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Dominion

DEC 20 2001

Docket No. 50-423
B18553

RE: 10 CFR 50.90

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Millstone Nuclear Power Station, Unit No. 3
License Amendment Request Related to the Supplementary
Leakage Collection and Release System (PLAR 3-98-5)
Supplemental Information

The purpose of this letter is to provide supplemental information in support of the Nuclear Regulatory Commission (NRC) review of the License Amendment Request.[1][2] Specifically, Attachment 1 provides the revised dose consequences pertaining to the license amendment request. The revised dose assessment has been performed without reliance on time dependent mixing rates, but using a constant spray mixing rate as recommended in the Standard Review Plan 6.5.2.

This supplemental information will not affect the conclusions of the safety summary, significant hazards consideration discussion or the environmental consideration provided in the license amendment request (PLAR 3-98-5). For your convenience, a complete set of marked Final Safety Analysis Report (FSAR) pages reflecting the supplemental information and the June 6, 1998, submittal is included in Attachment 2.

There are no regulatory commitments contained within this letter.

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(1) M. H. Brothers letter to the U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 3 - Proposed License Amendment Request SLCRS Bypass Leakage (PLAR 3-98-5)," dated June 6, 1998.

(2) R. P. Necci letter to the U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 3, License Amendment Related to the Supplementary Leakage Collection and Release System (PLAR 3-98-5), Supplemental Information," dated September 28, 2000.

A017

Rec'd 01/23/02

If you should have any questions regarding the above submittal, please contact Mr. Ravi Joshi at (860) 440-2080.

Very truly yours,

DOMINION NUCLEAR CONNECTICUT, INC.

Raymond Necci

Raymond P. Necci, Vice President
Nuclear Operations - Millstone

Sworn to and subscribed before me

this 20th day of December, 2001

Sandra J. Anton

Notary Public

My Commission expires

SANDRA J. ANTON
NOTARY PUBLIC
COMMISSION EXPIRES
MAY 31, 2005

Attachments (2)

cc: H. J. Miller, Region I Administrator
V. Nerses, NRC Senior Project Manager, Millstone Unit No. 3
NRC Senior Resident Inspector, Millstone Unit No. 3

Director
Bureau of Air Management
Monitoring and Radiation Division
Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127

Attachment 1

Millstone Nuclear Power Station, Unit No. 3

License Amendment Request Related to the Supplementary Leakage Collection and Release System (PLAR 3-98-5)
Supplemental Information

License Amendment Request Related to the Supplementary Leakage Collection and Release System (PLAR 3-98-5) Supplemental Information

Background

In a letter dated June 6, 1998,[(1)] a license amendment request (PLAR 3-98-5) was submitted to the Nuclear Regulatory Commission (NRC) to reflect changes in the licensing basis for post-accident operation of the Supplementary Leakage Collection and Release System (SLCRS) as described in the Millstone Unit No. 3 Final Safety Analysis Report (FSAR).

In a letter dated April 5, 1999,[(2)] additional information was submitted to the NRC to support the Staff's requests dated August 20, 1998,[(3)] and January 25, 1999.[(4)] In May 1999, we verbally requested the NRC to temporarily suspend its review of the license amendment request. The suspension request was prompted by an internally identified concern related to the adequacy of the original licensing basis documentation supporting the determination of spray coverage within the free volume of containment. The concern related to the overall qualitative nature of the basis information supporting the original containment sprayed volume determination. Because the containment spray coverage determination is used to establish the iodine removal efficiency of the sprays, it has a direct impact on the associated post-accident dose assessment.

This matter was resolved by developing a formal calculation which accounted for spray pattern geometry, internal structural interference and post-loss of coolant accident (LOCA) pressure compression effects on overall spray distribution patterns. In addition, an enhanced containment mixing model was used to quantify the mixing rates for the unsprayed volumes in containment. An evaluation of the impact of these changes on the radiological analyses supporting the license amendment request (June 6, 1998, submittal - PLAR 3-98-5) was completed and results were submitted to the NRC on

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(1) M. H. Brothers letter to the U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 3 - Proposed License Amendment Request SLCRS Bypass Leakage (PLAR 3-98-5)," dated June 6, 1998.

(2) R. P. Necci letter to the U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 3 - License Amendment Related to the Supplementary Leakage Collection and Release System (PLAR 3-98-5), Response to Request for Additional Information," dated April 5, 1999.

(3) J. W. Andersen (U.S. NRC) letter to M. L. Bowling, Jr. "Millstone Nuclear Power Station, Unit No. 3 - Request for Additional Information (TAC NO. MA2035)," dated August 20, 1998.

(4) J. W. Andersen (U.S. NRC) letter to M. L. Bowling, Jr. "Millstone Nuclear Power Station, Unit No. 3 - Request for Additional Information (TAC NO. MA2035)," dated January 25, 1999.

September 28, 2000.[5] The submittal concluded that while several of the radiological assessment input parameters were changed, the analyses results and safety conclusion discussed in the original license amendment request (June 6, 1998, submittal) remained bounding.

During a conference call between the NRC Staff and Dominion Nuclear Connecticut, Inc. (DNC) personnel on August 29, 2001, the NRC raised questions related to the analysis of containment spray mixing rate during a design basis LOCA. Specifically the analyses uses an enhanced mixing model, which quantifies the spray coverage and the time dependent mixing rate between the unsprayed regions and the sprayed regions. The NRC indicated that additional information would be needed for approval of the application of the mixing model relied upon in the Millstone Unit No. 3 license amendment request. As noted the containment spray coverage and the derived mixing rates are used to establish the iodine removal efficiency of the sprays and therefore have an impact on the associated post-accident dose assessment. Therefore, in a letter dated September 21, 2001,[6] DNC committed to submit a revised dose assessment pertaining to this license amendment request, using an NRC approved methodology, prior to January 31, 2002.

Revised Dose Assessment

SLCRS is used to maintain the secondary containment under a negative pressure relative to atmospheric by collecting air from the enclosure building and the connecting areas, filtering it to remove iodines, and discharging to the atmosphere.

The potential release pathways were identified from secondary containment to the environment which could bypass the SLCRS filter after a LOCA. Although the SLCRS boundary is isolated by redundant safety-related dampers after the safety injection signal (SIS), certain non-nuclear safety grade fans (NNS) within the SLCRS boundary may remain running if offsite power is available. For instance, the Engineered Safety Features (ESF) supply fan receives trip signals from both trains of Safety Injection logic and will trip because of the redundancy. The exhaust fan, however, receives only a single isolation Safety Injection (SI) signal to the NNS starter. Bypass to the environment can occur through the closed boundary dampers if the supply fan HVQ-FN1 located in the Engineered Safeguards Features building trips but the exhaust fan 3HVQ-FN2 continues running. This scenario could create negative pressure in the fan

(5) R. P. Necci letter to the U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 3, License Amendment Related to the Supplementary Leakage Collection and Release System (PLAR 3-98-5), Supplemental Information," dated September 28, 2000.

(6) J. A. Price letter to the U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 3, Licensing Amendment Request Related to the Supplementary Leakage Collection and Release System (PLAR 3-98-5)," dated September 21, 2001.

suction ductwork and facilitate leakage through the closed dampers into vital areas, bypassing the SLCRS boundary.

Review of the plant ventilation systems identified five NNS fans whose operation after an accident may affect the analyzed doses to the vital areas. These fans are identified below (the list includes fan 3HVQ-FN2 for completeness) :

3HVV-FN1A and 1B	(Main Steam Valve Building exhaust fans)
3HVR-FN5 and 7	(Auxiliary Building exhaust fans)
3HVQ-FN2*	(ESF Building exhaust fan)

[* the fan does not receive a redundant trip signal from SIS. The remaining four fans receive redundant trip signals upon SIS]

These fans are not powered by vital power, so the scenarios evaluated assume that offsite power is available.

The license amendment request (PLAR 3-98-5) addressed the changes needed to ensure that all five fans are secured within one hour and 20 minutes after an accident, prior to shifting the control room ventilation into the filtration mode.

A revised radiological dose analysis has been completed which included the source term from the bypass leakage. The analysis recalculated the doses to the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) populations, as well as to the Control Room and Technical Support Center (TSC) vital areas. Three separate leakage scenarios were developed and analyzed, as described below:

Bypass Leakage for the EAB/LPZ Dose Analysis

For this case, NNS fans discharging from the secondary containment are assumed to continue operating, with leakage through associated boundary dampers, for the entire 30 day dose analysis period. A limiting single failure of a complete train of ESF equipment to operate is postulated, which results in only one of two redundant boundary dampers closing.

Bypass Leakage for the Unit 3 Control Room Dose Analysis

As in the LPZ/EAB case, a limiting single failure of a complete train of ESF equipment to operate is postulated. Only one of the two redundant boundary dampers close. NNS fans continue to run for 1 hour and 20 minutes after the accident. At that time the five fan breakers are assumed tripped. At 1 hour and 40 minutes, the control room ventilation system is aligned to the filtered recirculation mode and the control room is repressurized.

