NORTHEAST UTILITIES

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August 29, 1979

Docket No. 50-245

Director of Nuclear Reactor Regulation
Attn: Mr. D. L. Ziemann, Chief
Operating Reactors Branch #2
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Reference: (1) D. L. Ziemann letter to W. G. Counsil dated July 16, 1979.

Gentlemen:

Millstone Nuclear Power Station, Unit No. 1
SEP Structural Topics

In Reference (1), Northeast Nuclear Energy Company (NNECO) was requested to provide information on various structural topics. In response to that request, Attachment 1 is provided.

As noted in the Attachment, with respect to the requested information for Topics III-2, Wind and Tornado Loads: and III-7B, Design Codes, Design Criteria, Load Combination, and Reactor Cavity Design Criteria, efforts are continuing to address the remaining aspects of your request. It is currently estimated that the attached material will be supplemented on or about October 30, 1979.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

W. G. Counsil

W. G. Counsil
Vice President

Attachment

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DOCKET NO. 50-245

ATTACHMENT 1

MILLSTONE NUCLEAR POWER STATION, UNIT NO. 1

SEP STRUCTURAL TOPICS

AUGUST, 1979

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ENCLOSURE

MILLSTONE UNIT NO. 1
REQUEST FOR INFORMATION
STRUCTURAL TOPICS

Information is needed for the following structural topics:

III-2 Wind and Tornado Loads

Indicate which standards or codes (including edition date) were used in the design of each Category I structure for wind and tornado.

III-3.A Effects of High Water Level on Structures

Provide the design water level, including the hurricane flooding conditions, that was considered in the design of each Category I structure.

III-4 Missile Generation and Protection

Provide the missile barrier design criteria of the reactor building and turbine building.

III-7.B Design Codes, Design Criteria, Load Combination, and Reactor Cavity Design Criteria

1. With regard to the design of the steel containment, provide the design specifications and appropriate design reports. This information should include the information requested in items two through six below.

2. List the codes and standards (including edition date) used for design and construction of each Category I structure.

3. List all loads and load combinations considered in the design of each Category I structure, including any missile or pipe break effects.

4. Provide the pertinent material properties of the steel and concrete (i.e., fg and fi, etc.) used in the design of each safety related structure.

5. Describe the method of combining stresses induced by seismic action with the stresses resulted from non-seismic loads.

6. Provide a summary of stresses or strains at critical locations in all Category I structures for each load and load combination considered in the design.

III-7.D Containment Structural Integrity Tests

Provide any reports that describe the procedures and results of the primary containment structural integrity test.

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III 2 WIND AND TORNADO LOADS

The design utilizing the criteria of 115 mph wind velocity with gusts to 140 mph was based on "standard codes and normal engineering practice" (reference MP1 FSAR Section I 1.3.1.1). The analysis of the reactor building and all other Class I structures was based on a combination of dead loads (dead load of structure and equipment plus any other permanent load contributing stress such as soil, hydrostatic, temperature loads, or operating pressures and live loads expected to be present when the plant is operating) and wind loads in accordance with normal allowable code stresses (AISC for structural steel, ACI for reinforced concrete) with the customary increases in stresses when wind loads are considered (Reference MP1 FSAR Section XII, Item 1.1.2). Additional information; i.e., edition dates, etc., is not available at this time. Additional efforts are in progress to address this item.

III 3A EFFECTS OF HIGH WATER LEVEL ON STRUCTURES

The design water level was based on a maximum wave runup to elevation 19 feet MSL. All structures that do not have reinforced concrete walls were provided with a reinforced concrete flood wall built up to elevation 19 feet MSL. All openings in this wall are closed by flood gates also built to elevation 19 feet. The west wall of the plant, which has maximum exposure to flood waters, has been protected further with a poured or masonry concrete wall extending from the top of the flood wall to elevation 30 feet MSL (Reference MP1 FSAR Section II, Item 2.4.4.2).

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III 4 MISSILE GENERATION AND PROTECTION

The analysis of potential missiles generated as the result of a main turbine generator failure is discussed in full in GE Report TR-67SL211, titled "Analysis of Turbine Missiles Resulting From Last Stage Wheel Failure." This report shows that in the worst cast, a 120^{o} segment of the last stage turbine wheel could penetrate 2.9 feet of concrete. In the case of the Millstone Unit 1, the reactor building walls from grade level to the operating floor are 3.0 feet thick reinforced concrete walls. Therefore, the worst case turbine generator missile would not penetrate the reactor building walls to an extent that would preclude the safe shutdown of the plant.

