does it monitor radiation at that point. Millstone Unit No. 1 presently monitors the isolation condenser atmospheric vent with a gross gamma detector with procedural provisions for manual system isolation should the monitor indicate high activity and the operator determine that continued operation of the isolation condenser system is not necessary for a safe and orderly plant shutdown. NNECO believes this scheme allows the operator the greatest amount of flexibility and system availability to facilitate coping with all anticipated and unanticipated operational transients. As such, NNECO has determined that implementation of an automatic Isolation Condenser isolation scheme is unappropriate and has no intention of complying with this requirement. It is noted in addition to the above, NNECO submits that implementation of this requirement would be counterproductive to the intent of the study required by Item 11.K.3.16.

NNECO's position on this item has been provided to the Staff in References (2), (3), (11), and (12). Due to the absence of a Staff reply on this matter, NNECO has concluded that this is an acceptable position.

11.K.3.25 Effect of Loss of Alternating Current Power on Pump Seals

Item 11.K.3.25 of Reference (1) required NNECO to undertake a study to determine the effect of a loss of AC power on pump seals. In Reference (11), the Staff was informed that NNECO was pursuing resolution of this topic through the BWR Owners Group.

The results of the Owners Group study have been forwarded to the Staff via Reference (13). NNECO has determined that the study is applicable to Millstone Unit No. 1 and constitutes NNECO's response to this Action Plan item. Therefore, no further work on this item is planned.

Millstone Nuclear Power Station, Unit No. 1

CONTROL ROOM HABITABILITY STUDY

1.0 INTRODUCTION

The purpose of this submittal is to satisfy the requirements delineated in Action Item III.D.3.4 of NUREG-0737, Control Room Habitability. The specific references and sources of information employed in this evaluation will be identified in the context of the evaluation.

2.0 EVALUATION

2.1 Information Required for Control Room Habitability Evaluation

Attachment 1 provides the information required to be submitted for independent evaluation.

2.2 Toxic Gas/Chemical Analysis

2.2.1 On-Site Chemical Storage

A complete review of the Millstone Unit No. 1 site was performed to determine the types and quantities of chemicals considered to be hazardous in accordance with Regulatory Guides 1.78 and 1.95. Table 1 provides a complete listing of the various hazardous chemicals stored at the site along with their quantities and storage locations.

In accordance with the guidance provided by Regulatory Guides 1.78 and 1.95, and the methodology delineated in NUREG-0570, the below listing identifies the chemicals stored on-site at Millstone that have the potential to adversely affect control room personnel.

Chlorine
Ammonia
Sulfuric Acid

Attachment 2 and its associated appendix (Appendix 1 to Attachment 2) provide a detailed review of the potential accidents on-site involving these chemicals along with a summary of the results of this review.

2.2.2 Off-Site Manufacturing and Storage of Hazardous Chemicals

A review of the applicable plant documentation and surrounding areas was performed. Based upon this review, no significant manufacturing or storage facilities of hazardous chemicals have been identified within a five (5) mile radius of the Millstone site.

2.2.3 Transportation of Hazardous Chemicals

In the vicinity of the Millstone complex, highway, rail and waterway represent the modes of transportation that require consideration in the hazardous chemical evaluation.

The site is traversed from east to west be a railroad right-of-way of Conrail. The mainline tracks are approximately .5 miles from the Millstone Unit No. 1 control room. Table 2 (attached) provides a listing of the hazardous chemicals which were transported in the vicinity of Millstone by Conrail for the period of January 1978 through June 1979. In accordance with the guidance provided by Regulatory Guides 1.78 and 1.95, only the explosion of propane on the rail line is considered to be a potential hazard to the control room personnel.

The major highway in the vicinity of Millstone is U. S. Route 95. The hazardous materials transported on Route 95 are primarily gasoline, fuel oil, and propane. Considering the fact that U. S. Route 95 is located at a distance of 4.2 miles from Millstone, the maximum quantity normally transported by truck is 8,000 gallons and all trucking of hazardous materials is done in accordance with state and federal "DOT" requirements, only the explosion of propane in transit on Route 95 is considered to have the potential to adversely affect control room personnel.

Attachment 2 provides a detailed review of the potential explosions of propane on the railroad and highway in the vicinity of Millstone.

The shipping channels of Long Island Sound require any freighters, tankers, and barges remain a minimum of two (2) miles off-shore to preclude running aground on Barlett Reef. In addition to the shipping off Long Island Sound, the Thames River, located 4.2 miles from Millstone, represents a major waterway in the vicinity of Millstone upon which freight is shipped. The primary cargo on the waterways is fuel oil and gasoline. Considering the distance from Millstone of the shipping and the fact that the Coast Guard monitors all freighters in this area, shipping on these waterways is not considered to represent a hazard to control room personnel.

2.3 Radiological Accident

Attachment 3 provides a complete radiological evaluation of the Millstone Unit No. 1 control room.

3.0 CONCLUSIONS

3.1 Toxic Chemicals

As identified in the analysis performed in Attachment 2 and its appendix, modifications will be required to the control room to ensure the control room remains below toxic levels during an on-site accident involving chlorine. The options being considered are as listed below.

(a) Increasing the charcoal filtration capability of the control room.

(b) Reducing control room unfiltered in-leakage.

(c) Pressurizing the control room after release of chlorine.

(d) Reducing the amount of chlorine stored on-site.

3.2 Radiological Accident

As indicated in Attachment 3, modifications will be required to the Millstone Unit No. 1 control room, to reduce control room operator doses to levels set forth in GDC 19 and SRP 6.4. These modifications include installation of a filtration system and reducing unfiltered in-leakage. In addition, consideration is being given to a main steam isolation valve leakage system for Millstone Unit No. 1. Figure IV provides a preliminary schematic of the proposed modifications.

3.4 Installation Schedule

NUREG-0737 requires an inservice date of January 1, 1983 for all control modifications. A review of the necessary equipment lead times along with coincident plant refueling outages required to complete these modifications for Millstone Unit No. 1 indicates that the implementation date of NUREG-0737 is not practicable. It is NNECO's current intention to complete implementation by January 1, 1984.

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.

   The control room ventilation system is a recirculation type. A radiation detector located in the ventilation intake duct will initiate closure of the intake damper upon detection of 1 mr/hr, as well as putting the system into a recirculation mode. No filtration is provided for the radiological event or isolation capability for a toxic gas release.

2. Control Room Characteristics:

   (a) Control Room Air Volume:

   This volume will be defined as all areas presently included in the control room ventilation system.

   Control Room Air Volume: 150,500 ft^3

   (b) Control Room Emergency Zone:

   The areas listed below are presently included in the control room ventilation system:

   1. Viewing Gallery
   2. Shift Supervisor's Office
   3. Office
   4. Entrance Areas
   5. Conference Room
   6. Toilet
   7. Control Room
   8. Cable Vault
   9. Computer Room

(c) Control Room Ventilation System Schematic

The attached drawing, labeled Figure I, is a schematic of the Millstone Unit No. 1 control room ventilation system.

(d) Infiltration Leakage Rate:

The infiltration leakage rate based upon calculation is approximately 200 cfm.

(e) High Efficiency Particulate Air (HEPA) Filter and Charcoal Absorber Efficiencies

The Millstone Unit No. 1 control room ventilation system does not contain HEPA or charcoal filters.

(f) Closest Distance Between Containment and Air Intake:

Closest Distance to Millstone Unit No. 1 Containment = 60'

Closest Distance to Millstone Unit No. 2 Containment = 175'

(g) Layout of Control Room, Air Intakes, Containment Building, and Chlorine, or Other Chemical Storage Facilities with Dimensions:

The attached drawing, labeled Figure II, provides a layout of the Millstone Unit No. 1 and Unit No. 2 site identifying the location of the air intakes, containment building, sulfuric acid storage tanks, and chlorine tanks with associated dimensions.

The attached drawing, labeled Figure III, provides a layout of the Millstone Unit No. 1 and Unit No. 2 control rooms with associated dimensions.

(h) Control Room Shielding Including Radiation From Air Leakage From Penetrations, Doors, Ducts, Stairways, Etc.:

A control room shielding analysis is provided as Appendix 1 to this Attachment.

It should be noted that Appendix 1 contains some minor corrections to the shielding analysis submitted in Reference (3).

(i) Automatic Isolation Capability - Damper Closing Time, Damper Leakage and Area:

A local radiation monitor located in the control room ventilation intake duct closes the outside air damper upon detection of 1 mr/hr.

Damper Closing Time:	5 seconds
Intake Damper Leakage:	13.5 cfm (calculated)
Intake Damper Area:	5.4 ft^2

(j) Chlorine or Toxic Gas (Local or Remote):

The Millstone Unit No. 1 control room contains an alarm which is initiated by a remote chlorine detector located at the Unit No. 1 intake structure. The control room does not contain any other toxic gas detectors either local or remote.

(k) Self-Contained Breathing Apparatus Availability (Number):

The Millstone Unit No. 1 control room contains two self-contained air packs with additional air bottles as well as self-contained air packs at various designated sites in the plant.

(l) Bottled Air Supply (Hours):

The Millstone Unit No. 1 control room does not contain a bottled air supply with the exception of the self-contained breathing air packs and bottles identified in item (k).

(m) Emergency Food and Potable Water Supply:

Normally sufficient food is available to support five (5) people for a period of five (5) days. The water available is city water, however Millstone Unit No. 2 has a bottled water supply normally of five five-gallon containers which are available if required.

(n) Control Room Personnel Capacity (Normal and Emergency):
A normal shift consists of 7 individuals. During an emergency, an average of 10 with a maximum of up to 20 can be expected.

(o) Potassium Iodide Drug Supply:

A supply of 2,000 pills is maintained on site.

3. On Site Storage of Chlorine and Other Hazardous Chemicals:

(a) Total Amount and Size of Container:

Table 1 (attached) provides a complete listing of all identified hazardous chemicals stored on site.

(b) Closest distance from control room air intake:

Chlorine is the only chemical which has been identified as having the potential to adversely affect the control room personnel. The chlorine tank cars are located at a distance of 390 feet from the control room air intake for Millstone Unit No. 1

4. Off Site Manufacturing, Storage, or Transportation Facilities of Hazardous Chemicals:

(A) Identify Facilities Within a Five (5) Mile Radius

No significant manufacturing or storage facilities have been identified. The only significant transportation facility within a five (5) mile radius is Conrail (railroad). Table 2 (attached) provides a listing of the hazardous chemicals which was transported in the vicinity of Millstone Units No. 1 and No. 2 for the January 1978 through June 1979 period.

(B) Distance from the Control Room

The mainline tracks of Conrail are approximately .5 miles from the Millstone Units No. 1 and No. 2 control rooms.

(C) Quantity of Hazardous Chemicals in One Container

Propane is the only chemical which has been identified as being transported in a frequency above the minimum of thirty (30) carloads per year as defined in Regulatory Guide 1.78. For the period of January 1978 through June 1979 the average quantity per carload was approximately 73 tons/tank car. Table 2 (attached) provides a complete listing of the rail traffic of hazardous material quantities in the vicinity of Millstone for the period January 1978 through June 1979.

(D) Frequency of Hazardous Chemical Traffic

Table 2 (attached) provides the frequency of rail traffic of hazardous materials in the vicinity of Millstone for the period of January 1978 through June 1979.

5. Technical specifications.

(A) Chlorine Detection System

Millstone Unit No. 1 does not have any Technical Specifications applicable to chlorine or to the remote chlorine detection system.

(B) Control Room Emergency Filtration System

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

Millstone Unit No. 1 has no Technical Specifications applicable to the control room ventilation system.

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
1. Sulfuric Acid	MP1; 7000 gals	Sulfuric acid storage tank just north of the gas turbine building.
	MP2; 8000 gals	Elevation 4'6" condensate polishing facility.
2. Sodium Hydroxide 50% by Weight	MP1; 7500 gals	Caustic sol. storage tank just north of the gas turbine building.
	MP2; 7500 gals	Condensate polishing facility
3. Chloroethane	Negligible	N/A
4. Unisol	N/A	N/A
5. Hydrazine 35% by Weight (non-flammable)	MP1 One 55 gal drum	Reactor building; elevation 4[illegible]'6" near RBCCW pumps.
	MP2 Two 55 gal drums	Elevation 14'6" northwest corner of turbine building.
	Site: Ten 55 gal drums	Warehouse No. 3.

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
6. Penetone Products	Penetone 724; Six 55 gal drums	Warehouse No. 3.
7. Penetone Formula 2101	N/A	N/A
8. Ammonia 30% by Weight	MP2; 1500 gals	Northwest corner; elevation 14'6" turbine building.
10. Nitrogen (Liquid)	MP1; 10,000 gal	Just west of condensate storage tank.
	Seven 160 liter cylinders	Adjacent to radwaste and control buildings.
9. Acetone	Four 55 gal drums	Warehouse No. 3.
11. Hydrogen	108,333 scf/ month	South end of site; adjacent to chlorine tank cars.
12. Acetaldehyde	N/A	N/A
13. Acrylonitrile	N/A	N/A

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
14. Anhydrous Ammonia	N/A	N/A
15. Aniline	N/A	N/A
16. Benzene	Negligible	N/A
17. Butadiene	N/A	N/A
18. Butenes	N/A	N/A
19. Carbon Monoxide	N/A	N/A
20. Chlorine	Two 55 ton tank cars	South end of site adjacent to gas turbine building
21. Sodium Hypochlorite NaOCl 12½% by Weight	N/A	N/A
22. Ethyl Chloride	N/A	N/A
23. Ethyl Ether	N/A	N/A
24. Ethylene Dichloride	N/A	N/A

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATIO

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
25. Ethylene Oxide	N/A	N/A
26. Fluorine	N/A	N/A
27. Formaldehyde	Negligible	Environmental lab.
28. Helium	Four 20 ft^3 bottles Eight 213 ft^3 bottles	Gas bottle storage shed.
29. Hydrogen Cyanide	N/A	N/A
30. Hydrogen Sulfide	N/A	N/A
31. Methanol	15 gals	Chemistry lab.
32. Sodium Oxide	N/A	N/A
33. Sulfur Dioxide	N/A	N/A
34. Vinyl Chloride	N/A	N/A

TABLE I

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
35. Xylene	Negligible	N/A
36. Phosphoric Acid 60% by Weight	5700 gals	MP1: Radwaste; used for solidification. Scheduled to be replaced by Dow Process.
37. Ureaformaldehyde	5700 gals	MP1: Radwaste
38. Halon	MP1: Four 100# bottles	MP1: Computer room.
	MP2: One 22# bottle	MP2: Computer room.
	approximately 60#	Proposed for new MP2 computer room.
	MP2: Six 298# bottles	New records storage vault CPF building.
39. Carbon Dioxide - CO_2	MP1: Six 100# bottles	Turbine exciter.
	Six 75# bottles	Gas turbine building.
	One 750# tank	Turbine deck.
	MP2: Seven 75# bottles	Turbine exciter.
	17-75# bottles	Old records storage area.