Bypass Leakage for the TSC Dose Analysis

For the TSC dose analysis, credit is taken for the NNS fan trip circuits to operate as designed. This means that fans 3HVV-FN1A and B, 3HVR-FN5 and 7 will trip, but fan 3HVQ-FN2 will continue to run until secured by an operator 1 hour and 20 minutes after the accident. The basis for this assumption is that it is consistent with the design basis for the TSC ventilation system, which is not a safety-grade system. A reliability analysis of the NNS fan trip circuit components demonstrated that the reliability of the NNS fan trip circuits is equal to, or better than, the NNS TSC ventilation system components which are relied upon to provide a level of protection for accident mitigation and support personnel.

The revised radiological dose consequences resulting from a postulated LOCA at Millstone Unit No. 3 are provided in the FSAR Table 15.0-8, 15.6-13 and 15.6-22 (Attachment 2 of this submittal) and below. Major assumptions used to perform the assessment are summarized in the FSAR Table 15.6-9, 15.6-12 and 15.6-21 (Attachment 2 of this submittal).

Radiological Consequences (Rem)

	(EAB) Exclusion Area Boundary	(LPZ) Low Population Zone	MP-3 Control Room	(TSC) Technical Support Center
Thyroid				
Existing FSAR	88	11	12	4.7
Revised Calculation	80	27	26	4.4
Limit	300	300	30	30
Whole Body				
Existing FSAR	8.2	1.3	1.9	1.1
Revised Calculation	4.0	0.83	1.1	0.67
Limit	25	25	5	5
Beta Skin				
Existing FSAR	N/A	N/A	12	14
Revised Calculation	N/A	N/A	21	14
Limit	N/A	N/A	30	30

Since the revised doses for the EAB, LPZ, the Millstone Unit No. 3 Control Room and TSC are within the appropriate exposure guideline values specified in 10 CFR 100 and General Design Criterion 19, the proposed license amendment is safe and acceptable.

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Attachment 2

Millstone Nuclear Power Station, Unit No. 3

License Amendment Request Related to the Supplementary Leakage Collection and Release System (PLAR 3-98-5)
Supplemental Information
Marked-Up FSAR Pages

License Amendment Request Related to the Supplementary
Leakage Collection and Release System (PLAR 3-98-5)
Supplemental Information
Marked-Up FSAR Pages

The attached marked-up pages reflects the currently issued version of the FSAR.

The affected FSAR Page #	Effective Date
6.4-7	December 1997
9.4-4	September 2000
9.4-5	September 2000
9.4-8	September 2000
15.4-36	March 1998
15.6-32	April 2000
15.6-33	April 2000
Table 15.0-8	January 2000
Table 15.0-11	March 1998
Table 15.4-4	March 1998
Table 15.6-9	January 2000
Table 15.6-12	March 1998
Table 15.6-13	January 2000
Table 15.6-21	March 1998
Table 15.6-22	January 2000
Appendix 15A	March 1998

Outdoor air is supplied to the control room envelope at a constant rate of 1,450 cfm ~~and is held constant~~ during normal plant operation. Mechanical exhaust is provided from the control room toilet and kitchenette exhaust fan at a rate of 595 cfm. Thus, a positive pressure is maintained during normal operation.

When the control room must be isolated in an emergency (LOCA or high radiation alarm from intake monitors) or by manual actuation, the outdoor air and the exhaust air isolation butterfly valves close. The air-conditioning units serving the control room envelope continue operating without outdoor air to maintain required humidity and temperature. Following a Control Building Isolation (CBI), the control room pressure envelope is pressurized from one of two banks of air storage tanks to 1/8 inch water gage pressure differential. Although the differential pressure may fluctuate, the control room pressure envelope maintains a positive pressure relative to surrounding area. After one hour, the isolation valves can be opened to divert outside air through the control room emergency ventilation filter. INSERT A In the event that inlet isolation valves fail to open, operators are able to manually open these valves using the manual jack screw operator. Since the location of these valves is within the control room habitability zone and the valves are designed for manual manipulation, control room personnel are able to open these valves within one hour and forty minutes following control room isolation. (97-355 8/97) (97-360 8/97) (94-30 12/94)

The pressurization system for the control building envelope has two banks of air tanks with its associated piping, instrumentation, and controls. Each bank is of 100-percent capacity and in case of failure of one bank, the other redundant bank starts automatically.

The calculated ventilation filter flow rate is 1,225 cfm (clean) and 1,000 cfm (dirty). The actual flow rate is in accordance with performance testing requirements which ensures that filter flow rates are maintained within an acceptable tolerance of design flow. The recirculation air rate from the control room to either filter return can be varied between 0 to 915 cfm. (96-55 1/97)

Redundant Seismic Category I radiation monitors are located at the outdoor air intake. If high radiation is detected in the intake air stream, the CBIVs are automatically closed. A smoke detector is also provided at the air intake and, if smoke is detected, the alarm is annunciated in the control room for operator action. The radiation monitor high alarm setting is discussed in the Technical Specifications. (97-354 9/97)

A 1-hour air supply is provided from the control room area pressurizing air storage tanks. (94-22 10/94)

6.4.4 Design Evaluation

The control room air-conditioning system maintains a suitable environment for personnel and equipment during normal and emergency conditions. Components of the air-conditioning and chilled water systems are designed to Category I criteria and are enclosed in a Category I control building with the exception of the air conditioning unit electric heaters which are Seismic Category II. Electric heat is not required during design basis events.

All intake and exhaust openings are tornado missile protected. Outside air is not used for the first hour after an accident. Outdoor air is filtered by one of the emergency ventilation filter assemblies.

a minimum of one

<u>INSERT A to Page 6.4-7</u>

After one hour, realignment of the control room ventilation system from the pressurization mode to the filtration/recirculation mode of operation can be initiated. In the event of a LOCA, operator action is credited to secure selected Main Steam Valve House, Auxiliary Building and Emergency Safeguards Features Building exhaust fans, specifically fans 3HVV-FN1A&1B, 3HVR-FN5&7 and 3HVQ-FN2 are secured. This action is completed within 20 minutes during which time the control room will depressurize to ambient pressure. The isolation valves are opened, to divert outside air through the control room emergency ventilation filter.

6. The purge ventilation subsystem consists of a supply and exhaust fan. Each fan is rated at 4,000 cfm.

7. Each battery room has an independent exhaust fan and associated ductwork. Air to these areas is drawn in from adjacent switchgear areas through louvers, filters, and grills. To make up for the battery room exhaust and to provide ventilation air in the switchgear areas, independent supply ducts with an axial fan rated at 1500 cfm, electric heating coils, and prefilters are provided.

The control room emergency ventilation filtration and pressurization system consists of redundant pressurization air storage tanks and two redundant emergency air filtration units. The air pressurization system operates during the first hour of an accident. After 1 hour, outdoor air can be introduced into the system through the emergency ventilation filtration unit. INSERT B

Each of the air-conditioning units is supplied with chilled water by the control building chilled water system. The control building chilled water system is redundant and consists of two 100 percent capacity water chillers, two 100 percent capacity chilled water pumps, and two expansion tanks. Each chiller is rated at 250 tons of refrigeration. Each chilled water pump is rated at 450 gpm. The chilled water piping is arranged in two redundant flowpaths to serve the control building air-conditioning unit cooling coils.

Each air-conditioning unit cooling coil has a flow control valve controlled by a thermostat in the respective area. The differential pressure control valve automatically maintains constant return flow to the chilled water pump by modulating bypass flow in proportion to varying air-conditioning system flow.

All Category I electrically-powered motors and controls associated with the control building air-conditioning and ventilation systems and the chilled water systems are redundant to ensure operability of the control building air-conditioning and ventilation as a result of a single failure of any component. In the event of a loss of power under either normal operating or accident conditions, emergency power is supplied from either the preferred offsite source or the emergency diesel generators.

All outside air supply and exhaust ducts for the control room pressure envelope air-conditioning system, kitchen-toilet exhaust system, and purge system are fitted with air-operated butterfly valves located as close as possible to the control building wall.

The control building is heated electrically. Area thermostats activate heating elements in the control room air-conditioning units to maintain a minimum design temperature. A control switch activates heating elements in the instrument rack and computer room air-conditioning units in the event heating is required. The mechanical equipment space is heated with electric unit heaters that are controlled separately from thermostats located in the room. The chiller equipment space is heated with electric duct heaters and electric unit heaters that are controlled separately from thermostats. Electric heaters are not required to function following loss of offsite power.

The control building purge ventilation system removes smoke or carbon dioxide from the instrument rack and computer room, the cable spreading area, switchgear rooms, and the mechanical equipment room (zoned with the control room) through administrative

INSERT B to Page 9.4-4

After one hour, realignment of the control room ventilation system from the pressurization mode to the filtration/recirculation mode of operation can be initiated. In the event of a LOCA, operator action is credited to secure selected Main Steam Valve House, Auxiliary Building and Emergency Safeguards Features Building exhaust fans, specifically fans 3HVV-FN1A&1B, 3HVR-FN5&7 and 3HVQ-FN2 are secured. This action is completed within 20 minutes during which time the control room will depressurize to ambient pressure. The isolation valves are opened, to divert outside air through the control room emergency ventilation filter. In the event that the inlet isolation valves fail to open, operators are able to open these valves within one hour and 40 minutes following a CBI.

controls. The system is designed to permit the operator to purge each space containing smoke or carbon dioxide by opening the supply and exhaust purge isolation dampers from outside that space.

