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

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May 7, 1984

Docket No. 50-423
B11162

Director of Nuclear Reactor Regulation
Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

References: (1) B. J. Youngblood letter to W. G. Counsil, Requests for Additional Information for Millstone Nuclear Power Station, Unit No. 3, dated January 16, 1984.

Dear Mr. Youngblood:

Millstone Nuclear Power Station, Unit No. 3
Responses to Containment Systems Branch Questions 480.19 and 480.34

Attached are Northeast Nuclear Energy Company's (NNECO) responses to Containment Systems Branch Questions 480.19 and 480.34 which were contained in Reference (1). We trust these responses will fully resolve the Staff's concerns regarding these questions. If you have any questions, please contact our licensing representative directly.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY ET AL
By Northeast Nuclear Energy Company, Their Agent

W. G. Counsil

W. G. Counsil
Senior Vice President

C. F. Sears

By: C. F. Sears
Vice President Nuclear and
Environmental Engineering

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STATE OF CONNECTICUT)
) ss. Berlin
COUNTY OF HARTFORD)

Then personally appeared before me C. F. Sears, who being duly sworn, did state that he is Vice President of Northeast Nuclear Energy Company, an Applicant herein, that he is authorized to execute and file the foregoing information in the name and on behalf of the Applicants herein and that the statements contained in said information are true and correct to the best of his knowledge and belief.

Lorraine J. D'Amico
Notary Public

My Commission Expires March 31, 1988

NRC Letter: January 16, 1984

Question No. Q480.19 (Section 6.2.2)

Discuss the effectiveness of convection mixing and/or recirculation spray operation to mix combustible gases that may be generated within the containment following onset of a postulated LOCA. Describe the design features of the containment which promote mixing of the atmosphere, and identify the compartments which may not achieve effective mixing of combustible gases. Provide sketches to show the expected circulation patterns within the containment compartments.

Response:

Refer to revised FSAR Section 6.2.5 for a discussion of the effectiveness of combustible gas mixing within the primary containment following a postulated LOCA.

total hydrogen produced minus the amount removed in the purge flow. An inflow of outside air equal in volume to the purge flow, is assumed. The purge flow is sufficient to maintain the hydrogen concentration below 4 volume percent.

Mixing of hydrogen in the containment following a postulated loss-of-coolant accident (LOCA) results from three mechanisms:

- Momentum transfer from the fluid jet exiting the break
- Forced and natural convection flows within the containment atmosphere
- Molecular diffusion

All these mechanisms will work together to enhance mixing within the containment to provide a homogeneous gas mixture and prevent local accumulation of hydrogen. A brief discussion of each mixing mechanism follows.

Good containment compartment mixing will occur during the blowdown period of the postulated LOCA due to the break effluent. The momentum of the jet from the break will cause turbulent mixing within the containment. This was demonstrated in a test performed for a high velocity jet source (Bloom 1982). Results from this test showed that "when the jet was initiated, local gas velocities, even far from the source, increased by a factor of three to five times over background velocities caused by natural convection and fan induced recirculation." Although this test was performed for an ice condenser lower compartment geometry, the test results would be
480.19 applicable to subcompartments (e.g., steam generator cubicle, pressurizer cubicle) which are open to the containment.

Forced convection in the containment atmosphere will be generated by the containment spray systems which are designed to cool the containment atmosphere (see Section 6.2.2.). Approximately 4,000 gpm (long-term) recirculation spray flow rate (assuming minimum safeguards) is provided.

The spray will induce mixing by imparting momentum to the containment atmosphere. Air entrainment by the spray causes bulk mass motion which creates both large- and small-scale turbulence. Therefore, complete mixing should occur within a few minutes following a LOCA with containment spray operation (Sandia 1983).

In addition, steam condensation and cooling of the containment atmosphere by the sprays will result in flow to low pressure regions. This does not result in significant mixing within individual compartments although significant intercompartment fluid transfer can occur (IDCOR 1983).