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
39. CONTINUED	One 750# tank	Turbine deck.
	Site: Three 75# bottles	Flammable liquid storage building.
40. Nitrogen (Gas)	N/A	N/A
41. Argon (Gas)	N/A	N/A
42. Dimethyl-Amine	N/A	N/A
43. Sulfur Hexafluoride	N/A	N/A

TABLE 2

Railroad shipments of Hazardous Materials in the Vicinity of the Millstone Site from Janaury 1978 thru June 1979

Hazardous Material	Frequency - Number of Carloads from 1/78-6/79	Total Quantity (tons)
Chlorine	20	1593
Anhydrous Ammonia	8	639
Carbon Dioxide (Liquid)	9	725
Propane	66	4796
Ethyl Alcohol	22	1496
Rosin	1	33
Ammonium Nitiate	9	690
Hydrochloric (Muriatic) Acid	5	387

APPENDIX 1 TO ATTACHMENT 1

Control Room Shielding Analysis

A. Location and Description

The Millstone Unit 1 control room is located 58 feet north of the dry well center, on the 26'6" level. The shielding is summarized in the Table of Assumptions for MP-1. The north wall of the control room is shared with the south wall of the MP-2 control room.

B. Criteria

All source terms are consistent with NUREG-0588, and include: 100% of the core noble gas inventory and 50% of the core inventory of iodines in the containment air; 50% of the core iodines and 1 % of the core solid fission product inventory in the water sources. Specific source strengths are from TID-14884.

C. Methodology

Four sources of radiation were considered in determining the control room doses from a Unit 1 design basis accident. They are:

1. Direct shine from the drywell.
2. Direct shine from airborne activity in the secondary containment.
3. Direct shine from the overhead plume from the 375 foot stack.
4. Dose from the core spray line located south of the MP-1 control room.

Doses from those sources were calculated in both the Unit 1 and Unit 2 control rooms.

The direct dose from the drywell was determined using the QAD-P5F computer code. The drywell was modeled in two regions: a sphere and a cylinder. Each region was broken up into 27,000 point sources. The source strengths were determined using the ISOTOPE computer code, modeling the source into an eight energy group gamma spectrum.

The shine from the secondary containment (reactor building) was computed using a combination of the TACT-III, ISOTOPE, and QAD-P5F computer codes. The number of curies released from the drywell to the reactor building was determined by the TACT-III code. These results were then used to determine an eight energy group gamma spectrum using the ISOTOPE code. These source terms were used in the QAD-P5F code to determine the dose from the reactor building.

Total mixing of the drywell leakage activity was assumed. The activity was uniformly distributed within the entire building volume, half of which was used as the source volume. No shielding credit was taken for any floors, walls, etc., inside the reactor building.

The dose from the overhead plume due to releases from the 375' stack was analyzed using the QAD-P5F computer code with the source distributed as a cylinder whose centerline is 315 feet above the control room roof. The centerline concentration was used as the concentration for the entire plume volume. The TACT-III code provided a release rate for each isotope. The X/Q dispersion coefficient was based on the 95% worst case conditions and F class stability in the sector containing the control room. The ISOTOPE code was then used to model an eight energy group gamma spectrum for use in the QAD-P5F code. The results are applicable to both control rooms since they are shielded to the same amount and are at the same location in relation to the stack. The source concentration changes depending upon whether the Unit 1 or Unit 2 DBA is being considered.

The dose to the control room from the core spray line located two feet outside of the south wall of the control room was computed using the QAD-P5F code. The source concentration consisted of 50% of core iodines and 1% of the core solid fission product inventory diluted by the reactor and pressure suppression chamber water volumes.

The source terms, assumptions, and methodologies used to calculate the Unit 1 control room dose due to a Unit 2 DBA are presented in the Millstone Unit 2 Control Room Habitability Study.

D. Results

The results of the shielding analysis are tabulated on the attached sheet.

E. Conclusions

The analysis of the Millstone Unit 1 control room shielding shows that the 30-day whole body dose to the Millstone Unit 1 control room is 0.767 rem after a Unit 1 DBA and 0.276 rem after a Unit 2 DBA.

These doses were calculated using very conservative methods and assumptions. Therefore, the doses are expected to be an upper bound on the doses to the control room after any incident.

It should be recognized that the total whole body dose cannot be determined until the final design details of the ventilation systems are complete and the dose from airborne sources within the control room are calculated, however, the doses computed here from sources outside the control room are well within the guidelines of General Design Criteria 19 of Appendix A to 10CFR, part 50 and are therefore acceptable.

MILLSTONE SITE

INTEGRATED 30-DAY WHOLE BODY DOSES, REM

	Millstone Unit 1 Control Room					Millstone Unit 2 Control Room				
	Overhead Plume	Direct Primary Cntnment.	Direct Secondary Cntnment.	Unit 1 Core Spray Line	Total	Overhead Plume	Direct Primary Cntnmnt.	Secondary Containment	Unit 1 Core Spray Line	Total
MP-1 DBA	0.007	0.002	0.028	.730	0.767	0.007	Negligible	0.003	0.050	0.060
MP-2 DBA	0.003	0.210	0.063	-----	0.276	0.003	0.400	0.520	-----	0.920

MP-1 DBA ASUMPTIONS

ASSUMPTIONS	BASIS
1. Core Power Level = 2011 Mwt	FSAR
2. Core Inventory	TID-14884
3. Core Release Fractions: 50% of equilibrium iodine activity 100% of equilibrium noble gas activity	NUREG-0588
4. Iodine Form: 91% elemental 5% particulate 4% organic	Reg. Guide 1.4
5. Containment Leak Rate: 1.2%/day	Tech. Specs.
6. SGTS Filter Efficiencies: 90% of all species of iodines	Tech. Specs.
7. Containment Volume: Drywell = 146,900 ft^3 Torus = 109,900 ft^3 Total = 256,800 ft^3	FSAR
8. Dry well shielding dimensions: all parts = 5 feet	NUSCO Dwg. #25202-27003
9. Control Room Shielding: south wall = 3.5 feet west wall = 1.5 feet east wall = 6 inches floor = 12 inches ceiling = 2 feet	FSAR
10. Shortest distance to dry well surface: = 36 feet	NUSCO Dwg. #25203-27022
11. X/Q's at plume axis: (0-8) hrs. = 4.84×10^{-3} sec/m^3 (8-24) hrs. = 4.19×10^{-4} sec/m^3 (24-96) hrs. = 1.65×10^{-4} sec/m^3 (96-720) hrs. = 9.92×10^{-5} sec/m^3	W. G. Counsil letter to R. Reid dated December 15, 197

ATTACHMENT 2

MILLSTONE UNIT NO. 1
HAZARDOUS CHEMICAL/MATERIAL ANALYSIS

1.0 EVALUATION OF POTENTIAL ACCIDENTS

In this attachment the potential effects of accidental releases of hazardous materials identified as having the potential to effect control room habitability are briefly discussed and summarized. These effects are calculated in accordance with NRC guidelines. The potential accidents stem from possible explosions from flammable materials or toxic clouds of materials that may be accidentally released outside of the control room.

The approach and procedures for the various calculations are contained in Appendix 1 to this attachment.

1.1 Potential for Explosions

Gaseous propane is a flammable material which has an explosive potential. An accidental release of propane will form a cloud that can drift toward a plant and explode, provided its concentration is within the flammability limits.

Regarding possible effects at Millstone Unit No. 1, propane is transported over the New London line (Conrail) which passes approximately 1,000 meters to the north of the Millstone power plant complex. Calculations indicate that, in the event of a railroad tank car accident at the point nearest the complex, the propane concentration in a cloud drifting nearest the complex would still be within the flammability limit. Based upon communications with Conrail, there have been no reported accidents on the New London line involving propane. NRC guidelines provide a means for estimating the risk of damage due to explosions or accidents involving tank car/trucks occurring near power plants in Regulatory Guide 1.91. Using the guideline, which considers the non-occurrence of accidents, the risk of damage at Millstone is calculated to be zero. Therefore, propane transportation by rail poses no hazard to control room personnel at the Millstone complex.

Propane is a commodity which is commonly transported on highways in the vicinity of Millstone Unit No. 1. As previously indicated, the major highway in the area of Millstone is approximately four (4) miles from the site. Considering the guidelines provided in Regulatory Guide 1.91, and above the distance, transportation of propane will not pose a problem to Millstone Unit No. 1.

1.2 Toxic Chemicals -- On Site

As previously discussed in Section 2.2.1 of this submittal, the chemicals stored on site at the Millstone site that have been identified as having the potential for adversely affecting control room personnel are listed below.

Sulfuric Acid
Ammonia
Chlorine

1.2.1 Sulfuric Acid

Sulfuric acid is stored at Millstone Units No. 1 and No. 2. The table below shows the amounts stored and distance to the control room intake plenum.

Amount	Distance to Control Room Intake Plenum
7000 gal	325 ft (99.0 m)

Concentration levels calculated at each control room intake were based on the following general conditions:

total tank failure; ambient temperature - 38°C; continuous release of material; worst-case meteorological conditions; spill radius - 4.6 m.

Because of the low volatility of sulfuric acid the calculated concentration is very low; and has been determined to be 8×10^{-6} mg/m^3.

This is considerably below the H_2SO_4 toxicity limit of 2 mg/m^3 (Regulatory Guide 1.78). Therefore, failure of H_2SO_4 storage tanks at the site poses no threat to control room personnel.

1.2.2 Ammonia

Ammonia is stored at the Millstone complex. A 1,500 gallon tank of aqueous ammonia, 28% concentration, is stored in the northwest corner of the Unit 2 turbine building. The initial concentration calculations assume: (1) total tank failure with contents spreading over the entire floor of the turbine building; (2) ambient temperature is 38°C; and (3) resulting cloud emanates from an open doorway in the northeast corner of the building and drifts directly toward the control room intake plenum under near-worst-case meteorological conditions. The distance is 110 m to the Millstone Unit No. 1 intake plenum. The resulting concentration, assuming failure of the existing tank dikes, is 80 mg/m^3, compared to the toxic level of 100 mg/m^3 (per Regulatory Guide 1.78). Considering the existing tank diking system, and making the conservative assumption the dikes are 15 m x 15 m, which will allow for some spillage, the decreased spill area reduces the rate of NH_3 evaporation resulting in a concentration of 12.9 mg/m^3. This is significantly below the above mentioned toxic level; therefore, ammonia is not considered a hazard to control room habitability.

1.2.3 Chlorine

Chlorine is stored at the Millstone complex. The present situation at Millstone does pose a problem in the event of an accidental release of chlorine under near-worst-case meteorological conditions. Two (2) 55 ton chlorine tanks are situated 120 m from the intake plenum of the Millstone Unit No. 1 control room. A computer program was written to determine the consequences of the worst case accident situation stemming from catastrophic total failure of the two tank cars under worst case meteorological conditions as well as assess the various options available to ensure control room personnel are protected from this accident.

The equations, assumptions, and meteorological conditions for assessing such a situation are presented and discussed in Regulatory Guides 1.78 and 1.95, and NUREG-0570. These were utilized along with the operating parameters of the Millstone Unit No. 1 control room (i.e., damper, isolation, and internal ventilation systems provided in Attachment 1) in making the assessments.

The specific conditions and assumptions for which the calculations were made included:

- wind speed; 1 m/sec, stability Class F
- ambient temperature: 38°C
- total tank failure; both tanks simultaneously
- 25% of spill flashed to cloud (Gaussian puff)
- remainder evaporates continuously until depleted (Gaussian plume)
- area of spill is calculated rather than assumed
- both puff and plume drift toward intake plenums
- above conditions remain constant for twelve (12) hours.

The various control room modification options reviewed included the following.

1. Modifying the flow rates through the charcoal filter system.
2. Reducing control room in-leakage after isolation.
3. Varying the delay times after detection of chlorine.
4. Pressurizing the control room after the chlorine spill for a specified period of time.

Based upon this review, it has been determined that it is feasible to reduce the control of the concentrations below toxic levels (45 mg/m^3 per Regulatory Guide 1.78) through modifications of the existing control room. Section 3 of this submittal will delineate the various modifications that are being considered to ensure control room habitability is not affected for the chlorine accident.