9.4.1.3 Safety Evaluation

The control building air-conditioning, emergency ventilation filtration, and chilled water systems are Seismic Category I and QA Category I. Ventilation, except for the kitchen-toilet exhaust and the purge system, are Seismic Category I and QA Category I. All of the systems are enclosed in a Category I missile- and tornado-protected building.

The control building habitability envelope air bottle pressurization system is designed to ASME B and PV Code Section VIII, Division 1 and ANSI B31.1 standards. The air pressurization system is designed to Seismic Category I requirements.

A radiation monitor connected with the makeup air duct of the control room area air-conditioning units detects and respond to the presence of radioactivity. At the discretion of the operator, the emergency ventilation system can be started manually and the return air of the control room or the outdoor air supply diverted through the emergency ventilation filtration assembly.

High radiation detected by the monitors located in the air intakes result in control building isolation (Section 6.4).

During control building isolation, the air bottle pressurization subsystem supplies breathable air and maintains a positive pressure within the control room envelope. The air is discharged to the 64'6" elevation, from where the balanced control room air conditioning units maintain equal pressure between the two elevations of the envelope. The air intake isolation valves can be opened and emergency ventilation started following 1 hour of air bottle pressurization. These valves and emergency ventilation filter fans are manually operated from the main ventilation panel in the control room. The valves are located within the habitability zone and can be opened, in the event either valve fails to open by manual activation, with a rack screw operation. This design enables these valves to be opened within 1 hour following control room isolation.

INSERT C

The storage bottles are normally refilled via breathing air quality compressors. These are located in the turbine building. Additionally, a fill connection is located on the outside wall of the turbine building. Refilling is usually accomplished using breathing air quality air compressors. Alternately an air tank truck can be on site within 3 days for refilling purposes.

Fusible link fire dampers are provided on openings in fire barriers separating fire areas. The dampers automatically isolate the area affected by fire. Fire damper assemblies installed in ventilation ductwork common to redundant portions of this system consist of at least two fire dampers in parallel in order to preclude a single failure of one fire damper from impairing the safety function of the system. Administrative controls to shut down control room air-conditioning units in the event of a fire detection alarm within the control room envelope are used to ensure fire damper closure if a fire exists. Airtight doors, sealed penetrations and fire walls prevent smoke, heat, and carbon dioxide from entering the control room. A purge system is provided to remove smoke and carbon dioxide from

INSERT C to Page 9.4-5

After one hour, realignment of the control room ventilation system from the pressurization mode to the filtration/recirculation mode of operation can be initiated. The air intake isolation valves and the emergency ventilation filter fans are manually operated from the main ventilation panel in the control room. In the event of a LOCA, operator action is credited to secure selected Main Steam Valve House, Auxiliary Building and Emergency Safeguards Features Building exhaust fans, specifically fans 3HVV-FN1A&1B, 3HVR-FN5&7 and 3HVQ-FN2 are secured. This action is completed within 20 minutes during which time the control room will depressurize to ambient pressure. The isolation valves are opened, to divert outside air through the control room emergency ventilation filter. In the event that the inlet isolation valves fail to open, operators are able to manually open these valves using the manual jack screw operator. Since the location of these valves is within the control room habitability zone and the valves are designed for manual manipulation, control room personnel are able to open these valves within one hour and forty minutes following control room isolation.

running Train (A and B), or if the running chiller's outlet chilled water temperature is high, or if the running chilled water pump flow is low. Starting the standby chilled water pump causes a complete change over of air-conditioning trains. The train that was running is shut down and the standby train is started.

In normal operation, the chilled water pumps are not affected by a CBI signal. The CBI signal prevents the running pump from being manually stopped from the control room.

The chillers are provided with ON-STOP chiller safety circuit push buttons and START-STOP pushbuttons for local manual control. The chiller safety circuit is normally ON for both chillers. The chillers are started automatically when the associated chilled water pump is started.

Control room air-conditioning unit heaters are controlled by automatic temperature controllers. Instrument rack and computer room air-conditioning units are controlled by temperature switches in the event heating is required.

The control room pressure envelope area is automatically isolated from the outside atmosphere upon receipt of a CBI signal, and 60 seconds after a CBI signal is initiated, the control room is automatically pressurized with air from the control room pressurizing air storage tanks. These air tanks have a 1-hour supply of air. After this time, an emergency ventilation filtration train can be manually started to maintain pressurization of the control room.

INSERT 1

A CBI signal is initiated when any of the following conditions exist:

- air-intake radiation high;
- containment pressure high 2 out of 3 signal;
- manual initiation from main control board;
- manual initiation from main heating and ventilation; or
- manual safety injection signal.

The control building ventilation makeup dampers and the control building isolation valves have control switches and indicator lights on the main heating and ventilation panel. Engineered safety features status lights on the main control board indicate when the valves and dampers are closed. The opened and closed positions are monitored by the plant computer. The control building air makeup dampers and isolation valves are automatically closed on receipt of a CBI signal.

Control switches and valve position indicator lights are provided for the air storage tanks' outlet valves on the main heating and ventilation panel. Engineered safety features status lights on the main control board indicate when the valves are open, and the open and closed positions are monitored by the plant computer. The air storage tanks' outlet valves are opened automatically after a time delay on receipt of a CBI signal.

The chiller equipment space supply fans have control switches and indicator lights on the

<u>INSERT D to Page 9.4-8</u>

Realignment of the control room ventilation system from the pressurization mode to the filtration/recirculation mode of operation can be initiated as described in section 9.4.1.3.

gap activities to the reactor coolant. The gap activity is assumed to be released instantaneously into the containment atmosphere via the break in the reactor vessel head. In addition, it is further postulated that 0.25 percent of the core fuel experiences melting resulting in 100 percent of the noble gases and 25 percent of iodines in the fraction of melted fuel to be available for release from the containment. The releases to the environment are assumed to take place from the secondary system until such time that the secondary system pressure decreases below relief valve actuation. The containment - building releases are assumed to last for 30 days after initiation of the accident. Activity released from the secondary system is derived from the technical specification primary to secondary leakage of reactor coolant containing activity associated with technical specification fuel defects, releases from fuel with clad damage, and 100 percent of the noble gases and 50 percent of the iodine contained in this fraction of fuel assumed to have melted. Releases from the secondary side are evaluated assuming coincident loss of offsite power. Pertinent parameters used to describe the ~~secondary side~~ releases are presented in Tables 15.4-4 ~~and~~, 15.4-6 and 15.6-9 (21-27).

ASIS signal is generated within 1 minute following the accident which initiates secondary containment.
Assumptions regarding the time for the secondary containment to achieve negative pressure are the same as that which was used for the LOCA analysis. The bypass leakage is released unfiltered to the environment at ground level. The leakage which is not bypass leakage is assumed to be processed by the secondary containment filtration system. A more detailed description of containment leakage is found in 15.6.5.4.

For purposes of conservatism, all collected leakage is assumed to exhaust via a release point located above the turbine building. This assumption is made as a result of the simultaneous operation of the charging pump ventilation supply and exhaust system which may entrap and filter some fraction of containment leakage as described in Section 9.4.3. This effluent is analyzed as a ground level release. Delete

The releases, together with the atmospheric dispersion factors listed in Table 15.0-11, are used to compute the doses to the EAB (0-2 hr) and LPZ (0-30 days).

The radiological consequences of a postulated rod ejection accident are analyzed (for both N-loop and N-1 loop operation) with the information contained in Regulatory Guide 1.77 and the Standard Review Plan 15.4.8. For the N-1 loop analysis, it is assumed that the plant had been in N-loop operation at full power sufficiently long to achieve equilibrium core activities and coolant concentrations. The plant then began N-1 loop operation, shortly after which the rod ejection accident occurred. The calculated dose results (for both the N-loop and the N-1 loop analyses) described in Table 15.0-8 for the rod ejection accident are presented separately for the releases from the containment building and the releases via the secondary system.

The radiological consequences of the postulated rod ejection accident are within the guidelines of 10CFR100; i.e., 75 Rem to the thyroid and 6 Rem to the whole body.

15.4.9 References for Section 15.4

Bishop, A. A.; Sandburg, R. O.; and Tong, L. S., 1965. Forced Convection Heat Transfer at High Pressure After the Critical Heat Flux. ASME 65-HT-31.

Liimataninen, R. C. and Testa, F. J. 1966. Studies in TREAT of Zircaloy-2-Clad, UO_2 Core Simulated Fuel Elements. ANL-7225, January - June 1966, p. 177.

enclosure, auxiliary building, engineered safety features (ESF) building, hydrogen recombiner building, and the main steam valve building during accident conditions. The nuclide inventory assumed to be initially available for release from within the containment building consists of 100 percent of the core noble gases and 50 percent of the halogens, as described in Standard Review Plan 6.5.2, Rev. 1.