Natural convection due to density differences (buoyant effects) is another source which will cause mixing to occur in the containment atmosphere. Gas flow occurs whenever there is a temperature

difference between the wall and the bulk atmosphere. Gases heated or cooled by the walls will rise or fall, respectively, due to the density differences between the gas and the surrounding atmosphere. This buoyant force imparts momentum to the gas, and significant turbulence mixing will result.

The presence of large heat sinks in the containment, such as internal walls, together with localized heat sources, such as hot equipment surfaces, will be expected to set up large scale natural circulation cells. These circulation cells will help decrease any stratification which may occur in areas with the absence of jet-induced or forced-convection flows. Tests conducted during the containment systems experiment (CSE) program in a steam/air atmosphere indicated that natural convection caused good mixing in a large vessel (Hilliard/Coleman 1970 and Knudsen 1969).

After completion of the blowdown period of the postulated LOCA, natural convection flows within the containment atmosphere also will be developed due to the break effluent. Cooling water is injected into the reactor core by the ECCS (see Section 6.3). The injected water will exit the break as steam/water mixture. Buoyancy forces will cause the released steam to rise. This upward steam flow will generate containment mixing due to the entrainment of the atmosphere gases in the steam plume. The extent of mixing in areas away from the break due to the buoyant thermal plume discharging into the containment is a function of geometry, plume to atmosphere density ratio, and ratio of momentum to buoyancy forces (IDCOR 1983). 480.19

Molecular diffusion is another mechanism which would provide mixing within the containment following a postulated LOCA. Diffusion occurs due to concentration gradients. The rate of diffusion is too slow to expect mixing of large containment volumes in short times by itself, although molecular diffusion would add to the other mixing processes previously discussed.

The containment internal structures are designed to be as open as practical to allow the circulation and mixing mechanisms to function. The volume above the operating floor which comprises the majority of the containment volume does not have significant barriers to obstruct mixing from the various mechanisms. The steam generator and pressurizer subcompartments, the annulus between the crane wall and containment wall, and the hoisting spaces are open at the top and bottom and connect with each other at various elevations (see Figure 6.2-56). Extensive use is made of grating at intermediate levels within the compartments. The quench and recirculation spray nozzles are located and oriented to cover as much area as possible. This design arrangement enhances mixing by establishing air movement and flow paths. In summary, the design of the internal containment structure allows free circulation and mixing of gases, while the spray system enhances the circulation process throughout the containment.

The lower reactor cavity and incore instrumentation tunnel are the only areas that may not be effectively mixed with the bulk

containment volume. Since accumulation of water on the floor in the lower reactor cavity is expected to be insignificant, the generation of hydrogen from radiolysis, in turn, would be insignificant in this area. Small amounts of hydrogen will enter and exit the tunnel area by diffusion; however, hydrogen accumulation and large concentration gradients will not occur due to the absence of a hydrogen source. With diffusion being the only mixing mechanism present, the maximum concentration of hydrogen that can occur is equal to the maximum concentration that exists in the well mixed region just outside the entrance to this area.

Figure 6.2-57 depicts the expected predominant circulation patterns within the containment after termination of the initial release from LOCA.

The majority of gas mixing results from the spray systems. The recirculation spray entrains air, and its predominantly downward motion forces the gas mixture to the lower elevations and, in turn, up through and between the various compartments.

Steam pluming is a secondary mixing effect which assists in the overall gas mixing process. The steam plume from the break is
480.19 vertically upward from either the steam generator, pressurizer, or upper reactor cavity subcompartment depending on the break location. This effect generally enhances the mixing process in the region above the operating floor and within the compartment where the break occurs.

Hydrogen generation from oxidation of zircaloy fuel cladding, radiolysis of the water in the core, and hydrogen present in the reactor coolant system would be released through the break opening to the containment. Local accumulation of hydrogen within the compartment where the break occurred is unlikely due to the mixing action of the released effluent and the containment compartment design which does not significantly impede the mixing process.