The following tornado-driven missiles are considered to provide a conceivable spectrum of possibilities.

1. A 2-inch by 4-inch by 12-foot board weighing 40 pounds per cubic foot, end on.
2. A crosstie, 7 inches by 9 inches by 8.2 feet weighing 50 pounds per cubic foot, end on.
3. A compact car weighing 1,800 pounds, with an impact area of 20 square feet.

Each missile was assumed to be traveling at 200 mph at impact. The ability of concrete walls to resist penetration by possible missiles generated by a tornado has been investigated. The depth to which a missile will penetrate a concrete wall has been estimated by use of the modified Petri formula.

The reactor building has reinforced concrete walls approximately 18 inches thick. As computed by the above formula, none of the above missiles would penetrate more than 10 inches into an 18-inch thick reinforced concrete wall. The superstructure is vulnerable to missiles, however, no safety-related equipment is located at the superstructure level.

The turbine building is a Class II structure containing Class I equipment. This equipment is protected in varying degree against missile damage by building structures, shield walls, foundations, other equipment, etc. This inherent protection in conjunction with the redundancy provided in essential equipment provides assurance that a safe shutdown and cooldown of the plant can be accomplished with due consideration to potential damage by tornado-driven missiles.

Further discussion is available in Section 12 of the MP1 FSAR.

III 7B <u>DESIGN CODES, DESIGN CRITERIA, LOAD COMBINATION, AND REACTOR CAVITY DESIGN CRITERIA</u>

Included is a portion of Item 1.0, "Structural Design" of Section XII of the MP1 FSAR which partially addresses this request. The additional information requested (code and standard edition dates, material properties, stresses, and strains calculated at critical locations, etc.) are under investigation and will be forwarded when available.

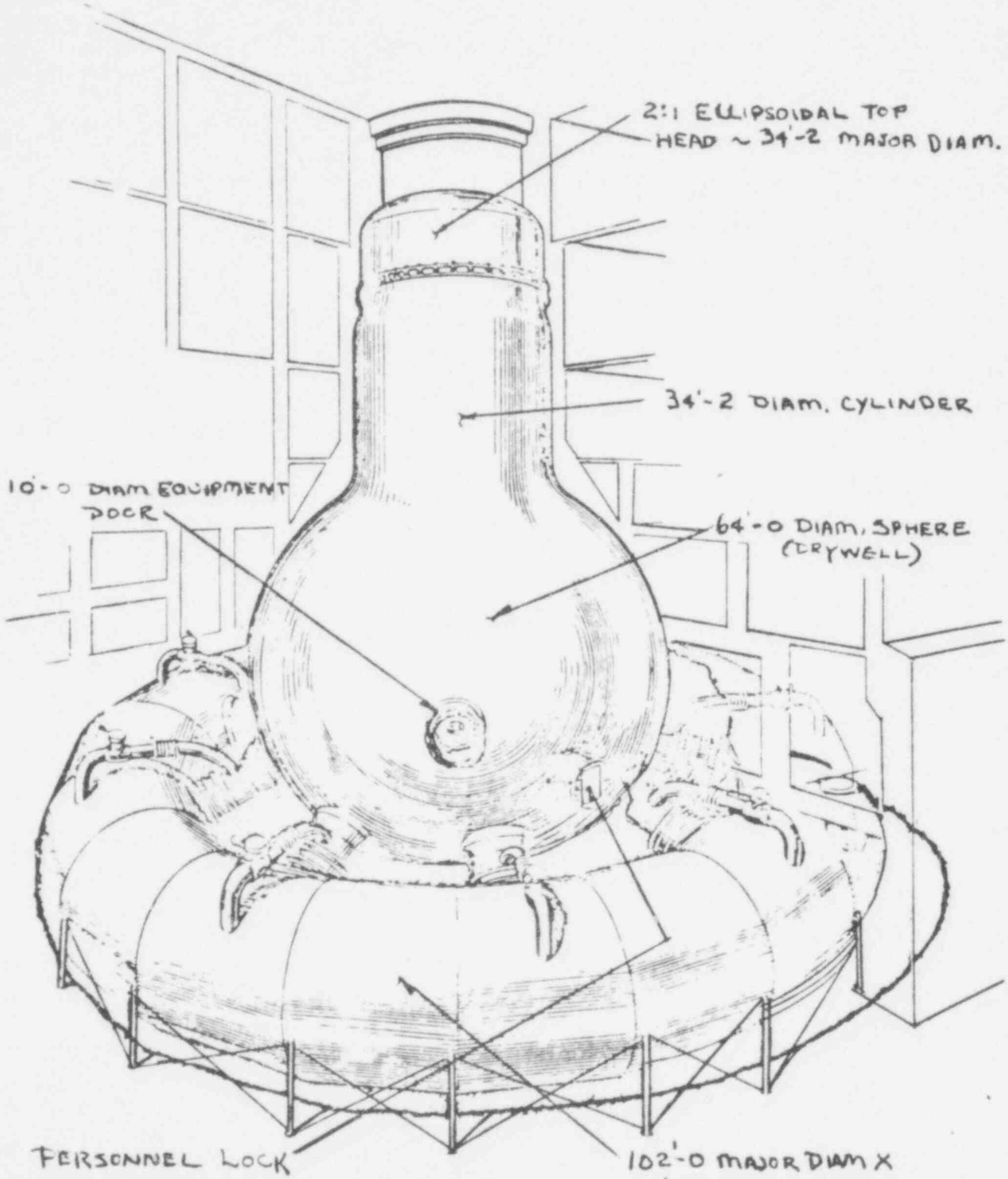
III 7D <u>CONTAINMENT STRUCTURAL INTEGRITY TESTS</u>