The containment pressure Hi-1 signal also initiates control room isolation (CBI) and pressurization with bottled air for a period of 1 hour. There is a 1-minute delay from control room isolation to initiation of the bottled air system. After 1 hour, line up of the control room ventilation system begins. Due to an assumed loss of instrument air to the outside air valves, 40 minutes is assumed for operator action to open these valves to take filtered air into the control room. ~~During this 40 minute period, 230 cfm unfiltered inleakage is assumed.~~ During the period of pressurization, 115 cfm of unfiltered inleakage is assumed.

this 40 minute period and

Release Pathways

The release pathways to the environment subsequent to a loss-of-coolant DBA are leakages from the containment building and ESF systems, which are collected and processed, and leakage from the containment building which is assumed to bypass SLCRS.

Containment Leakage Pathway

The containment is assumed to leak at the design leak rate for 24 hours after the accident. After 24 hours, since the pressure has been decreased significantly, Regulatory Guide 1.4 allows the containment leakage to be reduced to one-half the design leak rate. For the dose calculations to the Control Room and Technical Support Center, a reduced containment leak rate was assumed at T = 1 hour. This was justified and approved as part of the Amendment that eliminated the post-LOCA negative pressure containment requirement. It is based on the fact that the Millstone Unit 3 containment pressure is rapidly reduced compared to typical PWRs because of its original design as a negative pressure containment.

The collection, processing, and release of containment leakage varies depending on the location of the leak. Ventilation characteristics and release paths are different for each building comprising the secondary containment.

Two emergency ventilation systems collect most of the containment leakage and process it through HEPA and charcoal filters. The SLCRS exhausts from the containment enclosure, auxiliary, ESF, and the main steam valve buildings, and the compartment of the hydrogen recombiner building abutting the containment. SLCRS flow is filtered and released through the Unit 1 stack. The charging pump, component cooling water pump, and heat exchanger area portion of the auxiliary building ventilation system (ABVS), described in Section 9.4.3, supplies and exhausts a relatively high flow on the 24 foot-6 inch elevation floor of the auxiliary building. The exhaust flow is filtered and released through the ventilation vent on the roof of the turbine building.

The specific areas of the secondary containment into which the primary containment will leak cannot be predicted. Some areas would be released primarily through the filters to the MP3 ventilation vent. Other areas may have some bypass leakage paths, but the

3

majority of the activity would go through filters to the elevated MP1 stack. An analysis was performed to determine the worst case location for assumed containment leakage. It was determined that the assumption that all containment leakage is into the 24' level of the auxiliary building and is released instantaneously (no mixing) through filters to the lower ventilation vent release point bounds any more mechanistic analysis which would include mixing, some bypass and elevated releases.

INSERT E

Credit is taken for iodine removal due to containment sprays during the duration of the accident. Assumptions pertaining to the spray system are listed in Table 15.6-9.

ESF System Leakage Pathway

Post-accident radioactive releases from the ESF system are derived from fluid leakages assumed during recirculation of containment sump water through systems located outside the containment building. The quantity of leakage is based on the assumption that the ESF equipment leaks at twice the maximum expected operational leak rate and that a fraction of the iodine nuclides contained in the leakage fluid becomes airborne in the areas containing ESF equipment. For purposes of analysis, all liquid leakage from the ESF systems are assumed to be in the auxiliary building. The nuclides which become airborne are collected and released to the environment through the auxiliary building ventilation system HEPA and charcoal filtration units. The releases are from above the turbine building, but are analyzed as ground level releases.

RWST Backleakage Pathway

Post-accident radioactive releases from the ECCS system are a result of ECCS subsystems containing recirculated sump fluid backleaking to the RWST. The backflow rate to the RWST, as a result of isolation valve leakage, is pre-defined and time dependent. Due to this time dependency, the contaminated sump fluid from backleakage does not arrive into the RWST until 8.5 hours post-LOCA. Since the RWST is vented to atmosphere, the release is a result of the breathing rate of the RWST due to solar heating. The EAB dose is a 2 hour dose therefore it is not affected by backleakage. 98-61

Control Room Habitability

The potential radiation dose to a control room operator is evaluated for the limiting postulated DBA, namely the LOCA. The analysis is based on the assumptions and meteorological parameters (X/Q values) given in Tables 15.6-12 and 15.0-11, respectively.

The control room is designed to be continuously occupied for the duration of the accident; i.e., 30 days. The control building shielding serves to protect the operators from direct radiation due to the passing cloud of radioactive effluent assumed to have leaked from the containment structure and from the ESF system. The control building walls also provide shielding protection for radiation emanating from buildings located onsite which may contain significant quantities of radioactivity.

The control room ventilation system, as described in Sections 6.4 and 9.4, is designed to maintain the dose from activity inside the control room within GDC 19 limits. The calculated whole body dose, beta skin dose, and thyroid dose are presented in Table 15.6-13 and are below the General Design Criterion 19 limits.

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All containment leakage is collected and filtered by these 2 ventilation systems except for the following:

1. The fraction of containment leakage which is assumed to bypass the secondary containment. This is assumed to be an unfiltered ground level release to the environment.
2. The initial containment leakage during the 2 minute time period required for SLCRS to establish negative pressure conditions. This is assumed to be an unfiltered ground level release to the environment.
3. The leakage past closed dampers which isolate non-ESF ventilation systems in the auxiliary, ESF and main steam valve building. This leakage is assumed to be an unfiltered ground level release to the environment. For Control Room habitability the analysis assumes, the main steam valve, auxiliary and ESF building normal exhaust portions are secured prior to placing the control room on filtered intake/recirculation pressurization mode. For TSC habitability, the main steam valve and auxiliary building normal exhaust portions trip upon receipt of a SIS signal. The ESF normal exhaust is secured locally prior to 1 hour and 20 minutes post LOCA.
4. The ductwork leakage from the auxiliary building into the SLCRS and emergency portion of the ABVS between the filter and the exhaust fan. This leakage is released unfiltered, along with the rest of the flow for these systems, through the Millstone stack for the SLCRS flow and through the ventilation vent for the ABVS flow.

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Since other operating reactors are located on the site, an assessment was made of the habitability of the Millstone 3 control room subsequent to an assumed DBA at either Millstone 1 or 2. All other DBAs (e.g., small line breaks) were considered and found to be bounded by the LOCA. For the assumed DBA at Millstone Unit 2, a low wind speed condition and a high wind speed condition have been analyzed. As described in the Millstone Unit 2 FSAR, Question 6.15.2, Amendment 27, it has been assumed that the high wind speed condition exists for 36 hours after the LOCA and 10 percent of the activity in the enclosure building bypasses the enclosure building filtration system resulting in a ground level release to the environment. Displacement of the enclosure building atmosphere with outside air would begin at wind speed above 25 mph. However, for conservatism, it is assumed that this displacement would begin with a 23 mph wind.

The calculated Millstone 3 control room whole body dose and thyroid dose from Millstone 1 releases and from Millstone 2 releases are presented in Table 15.6-13. The tabulated control room doses also include the calculated beta skin dose.

Technical Support Center Habitability

The potential radiation doses to a person occupying the technical support center (TSC) have been evaluated for the Unit 3 LOCA.

The meteorological parameters for the TSC are listed in Table 15.0-11.

The results of the control room habitability analysis in Table 15.6-13, show that for the three units on site, a postulated Unit 3 LOCA is the limiting event for the Unit 3 control room. The TSC habitability was therefore based on a postulated Unit 3 LOCA.

The TSC is designed for continuous operation for the duration of the accident (i.e., 30 days). The building roof and walls provide adequate shielding to protect the occupants against direct radiation from the external radioactive cloud and from the containment during the postulated LOCA. Double vestibule doors are provided at the building entrance to eliminate inleakage due to personnel ingress/egress.

The TSC ventilation system is described in Section 9.4.13.

The data and assumptions used in the TSC dose evaluation are given in Table 15.6-21. Meteorological parameters (X/Q values) are given in Table 15.0-11.

The 30-day integrated thyroid dose, whole body gamma dose, and beta skin dose for an individual occupying the TSC following the DBA are presented in Table 15.6-22.

Dose Computation

The radiological off-site dose consequences resulting from a postulated LOCA at Millstone 3 are reported in Table 15.0-8. Assumptions used to perform the evaluation are summarized in Table 15.6-9. The inventory of noble gases and halogens in the containment building atmosphere available for release are presented in Table 15.6-10. The calculations show that the thyroid and whole body doses are within the appropriate exposure guideline values specified in 10CFR100. The dose methodology used to determine the results of the hypothetical DBAs are described in Appendix 15A.

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Radiological consequences of a LOCA at Millstone 3 during N-1 loop operation are bounded by the consequences of a LOCA during N-loop operation.