Hydrogen generation from the radiolysis of water in the sump and corrosion of metals by the spray would be generated over long periods of time. Due to the slow rates of release, diffusion and spray mixing mechanisms would tend to keep the atmosphere mixed (IDCOR 1983).

Provisions to sample the containment atmosphere following a LOCA are provided (Section 9.3.2).

The failure modes and effects analysis performed for the DBA hydrogen recombiner system is described in Section 7.3.

6.2.5.4 Inspection and Testing Requirements

A preoperational performance test was performed by the supplier of the skid mounted portion of each DBA hydrogen recombiner train before shipment. This test was accomplished by placing the subsystem into operation. The DBA hydrogen recombiner blower was started, the test

air inlet was opened, and atmospheric air was allowed to flow through the subsystem. A minimum flow of 50 scfm was maintained and checked by the flowmeter. Hydrogen was added through a test connection to the rotameter until a concentration of 4 percent hydrogen was reached in the gas stream. The flow of hydrogen was increased slowly from 1/2 percent to 4 percent. Normal operation of the various components, together with a satisfactory temperature rise through the electric preheater and thermal recombiner and a check of the hydrogen concentration in the exit stream, indicated proper operation of the train.

In-place testing of the system will be accomplished by placing each subsystem into normal operation and by testing as indicated above. For in-place testing, the containment atmosphere will be used in place of atmospheric air.

6.2.5.5 Instrumentation Requirements

The DBA hydrogen recombiner system is initially started and monitored locally in the hydrogen recombiner building. After the initial heatup of the system, the system operates automatically with common alarms located in the control room to alert the operator of a system malfunction. Each hydrogen recombiner/analyzer train is totally

Containment isolation valve testing (Type C tests) is performed prior to initial criticality and periodically, thereafter, during each reactor shutdown for refueling, but in no case at intervals greater than 2 years.

A report of each periodic Type A test is submitted to the Nuclear Regulatory Commission (NRC). The report contains an analysis and interpretation of the Type A test results. In addition, the report has a summary analysis of the periodic Type B and C tests performed since the last Type A test.

If any periodic Type A test fails to meet the acceptance criteria, the schedule for subsequent Type A tests is subject to review and approval by the NRC. If two consecutive Type A tests fail, Type A testing must be performed during each refueling outage or at intervals not exceeding 18 months until two consecutive Type A tests meet the acceptance criteria, at which time the previous schedule may be resumed.

6.2.6.5 Special Testing Requirements

Type A, B, and C tests, as applicable, are conducted following containment structure modifications in accordance with Paragraph IV.A of Appendix J, 10CFR50.

A special test to verify the allowable in-leakage to the subatmospheric containment is not required as the integrated leak-rate test described in Section 6.2.6.1 adequately demonstrates the leak tightness of the containment.

An evaluation of in-leakage following a LOCA shows the containment pressure to be effectively subatmospheric at -0.5 psig 30 days following the accident. The inleakage analysis is based on the maximum specified out-leakage rate of 0.9 percent per day at approximately 45 psig adjusted to the pressure differences determined 480.22
to be present following a LOCA.

The maximum in-leakage rate to the subatmospheric containment during normal operation is approximately 14 scfm at 9.5 psia, the lowest normal operating containment pressure. This corresponds to the out-leakage rate of 0.9 percent per day at 45 psig adjusted for the pressure differential and other important flow paramaters.

The containment structure enclosure will be evacuated by the supplementary leak collection and release system (SLCRS) to slightly negative pressure immediately following the design bases accident initiation of the engineered safety features actuation system (ESFAS). This will ensure all leakage from the primary containment (0.9 percent per day) is passed through the high-efficiency particulate air (99-percent efficient) filters of the SLCRS prior to release from the containment structure enclosure, engineered safety feature building, main steam valve building, hydrogen recombiner building or auxiliary building which are all connected to the SLCRS.