Included is a copy of the CB&I report of Initial Overload Tests and Leakage Rate Determination of the Pressure Suppression Containment. The attachments to this report are included in Appendix D of the MP1 FSAR.

EXHIBIT D.A

CB&I REPORT OF INITIAL OVERLOAD TESTS AND LEAKAGE RATE DETERMINATION OF THE PRESSURE SUPPRESSION CONTAINMENT

TABLE OF CONTENTS



POOR ORIGINAL

INTRODUCTION

The Millstone Nuclear Power Plant of the Millstone Electric Company incorporates a pressure suppression containment system with a drywell having interconnecting vent lines to a suppression chamber. The system is intended to provide a leak-tight enclosure for the nuclear reactor and any steam or gases that may be released. The vessel is of the shape and size as shown on page 1.

The drywell and suppression chamber were designed, erected and tested by Chicago Bridge & Iron under a contract with Ebasco, Inc., and in accordance with Ebasco Specifications. The containment was designed and constructed in accordance with the rules of Section III of the ASME Code. The containment vessel, consisting of the innerconnected drywell and suppression chamber, was stamped after construction and testing with the ASME symbol for the design, internal pressure and design temperature.

The drywell was constructed on a skirt and the bottom is to be later embedded in concrete. The suppression chamber was constructed on permanent steel columns. All plate seams were accessible for inspection, inside and outside, before and after the test. All permanent connections were welded in place in the shell of each vessel.

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GENERAL PROCEDURE

The following tests were made.

The procedure for the overload test fulfilled the requirements of Section III of the ASME Code. Two overload tests were made, one with the suppression chamber in a dry condition, the other with the suppression chamber partially filled with water to the accident condition level (89000 cu.ft.). Both the drywell and suppression chamber were simultaneously pressurized with air to 115% of the design pressure.

The method used for leakage rate test consists of comparing the pressure in the containment vessel with an airtight inner-chamber which is an integral part of a reference system. In order to assure a sound reference system, the system was tested with a halogen leak detector, and held at pressure for at least 24 hours to assure no leakage.

The drywell and suppression chamber were tested for leaks in accordance with the specifications. The general philosophy of the reference system type of leakage test is as follows. By locating the inner-chambers inside of the drywell and inside of the suppression chamber, approximately at the center of the individual air masses, the average temperature of the air vapor in each air mass can be proportionately represented. Data attained from previous tests have shown that the data between successive midnight-dawn periods can be compared because of the relatively uniform temperature conditions during such a period. With negligible difference in average air temperature between the inner-chamber and the containment vessel, the possibility of a pressure differential being caused by temperature can be eliminated. With the complete reference system proved to be tight by thorough inspection methods, any relative decrease in containment vessel pressure under this temperature condition must be considered to be external leakage. By measuring the difference in pressure between the two air volumes with a water manometer, a high degree of sensitivity to this pressure differential can be accomplished. Appendix 1 describes the relationship of the differential pressure measurements to the percent leakage.