15.6.5.5 Conclusions

Analysis shows that the acceptance criteria described in Section 15.6.5.1 are met and that the radiological consequences are with 10CFR100 guidelines. Control room doses are within the limits of General Design Criterion 19.

15.6.6 BWR Transients

Not applicable to Millstone 3.

15.6.7 References for Section 15.6

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TABLE 15.0-8

POTENTIAL OFFSITE DOSES DUE TO ACCIDENTS

Postulated Accident	FSAR Section	Dose (rem) 2 hr Exclusion Area Boundary (524 m) Thyroid	Dose (rem) 2 hr Exclusion Area Boundary (524 m) Gamma	Dose (rem) Low Population Zone (3862 m) Thyroid	Dose (rem) Low Population Zone (3862 m) Gamma
Main Steam Line Break	15.1.5				
1. N-Loop					
a. Case I: MSLB with 1% failed fuel		2.7E+01	(1) 1.6E-01	5.4E+00	1.9E-02
b. Case II: MSLB with preaccident iodine spike		4.1E+00	5.1E-03	6.6E-01	6.7E-04
2. N-1 Loop					
a. Case I: MSLB with 1% failed fuel		3.9E+01	2.4E-01	7.7E+00	2.8E-02
b. Case II: MSLB with preaccident iodine spike		5.1E+00	6.6E-03	8.5E-01	8.9E-04
Locked Rotor Accident	15.3.3				
1. N-Loop		2.98E+01	3.5E-01	3.3E+00	3.6E-02
2. N-1 Loop		3.2E+01	3.9E-01	4.3E-00	4.1E-02
Rod Ejection Accident	15.4.8				
1. N-Loop					
a. Primary side		1.7E+01(4)	2.9E-01(4)	1.1E+01(4)	5.7E-02(4)
b. Secondary side		1.7E-01	2.1E-02	9.1E-03	1.1E-03
2. N-1 Loop					
a. Primary side		1.7E+01	2.9E-01	1.1E-01	5.7E-02
b. Secondary side		2.0E-02	4.4E-03	1.1E-03	2.3E-04
Small line LOCA Outside Containment	15.6.2	2.1E+01	1.5E-01	(2)	(2)

TABLE 15.0-8

POTENTIAL OFFSITE DOSES DUE TO ACCIDENTS

Postulated Accident	FSAR Section	Dose (rem) 2 hr Exclusion Area Boundary (524 m) Thyroid	Gamma	Dose (rem) Low Population Zone (3862 m) Thyroid	Gamma
Steam Generator Tube Rupture	15.6.3				
a. Preaccident iodine spike		5.1E+01	2.0E-01	4.0E+00	<1.0E-01
b. Concurrent iodine spike		1.9E+01	2.0E-01	2.0E+00	<1.0E-01
LOCA	15.6.5	~~1.4E+02[5]~~ 8.0E+01	~~9.4E+00[5]~~ 4.0E+00	~~3.0E+01[5]~~ 2.7E+01	~~1.7E+00[5]~~ 8.3E-01
Waste Gas System Failure	15.7.1	0.0E+00	2.2E-01	(2)	(2)
Radioactive Liquid Waste System Leak or Failure (Atmospheric Release)	15.7.2	4.3E-01	4.7E-04	(2)	(2)
Fuel Handling Accident	15.7.4	7.6E+00	5.1E-01	(2)	(2)
Spent Fuel Cask Drop	15.7.5	(3)	(3)	(3)	(3)

NOTES:

(1) 1.6E-01 = 1.6×10^{-1}

(2) 2 hours of release or less; a 30-day dose is not applicable.

(3) Not applicable; see Sections 15.7.5.2 and 15.7.5.3.

(4) The current rod ejection analysis result in an EAB thyroid dose of ~~9.5E+00~~ 1.0E+01, an EAB gamma dose of ~~1.3E-01~~ 1.0E-01, an ~~LPZ~~ LPZ thyroid dose of ~~4.6E+00~~ 1.03E+01 and an ~~LPZ~~ LPZ gamma dose of 4.0 ~~2.0~~E-02. The current results are bounded by the licensed numbers listed in the table.

98-61 (5) The current LOCA analysis result in an EAB thyroid dose of 8.8E+01, an EAB gamma dose of 8.2E+00, an LPZ thyroid dose of 1.1E+01 and an LPZ gamma dose of 1.3E+00. The current results are bounded by the licensed numbers listed in the table.

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TABLE 15.0-11

ATMOSPHERIC DISPERSION DATA USED FOR DESIGN BASIS ACCIDENT ANALYSIS

EAB X/Qs (sec m^{-3})	
Ground level release-containment 0-2 hr.	5.42 x 10^{-4}
Ground level release-ventilation vent 0-2 hr.	4.3 x 10^{-4}
Elevated release ~~Unit 1~~ Millstone Stack 0-2 hr.	~~7.0 x 10^{-5}~~ 1.0 x 10^{-4}
LPZ X/Qs (sec m^{-3})	
Ground level release-containment 0-8 hr.	2.91 x 10^{-5}
Ground level release-ventilation vent	
0-8 hr.	2.91 x 10^{-5}
8-24 hr.	1.99 ~~2.0~~ x 10^{-5}
1-4 days	8.66 ~~8.7~~ x 10^{-6}
4-30 days	2.63 x 10^{-6}
Elevated release ~~Unit 1~~ Millstone stack	
0-4 hr.	2.69 x 10^{-5}
~~0~~4-8 hr.	~~3.30 x 10^{-6}~~ 1.07 x 10^{-5}
8-24 hr.	6.72 ~~2.30~~ x 10^{-6}
1-4 days	2.46 ~~1.05~~ x 10^{-6}
4-30 days	5.83 ~~3.39~~ x 10^{-7}

Control room X/Qs[4] (sec m^{-3})	Millstone 1	Millstone 2	Millstone 3
a. Ground level release-containment			
0-8 hr.	1.9 x 10^{-3}	1.4 x 10^{-3}	~~8.08 x 10^{-4}~~ 1.52 x 10^{-3}
8-24 hr.	1.3 x 10^{-3}	9.7 x 10^{-4}	8.53 ~~5.49~~ x 10^{-4}
1-4 days	4.2 x 10^{-4}	3.4 x 10^{-4}	2.59 ~~1.95~~ x 10^{-4}
4-30 days	3.8 x 10^{-5}	2.7 x 10^{-5}	3.21 ~~2.75~~ x 10^{-5}
0-24 hr[1]	NA	8.7 x 10^{-5}	NA
24-36 hr[1][3]	NA	5.2 x 10^{-5}	NA
b. Elevated release ~~Unit 1~~ Millstone Stack[2]			
0-4 hr.	1.6 x 10^{-4}	1.6 x 10^{-4}	~~NA~~ 1.39 x 10^{-4}
4-8 hr.	4.4 x 10^{-6}	4.4 x 10^{-6}	NA 3.23 x 10^{-5}
8-24 hr.	2.4 x 10^{-6}	2.4 x 10^{-6}	NA 1.56 x 10^{-5}
1-4 days	6.3 x 10^{-7}	6.3 x 10^{-7}	NA 1.92 x 10^{-6}
4-30 days	9.3 x 10^{-8}	9.3 x 10^{-8}	NA 1.32 x 10^{-7}
0-24 hr.[1]	NA	2.0 x 10^{-8}	NA
24-36 hr.[1][3]	NA	1.2 x 10^{-8}	NA
c. Ground level release-ventilation vent			
0-8 hr.	NA	NA	3.75 ~~2.24~~ x 10^{-3}
8-24 hr.	NA	NA	2.28 ~~1.40~~ x 10^{-3}
1-4 days	NA	NA	7.43 ~~5.08~~ x 10^{-4}
4-30 days	NA	NA	9.69 ~~9.68~~ x 10^{-5}

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d. Unit 3 MSVB			
0-8 hr	N/A	N/A	5.78E-3
8-24 hr	N/A	N/A	3.20E-3
1-4 days	N/A	N/A	9.52E-4
4-30 days	N/A	N/A	9.16E-5
e. Unit 3 ESFB			
0-8 hr	N/A	N/A	4.86E-3
8-24 hr	N/A	N/A	2.69E-3
1-4 days	N/A	N/A	8.00E-4
4-30 days	N/A	N/A	6.77E-5
f. Unit 3 RWST			
0-8 hr	N/A	N/A	N/A
8-24 hr	N/A	N/A	8.53E-4
1-4 days	N/A	N/A	4.32E-4
4-30 days	N/A	N/A	8.03E-5