This filtration will ensure the reduction of primary leakage from 0.9 percent per day to less than 0.1 percent per day released to the environment. The SLCRS will be tested prior to loading fuel to verify that a slightly negative pressure can be obtained and maintained following an ESFAS actuation in the areas mentioned above. This test will be conducted again at each refueling or at intervals not to exceed 18 months. Some leakage through piping systems may bypass the secondary containment. This leakage is limited to the design leak rates through these piping systems. The bypass leakage penetrations, identified in Table 6.2-65, are tested in accordance with Section 6.2.6.3, and the combination of their leakage rates is compared with the maximum allowable rate (9 scfh). When the actual leakage rate approaches this limit, corrective action will be taken.

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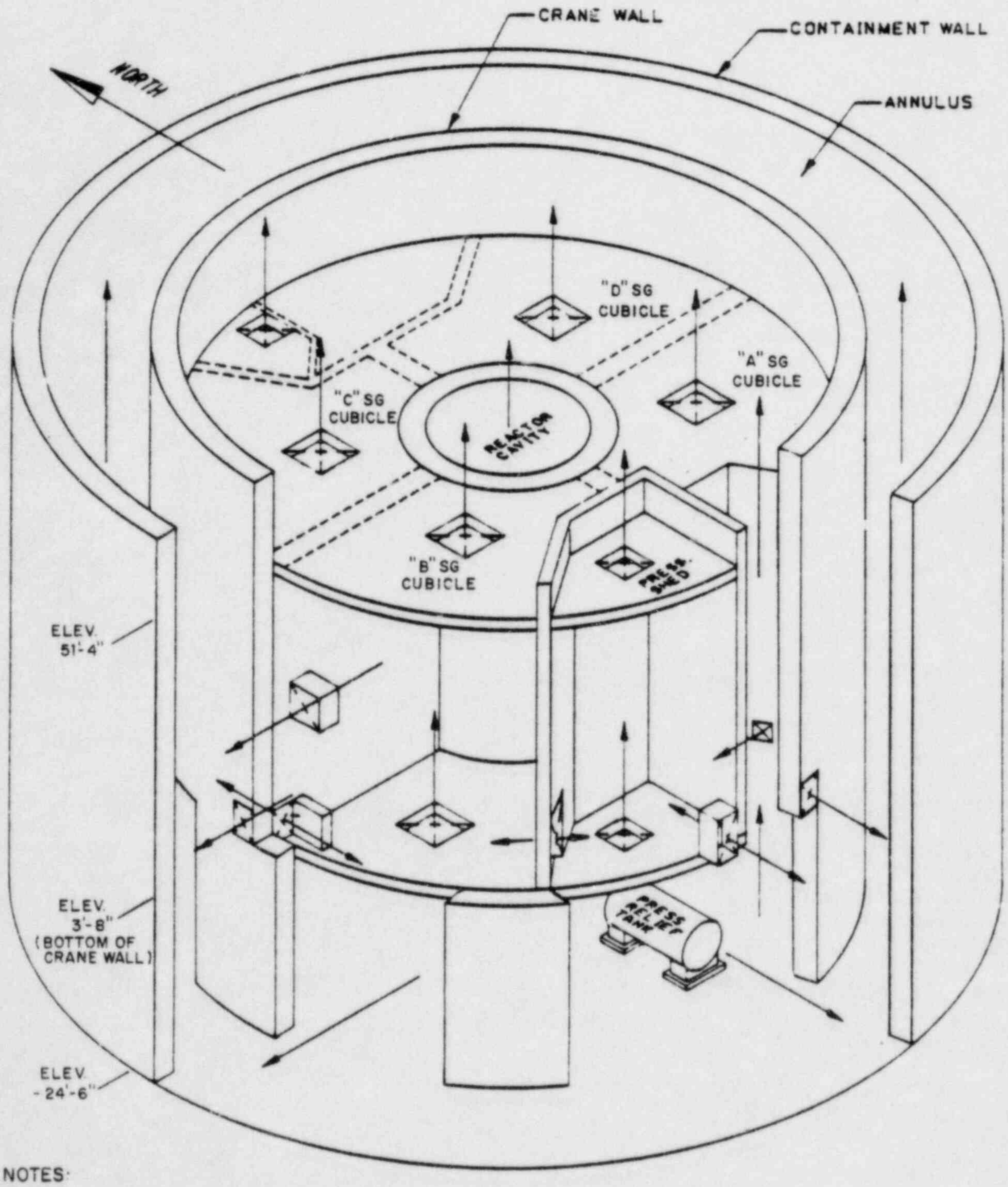