2.0 METHODOLOGY FOR H_2SO_4, NH_3, AND Cl_2

2.1 Sulfuric Acid

Because sulfuric acid (98% concentration) is relatively nonvolatile, no flashing into an H_2SO_4 cloud was assumed. Therefore, Equation 1 did not apply. Also, since the storage tanks are surrounded by a diking arrangement (24'9" x 28') Equation 5 was not applicable. Equation 3 was used to calculate vapor pressure; an ambient temperature of 311°K and pure H_2SO_4 was assumed (rather than 98% aqueous) to assure conservatism of the approximation. Equation 4 qas used to calculate the H_2SO_4 evaporation rate, which provides the source emission rate for Equation 2. The evaporation computations were based on the following calculated inputs: spill area, 65 m^2; vapor pressure, .00057 mm Hg; equivalent dike diameter, 900 cm; the Hd term was calculated for laminar flow. Ambient temperature and wind speed were assumed to be 38°C and 1m/sec. The resulting evaporation rate was calculated as 0.0659 ug/sec. Equation 2 was then used to calculate H_2SO_4 concentrations at the appropriate distance for the Millstone Unit No. 1 control room. The initial H_2SO_4 plume width (yo) was based on the radius of a circle with an area equivalent to that of the area enclosed by the dikes (65 m^2). The worst case meteorological conditions were 1m/sec and stability Class F. The H_2SO_4 concentration was calculated to be 8×10^{-6} mg/m^3.

2.2 Ammonia

Ammonia at 28% concentration is stored in the Millstone Unit 2 turbine buidling in a single 1,500 gallon tank. Vapor pressure measurements were obtained for various NH_3 solution concentrations and temperatures reported at Millstone. At 80°F, 30% NH_3 has a vapor pressure of 15.2 lb/in^2, or about 760 mm Hg for 28% NH_3.

The spill area resulting from a total failure of the tank was calculated in two ways, both of which yielded similar results. Equation 5 yielded about 38×10^6 cm^2. However, the total floor area was 42×10^6 cm^2; therefore, evaporation was based on the total floor area to be conservative. Equation 4 yielded an evaporation rate of 0.52 ug/sec.

The source geometry is complicated. For the calculation, the NH_3 gas cloud was assumed to pass through a 5 x 5 meter door opening (25 m^2 cross-sectional area) which yielded an initial NH_3 plume size (yo) of 1.03 meters.

Because of the relatively low volatility of 28% NH_3 at 80°F, flashing into a puff would not take place. Therefore, only Equation 2 was used to estimate concentrations. The distance from the NH_3 emmission point to the Millstone Unit No. 1 air intake is 110 m. Under worst-case meteorology, the concentration was calculated to be 80 mg/m^3 compared to the toxicity limit of 100 mg/m^3 (Regulatory Guide 1.78). To provide a more realistic estimate of the actual concentrations, the conservative value of a 50 foot diking area was assumed, thus allowing for some spillage over the existing dike. The area rate was calculated as 0.084 g/sec, which yielded a concentration of 12.9 mg/m^3 at the Millstone Unit No. 1 air intake.

2.3 Chlorine

As previously stated in Section 1.2.3 of Attachment 2, two (2) 55 ton chlorine tanks are located at the Millstone complex, 119 m from the Millstone Unit No. 1 control room intake plenum.

As a result of the number of variables involved in the dynamics of the process that relates an accidental release of chlorine to the resulting concentration in the control room, a computer program was prepared to evaluate the consequences and assess the alternatives for preventing toxic levels from being reached in the control room. A general description of this program is discussed below.

Equations 1 through 7 are computerized in an interactive fashion that relates the amount of a volatile material (in this case, chlorine) that is released to the resulting concentration in the control room by considering the configuration of the release, the conditions under which it is released, transported, and diffused, the physical characteristics of the control room, and the operating characteristics of the control room (e.g., isolation time, in-leakage rate, charcoal filtration system). The following inputs are required:

(a) Volume of control room (m^3).

(b) Normal ventilation rate ($m^3 sec^{-1}$).

(c) Ventilation rate after isolation ($m^3 sec^{-1}$).

(d) Time delay between chlorine detection and damper close (sec).

(e) Concentration that triggers damper close ($mg\ m^{-3}$).

(f) Mass of the initial puff (g); 25% of the total mass released.

(g) Mass of the remaining material (g).

(h) Flow rate handled by charcoal filtering system ($m^3 sec^{-1}$).

(i) Time delay between chlorine detection and activation of charcoal filtering system (sec).

(j) Time delay between chlorine detection and positive pressure system activation (sec).

(k) Duration of positive pressure system operation (sec).

(l) Efficiency of charcoal adsorption (fraction).

(m) Time input to spill size equation (sec).

(n) Input spill area to override calculated area (cm^2).

(o) Wind speed (m sec^{-1}).

(p) Distance from spill to intake (m).

(q) Atmospheric stability class (E, F, G).

(r) Vapor density of material relative to air.

(s) Molecular weight of material.

(t) Total time simulated (hours).

The puff and plume models are activated in sequence such that the puff passes the intake first followed by the plume (which reflects steady state conditions after puff passage); however, the peak concentration resulting from the puff alone is maintained until the sum of the plume and puff concentrations at time t_i after puff passage is less than the peak due to the puff alone, after which the concentration decreases until the steady state concentration (plume) is reached.

APPENDIX 1 TO ATTACHMENT 2

APPROACHES AND SPECIFIC PROCEDURES FOR CALCULATING AFFECTS FROM ACCIDENTAL RELEASES OF SULFURIC ACID, AMMONIA, AND CHLORINE

1.0 APPLICABLE EQUATIONS

A number of equations are applicable for calculating the effects of the above materials. All those used in this analysis are summarized in NUREG 0570, and are presented below.

- Gaussian Puff Equation

$$\chi(x, y, z, h) = \frac{Q}{(2\pi)^{3/4}\sigma_{XI}\ \sigma_{YI}\ \sigma_{ZI}} \cdot \exp\left\{ -\frac{1}{2}\left[\frac{x^2}{\sigma_{XI}^2} + \frac{y^2}{\sigma_{YI}^2}\right]\right\}$$

$$\cdot\left\{ \exp\left[-\frac{1}{2}\,\frac{(z-h)^2}{\sigma_{ZI}^2}\right] + \exp\left[-\frac{1}{2}\,\frac{(z+h)^2}{\sigma_{ZI}^2}\right]\right\} \quad ①$$

Where χ = concentration (g/m^3)

Q = source strength (g) = m_{vo}

$\sigma_{XI}, \sigma_{YI}, \sigma_{ZI}$ = adjusted standard deviations of the puff concentration in the horizontal along-wind (X), horizontal cross-wind (Y), and vertical cross-wind directions (Z), respectively (m).

x, y, z = distances from the puff center in the X, Y, and Z directions, respectively (m). z is also the effective above-ground elevation of the receptor, e.g., the fresh-air intake of a control room.

h = effective above-ground elevation of the source.

To account for the initial volume of the puff, it is assumed that:

$$\sigma_{XI}^2 = \sigma'^2_{XI} + \sigma_o^2$$
$$\sigma_{YI}^2 = \sigma'^2_{YI} + \sigma_o^2$$
$$\sigma_{ZI}^2 = \sigma'^2_{ZI} + \sigma_o^2$$
$$\sigma_{XI}^2 = \sigma YI^2$$

and letting $x = x_o - ut$

$$\sigma_o = \left[m_{vo}/(2^{1/2}\,\pi^{3/2}\,\rho_v)\right]^{1/3}$$

where

σ_o = initial standard deviation of the puff (m)

σ'_{XI}, σ'_{YI} σ'_{ZI} = standard deviation of puff concentration in the X, Y and Z directions, respectively (m)

m_{vo} = mass of the instantaneously released puff (g)

ρ_v = density of the puff (g/m^3)

x_o = ground distance between the source of spill and receptor (m)

u = wind speed (m/sec)

t = time after release (sec)

• Gaussian Plume Equation

$$\chi(x,y,z,h) = \frac{Q'}{2\pi\, u\sigma_Y \quad \sigma_Z} \exp\left\{ \left(-\frac{y^2}{2\sigma_Y^2}\right) \right\} \left\{ \exp\left[-\frac{(z-h)^2}{2\sigma_Z^2}\right] + \exp\left[-\frac{(z+h)^2}{2\sigma_Z^2}\right] \right\} \quad ②$$

where

σ_Y, σ_Z = standard deviations of the plume concentration in the Y and Z directions, respectively (m)

Q' = continuous source strength (g/sec)

y is also modified to account for initial plume size as is done in Equation 1.

• Equation for Obtaining Vapor Pressure

(Handbook of Chemistry and Physics)

$$\text{Log } P = (-0.2185\ A/K) + B \qquad (3)$$

where:

P = vapor pressure (mm Hg)

K = temperature (°K)

A = molar heat of vaporization (cal per gram-male)

B = constant of integration

Values of A and B are given in the above reference.

- Calculation of Evaporation Rates

$$(dm_v/dt) = h_d\ M\ A(t)\ (P_s - P_a)/R_g\ (T_a + 273) \qquad (4)$$

where, for a laminar flow

$$h_d = 0.664\ \frac{D}{L}\ (Re)^{1/2}\ (Sc)^{1/3}$$

and for a turbulent flow

$$h_d = 0.037\ \frac{D}{L}\ (Re)^{0.8}\ (Sc)^{1/3}$$

Re = Reynold number = $L\ u\ \rho/\mu$

Sc = Schmidt number = $\mu/D\rho$

L = characteristic length (cm)

μ = viscosity of air (g/cm sec)

M = molecular weight of the liquid (g/mole)

P_s = saturation vapor pressure of the liquid at temperature Ta (mm Hg)

P_a = actual vapor pressure of the liquid in air (mm Hg)

h_d = mass transfer coefficient (cm/sec)

R_g = universal gas constant

D = diffusion coefficient (cm^2/sec)

u = wind speed (cm/sec)

ρ = density of air (g/cm^3)

- Calculation of Spill Size

$$A(t) = \pi \{ r_o^2 + 2t [\frac{gV_o (\rho_\ell - \rho)}{\pi \rho_\ell}]^{1/2} \} \quad (5)$$

and $V_o = \pi r_o^3$

where

r_o = initial radius of the spill (cm)

g = gravitational constant = 981 (cm/sec^2)

V_o = volume of the spill (cm^3)

ρ_ℓ = density of the liquid or gas (g/cm^3)

ρ = density of air (g/cm^3)

t = time (sec)

- Calculation of Concentration at Air Intake and Within Control Room

The concentration, Co, at the outside air intake at time t_i is:

$$C_o (t_i) = m_{v,\ puff} (\chi/Q)_{ti} + (dm_v/dt)_{ti,\ plume} (\chi/Q') \quad (6)$$

The concentration build-up inside control room C_r in g/m^3, at time t_i is:

$$C_r(t_i) = C_r(t_{i-1}) + [C_o(t_i) - C_r(t_{i-1})] [1 - \exp (-W\Upsilon/V_r)] \quad (7)$$

where $\Upsilon = t_i - t_{i-1}$

W = air flow rate in control room (m^3/sec)

V_r = control room air space (m^3)

Υ = time duration (sec)

ATTACHMENT 3

MILLSTONE UNIT 1 CONTROL ROOM

RADIOLOGICAL EVALUATION

I. General

A radiological analysis is given below based on the conceptual ventilation system design described in section 3.

II. Methodology

A. Activity

The dose analysis was based on the actual amount of activity which enters the control room via supply fans, doors and other inleakage paths. Filtration of iodine by the control room ventilation system was factored in the calculation. The activity distribution model is based on the following assumptions:

1. activity entering the control room is instantaneously mixed in the control room volume.
2. airflow into the control room = airflow out of the control room.
3. activity is instantaneously transported to the control room air intake immediately after release from the control volume.

The rate of change of activity in the control room is based on the following production and loss equation:

$$\begin{pmatrix}\text{rate of change}\\ \text{of activity in}\\ \text{control room}\end{pmatrix} = \begin{pmatrix}\text{rate at which}\\ \text{activity is}\\ \text{input}\end{pmatrix} - \begin{pmatrix}\text{rate at which}\\ \text{activity is}\\ \text{removed}\end{pmatrix}$$

The differential-equation which describe the time dependent change of activity is:

$$\frac{dA_{cr}(t)}{dt} = C_{At}(t) \times TR_{I} - (\lambda_{di} + \lambda_{c_{2i}} + \lambda_{L_2})A_{cr}(t) \qquad (1)$$

where: $\frac{dA_{cr}(t)}{dt}$ = rate of change of activity in the control room with respect to time

$C_{At}(t)$ = concentration of activity (Ci/m^3) in the atmosphere outside the control room at time = t

TR_I = rate at which air is being admitted into the control room (m^3/hr).

λ_{d_i} = decay constant for isotope i (1/hr)

λc_{2i} = internal control room removal constant by internal recirculated flow thru filters (1/hr) for isotope i.

λ_{L_2} = removal rate by outleakage from control room (1/hr)

$A_{cr}(t)$ = activity (Ci) in the control room at time = t

The equation which expresses the activity outside the control room from containment leakage is:

$$C_{at}(t) = \lambda_{L_{1j}} A_I(0)\, X/Q_j e^{-(\lambda_{d_i} + \lambda_{c_{1_{ij}}} + \lambda_{L_{1j}})t} f_s \qquad (2)$$

where: f_s = fraction of activity which is released from secondary containment = (1 - Filter Effeciency/100)

$\lambda_{L_{1j}}$ = containment leakrate or RHR leakage (1/HR) during time step j.

$A_i(0)$ = initial activity of isotope in the containment atmosphere or RHR system.

X/Q_j = atmospheric dispersion coefficient during time period j.

$\lambda_{cl_{ij}}$ = removal coefficient for containment air recirculation fans for isotope i and time period j for containment release

= 0.0 for Millstone I

After substituting equation 2 into equation 1 and integrating equation 1, we obtain:

$$A_{cr}(t) = \frac{\lambda_{L_{1j}} A_i(0)\ X/Q_j\ TR_j e^{(\lambda_{di} + \lambda_{c_{2_i}} + \lambda_{L_{2_j}})t} f_s}{\lambda_{c_{1_{ij}}} + \lambda_{L_{ij}} - \lambda_{c_{2_{ij}}} - \lambda_{L_{2_j}}}$$

$$\times\ (1-e)^{-(\lambda_{c_{1_{ij}}} + \lambda_{L_j} - \lambda_{c_2} - \lambda_{L_{2_j}})t} + A_{cr_i}(0)e^{-(\lambda_{di} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}$$

where: all parameters are as defined previously.