The leakage rate of the containment vessel was conducted with the suppression chamber in a dry condition, and again with the suppression chamber filled with water to the accident level. For this "wet" test, interior measurements of vapor pressures and temperatures were made and included in the calculation of leakage. The results of the test are in Section II.

Test Report
Contract 9-5420
Millstone, Conn.

This report covers the testing completed on Contract 9-5420, Millstone, Conn. Representing Chicago Bridge & Iron Co. were Darwin Wilbur (Eastern), Garland Mahan and Dick Kollmansberger (Oak Brook Testing). The foreman is Larry Daricek.

By Wednesday June 7, 1967 the reference system, consisting of the copper tubing and the copper chambers, had been positioned in the vessel and needed only to be tested with a Halogen Leak Detector. Thursday afternoon the dewcel elements and dynatherm resistance bulbs were in place and the halogen testing had been successfully completed revealing no detectable leaks. At 1900 hours we began recording data for the 24 hour hold test on the reference system. The following calculations indicate the reference system was free of leaks within the sensitivity of the test.

1900 Hrs. 6-8-67 to 1900 Hrs. 6-9-67

$$\text{Theoretical } P = \frac{\text{Final vessel temp}}{\text{Initial vessel temp}} \text{ (Initial Pressure)}$$

$$P = \frac{536.8}{529.1} (72.3) = 73.31\text{psig}$$

The actual gauge reading (P_2) was 73.3 comparing favorable with the theoretical "P_2", 73.31.

At 0900, June 9, 1967, we reached a pressure of 5 psig and stopped pressurizing to begin the soap solution test. This test revealed eight fillet weld leaks on the control rods, all were shop welds. The bottom manhole gasket and a number of small plugs, couplings and conax fittings also revealed small leakage.

The vessel was vented and all repairs made. At 1640 hours we resumed pressurizing, stopping at 5 psig to retest the repairs and the personnel lock. Overload procedure was performed in accordance with steps "B-23" to "B-26" of the test procedure. at 62 psig another soap solution test was performed. At this time seven leaks were found in the fillet welds of the control rods, two in the control rod coupling welds and several loose control rod plugs. These were large leaks and definitely would have led to the failure of the test. As in the 5 psig test a number of smaller leaks were found in the conax fittings and some of the smaller couplings and plugs around the vessel. All substantial leaks were temporarily sealed. Repairs were made after the Leak Rate Test (Dry Condition) was completed.

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Dry Leakage Test

At 2400 hours 6-11-67 the leak rate test with the vessels in the dry condition was started. Weather conditions during the test were good in that the temperature and barometric cycles of the two days were very close. Relative humidity inside the vessel was 100% through most of the test. At 0600 hours (6-12-67) the leak test of the vessel in the dry condition was terminated and the percent leakage was calculated in accordance with step "C-8" of the test instructions. An average ΔP is as used for both nights to represent the 24 hour period. The hours of 0300 to 0500 are considered to present the most stable period. For these hours the average initial ΔP was 5.93, and the average final ΔP was 6.60.

$$\text{Percent Loss} = \left(\frac{\text{Initial}\,\Delta P - \text{Final}\,\Delta P}{\text{Initial}\,\Delta P \times 27.7}\right) 100$$

$$\text{Percent Loss} = \left(\frac{5.93 - 6.60}{5.93 \times 27.7}\right) 100 = .0408\%$$

The equation from "C-8" does not take into consideration any temperature changes taking place during the period in question. Temperature corrections were made in accordance with the equation under section "E-8" of test instructions as shown below.

For the period of 0300 hours to 0500 hours the initial average temperature was 62.0°F, and the final average temperature was 59.5°F.

$$\text{Percent Loss} = \frac{100}{\text{Initial}\,\Delta P \times 27.7}\left(\text{Initial}\,\Delta P - (\text{Final}\,\Delta P)\left(\frac{\text{Initial IAT}}{\text{Final IAT}}\right)\right)$$

$$\text{Percent Loss} = \frac{100}{5.93 \times 27.7}\left(5.93 - 6.60\left(\frac{522}{519.5}\right)\right) = .0432\%$$

The total allowable leakage rate for the vessel is .2% leakage/24 hr. period. All of our calculations were well under this standard. The data and our calculations were phoned to Bill Triplett, then reviewed and accepted by him and Roger Reedy.