TABLE 15.0-11

ATMOSPHERIC DISPERSION DATA USED FOR DESIGN BASIS ACCIDENT ANALYSIS

TSC X/Qs (sec./m^3)	Millstone 1[4]	Millstone 2[4]	Millstone 3
a. Ground level release-containment			
0-8 hr.	1.9×10^{-3}	1.4×10^{-3}	1.52×10^{-3} ~~8.1×10^{-4}~~
8-24 hr.	1.3×10^{-3}	9.7×10^{-4}	4.27 ~~2.7~~ $\times 10^{-4}$
1-4 days	4.2×10^{-4}	3.4×10^{-4}	2.59 ~~1.9~~ $\times 10^{-4}$
4-30 days	3.8×10^{-5}	2.7×10^{-5}	3.21 ~~3.0~~ $\times 10^{-5}$
0-24 hr[1]	NA	8.7×10^{-5}	NA
24-36 hr.[1][3]	NA	5.2×10^{-5}	NA
b. Elevated release ~~Unit 1~~ Millstone Stack			
0-4 hr.	1.6×10^{-4}	1.6×10^{-4}	~~NA~~ 1.34×10^{-4}
4-8 hr.	4.4×10^{-6}	4.4×10^{-6}	~~NA~~ 3.23×10^{-5}
8-24 hr.	2.4×10^{-6}	2.4×10^{-6}	~~NA~~ 7.80×10^{-6}
1-4 days	6.3×10^{-7}	6.3×10^{-7}	~~NA~~ 1.92×10^{-6}
4-30 days	9.3×10^{-8}	9.3×10^{-8}	~~NA~~ 1.32×10^{-7}
0-24 hr.[1]	NA	2.0×10^{-8}	NA
24-36 hr.[1][3]	NA	1.2×10^{-8}	NA
c. Ground level release-ventilation vent			
0-8 hr.	NA	NA	3.75×10^{-3} ~~2.0E-3~~
8-24 hr.	NA	NA	~~6.7E-4~~ 1.14×10^{-3}
1-4 days	NA	NA	7.43 ~~4.8~~E-4
4-30 days	NA	NA	9.69 ~~7.5~~E-5

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NOTES:

1. High wind speed condition only (no fumigation).
2. Fumigation conditions assumed for 0-4 hour period.
3. X/Q values for Unit 2 high wind speed condition after 36 hours are the same as for low wind speed condition.
4. Control room X/Q values are applicable to the TSC due to the proximity of the air intakes of the two buildings.

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d. Unit 3 MSVB			
0-8 hr	N/A	N/A	5.78E-3
8-24 hr	N/A	N/A	1.60E-3
1-4 days	N/A	N/A	9.52E-4
4-30 days	N/A	N/A	9.16E-5
e. Unit 3 ESFB			
0-8 hr	N/A	N/A	4.86E-3
8-24 hr	N/A	N/A	1.35E-3
1-4 days	N/A	N/A	8.00E-4
4-30 days	N/A	N/A	6.77E-5
f. Unit 3 RWST			
0-8 hr	N/A	N/A	N/A
8-24 hr	N/A	N/A	4.27E-4
1-4 days	N/A	N/A	4.32E-4
4-30 days	N/A	N/A	8.03E-5

TABLE 15.4-4

PARAMETERS USED IN ROD EJECTION ACCIDENT ANALYSIS

	Analysis Input Parameters	
	N-Loop	N-1 Loop
1. Core thermal power (MWt)	3,636[1]	3,636[1]
2. Containment free volume (ft^3)	$2.32x10^6$	$2.32x10^6$
3. Primary coolant concentrations	Table 15.0-10	Table 15.0-10
4. Primary to secondary leak rate (gpm)	1.0	1.0
5. Secondary coolant concentration	Table 15.0-10	Table 15.0-10
~~6. Not used~~		
~~7.~~ 6 Failed fuel as a result of the accident (%)	10.0	10.0
~~8.~~ 7 Core and gap activity	Table 15.0-7	Table 15.0-7
~~9.~~ 8 Quantity of fuel in the core which melts as a result of the accident (%)	0.25	0.25
~~10.~~ 9 Quantity of radionuclides from the melted fuel available for release from the containment (%)		
a. Iodine	25.0	25.0
b. Noble gases	100	100

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TABLE 15.4-4

PARAMETERS USED IN ROD EJECTION ACCIDENT ANALYSIS

	Analysis Input Parameters N-Loop	N-1 Loop
10 ~~11~~. Quantity of radionuclides from the melted fuel available for release from the secondary side via primary-to-secondary leakage (%)		
a. Iodines	50.0	50.0
b. Noble gases	100	100
11 ~~12~~. Iodine partition factor in steam generator prior to and during accident	0.01	0.01
12 ~~13~~. Offsite power	Lost	Lost
13 ~~14~~. Steam dump from relief valves (lb)	40,604	40,604
14 ~~15~~. Duration of dump from relief valves (sec)	125.0	125.0
15 ~~16~~. Containment leak rate (% per day)		
a. 0-24 hrs	0.30	0.30
b. 24-720 hrs	0.15	0.15
16 ~~17~~. Bypass leakage (fraction of containment leakage)	0.042	0.042
17 ~~18~~. Time between accident and equalization of primary and secondary pressures (sec)	140.0	140.0
18. Time to Initiate SIS (min)	1	N/A
19. Time estimated for SLCRS to become effective (min)	2	2

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TABLE 15.4-4

PARAMETERS USED IN ROD EJECTION ACCIDENT ANALYSIS

	Analysis Input Parameters	
	N-Loop	N-1 Loop
20. Duration of leakage from containment (hr)	720.0	720.0
21. Iodine removal filter efficiency (%)	95.0	95.0
22. Steam generator contents (lb/SG)		
a. Steam	8,000	7,600
b. Liquid	103,000	104,000
23. Primary coolant mass (lb)	520,000	350,000[2]
24. Credit for Sprays	No	N/A

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NOTES:

1. Fuel gap activities are based on reactor power of 3,636 MWt.
2. In the N-1 loop operation analysis, the pressurizer volume has been conservatively excluded from the primary coolant. 97-426

25. Iodine Inhalation Dose Conversion Factors	ICRP 30	N/A

TABLE 15.6-9

ASSUMPTIONS USED FOR THE RADIOLOGICAL CONSEQUENCES OF A LOCA ANALYSIS

1. Power level (MWt)	3,636
2. Core inventory	Table 15.0-7
3. Iodine composition	
Elemental (%)	~~95.5~~ 91
Particulate (%)	~~2.5~~ 5
Organic (%)	~~2.0~~ 4
4. Fraction of core inventory released into reactor coolant	
Iodine	0.5
Noble gas	1.0
5. Fraction of reactor coolant inventory available for release from containment	
Iodine	1.0
Noble gas	1.0
6. Core inventory, available for release from containment	
Iodine (%)	~~50~~ 25
Noble gas (%)	100
7. Containment free volume (ft^3)	2.~~3~~2 x 10^6
8. Containment leak rate (percent per day)	
0-24 hr	0.30
24-720 hr	0.15
9. Bypass leakage (fraction of containment leakage)	0.042
Elemental wall deposition rate	5.1/hr 9a
10. Secondary enclosure time to reach negative pressure (100% bypass assumed)	2 min.

TABLE 15.6-9

ASSUMPTIONS USED FOR THE RADIOLOGICAL CONSEQUENCES OF A LOCA ANALYSIS

Containment spray assumptions

- Length of time QSS is in operation: 7480 sec.
- Volume of sprayed region = $1.17 \times 10^6 \times ft^3$
- Volume of unsprayed region = $1.15 \times 10^6 ft^3$
- Maximum iodine DF during spray operation = 140.2
- Quench spray operation initiation time = 70.2 sec.
- Mixing rate between sprayed and unsprayed regions = 2 turnovers/hr
- Iodine removal rates in sprayed region:
  λelem = 20.0/hr
  λpart = 12.7/hr

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26. Duration of release from containment (hr)	720
Post-LOCA Equipment Leakage	
27. Leak initiation and cessation times	220 sec to 720 hr
28. Maximum operational leak rate (cc/hr)	5,000[3]
29 ECCS Leakage Location	80% ESF Building, 20% EL 24'-6" Aux. Building
30 Fraction of core iodine inventory in sump water	0.50
31 Sump water temperature (°F)	256-<212
32 Iodine release to building atmosphere from recirculation leakage (%)	10[2]
33 Filter efficiency	
Elemental iodine(%)	95
Methyl iodine (%)	95
HEPA (%)	95
RWST Backleakage	
34 98-61 Leak duration time	8.5 to 720 hours
35 Leak rate	0.1 to 0.9 gpm
36 Iodine DF	100

INSERT G to Table 15.6-9

11. Length of Time QSS is in Operation:		7480 sec
12. Spray Coverage		50.27%
13. Maximum Iodine DF		140
14. Quench Spray Effective Time		70.2 sec
15. Mixing Rate for Unsprayed to Sprayed Regions		2 per hour
16. Sprayed Region Elemental Iodine Removal Coefficients (hr-1)		
	spray	20
17. Sprayed Region Particulate Iodine Removal Coefficients (hr-1)		
	<DF 50	12.7
	>DF 50	1.27
18. No credit taken for iodine removal after QSS stop time		
19. Percentage of Total Containment Leakage into the Secondary Containment		
	ESF building	10.59
	MSV building	23.64
	H2 Recombiner building	0.51
	Containment Enclosure	7.77
	Aux. Bldg, El. 4'-6"	12.43
	Aux. Bldg, El. 24'-6"	21.08
	Aux. Bldg, El. 43'-6"	20.82
	Aux. Bldg, El. 66'-6"	3.17
20. Secondary Containment Free Volume (ft3)		
	ESF building	168,373
	MSV building	70,000
	H2 Recombiner building	15,000
	Containment Enclosure	816,00
	Aux. Bldg, all elevations	913,500