The integrated activity (Ci - Hrs) can be obtained by integrating the above equation with respect to time.

$$A_{I_{cr}}(t) = \int_0^t A_{cr}(t)\ dt$$

$$A_{I_{cr}}(t) = \frac{\lambda_{L_{1j}} A_i(0)\ X/Q_j\ TRI_j f_s}{(\lambda_{cl_{ij}} + \lambda_{L_{ij}} - \lambda_{c_{2_{ij}}} - \lambda_{L_{2_j}})} \left[- \frac{e^{-(\lambda_{di} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}}{(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})} \right.$$

$$+ \frac{e^{-(\lambda_{c_{1_{ij}}} + \lambda_{L_{1j}} + \lambda_{d_i})t}}{(\lambda_{c_{1_{ij}}} + \lambda_{L_{1_j}} + \lambda_{d_i})} + \frac{1}{(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})}$$

$$- \left. \frac{1}{(\lambda_{c_{1_{ij}}} + \lambda_{L_{ij}} + \lambda_{d_i})} \right] + \frac{A_{cr}(0)(1-e)^{-(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}}{(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})}$$

B. Dose Calculation

1. General

The dose calculation was based on 18 isotopes, 5 of which were iodines and 13 noble gas. Activity levels were based on equilibrium core levels and were obtained using the methodology employed in TID-14844. Thyroid, whole body, and skin dose conversion factors were obtained from Regulatory Guide 1.109, Revision 1.

2. Thyroid

The thyroid dose was computed using the following equation:

$$D_{thy} = \sum_{j=1}^{n} \frac{BR}{V} \sum_{i=1}^{n} IA_{cr_{ij}}(t) \times DCF_i$$

where: BR = breathing rate = 3.47×10^{-4} in^3/sec

DCF_i = adult thyroid dose conversion factor for isotope i (rem/Ci inhaled)

V = control room volume (m^3)

$IA_{cr_{ij}}(t)$ = integrated activity (Ci-Hrs) from isotope i during time period j.

3. Whole Body

The whole body dose was based on activity concentrations which exist in the control room. A semi-infinite cloud dose was obtained using the dose conversion factors from Regulatory Guide 1.109, Revision 1. Since the control room personnel are in a less than infinite cloud source, a correction factor was based on assuming an average gamma energy of .77 MeV for noble gas at t = 0 after the accident. The correction factor was determined using the following equation:

$$PF = \frac{D\gamma_\infty}{D\gamma_R} = \frac{\int_0^{\pi 2}\int_0^{\frac{\pi}{2}}\int_0^{\infty} \frac{S_v e^{-\mu R}}{4\pi R^2} B(\mu R) DCF\ R^2\ dR\ \sin\phi d\phi d\theta}{\int_0^{2\pi}\int_0^{\frac{\pi}{2}}\int_0^{R} \frac{S_v e^{-\mu R}}{4\mu R^2} B(\mu R) DCF\mu R^2\ dR\ \sin\phi d\phi d\theta}$$

where: S_v = volume source (MeV/cm^3-sec)

μ = attenuation coefficient for air

R = distance from dose point to incremental volume dV

$B(\mu R)$ = buildup factor for air

DCF = dose conversion factor $\left(\frac{\text{mRem-Hr}}{\text{MeV/cm}^2\text{-sec}}\right)$

$R^2 dR\ \sin\phi d\phi d\theta$ = volume increment

$$PF = \frac{1097}{V^{.338}}$$

Therefore, the whole body dose to control room operators is:

$$Dose_{WB} = \frac{\text{Semi Infinite Cloud Dose}}{PF}$$

4. Beta Dose

The beta dose was calculated using the semi-infinite cloud dose model based on the concentration of activity in the control room. This method is appropriate because of the relatively short range of beta particles in air.

A computer code CRADLE (Reference 2) was developed to implement the methodology discussed in this section.

III. Discussion

The control room radiological dose analysis is consistent with the assumptions stated in the Millstone I SEP LOCA reanalysis submittal. NNECo has postulated no seismic event coincident with a LOCA which is consistent with the NNECo position stated in Reference 5.

As described in Section 3, the modified control room ventilation system will consist of isolating the control room and providing recirculated filtration with a means of drawing in outside air at selected periods. Radiation monitors in the intake will automatically cause isolation of control room and initiate the recirculated ventilation filtration system upon a high radiation signal. Actual filtration flow rates and filter sizes have not been finalized because NNECo is currently exploring the possibility of reducing the MSIV leakage. Some means of reducing the MSIV leakage may be included pending an engineering review of this system. Reduction of MSIV leakage will significantly decrease the recirculated flow requirements. A radiological evaluation of the doses, however, was performed assuming no mitigation of MSIV leakage.

The assumptions used regarding the control room ventilation system are:

1. Control Room Volume = 150,500 ft^3 (includes computer room volume)
2. Unfiltered Inleakage = 60 cfm (NNECo intends to reduce the potential for inleakage [see Section 3])
3. Control Room Recirculation Flowrate = 10,000 cfm
4. Control Room Filter Efficiency = 95%
5. Control Room Makeup Air Reguirement = 10,000 cfm for 15 to 20 minutes every 4½ days assuming an average occupancy of 10 people in the control room.
6. Damper Closure Time = 5 seconds
7. Normal Makeup Air Flowrate = 2600 cfm

It is also assumed that significant release of fission products from the fuel does not occur until one minute after pipe rupture.

In addition to determining the control room dose from a design basis LOCA at Millstone I, NNECo has analyzed the effect of accidents at Millstone II and Millstone III on the Millstone I control room. Tables 3A to 3C list the assumptions used regarding the accident at each of the plants.

IV. Results

Table 3D lists the results which were calculated for the 30 day dose to control room operators.

Also listed in Table 3D are the results of the shielding analysis.

V. Conclusions

Based on the assumptions used in this analysis and the Millstone I LOCA SEP analysis, it is evident that modifications will have to be made to the Millstone I control room ventilation system and/or MSIV leakage. An engineering analysis will determine what modifications will be most effective to reduce doses to within the requirements of GDC19.

TABLE 3A

MILLSTONE I LOCA
(Containment Contribution)

Assumption	Basis
1. Containment Volume = 256,800 ft^3	Millstone I FSAR
2. Fission Produce Release @ t = 1 minute 25% iodine 100% noble gas	Reg. Guide 1.3/Section III
3. Iodine Form: 91% elemental 4% organic 5% particulate	Reg. Guide 1.3
4. Containment Leakrate	Reference 4

Time Period	Leakrate
(0-100) sec.	1.0%/day
(100 sec.-30 days)	0.765%/day

Assumption	Basis
5. Negative Drawdown Time on Reactor Building = 0.0 sec	Reference 4
6. SGTS Filter Efficiencies 90% all forms of iodine	Millstone I Tech. Specs.
7. Millstone I Stack X/Q's (sec/m^3):	Reference 3

Time Period (hr)	X/Q (sec/m^3)
(0-8) hr	2.51×10^{-9}
(8-24) hr	1.00×10^{-9}
(24-96) hr	2.51×10^{-10}
(96-720) hr	3.98×10^{-11}

TABLE 3A (Continued)

Assumption	Basis
8. Breathing Rate = 3.47×10^{-4} (m^3/sec)	Reference 3
9. Core Thermal Power Level = 2011 Mwt	FSAR

MSIV Leakage Contribution

Assumption	Basis
1. Activity Available For Release From Containment: 25% iodines 100% noble gas	Reg. Guide 1.3
2. Free Air Volume of Condenser and and associated piping = 71,754 ft^3	Reference 4
3. Leakage From Containment Into Condenser 60.4 scfh $0 < t \leq 100$ sec 46.0 scfh $t > 100$ sec	Reference 4
4. Condenser X/Q's:	Reference 3

Time Period	X/Q
(0-8) hr	3.83×10^{-3}
(8-24) hr	2.79×10^{-3}
(24-96) hr	1.18×10^{-3}
(96-720) hr	4.35×10^{-4}

Main Steam Drain Lines

Assumption	Basis
1. Activity Available for Release From Containment: 25% core iodine 100% core noble gas	Reg. Guide 1.3
2. Free Air Volume of Condenser = 69,700 ft^3	Reference 4
3. Leakage From Containment Into Condenser Through Main Steam Drain Lines: $0 \leq t$ 100 sec, L = 0.045%/day $t >$ 100 sec, L = 0.034%/day	Reference 4

TABLE 3B

MILLSTONE II LOCA ASSUMPTIONS

Assumption	Basis
1. Core Power Level = 2700 Mwt	Millstone II FSAR
2. Core Release Fractions @ t = 1 minute 25% iodines 100% noble gas	Reg. Guide 1.4/Section III
3. Iodine Composition 91% elemental 4% organic 5% particulate	Reg. Guide 1.4
4. a) Assumed Ground Level Unfiltered Release from 60 seconds to 110 seconds	Millstone II Tech Spec/ Section III
b) Release through EBFS and out Millstone I stack for t >110 seconds	Seismic event not assumed per Reference 5
5. Containment Free Air Volume = 1.899 x 1 ft^3	Millstone II FSAR
6. X/Q's (sec/m^3) (from Unit 2 Containment)	Reference 3
7. Containment Leakrate: L = .5%/day, t<24 hrs L = .25%/day, $\overline{t}$>24 hrs	Millstone II Tech Spec/ Reg. Guide 1.4

Time Period	X/Q (sec/m^3)
(0-8) hr	1.25×10^{-3}
(8-24) hr	8.30×10^{-4}
(24-96) hr	3.17×10^{-4}
(96-720) hr	7.29×10^{-5}

TABLE 3C

MILLSTONE III LOCA ASSUMPTIONS

Assumption	Basis
1. Core Thermal Power Level = 3565 Mwt	PSAR
2. Containment Leakrate = 0.9%/day	PSAR
3. Bypass Leakage = 0.42%	PSAR
4. Containment Volume = 2.32×10^6 ft^3	PSAR
5. Activity Release Fractions @ t = 1 minute: 25% core iodines 100% core noble gases	Reg. Guide 1.4/ Section III
6. Iodine Composition Elemental = 91% Organic = 4% Particulate = 5%	Reg. Guide 1.4
7. Assumed Time for EBFS to Reach .25 lbs/in^2 negative pressure = 1 minute	PSAR
8. Ground Level X/Q's from Millstone III Containment:	Reference 3

Time Period	X/Q
(0-8) hr	4.85×10^{-4}
(8-24) hr	3.18×10^{-4}
(24-96) hr	1.17×10^{-4}
(96-720) hr	2.17×10^{-5}

TABLE 3D

MILLSTONE I CONTROL ROOM DOSES (REMS) FROM A DBA LOCA

gan	Millstone I LOCA					Millstone II LOCA			Millstone III LOCA		
	Containment	MSIV	M. S. Drain	Shielding	Total	Containment	Shielding	Total	Containment	Shielding	Total
yroid	1.1×10^{-4}	2.55×10^{1}	1.17×10^{0}	-----	2.67×10^{1}	2.97×10^{-1}	-----	2.97×10^{-1}	8.04×10^{-1}	---	8.04×10^{-1}
ole Body	2.2×10^{-6}	2.5×10^{-2}	1.08×10^{-3}	7.67×10^{-1}	7.93×10^{-1}	3.07×10^{-3}	2.72×10^{-1}	2.75×10^{-1}	7.77×10^{-3}	---	7.77×10^{-3}
in	3.2×10^{-5}	4.7×10^{-1}	2.09×10^{-2}	----	4.91×10^{-1}	4.41×10^{-1}	----	4.41×10^{-2}	1.14×10^{-1}	---	1.14 x 10-1

REFERENCES

1. Letter, W. G. Counsil to Darrell G. Eisenhut, transmitting Haddam Neck Plant, Millstone Nuclear Power Station, Units 1 and 2 Post-TMI Requirement, Implementation of NUREG -737, dated December 31, 1980.

2. Miller, D. W., CRADLE computer code, "Control Room Accident Dose Level Evaluations," Revision 1, February, 1981.

3. Murphy, K. G., and Campe, K. M., "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Design Criterion-19," Preaented at the 13th AEC Air Cleaning Conference.

4. Letter, W. G. Counsil to D. M. Crutchfield, dated June 30, 1981.

5. Letter, W. G. Counsil to R. Reid, dated March 1, 1979.

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Docket No. 50-336

Enclosure 3

Millstone Unit No. 2

Post TMI Requirements - Response to NUREG-0737

July, 1981

Docket No. 50-336

Millstone Unit No. 2

Index

Item No.	Description
11.D.1	Relief and Safety Valve Testing
11.E.4.2	Containment Isolation Dependability
11.F.1.3	Containment Hi-Range Radiation Monitor
11.K.3.1	Auto PORV Isolation
11.K.3.5	Auto Trip of RCP's
111.D.3.4	Control Room Habitability

11.D.1 Relief and Safety Valve Testing

By letter dated July 1, 1981, R. C. Youngdahl transmitted the Interim Data Report for the EPRI PWR Safety and Relief Valve Test Program. This report summarizes the test data collected to date on relief and safety valves. Millstone Unit No. 2 has Dresser 31533VX-30 relief valves and Dresser 31739A Safety Valves. Relief and safety valves representative of the above valves are being tested in the EPRI program. NNECO will submit evaluations and other plant specific data on a schedule consistent with the R. C. Youngdahl letter of December 15, 1980 and modified on July 1, 1981.