The vessel was vented to atmospheric pressure following a short hold test on the reference system in which 3"H_2O Press was released from the vessel. By monitoring temperature changes along with the changes in the ΔP we were able to help confirm the tightness of our reference system.

Wet Leakage Test

Preparation for the Wet Test began immediately. Half of the reference system in the Suppression Chamber was cut away and another 24 hour reference system hold test was started. At the end of 42 hours our calculations showed no apparent leakage.

0900 Hrs. 6-14-67 to 0845 Hrs. 6-15-67

Initial Temp. 516.63

Final Temp. 524.03

Initial Press. 86.7

Final Press. 87.93

$$P_2 = \frac{T_2}{T_1}(P_1)$$

$$P_2 = \frac{524.03}{516.63}(86.7)$$

$P_2 = 87.91$ Comparing favorably with the actual reading of 87.93 psia

1015 Hrs. 6-14-67 to 1015 Hrs. 6-15-67

Initial Temp. 519.2 °R

Final Temp. 527.11 °R

Initial Press. 87.2 psia

Final Press. 88.6 psia

$$P_2 = \frac{T_2}{T_1}(P_1)$$

$$P_2 = \frac{527.11}{519.2}(87.2)$$

$P_2 = 88.508$ Comparing favorable with the actual reading of 88.6 psia

Leaks found during the previous 62 psig solution film test were repaired and inspected. A check of the relative humidity data as recorded from the dewcel elements was performed at this time.

Readings taken with a sling psychrometer inside the suppression chamber and the drywell were all 98-100% during the heat of the afternoon, verifying our data. On Wednesday, June 14, water was pumped into the suppression chamber in accordance with section "D-2" of the test instructions. The chamber was then visually inspected. Resistance Bulb #B-10 was then lowered into the water in order to record water temperatures throughout the wet test.

At 1630 hours 6-15-67 a pressure of 5 psig was reached and a soap solution test was performed as specified in section "D-10" of the test instructions. The vessel was pressurized to overload (71.3psig), held for one hour and then vented to design pressure (62 psig). At this time another soap solution test was applied (section "D-16").

The leak rate test of the vessel in the wet condition began at 2400 hours 6-17-67 and terminated at 0600 hours 6-18-67. During this test three substantial leaks were discovered and eliminated. The seat of the 6" valve on the pressurizing line, one of the control rod plugs, and the air manifold system were the areas of leakage.

The preliminary percent leakage was calculated in accordance with section "E-8" of the test instructions. The average values of the data from the hours 0300 to 0600 were used as being representative of the stable condition of the vessel. For these hours, the initial ΔP was 7.6 inches of water and the initial vessel temperature was 66.5°F. The final ΔP was 8.23 inches of water and the final vessel temperature was 66.0°F. The initial pressure was 73.02 psig.

$$\text{Preliminary \% Loss} = \frac{100}{27.7 \times \text{initial P}} \left(\text{initial}\Delta P - (\text{final}\Delta P) \left(\frac{\text{Initial IAT}}{\text{Final IAT}} \right) \right)$$

Preliminary % Loss = .0262%

The apparent percent loss was calculated in accordance with section "E-10" using the same hours as for the preliminary percent loss. These are based on an initial average dew point temperature of 67.2 and a final average dew point temperature of 66.6. Interpolating from Keenan and Keys <u>Thermodynamic Properties of Steam</u> yields an initial vapor pressure of .3299 psia or 9.15 inches of water and a final vapor pressure of .323 psia or 8.95 inches of water.

$$\text{Apparent percent loss} = \frac{100}{73.02 \times 27.7} \left(8.95 \left(\frac{526.5}{526.0} \right) - 9.15 \right)$$

Apparent percent loss = - .0099%

In accordance with section "E-11", the corrected percent loss is equal to the preliminary percent loss less the apparent percent loss as a negative number.

Corrected percent loss = .0264 - (-.0097)

Corrected percent loss = .0361%

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All data was telephoned in for review by Bill Triplett and Roger Reedy and proved to be well within the specifications set in the test instructions. The customers' representatives were satisfied with the manner in which the test was conducted and the results obtained. We obtained from them a letter substantiating our data and stating that they were in agreement that the test should be terminated.