21. 50% mixing in buildings that together form the secondary containment
22. Unfiltered leakage via closed dampers occur in Aux, MSV and ESF buildings

Insert G

23 ~~24~~ ~~25~~. Unfiltered releases occur from ventilation vent, Unit 1 stack, ESF bldg roof vent and MSV bldg roof vent

24 ~~25~~ ~~26~~. Site boundary case: leakage values based on single damper closure, leakage occurs for 30 days

25 ~~26~~ ~~27~~. Ventilation and Leakage Parameters

T=0 hrs to T=30 days Post-LOCA

Ground Level Release	cfm
3HVQ-FN2 (ESF bldg normal exhaust)	77
3HVV-FN1A&B (MSVB exhaust)	134
3HVQ*ACUS1A&B (ESF bldg AC)	4
3HVQ*ACUS2A&B (ESF bldg AC)	2
Unit 1 Stack	
3GWS-FN1A&B (Process Vent Fan)	70 (Aux 66'-6")
3HVR*FN12A&B (SLCRS exhaust - duct leakage)	63 (Aux 66'-6")
Ventilation Vent	
3HVR-FN5 (Aux bldg normal exhaust)	553 (Aux 43'-6" & 66'-6")
3HVR-FN7 (Aux bldg normal exhaust)	218 (Aux bldg - all ele)
3HVR-FN8A&B (Waste Disposal bldg normal exhaust)	43 (Aux bldg 66'-6")
3HVR-FN11 (Electrical Tunnel purge air)	28
3HVR-FN9 (Fuel bldg exhaust - duct leakage)	75 (Aux bldg 66'-6")
3HVR*FN6A&B (Aux bldg filter exhaust)	17 (Aux bldg 66'-6")
3HVR*AOD44A&B (Normal exhaust isol)	113 (Aux bldg 24'-6")
3HVR*AOD32A&B (Containment purge exhaust)	118 (Aux bldg 24'-6")

TABLE 15.6-9

ASSUMPTIONS USED FOR THE RADIOLOGICAL CONSEQUENCES OF A LOCA ANALYSIS

NOTES:

1. Includes instrument error of 2 percent.
2. Despite temperature variation, at no time is there greater than 10 percent of the water in the sump flashing to steam.
3. In accordance with SRP 15.6.5 Appendix B, Revision 1, the calculation assumed the maximum post-LOCA equipment leakage was a factor of two times the max operational leakage to give a total leakage of 10,000 cc/hr.

TABLE 15.6-12

ASSUMPTIONS USED FOR THE CONTROL ROOM HABITABILITY ANALYSIS

Control room (CR) parameters:		
Control room volume (ft^3)	238,226	
Control building concrete wall thickness (ft)	2	
Filtered ventilation intake rate post CR isolation (cfm)	230	97-426 3/98
Filtered recirculation rate post CR isolation (cfm)	666	97-426
Inleakage rate (cfm)	10 (115 cfm for first minute)	
Time to place ventilation on recirculation assuming loss of instrument air	40 minutes	97-426
Inleakage after depressurization until recirculation	~~230~~ 115 cfm	
Intake ventilation filter efficiencies (percent):		
HEPA	95	
Charcoal (methyl and elemental)	95	
Duration of isolation (min)	61	
Duration of unfiltered intake prior to control room isolation (sec)	5.7(2)	97-426 (96-44 3/97
Release points (distance to Unit 3 control room intake in meters):		
Unit 1 turbine building	320	
Millstone ~~Unit 1~~ stack	351	
Unit 2 containment surface	223	
Unit 3 containment surface	72	
Unit 3 reactor plant ventilation vent	38	
Control room air intake height	~~12.3~~ 28.7	(92-22) 6/92

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NOTES:

1. See Table 1.9-2, SRP 6.5.1, Section B.5.

2. For analysis of assumed LOCA at either Millstone Unit 1 or 2. The duration of unfiltered inleakage is 5.7 seconds to account for 3 seconds for radiation monitor response, 3 seconds for isolation damper closure, with 0.3 seconds of activity trapped between radiation monitor and isolation damper. Other Unit 1 and Unit 2 LOCA assumptions are given in the following references: 97-426

INSERT H TO TABLE 15.6-12

- Leakage values based on single damper closure
- 3HVV-FN1A/B, 3 HVQ-FN2, 3HVR-FN5 and 3HVR-FN7 are locally secured prior to 1 hour 20 minutes post-LOCA.
- Ventilation and Leakage Parameters

T=0 hrs to T=30 days Post-LOCA

Ground Level Release	
3HVQ-FN2 (ESF bldg normal exhaust) **Note 1**	cfm
3HVV-FN1A&B (MSVB exhaust) **Note 1**	77
3HVQ*ACUS1A&B (ESF bldg AC)	134
3HVQ*ACUS2A&B (ESF bldg AC)	4
	2
Unit 1 Stack	
3GWS-FN1A&B (Process Vent Fan)	
3HVR*FN12A&B (SLCRS exhaust - duct leakage)	70 (Aux 66'-6")
	63 (Aux 66'-6")
Ventilation Vent	
3HVR-FN5 (Aux bldg normal exhaust) **Note 1**	
3HVR-FN7 (Aux bldg normal exhaust) **Note 1**	553 (Aux 43'-6" & 66'-6")
3HVR-FN8A&B (Waste Disposal bldg normal exhaust)	218 (Aux bldg - all ele)
3HVR-FN11 (Electrical Tunnel purge air)	43 (Aux bldg 66'-6")
3HVR-FN9 (Fuel bldg exhaust - duct leakage)	28
3HVR*FN6A&B (Aux bldg filter exhaust)	75 (Aux bldg 66'-6")
3HVR*AOD44A&B (Normal exhaust isol)	17 (Aux bldg 66'-6")
3HVR*AOD32A&B (Containment purge exhaust)	113 (Aux bldg 24'-6")
	118 (Aux bldg 24'-6")

Note 1: These fans are secured at 1 hour 20 minutes post-LOCA and the bypass flow is terminated.

TABLE 15.6-12

ASSUMPTIONS USED FOR THE CONTROL
ROOM HABITABILITY ANALYSIS

Unit 1 - Counsil, W. G., 1981 (NUSCO) letter to P. M. Crutchfield (NRC), transmitting Millstone Nuclear Power Station, Unit 1, Systematic Evaluation Program, Section XV Topics; Design Basis Events, June 30, 1981.

Unit 2 - Millstone Nuclear Power Station, Unit 2, FSAR.

97-426 3/98 (96-44 3/97) For MP3 LOCA, there is no initial unfiltered inleakage as dampers close on isolation signal and hence will be closed prior to plume arrival.

TABLE 15.6-13

DOSE TO MILLSTONE 3 CONTROL ROOM ASSUMING LOCA RELEASE FROM MILLSTONE 1, 2, AND 3, RESPECTIVELY

Release From	Thyroid Dose (rem)	Whole Body Dose (rem)	Beta Skin Dose (rem)
Millstone 1	6.0E+00	1.7E-01	1.3E+00
Millstone 2			
(low wind speed condition)	2.8E+01	9.0E-01	1.2E+00
(high wind speed condition)	1.6E+01	1.1E-01	3.8E-01
Millstone 3	2.60E+01[2]	~~3.1~~E+00[2] 1.1	~~2.5~~E+01[2] 2.1

NOTE:

1. 6.0E+00 = 6.0 x 10^0
2. The current Control Room LOCA analysis result in a thyroid dose of 1.2E+01, a whole body gamma dose of 1.90E+00 and a beta skin dose of 1.2E+01. The current results are bounded by the licensed numbers listed in the table. 98-61

TABLE 15.6-21

DATA USED IN THE TECHNICAL SUPPORT CENTER
HABITABILITY ANALYSIS

TSC Building Parameters

Free air volume (ft^3)	33,200
Concrete wall thickness (ft)	2.0
Concrete roof thickness (ft)	1.0
Infiltration rate during isolation (cfm)	50

Ventilation Parameters

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3/98

Duration of isolation (min)	30
Intake rate prior to isolation (cfm)	100
Intake rate postisolation-filtered (cfm)	100
Recirculation rate during isolation (cfm)	2,000
Recirculation rate postisolation (cfm)	1,900
Charcoal filter efficiency (methyl and elemental %)	95
HEPA filter efficiency (%)	95

Occupancy Factors

(92-22
6/92)

Time Period	Factor
0-8 hr	1.0
8-24 hr	0.5
24-96 hr	0.6
96-720 hr	0.4

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- Leakage values based on double damper closure
- 3HVV-FN1A/B, 3HVR-FN5 and 3HVR-FN7 trip upon receipt of an SIS signal. 3HVQ-FN2 is secured locally at 1 hour 20 minutes post-LOCA.
- Ventilation and Leakage Parameters