NOTES:

1. REFUELING CAVITY AND PRESSURIZER SHED AND STEAM GENERATOR SHIELD WALLS ABOVE OPERATING FLOOR NOT SHOWN FOR CLARITY.
2. OPENINGS ARE SHOWN SCHEMATICALLY AND DO NOT INDICATE EXACT SIZES AND SHAPES.

FIGURE 6.2-56
CONTAINMENT INTERNAL STRUCTURE OPENINGS
MILLSTONE NUCLEAR POWER STATION
UNIT 3
FINAL SAFETY ANALYSIS REPORT

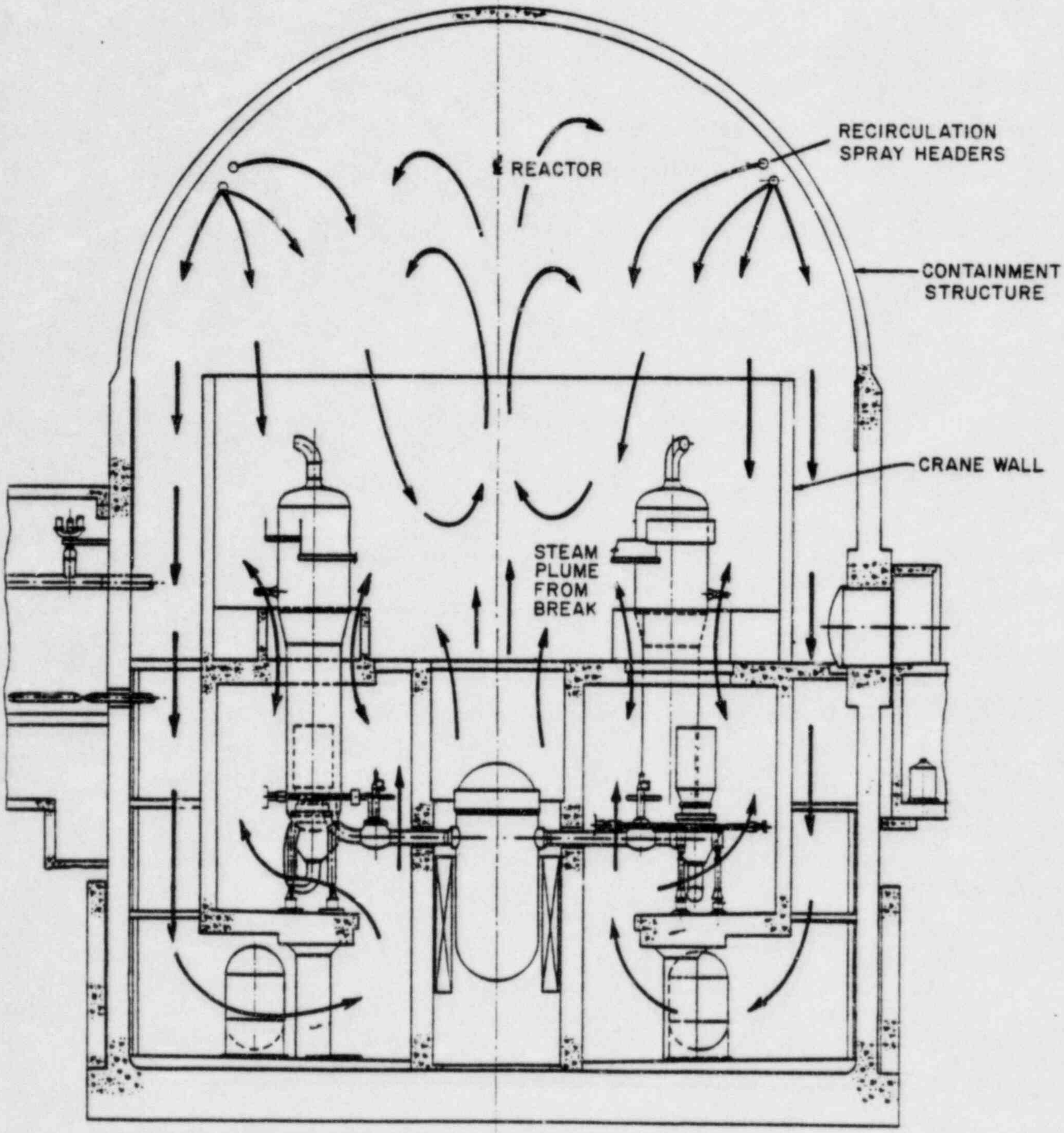

FIGURE 6.2-57
EXPECTED LONG-TERM CIRCULATION PATTERNS IN CONTAINMENT
MILLSTONE NUCLEAR POWER STATION
UNIT 3
FINAL SAFETY ANALYSIS REPORT

NRC Letter: January 16, 1984

Question No. Q480.34 (Section 6.2.6)

According to Section 6.2.6.3, the isolation valves for the seal water injection lines serving the reactor coolant pumps are not Type C tested because the lines would be continually pressurized following an accident. Discuss how this would be accomplished assuming a single active failure or the termination of seal water injection.

Response:

Type C testing will be incorporated for these valves. The following valves will be Type C tested:

3CHS*V394, V434, V467, V501
3CHS*MV8109A, B, C, D

Refer to revised FSAR Section 6.2.6.3 and revised FSAR Table 6.2-65.

The fuel transfer tube consists of a sleeve welded to the containment liner and attached to the transfer tube by means of a bellows connection. The area between the tube and the sleeve is provided with a test connection for testing the bellows seal connection to a pressure of P_a.

The results of the combined containment penetration leakage results are acceptable if, when combined with the total leakage of the Type C test, they are equal to or less than 60 percent of L , as defined by Appendix J, Section III.B.3.

6.2.6.3 Containment Isolation Valve Leakage Rate Test (Type C)