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SECTION XII

STRUCTURAL DESIGN

1.0 STRUCTURAL DESIGN

1.1 General. The principal safety related structures of the Millstone Station are: the reactor building (which includes the primary containment), turbine building, control room and radwaste building, intake structure and stack. The primary containment is discussed in detail in Section V. The arrangement of the structures on the site is shown on Figure XII-1.1.

1.1.1 Safety Categories. The plant structures and equipment are divided into two structural safety categories:

Class I - Structures and equipment whose failure could cause significant release of radioactivity or which are vital to a proper shutdown of the plant and the removal of decay heat.

Class II - Structures and equipment which are not essential to the containment of radioactivity or proper shutdown of the plant or removal of decay heat.

1.1.2 Design Basis - Class I Structures and Equipment. General requirements for the design of all structures and equipment include provisions for resisting the stresses resulting from dead loads, live loads, and wind or seismic loads with impact loads considered as part of the live load. The treatment of equipment stresses are generally limited to those produced by non-operating loads such as the effect of building motion due to earthquake on the anchorage or support for a piece of equipment. However, the loads resulting from operating pressures or temperatures on equipment are considered where they would increase the stresses. Flooding from hurricanes is a special requirement at this site which requires flood protection for all structures to elevation 19' 0".

Selection of materials to resist the expected loads is based on standard practice in the power plant field. The use of these materials is governed by local building codes and the experience and knowledge of the designers and builders.

The stress loadings which are loads of concern are the following:

D = Dead load of structure and equipment plus any other permanent loads contributing stress, such as soil, hydrostatic, temperature loads, or operating pressures and live loads expected to be present when the plant is operating.

P = Pressure due to loss-of-coolant accident.

R = Jet force or pressure on structure due to rupture of any one pipe.

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H = Force on structure due to thermal expansion of pipes.

T = Thermal loads on containment due to loss-of-coolant accident.

E = Design earthquake load.

E' = Maximum earthquake load.

W = Wind load.

The criteria which have been followed for all Class I structures and equipment with respect to stress levels and load combinations for the postulated events are noted below:

LOAD CONSIDERATIONS	ALLOWABLE STRESS
1. Primary Containment (Including Penetrations)	
a. D + P + H + T + E	ASME, Section III, Class B, without the usual increase for seismic loadings.
b. D + P + R + H + T + E	Same as a. above, except local yielding is permitted in the area of the jet force where the shell is backed up by concrete. In areas not backed up by concrete, primary local membrane stresses at the jet force do not exceed 0.90 time yield point of the material at 300° F.
c. D + P + R + H + T + E'	Primary membrane stresses, in general, do not exceed the yield point of the material. If the total stress exceeds yield point, an analysis will be made to determine that the energy absorption capacity exceeded the energy input from the earthquake. The same criteria as in b. above, is applied to the effect of jet forces for this loading condition.

2. Reactor Building and All Other Class I Structures

a. D + R + E

Normal allowable code stresses are used (AISC for structural steel, ACI for reinforced concrete). The customary increase in design stresses, when earthquake loads are considered, is not permitted.

b. D + R + E'

Stresses are limited to the minimum yield point as a general case. However, in a few cases, stresses may exceed yield point. In this case an analysis, using the Limit-Design approach, will be made to determine that the energy absorption capacity exceeded the energy input. This method has been discussed in the AEC publication TID-7024 "Nuclear Reactor and Earthquakes" Section 5.7. The resulting distortion is limited to assure no loss of function and adequate factor of safety against collapse.

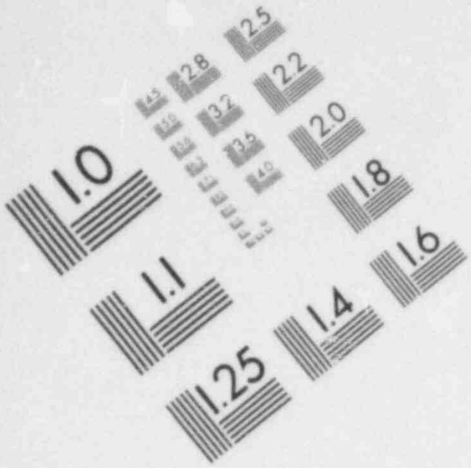
c. D + W

Normal allowable code stresses (AISC for structural steel, ACI for reinforced concrete) with the customary increases in stresses when wind loads are considered.

3. Reactor Vessel Supports

a. D + H + E

Stresses remain within Code Allowables without the usual increase for earthquake loadings (AISC for structural steel, ACI for reinforced concrete).