11.E.4.2 Containment Isolation Dependability

Position 7 of Item 11.E.4.2 of Reference (1) requires that containment purge and vent valves automatically isolate on a high radiation signal. Millstone Unit No. 2 has two systems for purging and venting of the containment. The 42-inch butterfly valves on the large purge lines locked closed during operational modes, as required by Amendment 61 to DPR-65. The 6-inch vent valves automatically isolate on high containment pressure or low pressurizer pressure. NNECO has determined that these diverse signals are adequate to ensure that the vent valves will isolate when required, and as such, no modifications are planned. In the event of a loss of coolant accident, the high containment pressure and low pressurizer pressure signals would precede a high radiation signal and isolate the containment. Thus, the addition of a high radiation signal is neither desirable nor necessary to ensure safe operation of Millstone Unit No. 2.

For these reasons, no modifications to the containment isolation logic at Millstone Unit No. 2 are planned. This position was previously noted to the Staff in Reference (6).

11.F.1.3 Containment Hi-Range Radiation Monitor

Item 11.F.1.3 of Reference (1) states that "in-situ calibration by electronic signal substitution is acceptable for all range decades above 10 R/hr. In-situ calibration for at least one decade below 10 R/hr shall be by means of calibrated radiation source."

In-situ calibration by electronic signal substitution at the detector is not feasible or necessary for the following reasons:

1. Cable connections to detectors in containment are environmentally sealed and are not designed to be disassembled on a regular basis.

2. The required in-situ calibration for one decade below 10 R/hr by means of a calibrated radiation source will serve to functionally check the detector and the cables from the detectors to the indicating modules in the control room.

For the above reasons, NNECO intends to perform calibration by electronic signal substitution of the indicating module in the instrument calibration facility rather than in-situ.

Section 11.F.1.3 of Reference (1) also requires that prior to initial use, each detector must be calibrated to at least one point per decade of range between 1 R/hr and 10^3 R/hr by means of a calibrated radiation source. The detectors already installed at Millstone Unit No. 2 have been calibrated at the manufacturers facility for 35 R/hr. Since NNECO does not possess a portable calibration source of 100 R and in-situ testing as indicated above is not possible, NNECO will not meet the NRC calibration requirements for the Millstone Unit No. 2 detectors.

11.K.3.1 Auto PORV Isolation

As required by Item 11.K.3.2 of Reference (1), a study was undertaken to determine the need for an automatic PORV isolation system at Millstone Unit No. 2. In Reference (14), NNECO informed the Staff that the modifications which have already been implemented at Millstone Unit No. 2 have reduced the probability of a LOCA caused by a stuck-open PORV to an acceptably low level, and that an automatic isolation system for the PORV's was not required. NNECO reiterates this position and, therefore, no further work on Item 11.K.3.1 is planned.

11.K.3.5 Auto Trip of RCP's

Implementation of this requirement has been deferred pending issuance of further Staff requirements. As such, no information is provided here.

Millstone Nuclear Power Station, Unit No. 2

CONTROL ROOM HABITABILITY STUDY

1.0 INTRODUCTION

The purpose of this submittal is to satisfy the requirements delineated in Action Item III.D.3.4 of NUREG-0737, Control Room Habitability. The specific references and sources of information employed in this evaluation will be identified in the context of the evaluation.

2.0 EVALUATION

2.1 Information Required for Control Room Habitability Evaluation

Attachment 1 provides the information required to be submitted for independent evaluation.

2.2 Toxic Gas/Chemical Analysis

2.2.1 On-Site Chemical Storage

A complete review of the Millstone Unit No. 2 site was performed to determine the types and quantities of chemicals considered to be hazardous in accordance with Regulatory Guides 1.78 and 1.95. Table 1 provides a complete listing of the various hazardous chemicals stored at the site along with their quantities and storage locations.

In accordance with the guidance provided by Regulatory Guides 1.78 and 1.95, and the methodology delineated in NUREG-0570, the below listing identifies the chemicals stored on-site at Millstone that have the potential to adversely affect control room personnel.

Chlorine
Ammonia
Sulfuric Acid

Attachment 2 and its associated appendix (Appendix 1 to Attachment 2) provide a detailed review of the potential accidents on-site involving these chemicals along with a summary of the results of this review.

2.2.2 Off-Site Manufacturing and Storage of Hazardous Chemicals

A review of the applicable plant documentation and surrounding areas was performed. Based upon this review, no significant manufacturing or storage facilities of hazardous chemicals have been identified within a five (5) mile radius of the Millstone site.

2.2.3 Transportation of Hazardous Chemicals

In the vicinity of the Millstone complex, highway, rail and waterway represent the modes of transportation that require consideration in the hazardous chemical evaluation.

The site is traversed from east to west be a railroad right-of-way of Conrail. The mainline tracks are approximately .5 miles from the Millstone Unit No. 2 control room. Table 2 (attached) provides a listing of the hazardous chemicals which were transported in the vicinity of Millstone by Conrail for the period of January 1978 through June 1979. In accordance with the guidance provided by Regulatory Guides 1.78 and 1.95, only the explosion of propane on the rail line is considered to be a potential hazard to the control room personnel.

The major highway in the vicinity of Millstone is U. S. Route 95. The hazardous materials transported on Route 95 are again primarily gasoline, fuel oil, and propane. Considering the fact that U. S. Route 95 is located at a distance of 4.2 miles from Millstone, the maximum quantity normally transported by truck is 8,000 gallons and all trucking of hazardous materials is done in accordance with state and federal "DOT" requirements, only the explosion of propane in transit on Route 95 is considered to have the potential to adversely affect control room personnel.

Attachment 2 provides a detailed review of the potential explosions of propane on the railroad and highway in the vicinity of Millstone.

The shipping channels of Long Island Sound require any freighters, tankers, and barges remain a minimum of two (2) miles off-shore to preclude running aground on Barlett Reef. In addition to the shipping off Long Island Sound, the Thames River, located 4.2 miles from Millstone, represents a major waterway in the vicinity of Millstone upon which freight is shipped. The primary cargo on the waterways is fuel oil and gasoline. Considering the distance from Millstone of the shipping and the fact that the Coast Guard monitors all freighters in this area, shipping on these waterways is not considered to represent a hazard to control room personnel.

2.3 Radiological Accident

Attachment 3 provides a complete radiological evaluation of the Millstone Unit No. 2 control room.

3.0 CONCLUSIONS

3.1 Toxic Chemicals

As identified in the analysis performed in Attachment 2 and its appendix, modifications will be required to the control room to ensure the control room remains below toxic levels during an on-site accident involving chlorine. The options being considered are as listed below.

(a) Increasing the charcoal filtration capability of the control room.

(b) Reducing control room unfiltered in-leakage.

(c) Pressurizing the control room after release of chlorine.

(d) Reducing the amount of chlorine stored on-site.

3.2 Radiological Accident

As identified in the analysis provided in Attachment 3, modifications will be required to the Millstone Unit No. 2 control room or to the Millstone Unit No. 1 main steam isolation valves, to reduce control room operator doses to levels set forth in GDC 19 and SRP 6.4. These modifications include modification of the control room filtration system, reducing unfiltered in-leakage, or installation of a MSIV leakage system on the Millstone Unit No. 1 main steam isolation valves. Figure IV provides a preliminary schematic of the proposed modifications.

3.4 Installation Schedule

NUREG-0737 requires an inservice date of January 1, 1983 for all control modifications. A review of the necessary equipment lead times along with coincident plant refueling outages required to complete these modifications for Millstone Unit No. 2 indicates that the implementation date of NUREG-0737 is not practicable. It is NNECO's current intention to complete implementation by January 1, 1984.

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.

   The control room ventilation system is a recirculation type. An enclosure building filtration actuation signal (initiated by a loss of coolant accident), auxiliary exhaust actuation signal (initiated by a fuel handling incident in the spent fuel pool area), or detection of chlorine in the intake duct will automatically shift the control room ventilation system into a complete recirculation mode of operation, in which all outside air dampers are closed and a portion of the recirculated air is bypassed through the control room filtration system.

2. Control Room Characteristics:

   (a) Control Room Air Volume:

   This volume will be defined as all areas presently included in the control room ventilation system.

   Control Room Air Volume: 77,000 ft^3

   (b) Control Room Emergency Zone:

   The areas listed below are presently included in the control room ventilation system:

   1. Shift Supervisor's Office
   2. Office
   3. Entrance Area
   4. Control Room
   5. Computer Room.

   (c) Control Room Ventilation System Schematic:

   The attached drawing, labeled Figure I, is a schematic of the Millstone Unit No. 2 control room ventilation system.

   (d) Infiltration Leakage Rate:

   The infiltration leakage rate based upon calculation is estimated at 123 cfm.

(e) High Efficiency Particulate Air (HEPA) Filter and Charcoal Adsorber Efficiencies:

HEPA -- $>$ 99% as per Technical Specification 4.7.6.1

Charcoal Adsorber -- $>$ 90% for methyl iodide as per Technical Specification 4.7.6.1

(f) Closest Distance Between Containment and Air Intake:

Closest Distance to Millstone Unit No. 2 Containment = 70'
Closest Distance to Millstone Unit No. 1 Containment = 180'

(g) Layout of Control Room, Air Intakes, Containment Building, and Chlorine, or Other Chemical Storage Facilities with Dimensions:

The attached drawing, labeled Figure II, provides a layout of the Millstone Unit No. 1 and Unit No. 2 site identifying the location of the air intake, containment building, sulfuric acid storage tanks, and chlorine tanks with associated dimensions.

The attached drawing, labeled Figure III, provides a layout of the Millstone Unit No. 1 and Unit No. 2 control rooms with associated dimensions.

(h) Control Room Shielding Including Radiation From Air Leakage From Penetrations, Doors, Ducts, Stairways, Etc.:

A control room shielding analysis is provided as Appendix 1 to this Attachment.
It should be noted that Appendix 1 contains some minor corrections to the shielding analysis submitted in Reference ([illegible]).

(i) Automatic Isolation Capability - Damper Closing Time, Damper Leakage, and Area:

An enclosure building filtration actuation signal, auxiliary exhaust activation signal or detection of chlorine in the intake duct will automatically shift the control room air conditioning system into a complete recirculation mode of operation, in which all outside air dampers are closed.

Damper Closing Time: 5 seconds

Intake Damper Leakage: 26 cfm

Intake Damper Area: Normal -- 8.25 ft^2
Minimum -- 2.25 ft^2

(j) Chlorine or Toxic Gas (Local or Remote):

The Millstone Unit No. 2 control room has provisions for isolation upon indication of chlorine in the supply air stream. These detectors are completely redundant and independent. In addition, chlorine detectors are located locally at both the intake structure and chlorine tank car storage area which alarm in the control room upon detection of chlorine in these areas. The control room does not contain any other toxic gas detectors local or remote.

(k) Self Contained Breathing Apparatus Availability (Number):

The Millstone Unit No. 2 control room contains two (2) self-contained air packs with additional air bottles as well as self-contained air packs at various designated sites in the plant.

(l) Bottled Air Supply (Hours):

The Millstone Unit No. 2 control room does not contain a bottled air supply with the exception of the self-contained breathing air packs and bottles identified in item (k).

(m) Emergency Food and Potable Water Supply:

No food is maintained in the Millstone Unit No. 2 control room, however Millstone Unit No. 1 normally maintains sufficient food for five (5) people for a period of five (5) days which is available if required. A bottled water supply of five (5) five-gallon containers is normally maintained in the control room.

(n) Control Room Personnel Capacity (Normal and Emergency):
A normal shift consists of 7 individuals. During an emergency, an average of 10 with a maximum of up to 20 can be expected.

(o) Potassium Iodide Drug Supply:

A supply of 2,000 pills is maintained on site.

3. On Site Storage of Chlorine and Other Hazardous Chemicals:

(a) Total amount and size of container:

Table 1 (attached) provides a complete listing of all identified hazardous chemicals stored on site.

(b) Closest distance from control room air intake:

Chlorine is the only chemical which has been identified as having the potential to adversely affect the control room personnel. The chlorine tank cars are located at a distance of 390 feet from the control room air intake for Millstone Unit No. 1 and 490 feet from the control room air intake for Millstone Unit No. 2.

4. Off-site manufacturing storage or transportation facilities of hazardous materials.

(A) Identify Facilities Within a Five (5) Mile Radius

No significant manufacturing or storage facilities have been identified. The only significant transportation facility within a five (5) mile radius is Conrail (railroad). Table 2 (attached) provides a listing of the hazardous chemicals which was transported in the vicinity of Millstone Units No. 1 and No. 2 for the January 1978 through June 1979 period.

(B) Distance from the Control Room

The mainline tracks of Conrail are approximately .5 miles from the Millstone Units No. 1 and No. 2 control rooms.

(C) Quantity of Hazardous Chemicals in One Container

Propane is the only chemical which has been identified as being transported in a frequency above the minimum of thirty (30) carloads per year as defined in Regulatory Guide 1.78. For the period of January 1978 through June 1979 the average quantity per carload was approximately 73 tons/tank car. Table 2 (attached) provides a complete listing of the rail traffic of hazardous material quantities in the vicinity of Millstone for the period January 1978 through June 1979.

(d) Frequency of Hazardous Chemical Transportation Traffic (Truck, Rail, and Barge):

Table 2 (attached) provides the frequency of rail traffic of hazardous materials in the vicinity of Millstone for the period of January 1978 through June 1979.

5. Technical Specifications:

(a) Chlorine Detection System:

Millstone Unit No. 2 Technical Specification 3.3.3.6, page 3/4 3-42, is applicable to the Millstone Unit No. 2 control room ventilation chlorine detection system.

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

Millstone Unit No. 2 Technical Specification 3.7.6.1 provides the testing and surveillance requirements applicable to the control room ventilation system.

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
1. Sulfuric Acid	MP1; 7000 gals	Sulfuric acid storage tank just north of the gas turbine building.
	MP2; 8000 gals	Elevation 4'6" condensate polishing facility.
2. Sodium Hydroxide 50% by Weight	MP1; 7500 gals	Caustic sol. storage tank just north of the gas turbine building.
	MP2; 7500 gals	Condensate polishing facility
3. Chloroethane	Negligible	N/A
4. Unisol	N/A	N/A
5. Hydrazine 35% by Weight (non-flammable)	MP1 One 55 gal drum	Reactor building; elevation 41'6" near RBCCW pumps.
	MP2 Two 55 gal drums	Elevation 14'6" northwest corner of turbine building.
	Site: Ten 55 gal drums	Warehouse No. 3.