Table 6.2-65 lists all containment isolation valves and identifies those requiring Type C tests along with the test methods used. The following valves are excluded for the following reasons:

Penetrations	Reason for Type C Testing Exemption
1,2,3,4,5,6,7,8, 47,48,49,50, 74,75,76,79, 80,81,82,122A, B,C, & D,123	These penetrations are directly connected to the steam generator secondary side and, therefore, are considered an extension of the primary containment.
9,13D,31,33	Class 2 instrument piping outside containment will not be considered to rupture.

480.34

There are two methods used in Type C tests. With either method, each valve to be tested is closed by normal operation without any preliminary exercise or adjustment.

In Method 1, the section of piping with the containment isolation valves is isolated from the remainder of the fluid system by using valves or blanking flanges as necessary, and the piping is drained (if applicable). The inside and outside containment isolation valves are tested individually with air at a pressure equal to P . Test air is applied at a test connection on the inboard side (toward the inside of the containment structure) of the valve to be tested, and the leakage air is vented through a test vent on the outboard side of the valve. A flowmeter, connected to the pressure source or to the test vent, is used to measure leakage through the containment isolation valve as a function of time. In this procedure, airflow across the valve seat is always in the inside-to-outside containment structure direction.

In Method 2, test pressure is applied between the two isolation valves where the innermost valve (inside containment) is a diaphragm, symmetric butterfly type valve, or a globe type valve where the test pressure will be under the seat. The outermost valve (outside