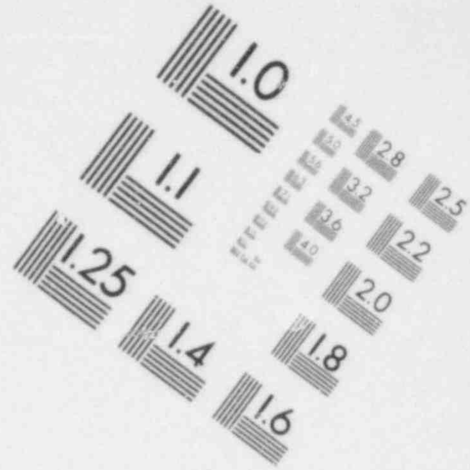
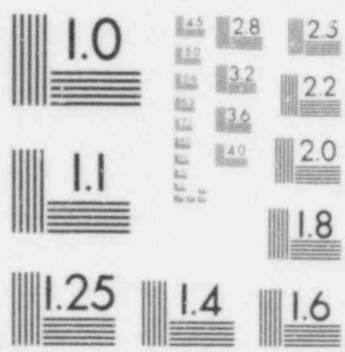


IMAGE EVALUATION
TEST TARGET (MT-3)



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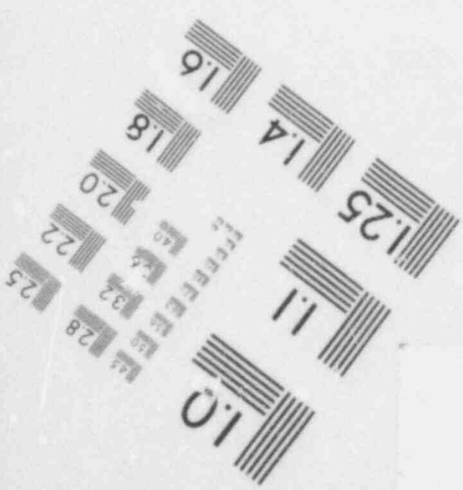

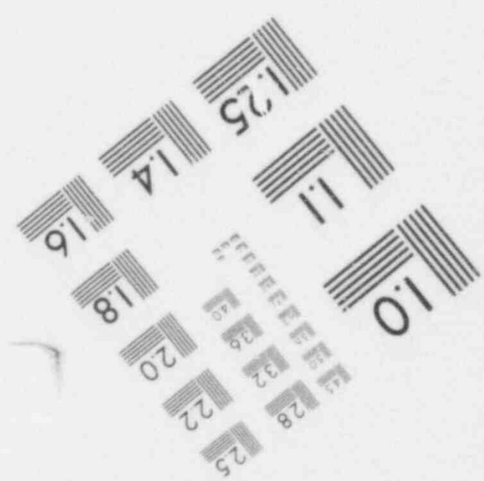

b. D + H + R + E	Stresses do not exceed . . . - 150% of AISC allowables for structural steel - 90% of yield stress for reinforcing bars - 85% of ultimate stress for concrete.
c. D + H + E'	No functional failure - usually stresses do not exceed the yield point of the material for steel or the ultimate strength of the concrete. If these limits are exceeded energy absorption capacity is determined and compared to the energy input from the earthquake. The design is such that energy absorption capacity exceeds energy input.
4. Reactor Vessel Internals	
a. D + E	Stresses which occur as a result of the maximum possible combination of loadings encountered when the plant is in operation are within the stress criteria of ASME, Section III Class A Vessel.
b. D + E'	The secondary and primary plus secondary stresses are examined on a rational basis taking into account elastic and plastic strains. These strains are limited to preclude failure by deformation which would compromise any of the engineered safeguards or prevent safe shutdown of the reactor.

c. P + D	Primary stresses are within the stress criteria of ASME, Section III, Class A. The secondary and primary plus secondary stresses are examined on a rational basis taking into account elastic and plastic strains. These strains are limited to preclude failure by deformation which would compromise any of the engineered safeguards or prevent safe shutdown of the reactor.
5. Emergency Core Cooling Systems (ECCS)	
a. D + T + H + E	Stresses remain within code allowable. USAB-B31.1 - 1955 plus code cases (piping). ASME Section III, Class C (pumps). ASME Section III. Class C and TEMA C, shell side. ASME Section VIII. TEMA C on tube side (LPCI heat exchanger).
b. D + T + H + E'	Same as c. above.