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
6. Penetone Products	Penetone 724; Six 55 gal drums	Warehouse No. 3.
7. Penetone Formula 2101	N/A	N/A
8. Ammonia 30% by Weight	MP2; 1500 gals	Northwest corner; elevation 14'6" turbine building.
9. Acetone	Four 55 gal drums	Warehouse No. 3.
10. Nitrogen (Liquid)	MP1; 10,000 gal Seven 160 liter cylinders	Just west of condensate storage tank. Adjacent to radwaste and control buildings.
11. Hydrogen	108,333 scf/month	South end of site; adjacent to chlorine tank cars.
12. Acetaldehyde	N/A	N/A
13. Acrylonitrile	N/A	N/A

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

CHEMICAL	MILLSTONE	
	QUANTITY	LOCATION
14. Anhydrous Ammonia	N/A	N/A
15. Aniline	N/A	N/A
16. Benzene	Negligible	N/A
17. Butadiene	N/A	N/A
18. Butenes	N/A	N/A
19. Carbon Monoxide	N/A	N/A
20. Chlorine	Two 55 ton tank cars	South end of site adjacent to gas turbine building
21. Sodium Hypochlorite NaOCl 12½% by Weight	N/A	N/A
22. Ethyl Chloride	N/A	N/A
23. Ethyl Ether	N/A	N/A
24. Ethylene Dichloride	N/A	N/A

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

CHEMICAL	MILLSTONE	
	QUANTITY	LOCATION
25. Ethylene Oxide	N/A	N/A
26. Fluorine	N/A	N/A
27. Formaldehyde	Negligible	Environmental lab.
28. Helium	Four 20 ft^3 bottles Eight 213 ft^3 bottles	Gas bottle storage shed.
29. Hydrogen Cyanide	N/A	N/A
30. Hydrogen Sulfide	N/A	N/A
31. Methanol	15 gals	Chemistry lab.
32. Sodium Oxide	N/A	N/A
33. Sulfur Dioxide	N/A	N/A
34. Vinyl Chloride	N/A	N/A

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
35. Xylene	Negligible	N/A
36. Phosphoric Acid 60% by Weight	5700 gals	MP1: Radwaste; used for solidification. Scheduled to be replaced by Dow Process.
37. Ureaformaldehyde	5700 gals	MP1: Radwaste
38. Halon	MP1: Four 100# bottles	MP1: Computer room.
	MP2: One 22# bottle	MP2: Computer room.
	approximately 60#	Proposed for new MP2 computer room.
	MP2: Six 298# bottles	New records storage vault CPF building.
39. Carbon Dioxide - CO_2	MP1: Six 100# bottles	Turbine exciter.
	Six 75# bottles	Gas turbine building.
	One 750# tank	Turbine deck.
	MP2: Seven 75# bottles	Turbine exciter.
	17-75# bottles	Old records storage area.

TABLE 1

ON-SITE STORAGE OF CHLORINE AND OTHER HAZARDOUS CHEMICALS -- TOTAL AMOUNT AND LOCATION

	MILLSTONE	
CHEMICAL	QUANTITY	LOCATION
39. CONTINUED	One 750# tank Site: Three 75# bottles	Turbine deck. Flammable liquid storage building.
40. Nitrogen (Gas)	N/A	N/A
41. Argon (Gas)	N/A	N/A
42. Dimethyl-Amine	N/A	N/A
43. Sulfur Hexafluoride	N/A	N/A

TABLE 2

Railroad shipments of Hazardous Materials in the Vicinity of the Millstone Site from Janaury 1978 thru June 1979

Hazardous Material	Frequency - Number of Carloads from 1/78-6/79	Total Quantity (tons)
Chlorine	20	1593
Anhydrous Ammonia	8	639
Carbon Dioxide (Liquid)	9	725
Propane	66	4796
Ethyl Alcohol	22	1496
Rosin	1	33
Ammonium Nitiate	9	690
Hydrochloric (Muriatic) Acid	5	387

APPENDIX 1 TO ATTACHMENT 1

Control Room Shielding Analysis

A. Location and Description

The Millstone Unit 2 control room is located 122.5 feet from the containment center, on the 26'6" level. The south wall of the control room is a shared wall with the north wall of the MP-1 control room and is only a barrier to provide ventilation isolation for the control rooms and provides no shielding for either control room. The shielding is summarized in the Table of Assumptions from MP-2.

B. Criteria

All source terms are consistent with NUREG-0588, and include: 100% of the core noble gas inventory and 50% of the core inventory of iodines in the containment air; 50% of the core iodines and 1 % of the core solid fission product inventory in the water sources. Specific source strengths are from TID-14884.

C. Methodology

Three sources of radiation were considered in determining the control room doses from a Unit 2 DBA. They are:

1. Direct shine from the containment.
2. Direct shine from activity in the secondary containment (enclosure building).
3. Dose from the overhead plume from the 375 foot stack.

Doses from these sources were calculated in both the Unit 1 and Unit 2 control rooms.

The direct shine from the containment was determined using the QAD-P5F computer code. The containment was broken up into 27,000 source points and eight energy groups to simulate the entire gamma energy spectrum. A concrete density of 2.40 gm/cm^3 and an air density of .0012 gm/cm^3 were assumed in the calculations.

In calculating the direct dose from the enclosure building, total mixing of the primary containment activity leaking into the enclosure building was assumed. All the activity within the enclosure building was conservatively assumed to be released to the volume of the enclosure building directly opposite the control room. Buildup of the activity within the enclosure building was modeled using the TACT-III computer code. The source strengths from the TACT-III code were modeled into an eight energy group spectrum using the ISOTOPE code. These source terms were based on the highest curie level in the enclosure building which occurs at approximately 8 hours post LOCA. Only one half of the enclosure building volume was used as the source due to shielding by the containment. Doses were calculated using the QADP5F code.

The source terms, assumptions, and methodologies used to calculate the Unit 2 control room dose due to a Unit 1 DBA are presented in the Millstone Unit 1 Control Room Habitability Study.

D. Results

The results of the shielding analysis are tabulated on the attached sheet.

E. Conclusions

The analysis of the Millstone Unit 2 control room shielding shows that the 30-day whole body dose to the Millstone Unit 2 control room is 0.920 after a Unit 2 DBA and 0.060 rem after a Unit 1 DBA.

These doses were calculated using very conservative methods and assumptions. Therefore, the doses are expected to be an upper bound on the doses to the control room after any incident.

The doses computed here from sources outside the control room are well within the guidelines of General Design Criteria 19 of Appendix A to 10CFR, part 50 and are therefore acceptable.

It should be recognized that the total whole body dose cannot be determined until the final design details of the ventilation systems are complete and the dose from airborne sources within the control room are calculated.

MILLSTONE SITE

INTEGRATED 30-DAY WHOLE BODY DOSES, REM

	Millstone Unit 1 Control Room					Millstone Unit 2 Control Room				
	Overhead Plume	Direct Primary Cntnment.	Direct Secondary Cntnment.	Unit 1 Core Spray Line	Total	Overhead Plume	Direct Primary Cntnmnt.	Secondary Containment	Unit 1 Core Spray Line	Total
MP-1 DBA	0.007	0.002	0.028	0.730	0.767	0.007	Negligible	0.003	0.050	0.060
MP-2 DBA	0.003	0.210	0.063	-----	0.276	0.003	0.400	0.520	-----	0.920

MP-2 DBA ASSUMPTIONS

ASSUMPTIONS	BASIS
1. Core Power = 2700 Mwt	FSAR
2. Core Inventory	TID-14884
3. Core Release Fractions: 50% of equilibrium iodine activity 100% of equilibrium noble gas activity	NUREG-0588
4. Iodine Form 91% elemental 5% particulate 4% organic	Reg. Guide 1 4
5. Containment Leak Rate: .5%/day $\leq$ 24 hrs .25%/day $>$ 24 hrs	Tech. Spec.
6. EBFS Filter Efficiencies: 90% for elemental 70% for organic 90% for particulate	Tech. Specs.
7. By Pass Leakage Fraction: = 1.69% of containment leak rate	FSAR
8. Time for Enclosure Building to Reach .25 inches negative pressure = 110 sec	Tech. Specs.
9. Containment Volume: = 1.889×10^6 ft^3	FSAR
10. Containment shielding dimensions: walls = 3.75 feet dome = 3 feet	FSAR
11. Control Room Shielding: walls (except south), ceiling, and floor = 2 feet	NUSCO Dwg. #25203-2701 #25203-2701
12. X/Q's: (0-8) hrs. = 4.84×10^{-3} sec/m^3 (8-24) hrs. = 4.19×10^{-4} sec/m^3 (24-96) hrs. = 1.65×10^{-4} sec/m^3 (96-720) hrs. = 9.92×10^{-5} sec/m^3	W. G. Counsil letter to R. Reid dated December 15, 1978

ATTACHMENT 2

MILLSTONE UNIT NO. 2
HAZARDOUS CHEMICAL/MATERIAL ANALYSIS

1.0 EVALUATION OF POTENTIAL ACCIDENTS

In this attachment the potential effects of accidental releases of hazardous materials identified as having the potential to effect control room habitability are briefly discussed and summarized. These effects are calculated in accordance with NRC guidelines. The potential accidents stem from possible explosions from flammable materials or toxic clouds of materials that may be accidentally released outside of the control room.

The approach and procedures for the various calculations are contained in Appendix 1 to this attachment.

1.1 Potential for Explosions

Gaseous propane is a flammable material which has an explosive potential. An accidental release of propane will form a cloud that can drift toward a plant and explode, provided its concentration is within the flammability limits.

Regarding possible effects at Millstone Unit No. 2, propane is transported over the New London line (Conrail) which passes approximately 1,000 meters to the north of the Millstone power plant complex. Calculations indicate that, in the event of a railroad tank car accident at the point nearest the complex, the propane concentration in a cloud drifting nearest the complex would still be within the flammability limit. Based upon communications with Conrail, there have been no reported accidents on the New London line involving propane. NRC guidelines provide a means for estimating the risk of damage due to explosions or accidents involving tank car/trucks occurring near power plants in Regulatory Guide 1.91. Using the guideline, which considers the non-occurrence of accidents, the risk of damage at Millstone is calculated to be zero. Therefore, propane transportation by rail poses no hazard to control room personnel at the Millstone complex.

Propane is a commodity which is commonly transported on highways in the vicinity of Millstone Unit No. 2. As previously indicated, the major highway in the area of Millstone is approximately four (4) miles from the site. Considering the guidelines provided in Regulatory Guide 1.91, and above the distance, transportation of propane will not pose a problem to Millstone Unit No. 2.

1.2 Toxic Chemicals -- On Site

As previously discussed in Section 2.2.1 of this submittal, the chemicals stored on site at the Millstone site that have been identified as having the potential for adversely affecting control room personnel are listed below.

Sulfuric Acid
Ammonia
Chlorine

1.2.1 Sulfuric Acid

Sulfuric acid is stored at Millstone Units No. 1 and No. 2. The table below shows the amounts stored and distance to the control room intake plenum.

Amount	Distance to Control Room Intake Plenum
7000 gal	430 ft (131.0 m)

Concentration levels calculated at each control room intake were based on the following general conditions:

> total tank failure; ambient temperature - 38°C; continuous release of material; worst-case meteorological conditions; spill radius - 4.6 m.

Because of the low volatility of sulfuric acid the calculated concentration is very low; and has been determined to be 6.2×10^{-6} mg/m^3.

This is considerably below the H_2SO_4 toxicity limit of 2 mg/m^3 (Regulatory Guide 1.78). Therefore, failure of H_2SO_4 storage tanks at the site poses no threat to control room personnel.

1.2.2 Ammonia

Ammonia is stored at the Millstone complex. A 1,500 gallon tank of aqueous ammonia, 28% concentration, is stored in the northwest corner of the Unit 2 turbine building. The initial concentration calculations assume: (1) total tank failure with contents spreading over the entire floor of the turbine building; (2) ambient temperatur is 38°C; and (3) resulting cloud emanates from an open doorway in the northeast corner of the building and drifts directly toward the control room intake plenum under near-worst-case meteorological conditions. The distance is 73 m to the Millstone Unit No. 2 intake plenum. The resulting concentration, assuming failure of the existing tank dikes, is 108 mg/m^3, compared to the toxic level of 100 mg/m^3 (per Regulatory Guide 1.78). Considering the existing tank diking system, and making the conservative assumption the dikes are 15 m x 15 m, which will allow for some spillage, the decreased spill area reduces the rate of NH_3 evaporation resulting in a concentration of 17.4 mg/m^3. This is significantly below the above mentioned toxic level; therefore, ammonia is not considered a hazard to control room habitability.

1.2.3 Chlorine

Chlorine is stored at the Millstone complex. The present situation at Millstone does pose a problem in the event of an accidental release of chlorine under near-worst-case meteorological conditions. Two (2) 55 ton chlorine tanks are situated 150 m from the intake plenum of the Millstone Unit No. 2 control room. A computer program was written to determine the consequences of the worst case accident situation stemming from catastrophic total failure of the two tank cars under worst case meteorological conditions as well as assess the various options available to ensure control room personnel are protected from this accident.

The equations, assumptions, and meteorological conditions for assessing such a situation are presented and discussed in Regulatory Guides 1.78 and 1.95, and NUREG-0570. These were utilized along with the operating parameters of the Millstone Unit No. 1 control room (i.e., damper, isolation, and internal ventilation systems provided in Attachment 1) in making the assessments.