Ventilation and Leakage Parameters

T=0 hrs to T=30 days Post-LOCA

Ground Level Release	cfm
3HVQ-FN2 (ESF bldg normal exhaust) **Note 1**	550 5/3/0
3HVQ*ACUS1A&B (ESF bldg AC)	4
3HVQ*ACUS2A&B (ESF bldg AC)	2
Unit 1 Stack	
3GWS-FN1A&B (Process Vent Fan)	50 (Aux 66'-6")
3HVR*FN12A&B (SLCRS exhaust - duct leakage)	63 (Aux 66'-6")
Ventilation Vent	
3HVR-FN8A&B (Waste Disposal bldg normal exhaust)	43 (Aux bldg 66'-6")
3HVR-FN9 (Fuel bldg exhaust - duct leakage)	75 (Aux bldg 66'-6")
3HVR*FN6A&B (Aux bldg filter exhaust)	17 (Aux bldg 66'-6")
3HVR*AOD44A&B (Normal exhaust isol)	80 (Aux bldg 24'-6")
3HVR*AOD32A&B (Containment purge exhaust)	118 (Aux bldg 24'-6")

Note 1: This fan is secured locally at 1 hr 20 minutes post-LOCA

TABLE 15.6-22

TECHNICAL SUPPORT CENTER 30-DAY INTEGRATED DOSE

Event	Thyroid Dose (rem)	Whole Body Gamma Dose (rem)	Beta Skin Dose (rem)
Unit 3 LOCA	~~7~~.4E+00~~(2)~~ 4.4	~~1.4E+00(2)~~ 6.7E-01	~~2.5~~E+01~~(2)~~ 1.4

Note:

1. ~~7.4~~ 4.4E+00 = ~~7.4~~ 4.4 X 10^0

2. The current TSC LOCA analysis result in a thyroid dose of 4.7E+00, a whole body gamma dose of 1.1E+00 and a beta skin dose of 1.4E+01. The current results are bounded by the licensed numbers listed in the table. 98-61

APPENDIX 15A

DOSE METHODOLOGY

The radiological consequences of design-basis accidents are quantified in terms and of thyroid doses and whole-body gamma doses at the exclusion area boundary (EAB), at the low population zone (LPZ). The doses at the EAB are based upon releases of radionuclides over a period of two hours following the occurrence of an assumed accident; those at the LPZ are based upon releases over a thirty-day period following the occurrence of this accident. 97-426 3/98

Thyroid doses for the nonrevised accidents are calculated based upon Equation 15A-1: 97-426

$$D_{thy} = \sum_i (A_i)(X/Q)(B.R.)(C_{thy}) \qquad (15A\text{-}1)$$

where:

D_{thy}	=	thyroid dose (rem)
A_i	=	activity of iodine isotope i released (curies)
X/Q	=	atmospheric dispersion factor (sec/meter^3)
B.R.	=	breathing rate (meter^3/sec)
and C_{thy}	=	thyroid dose conversion factor (rem/ci) (Reg. Guide 1.109, 1977)

The X/Q values presented in Table 15.0-11 were calculated using the methodology described in FSAR Section 2.3.4.

Iodine nuclide contribution to the external whole body gamma dose for the nonrevised accidents is calculated using Equation 15A-2 (derived from equations in Regulatory Guide 1.4, 1974): 97-426

$$D_\gamma = 0.25 \sum_i A_i \overline{E_{\gamma i}} (X/Q) \qquad (15A\text{-}2)$$

97-426

where:

in 2 above lines

D_γ	=	gamma dose rate from a semi-infinite cloud (rem)
$E_{\gamma i}$	=	average gamma energy per disintegration of isotope i (MeV/dis)
A_i	=	activity of isotope i released over the given time interval (curies)

97-426

and X/Q = atmospheric dispersion factor (sec/m^3) 97-426

For the revised accidents the thyroid doses and the whole body doses are calculated by similar equations. However the dose conversion factors from ICRP 30 are used to calculate the thyroid dose.

97-426 3/98 Dose factors from Table B-1, Regulatory Guide 1.109 Revision 1 are used to calculate potential annual noble gas gamma whole body. ~~Iodine dose factors for the revised accidents are from ICRP 30~~. The equation from Regulatory Guide 1.109 is as follows:

$$D_\gamma = 3.17 \times 10^4 \sum_i (Q_i)(X/Q)(DF_i^\gamma) \qquad (15A\text{-}3)$$

where:

97-426

D_γ	=	annual noble gas gamma whole body dose (mrem)
Q_i	=	release rate of radionuclide i (Ci/year)
X/Q	=	atmospheric dispersion factor (sec/meter^3)
DF_i^γ	=	gamma whole body dose factor for a uniform semi-infinite cloud of radionuclide i $\frac{\text{mrem-m}^3}{\text{pCi-year}}$

97-426

The constant 3.17×10^4 is in units of $\frac{\text{pCi-year}}{\text{Ci-sec}}$

97-426 Dose contributions from the iodine and noble gas are added to obtain the total ~~net~~ gamma whole body dose.

97-426 The following is a list of computer programs which are used to calculate design-basis source terms and radiological consequences of the nonrevised design basis accidents in FSAR Chapter 15:

1. ACTIVITY 2

   Program ACTIVITY 2 calculates the concentration of fission products in the fuel, coolant, waste gas decay tanks, ion exchangers, miscellaneous tanks, and release lines to the atmosphere for a PWR system. The program uses a library of properties of more than 100 significant fission products and may be modified to include as many as 200 isotopes. The output of ACTIVITY 2 presents the isotopic activity and energy spectrum at the selected part of the system for a given operating time.

2. RADIOISOTOPE

   Program RADIOISOTOPE calculates the activity of isotopes in a closed system by solving the appropriate decay equations. Based on the activity of any isotope in the system at an initial time, the program calculates the activity of that isotope and its offspring at any later time, provided that the decay scheme is contained in the program library. Furthermore, because gamma activity is important for dose rate and shielding calculations, RADIOISOTOPE also calculates the energy releases in seven gamma energy groups from the decay of an inventory or radionuclides.

7. TACT III

The TACT III computer code simulates the movement of radioactivity released from a reactor core as it migrates through user-defined regions (nodes) of the containment, is immobilized by filters and sprays, and leaks to the outside environment. A run of the code carries out the integration of equations over a succession of contiguous time intervals following reactor shutdown, with the interval boundaries corresponding to transitions of system parameter values. Outputs include the level of radioactivity in each node of containment and in the environment, broken down as iodines, noble gases and solids and the radiation dose at the exclusion radius and the boundary of the low population zone.

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3/98

The basic formula of dose conversion used in TACT III is the following:

$$\sum D_n = (DCF)_n B \int X_n (t) dt$$

where:

D_n = the dose (rem) to the thyroid, the beta dose (rem) to the whole body or the gamma dose (rem) to the whole body from nuclide n

DCF = the respective dose conversion factors

B = the breathing rate for the referenced individual (thyroid only)

X_n (t) = the air concentration of nuclide n over any appropriate period of time

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References for Appendix 15A

Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I," Rev. 1, Oct. 1977.

Regulatory Guide 1.4, "Assumption Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactor," Rev. 2, June 1974.

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8. PERC 2

Program PERC 2 is identical to DRAGON 4 in terms of the environmental transport and dose conversion, but it includes the following:

- Provision of time-dependent releases from the reactor coolant system to the containment atmosphere
- Provision for airborne radionuclides other than noble gas and iodine, including daughter in-growth
- Provision for calculating organ doses other than thyroid
- Provisions for tracking time-dependent inventories of all radionuclides in all control regions of the plant model
- Provision for calculating energies as well as activities for the inventoried radionuclides to permit direct equipment qualification and vital access assessment

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9. RADTRAD

The RADionuclide Transport, Removal, and Dose (RADTRAD) model estimates doses at offsite locations: the exclusion area boundary (EAB) or the low population zone (LPZ), and in the control room. The code has two optional source terms to describe fission product release from the reactor coolant system: those specified in "Calculation of Distance Factors for Power and Test Reactor Sites" (TID-14844) along with Regulatory Guides 1.3 and 1.4; and those specified for boiling water reactors (BWRs) and pressurized water reactors (PWRs) in "Accident Source Terms for Light Water Nuclear power Plants" (NUREG-1465). As radioactive material is transported through the containment, the user can account for sprays and natural deposition that may reduce the quantity of radioactive material. Material can flow between buildings, from buildings to the environment, or into control rooms through high-efficiency particulate air (HEPA) filters, piping, or other connectors. An accounting of the amount of radioactive material retained due to these tortuous pathways is maintained. Decay and in-growth of daughters can be calculated over time as the material is transported. The code contains over 25 model and table options to perform these tasks. Dose Conversion Factors used in RADTRAD are from Federal Guidance Report No. 12, "External Exposure to Radionuclides in Air, Water and Soil." The RADTRAD code was developed by the Accident Analysis and Consequence Assessment Department at Sandia National Laboratories (SNL) for the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (NRR), Division of Reactor Program Management.