The maximum allowable stresses used for various loading conditions are given for Class I structures in Table XII-1.

Floor live loads were established based upon equipment and operating loads and applied to the basic Building Code, which is recommended to the boroughs by the State of Connecticut. Roof live loads are 60 psf for Class I buildings and 40 psf for Class II buildings.

All Class I structures will withstand the maximum potential loadings resulting from a wind velocity of 115 miles per hour with gusts up to 140 miles per hour. In addition, the safety related systems which are required to function for long periods during or following the postulated accidents are housed in structures designed to withstand short term tornado winds up to 300 miles per hour. These designs are based upon allowing the steel to approach yield stress, and the concrete to approach ultimate stress. Although some damage to these structures could perhaps occur, this damage would under no circumstances impair the functions of the safety related systems.

TABLE XII-1

ALLOWABLE STRESSES FOR CLASS I STRUCTURES

Loading Conditions	Reinforcing Steel Max. Allowable Stress	Concrete Max. Allowable Compression Stress	Concrete Max. Allowable Shear Stress	Concrete Max. Allowable Bearing	Structural Steel Tension on the Net Section	Structural Steel Shear on Gross Section	Structural Steel Compression on Gross Section	Structural Steel Bending
1. Dead Loads Plus Live Loads* Plus Operating Load Plus Seismic Loads (0.07g)	0.5 Fy	0.45 f'c	$1.1\sqrt{f'c}$	0.25 f'c	0.60 Fy	0.40 Fy	Varies with Slenderness Ratio	0.66 Fy to 0.60 Fy
2. Dead Loads Plus Live Loads*, Plus Operating Loads Plus Wind Loads	0.667 Fy	0.60 f'c	$1.467\sqrt{f'c}$	0.333 f'c	0.80 Fy	0.53 Fy	Varies with Slenderness Ratio	0.88 Fy to 0.80 Fy
3. Dead Loads, Plus Live Loads*, Plus Operating Loads, Plus Seismic Loads 0.17g		Safe Shutdown of the Plant can be Achieved (See Note 1 Below)						

* 25% of live loads were considered concurrent with the Seismic Loads.

Fy = Minimum yield point of the material   f'c = Compressive strength of concrete

Note 1: The structure was analyzed to assure that a proper shutdown can be made during ground motion having 17/7 the intensity of the spectra shown in Figure XII-1.2 even through stresses in some of the materials may exceed the yield point.

Based upon the seismology report in Volume II, Appendix F of the Millstone DAR, a ground acceleration of 0.07g has been used as a design basis for Class I Structures.

As an additional requirement, the design is such that a safe shutdown can be made with the containment and heat removal facilities intact during a ground motion of 0.17g.

John A. Blume and Associates, the seismic consultants, used the ground acceleration of 0.07g to prepare the response spectrum curves shown in Figures XII-1.2 and XII-1.3 which were used as a basis for the dynamic analysis of Class I structures.

The natural periods of vibration were calculated for buildings which are vital to the proper shutdown of the plant. The following damping factors were used for strong vibrations within the elastic limit:

Item	Percent of Critical Damping
Reinforced Concrete Structures	5.0
Steel Frame Structures	2.0
Welded Assemblies	1.0
Bolted and Riveted Assemblies	2.0
Vital Piping Systems	0.5

For the design of Class I structures and equipment the maximum horizontal acceleration and the maximum vertical acceleration were considered to act simultaneously. Where applicable the resulting seismic stresses for the two motions were combined linearly. The vertical acceleration assumed was equal to 2/3 the horizontal ground acceleration.

The discussion in XII-1.2 describes four of the Class I structures: the reactor building, the control room and radwaste building, the stack, and the gas turbine building. In addition, by way of illustration of application of the general seismic criteria to specific structures, the subsection discusses the seismic design of the reactor building and the stack. ‡

1.1.3 Design Basis-Class II Structures and Equipment. Class II structures and equipment are designed following the normal practice for the design of power plants in the State of Connecticut, but as a minimum this was not less than given in the "Uniform Building Code" for Zone 2. The usual practice of determining the stress due to earthquakes by applying a static load based on a specified seismic coefficient was followed.

Allowable stresses for building materials in Class II structures are as specified in the Basic Building Code, which is recommended to the boroughs by the State of Connecticut. A one-third increase is allowed for combinations including seismic or wind loads.