The specific conditions and assumptions for which the calculations were made included:

- wind speed; 1 m/sec, stability Class F
- ambient temperature: 38°C
- total tank failure; both tanks simultaneously
- 25% of spill flashed to cloud (Gaussian puff)
- remainder evaporates continuously until depleted (Gaussian plume)
- area of spill is calculated rather than assumed
- both puff and plume drift toward intake plenums
- above conditions remain constant for twelve (12) hours.

The various control room modification options reviewed included the following.

1. Modifying the flow rates through the charcoal filter system.
2. Reducing control room in-leakage after isolation.
3. Varying the delay times after detection of chlorine.
4. Pressurizing the control room after the chlorine spill for a specified period of time.

Based upon this review, it has been determined that it is feasible to reduce the control of the concentrations below toxic levels (45 mg/m^3 per Regulatory Guide 1.78) through modifications of the existing control room. Section 3 of this submittal will delineate the various modifications that are being considered to ensure control room habitability is not affected for the chlorine accident.

2.0 METHODOLOGY FOR H_2SO_4, NH_3, AND Cl_2

2.1 Sulfuric Acid

Because sulfuric acid (98% concentration) is relatively nonvolatile, no ashing into an H_2SO_4 cloud was assumed. Therefore, Equation 1 did not ply. Also, since the storage tanks are surrounded by a diking arrangement (24'9" x 28') Equation 5 was not applicable. Equation 3 was used to calculate vapor pressure; an ambient temperature of 311°K and pure H_2SO_4 was assumed (rather than 98% aqueous) to assure conservatism of the approximation. Equation 4 qas used to calculate the H_2SO_4 evaporation rate, which provides the source emission rate for Equation 2. The evaporation computations were based on the following calculated inputs: spill area, 65 m^2; vapor pressure, .00057 mm Hg; equivalent dike diameter, 900 cm; the Hd term was calculated for laminar flow. Ambient temperature and wind speed were assumed to be 38°C and 1m/sec. The resulting evaporation rate was calculated as 0.0659 ug/sec. Equation 2 was then used to calculate H_2SO_4 concentrations at the appropriate distance for the Millstone Unit No. 2 control room. The initial H_2SO_4 plume width (yo) was based on the radius of a circle with an area equivalent to that of the area enclosed by the dikes (65 m^2). The worst case meteorological conditions were 1m/sec and stability Class F. The H_2SO_4 concentration was calculated to be 6.2×10^{-6} mg/m^3.

2.2 Ammonia

Ammonia at 28% concentration is stored in the Millstone Unit 2 turbine buidling in a single 1,500 gallon tank. Vapor pressure measurements were obtained for various NH_3 solution concentrations and temperatures reported at Millstone. At 80°F, 30% NH_3 has a vapor pressure of 15.2 lb/in^2, or about 760 mm Hg for 28% NH_3.

The spill area resulting from a total failure of the tank was calculated in two ways, both of which yielded similar results. Equation 5 yielded about 38×10^6 cm^2. However, the total floor area was 42×10^6 cm^2; therefore, evaporation was based on the total floor area to be conservative. Equation 4 yielded an evaporation rate of 0.52 ug/sec.

The source geometry is complicated. For the calculation, the NH_3 gas cloud was assumed to pass through a 5 x 5 meter door opening (25 m^2 cross-sectional area) which yielded an initial NH_3 plume size (yo) of 1.03 meters.

Because of the relatively low volatility of 28% NH_3 at 80°F, flashing into a puff would not take place. Therefore, only Equation 2 was used to estimate concentrations. The distance from the NH_3 emmission point to the Millstone Unit No. 2 air intake is 73 m. Under worst-case meteorology, the concentration was calculated to be 107.5 mg/m^3 compared to the toxicity limit of 100 mg/m^3 (Regulatory Guide 1.78). To provide a more realistic estimate of the actual concentrations, the conservative value of a 50 foot diking area was assumed, thus allowing for some spillage over the existing dike. The area rate was calculated as 0.084 g/sec, which yielded a concentration of 17.4 mg/m^3 at the Millstone Unit No. 2 air intake.

2.3 Chlorine

As previously stated in Section 1.2.3 of Attachment 2, two (2) 55 ton chlorine tanks are located at the Millstone complex, 150 m from the Millstone Unit No. 2 control room intake plenum.

As a result of the number of variables involved in the dynamics of the process that relates an accidental release of chlorine to the resulting concentration in the control room, a computer program was prepared to evaluate the consequences and assess the alternatives for preventing toxic levels from being reached in the control room. A general description of this program is discussed below.

Equations 1 through 7 are computerized in an interactive fashion that relates the amount of a volatile material (in this case, chlorine) that is released to the resulting concentration in the control room by considering the configuration of the release, the conditions under which it is released, transported, and diffused, the physical characteristics of the control room, and the operating characteristics of the control room (e.g., isolation time, in-leakage rate, charcoal filtration system). The following inputs are required:

(a) Volume of control room (m^3).

(b) Normal ventilation rate ($m^3 sec^{-1}$).

(c) Ventilation rate after isolation ($m^3 sec^{-1}$).

(d) Time delay between chlorine detection and damper close (sec).

(e) Concentration that triggers damper close ($mg\ m^{-3}$).

(f) Mass of the initial puff (g); 25% of the total mass released.

(g) Mass of the remaining material (g).

(h) Flow rate handled by charcoal filtering system ($m^3 sec^{-1}$).

(i) Time delay between chlorine detection and activation of charcoal filtering system (sec).

(j) Time delay between chlorine detection and positive pressure system activation (sec).

(k) Duration of positive pressure system operation (sec).

(l) Efficiency of charcoal adsorption (fraction).

(m) Time input to spill size equation (sec).

(n) Input spill area to override calculated area (cm^2).

(o) Wind speed ($m\ sec^{-1}$).

(p) Distance from spill to intake (m).

(q) Atmospheric stability class (E, F, G).

(r) Vapor density of material relative to air.

(s) Molecular weight of material.

(t) Total time simulated (hours).

The puff and plume models are activated in sequence such that the puff passes the intake first followed by the plume (which reflects steady state conditions after puff passage); however, the peak concentration resulting from the puff alone is maintained until the sum of the plume and puff concentrations at time t_i after puff passage is less than the peak due to the puff alone, after which the concentration decreases until the steady state concentration (plume) is reached.

APPENDIX 1 TO ATTACHMENT 3

APPROACHES AND SPECIFIC PROCEDURES FOR CALCULATING AFFECTS FROM ACCIDENTAL RELEASES OF SULFURIC ACID, AMMONIA, AND CHLORINE

1.0 APPLICABLE EQUATIONS

A number of equations are applicable for calculating the effects of the above materials. All those used in this analysis are summarized in NUREG 0570, and are presented below.

- Gaussian Puff Equation

$$\chi(x, y, z, h) = \frac{Q}{(2\pi)^{3/4}\sigma_{XI}\ \sigma_{YI}\ \sigma_{ZI}} \cdot \exp\left\{-\frac{1}{2}\left[\frac{x^2}{\sigma^2_{XI}} + \frac{y^2}{\sigma^2_{YI}}\right]\right\}$$

$$\cdot \left\{\exp\left[-\frac{1}{2}\ \frac{(z-h)^2}{\sigma^2_{ZI}}\right] + \exp\left[-\frac{1}{2}\ \frac{(z+h)^2}{\sigma^2_{ZI}}\right]\right\} \quad ①$$

Where χ = concentration (g/m^3)

Q = source strength (g) = m_{vo}

$\sigma_{XI}, \sigma_{YI}, \sigma_{ZI}$ = adjusted standard deviations of the puff concentration in the horizontal along-wind (X), horizontal cross-wind (Y), and vertical cross-wind directions (Z), respectively (m).

x, y, z = distances from the puff center in the X, Y, and Z directions, respectively (m). z is also the effective above-ground elevation of the receptor, e.g., the fresh-air intake of a control room.

h = effective above-ground elevation of the source.

To account for the initial volume of the puff, it is assumed that:

$$\sigma_{XI}^2 = \sigma'^2_{XI} + \sigma_0^2$$

$$\sigma_{YI}^2 = \sigma'^2_{YI} + \sigma_0^2$$

$$\sigma_{ZI}^2 = \sigma'^2_{ZI} + \sigma_0^2$$

$$\sigma_{XI}^2 = \sigma_{YI}^2$$

and letting $x = x_0 - ut$

$$\sigma_0 = \left[m_{vo}/(2^{1/2}\,\pi^{3/2}\,\rho_v\right]^{1/3}$$

where

σ_0 = initial standard deviation of the puff (m)

σ'_{XI}, σ'_{YI}, σ'_{ZI} = standard deviation of puff concentration in the X, Y and Z directions. respectively (m)

m_{vo} = mass of the instantaneously released puff (g)

ρ_v = density of the puff (g/m^3)

x_0 = ground distance between the source of spill and receptor (m)

u = wind speed (m/sec)

t = time after release (sec)

- Gaussian Plume Equation

$$\chi(x,y,z,h) = \frac{Q'}{2\pi u\sigma_Y \sigma_Z} \exp\{ (-\frac{y^2}{2\sigma_Y^2}) \} \{\exp [-\frac{(z-h)^2}{2\sigma_Z^2}] + \exp[-\frac{(z+h)^2}{2\sigma_Z^2}] \}$$ ②

where

σ_Y, σ_Z = standard deviations of the plume concentration in the Y and Z directions, respectively (m)

Q' = continuous source strength (g/sec)

y is also modified to account for initial plume size as is done in Equation 1.

- Equation for Obtaining Vapor Pressure

(Handbook of Chemistry and Physics)

$$\text{Log } P = (-0.2185\ A/K) + B \qquad (3)$$

where:

P = vapor pressure (mm Hg)

K = temperature (°K)

A = molar heat of vaporization (cal per gram-male)

B = constant of integration

Values of A and B are given in the above reference.

• Calculation of Evaporation Rates

(4)

$$(dm_v/dt) = h_d\, M\, A(t)\, (P_s - P_a)/R_g\, (T_a + 273)$$

where, for a laminar flow

$$h_d = 0.664\, \frac{D}{L}\, (Re)^{1/2}\, (Sc)^{1/3}$$

and for a turbulent flow

$$h_d = 0.037\, \frac{D}{L}\, (Re)^{0.8}\, (Sc)^{1/3}$$

Re = Reynold number = $L\, u\, \rho/\mu$

Sc = Schmidt number = $\mu/D\rho$

L = characteristic length (cm)

μ = viscosity of air (g/cm sec)

M = molecular weight of the liquid (g/mole)

P_s = saturation vapor pressure of the liquid at temperature Ta (mm Hg)

P_a = actual vapor pressure of the liquid in air (mm Hg)

h_d = mass transfer coefficient (cm/sec)

R_g = universal gas constant

D = diffusion coefficient (cm^2/sec)

u = wind speed (cm/sec)

ρ = density of air (g/cm^3)

- Calculation of Spill Size

$$A(t) = \pi \left\{ r_o^2 + 2t \left[\frac{gV_o}{\pi} \frac{(\rho_\ell - \rho)}{\rho_\ell} \right]^{1/2} \right\} \qquad (5)$$

and $V_o = \pi r_o^3$

where

r_o = initial radius of the spill (cm)

g = gravitational constant = 981 (cm/sec^2)

V_o = volume of the spill (cm^3)

ρ_ℓ = density of the liquid or gas (g/cm^3)

ρ = density of air (g/cm^3)

t = time (sec)

- Calculation of Concentration at Air Intake and Within Control Room

The concentration, Co, at the outside air intake at time t_i is:

$$C_o(t_i) = m_{v,\ puff} (\chi/Q)_{ti} + (dm_v/dt)_{ti,\ plume} (\chi/Q') \qquad (6)$$

The concentration build-up inside control room C_r in g/m^3, at time t_i is:

$$C_r(t_i) = C_r(t_{i-1}) + [C_o(t_i) - C_r(t_{i-1})]\,[1 - \exp(-WT/V_r)] \qquad (7)$$

where $T = t_i - t_{i-1}$

W = air flow rate in control room (m^3/sec)

V_r = control room air space (m^3)

T = time duration (sec)

ATTACHMENT 3

MILLSTONE UNIT II CONTROL ROOM
RADIOLOGICAL EVALUATION

I. General

A radiological analysis is given below based on the conceptual ventilation system design described in section 3.

II. Methodology

A. Activity

The dose analysis was based on the actual amount of activity which enters the control room via supply fans, doors and other inleakage paths. Filtration of iodine by the control room ventilation system was factored in the calculation. The activity distribution model is based on the following assumptions:

1. activity entering the control room is instantaneously mixed in the control room volume.
2. airflow into the control room = airflow out of the control room.
3. activity is instantaneously transported to the control room air intake immediately after release from the control volume.

The rate of change of activity in the control room is based on the following production and loss equation:

$$\begin{pmatrix}\text{rate of change}\\ \text{of activity in}\\ \text{control room}\end{pmatrix} = \begin{pmatrix}\text{rate at which}\\ \text{activity is}\\ \text{input}\end{pmatrix} - \begin{pmatrix}\text{rate at which}\\ \text{activity is}\\ \text{removed}\end{pmatrix}$$

The differential-equation which describe the time dependent change of activity is:

$$\frac{dA_{cr}(t)}{dt} = C_{At}(t) \times TR_I - (\lambda_{di} + \lambda_{c_{2i}} + \lambda_{L_2})A_{cr}(t) \qquad (1)$$

where: $\frac{dA_{cr}(t)}{dt}$ = rate of change of activity in the control room with respect to time

$C_{At}(t)$ = concentration of activity (Ci/m^3) in the atmosphere outside the control room at time = t

TR_I = rate at which air is being admitted into the control room (m^3/hr).

λ_{d_i} = decay constant for isotope i (1/hr)

λc_{2i} = internal control room removal constant by internal recirculated flow thru filters (1/hr) for isotope i.

λ_{L_2} = removal rate by outleakage from control room (1/hr)

$A_{cr}(t)$ = activity (Ci) in the control room at time = t

The equation which expresses the activity outside the control room from containment is:

$$C_{at}(t) = \lambda_{L_{1j}} A_i(0)\ X/Q_j\, e^{-(\lambda_{d_i} + \lambda_{c_{1_{ij}}} + \lambda_{L_{1j}})t} f_s \qquad (2)$$

where: f_s = fraction of activity which is released from secondary containment = (1 - Filter Efficiency)

$\lambda_{L_{1j}}$ = containment leakrate or RHR leakage (1/HR) during time step j.

$A_i(0)$ = initial activity of isotope in the containment atmosphere or RHR system.

X/Q_j = atmospheric dispersion coefficient during time period j.

$\lambda_{c1_{ij}}$ = removal coefficient for containment air recirculation fans for isotope i and time period j for containment release

= 0.0 for Millstone II.

After substituting equation 2 into equation 1 and integrating equation 1, we obtain:

$$A_{cr}(t) = \frac{\lambda_{L_{1j}} A_i(0)\, X/Q_j\, TR_j e^{(\lambda_{di} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t} f_s}{\lambda_{c_{1_{ij}}} + \lambda_{ij} - \lambda_{c_{2_{ij}}} - \lambda_{L_{2_j}}}$$

$$\times (1-e)^{-(\lambda_{c_{1_{ij}}} + \lambda_{L_j} - \lambda_{c_2} - \lambda_{L_{2_j}})t} + A_{cr}(0)e^{-(\lambda_{di} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}$$

where: all parameters are as defined previously.

The integrated activity (Ci - Hrs) can be obtained by integrating the above equation with respect to time.

$$A_{I_{cr}}(t) = \int_0^t A_{cr}(t)\, dt$$

$$A_{I_{cr}}(t) = \frac{\lambda_{L_{1j}} A_i(0)\, X/Q_j\, TR_j f_s}{(\lambda_{c1_{ij}} + \lambda_{L_{ij}} - \lambda_{c_{2_{ij}}} - \lambda_{L_{2_j}})} \Bigg[- \frac{e^{-(\lambda_{di} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}}{(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})}$$

$$+ \frac{e^{-(\lambda_{c_{1_{ij}}} + \lambda_{L_{1j}} + \lambda_{d_i})t}}{(\lambda_{c_{1_{ij}}} + \lambda_{L_{1_j}} + \lambda_{d_i})} + \frac{1}{(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})}$$

$$- \left. \frac{1}{(\lambda_{c_{1_{ij}}} + \lambda_{L_{ij}} + \lambda_{d_i})} \right] + \frac{A_{cr}(0)(1-e)^{-(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})t}}{(\lambda_{d_i} + \lambda_{c_{2_{ij}}} + \lambda_{L_{2_j}})}$$

B. Dose Calculation

1. General

The dose calculation was based on 18 isotopes, 5 of which were iodines and 13 noble gas. Activity levels were based on equilibrium core levels and were obtained using the methodology employed in TID-14844. Thyroid, whole body, and skin dose conversion factors were obtained from Regulatory Guide 1.109, Revision 1.

2. Thyroid

The thyroid dose was computed using the following equation:

$$D_{thy} = \sum_{j=1}^{n} \frac{BR}{V} \sum_{i=1}^{n} IA_{cr_{ij}}(t) \times DCF_i$$

where: BR = breathing rate = 3.47×10^{-4} in^3/sec

DCF_i = adult thyroid dose conversion factor for isotope i (rem/Ci inhaled)

V = control room volume (m^3)

$IA_{cr_{ij}}(t)$ = integrated activity (Ci-Hrs) from isotope i during time period j.

3. **Whole Body**

The whole body dose was based on activity concentrations which exist in the control room. A semi-infinite cloud dose was obtained using the dose conversion factors from Regulatory Guide 1.109, Revision 1. Since the control room personnel are in a less than infinite cloud source, a correction factor was based on assuming an average gamma energy of .77 MeV for noble gas at t = 0 after the accident. The correction factor was determined using the following equation:

$$PF = \frac{D\gamma_\infty}{D\gamma_R} = \frac{\int_0^{\pi 2} \int_0^{\frac{\pi}{2}} \int_0^{\infty} \frac{S_v e^{-\mu R}}{4\pi R^2} B(\mu R) DCF\, R^2\, dR\, \sin\phi d\phi d\theta}{\int_0^{2\pi} \int_0^{\frac{\pi}{2}} \int_0^{R} \frac{S_v e^{-\mu R}}{4\mu R^2} B(\mu R) DCF \mu R^2\, dR\, \sin\phi d\phi d\theta}$$

where: S_v = volume source (MeV/cm^3-sec)

μ = attenuation coefficient for air

R = distance from dose point to incremental volume dV

$B(\mu R)$ = buildup factor for air

DCF = dose conversion factor $\left(\frac{\text{mRem-Hr}}{\text{MeV/cm}^2\text{-sec}}\right)$

$R^2 dR \sin\phi d\phi d\theta$ = volume increment

$$PF = \frac{1097}{V^{.338}}$$

Therefore, the whole body dose to control room operators is:

$$\text{Dose}_{WB} = \frac{\text{Semi Infinite Cloud Dose}}{PF}$$

4. **Beta Dose**

The beta dose was calculated using the semi-infinite cloud dose model based on the concentration of activity in the control room. This method is appropriate because of the relatively short range of beta particles in air.

A computer code CRADLE (Reference 2) was developed to implement the methodology discussed in this section.

III. Discussion

In addition to determining the control room dose from a design basis LOCA at Millstone II, NNECo has also analyzed the affect of accidents at Millstone I and Millstone III on the Millstone II control room operators. Consistent with NNECo policy transmittal in Reference 5, we have assumed no seismic event coincident with a LOCA for Millstone I and Millstone II accidents.

As described in Attachment 1, the present Millstone II control room ventilation system consists of a 2000 cfm recirculation filtration system with automatic isolation. It is not clear whether the original analysis considered the affect of an accident at Millstone I on the Millstone II control room operators. A new Millstone I LOCA analysis performed for the SEP review, discovered a discrepancy in the manner in which the MSIV leakage was treated. This fact is discussed in our previous submittal of December 31, 1980. It is apparent after performing a radiological evaluation on the affect of MSIV leakage on the Millstone II control operators, that some modifications will be required to either the control room and/or MSIV leakage. Modification to reduce MSIV leakage will significantly decrease the control room recirculation filter flow requirement. A radiological evaluation of doses, however, was performed assuming the same model for MSIV leakage as indicated in Reference 4.

The assumptions used regarding the modified control room ventilation system are:

1. Control room volume = 77,000 ft^3
2. Unfiltered inleakage = 60 cfm (NNECo intends to reduce the potential for inleakage)
3. Control Room Recirculation Flowrate = 10,000 cfm
4. Control Room Filter Efficiency = 95%
5. Control Room Makeup Air Requirements = (10000 cfm filtered makeup for 40 minutes every 2 days assuming an average occupancy of 10 people in the control room)

It is also assumed that significant release of fission products from the fuel does not occur until one minute after pipe ruptures.

Assumptions regarding the radiological release for each of the three units are given in Tables 4A to 4C.

IV. Results

Table 4D lists the results which were calculated for the 30 day dose to control room operators.

Also listed in Table 4D are the results of the shielding analysis.

V. Conclusions

Based on the assumptions used in this analysis and the Millstone I LOCA SEP analysis, it is evident that modifications will have to be made to the Millstone II control room ventilation system and/or MSIV leakage from Millstone I. An engineering analysis will determine what modifications will be most effective to reduce doses to within the requirements of GDC19.

TABLE 4A

MILLSTONE I LOCA
(Containment Contribution)

Assumption	Basis
1. Containment Volume = 256,800 ft^3	Millstone I FSAR
2. Fission Produce Release @ t = 1 minute 25% iodine 100% noble gas	Reg. Guide 1.3/Section III
3. Iodine Form: 91% elemental 4% organic 5% particulate	Reg. Guide 1.3
4. Containment Leakrate	Reference 4

Time Period	Leakrate
(0-100) sec.	1.0%/day
(100 sec.-30 days)	0.765%/day

Assumption	Basis
5. Negative Drawdown Time on Reactor Building = 0.0 sec	Reference 4
6. SGTS Filter Efficiencies 90% all forms of iodine	Millstone I Tech. Specs.
7. Millstone I Stack X/Q's (sec/m^3):	Reference 3

Time Period (hr)	X/Q (sec/m^3)
(0-8) hr	2.00×10^{-9}
(8-24) hr	1.00×10^{-9}
(24-96) hr	2.51×10^{-10}
(96-720) hr	5.01×10^{-11}

TABLE 4A (Continued)

Assumption	Basis
8. Breathing Rate = 3.47×10^{-4} (m^3/sec)	Reference 3
9. Core Thermal Power Level = 2011 Mwt	FSAR
MSIV Leakage Contribution	
1. Activity Available For Release From Containment: 25% iodines 100% noble gas	Reg. Guide 1.3
2. Free Air Volume of Condenser and and associated piping = 71,754 ft^3	Reference 4
3. Leakage From Containment Into Condenser 60.4 scfh $0 < t \leq 100$ sec 46.0 scfh $t \geq 100$ sec	Reference 4
4. Condenser X/Q's:	Reference 3
Main Steam Drain Lines	
1. Activity Available for Release From Containment: 25% core iodine 100% core noble gas	Reg. Guide 1.3
2. Free Air Volume of Condenser = 69,700 ft^3	Reference 4
3. Leakage From Containment Into Condenser Through Main Steam Drain Lines: $0 \leq t$ 100 sec, L = 0.045%/day $t \geq$ 100 sec, L = 0.034%/day	Reference 4

Condenser X/Q's (item 4 above):

Time Period	X/Q
(0-8) hr	4.45×10^{-3}
(8-24) hr	3.05×10^{-3}
(24-96) hr	1.20×10^{-3}
(96-720) hr	3.68×10^{-4}

TABLE 4B

MILLSTONE II LOCA ASSUMPTIONS

Assumption	Basis
1. Core Power Level = 2700 Mwt	Millstone II FSAR
2. Core Release Fractions @ t = 1 minute 25% iodines 100% noble gas	Reg. Guide 1.4/Section III
3. Iodine Composition 91% elemental 4% organic 5% particulate	Reg. Guide 1.4
4. a) Assumed Ground Level Unfiltered Release from 60 seconds to 100 seconds	Millstone II Tech Spec/ Section III
b) Release through EBFS and out Millstone I stack for t >110 seconds	Seismic event not assumed per Reference 5
5. Containment Free Air Volume = 1.899×10^6 ft^3	Millstone II FSAR
6. X/Q's (sec/m^3) (from Unit 2 Containment)	Reference 3

Time Period	X/Q (sec/m^3)
(0-8) hr	2.69×10^{-3}
(8-24) hr	1.90×10^{-3}
(24-96) hr	7.56×10^{-4}
(96-720) hr	2.30×10^{-4}

Assumption	Basis
7. Containment Leakrate: L = .5%/day, t<24 hrs L = .25%/day, t>24 hrs	Millstone II Tech Spec/ Reg. Guide 1.4

TABLE 4C

MILLSTONE III LOCA ASSUMPTIONS

Assumption	Basis
1. Core Thermal Power Level = 3565 Mwt	PSAR
2. Containment Leakrate = 0.9%/day	PSAR
3. Bypass Leakage = 0.42%	PSAR
4. Containment Volume = 2.32×10^6 ft^3	PSAR
5. Activity Release Fractions @ t = 1 minute: 25% core iodines 100% core noble gases	Reg. Guide 1.4/ Section III
6. Iodine Composition Elemental = 91% Organic = 4% Particulate = 5%	Reg. Guide 1.4
7. Assumed Time for EBFS to Reach .25 lbs/in^2 negative pressure = 1 minute	PSAR
8. Ground Level X/Q's from Millstone III Containment:	Reference 3

Time Period	X/Q
(0-8) hr	4.78×10^{-4}
(8-24) hr	3.29×10^{-4}
(24-96) hr	1.20×10^{-4}
(96-720) hr	2.26×10^{-5}

TABLE 4D

MILLSTONE II CONTROL ROOM DOSES (REMS) FROM A DBA LOCA

Organ	Millstone I LOCA					Millstone II LOCA			Millstone III LOCA		
	Containment	MSIV	M. S. Drain	Shielding	Total	Containment	Shielding	Total	Containment	Shielding	Total
Thyroid	7.10×10^{-5}	2.44×10^{-1}	2.71×10^{0}	----	2.7×10^{1}	6.43×10^{-1}	----	6.43×10^{-1}	7.97×10^{-2}	----	7.97×10^{-2}
Whole Body	1.3×10^{-6}	2.14×10^{-2}	8.47×10^{-4}	5.97×10^{-2}	8.20×10^{-2}	1.02×10^{-2}	9.29×10^{-1}	9.39×10^{-1}	1.17×10^{-3}	----	1.17×10^{-3}
Skin	2.19×10^{-5}	4.86×10^{-1}	2.00×10^{-2}	----	5.06×10^{-1}	1.85×10^{-1}	----	1.85×10^{-1}	2.16×10^{-2}	----	2.16×10^{-2}

REFERENCES

1. Letter, W. G. Counsil to Darrell G. Eisenhut, transmitting Haddam Neck Plant, Millstone Nuclear Power Station, Units 1 and 2 Post-TMI Requirement, Implementation of NUREG -737, dated December 31, 1980.

2. Miller, D. W., CRADLE computer code, "Control Room Accident Dose Level Evaluations," Revision 1, February, 1981.

3. Murphy, K. G., and Campe, K. M., "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Design Criterion-19," Preaented at the 13th AEC Air Cleaning Conference.

4. Letter, W. G. Counsil to D. M. Crutchfield, dated June 30, 1981.

5. Letter, W. G. Counsil to R. Reid, dated March 1, 1979.

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