NORTHEAST UTILITIES

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

General Offices • Selden Street, Berlin, Connecticut

P.O. BOX 270
HARTFORD, CONNECTICUT 06141-0270
(203) 665-5000

November 2, 1984

Docket No. 50-336

A03831

Director of Nuclear Reactor Regulation
Attn: Mr. James R. Miller
Operating Reactors Branch #3
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Gentlemen:

Millstone Nuclear Power Station, Unit No. 2
Request for Additional Information on IE Bulletin 80-11
Masonry Wall Design

By letter dated February 24, 1984(1), the NRC Staff requested that Northeast Nuclear Energy Company (NNECO) supply additional information on our December 3, 1982(2) submittal on Masonry Wall Design. NNECO's May 11, 1984 submittal provided a partial response to that request for additional information.

NNECO hereby supplements our May 11, 1984 response with the additional information as attached. Specifically, an additional response to Questions 1 and 2, a complete response to Question 3 and a partial response to Question 4 are provided. NNECO expects to complete and docket the final response to Question 4 by January 3, 1985.

Additionally, an introductory response is provided to address questions, concerning QA/QC of the masonry walls during construction, raised by the Staff during the September 27, 1984 masonry wall meeting in Bethesda.

We trust you will find the enclosed information acceptable.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

W. G. Counsil
Senior Vice President

(1) J. R. Miller letter to W. G. Counsil, dated February 24, 1984.

(2) W. G. Counsil letter to R. A. Clark, dated December 3, 1982.

Original To: Reg Files
IE11 1/40

Docket No. 50-336

Enclosure

Millstone Nuclear Power Station, Unit No. 2

Request for Additional Information

on IE Bulletin 80-11

Masonry Wall Design

NOVEMBER, 1984

INTRODUCTION

At Millstone Unit 2 there are 155 masonry walls supporting or in proximity to safety-related items. Of this number, 57 were modified to meet the established acceptance criteria.

The masonry walls at Millstone Unit 2 were furnished and installed in accordance with a specification which covered the furnishing of all labor, supervision, material, equipment, and all performance of all operations and incidentals necessary for the furnishing, delivery, and erection of the building masonry. The specification called for specific types of concrete masonry units that conformed, for example, to ASTM C-145, Type 1, Grade P-1. The mortar sand, grout, aggregate, reinforcement, and cementitious materials also conformed to specific standards. The masonry unit manufacturer was required to provide a signed certificate that stated that all concrete masonry units conformed to the requirements of the specification. Attachments 1 and 2 are documents which demonstrate that materials called for in the specification were actually used in the construction. Permanent shielding walls were made of two types of block. The first type was heavy-weight concrete block with vertical and horizontal reinforcing and all cells filled with grout. The second type consists of solid block with horizontal reinforcing.

A complete walkdown of all masonry walls was conducted following issuance of I&E Bulletin 80-11. Each walkdown package included such information as:

- Existing system drawing that wall appeared on.
- Whether or not wall was shown correctly on system drawing.
- Single or multiple wythe.
- Length, height, thickness.
- Boundary conditions.
- Function of wall (partition, shielding, etc.)
- Safety-related equipment attached to or in proximity to wall.
- General conditions of the masonry wall.
- Wall cracks.

NU maintains a strong commitment to quality assurance. Each QA/Category I wall was painted with a stencil to indicate, "This is a safety-related wall, contact civil engineering before altering." In addition, all plant design changes are reviewed to determine if any blockwalls are altered. If an alteration of any kind is to be made to a block wall, the change must first be approved by Civil Engineering to ensure that the evaluations performed in response to Bulletin 80-11 remain valid. All of the safety-related block walls at Millstone Unit 2 are included in NUSCO's Materials, Equipment, and Parts List (MEPL). This means that all of these walls are considered QA/Category I.

We believe there were and are numerous quality assurance and control requirements at Millstone Unit 2 which are adequate to control the installation and maintenance of the block walls.

QUESTION 1

With reference to the reinforcement in masonry walls, the ACI 531-79 Code (1) specifies that the minimum area of reinforcement in a wall in each direction, vertical or horizontal, shall be 0.0007 (0.07 percent) times the gross cross-sectional area of the wall and that the minimum total area of steel, combined vertical and horizontal, shall not be less than 0.002 (0.2 percent) times the gross cross-sectional area. Clarify whether the reinforced walls at this plant meet the above requirements. It should be noted that the horizontal reinforcement is installed to satisfy the minimum reinforcement requirement for a reinforced wall.

If the joint reinforcement is used to resist tension in the walls meeting the above minimum requirements, it should follow the working stress design method which limits its (Code) allowable to 30 ksi. Please clarify whether this requirement has been satisfied. If this requirement is not satisfied, identify all affected walls along with the calculated stress value for each wall and indicate specific actions planned to correct this situation.

Indicate if there are any walls that may have been qualified using the tensile resistance of the joint reinforcement but not satisfying the minimum steel requirements. It should be noted that the NRC, at present, does not approve the use of joint reinforcement to qualify this type of wall. (See attached staff position). In view of this, indicate all walls belonging to this category and your intended specific actions to bring these walls in compliance with the staff position.

RESPONSE

Upon further investigation of the Millstone Unit No. 2 masonry block walls, we have found that 55 of them, as opposed to 57 as originally reported, are considered to be reinforced masonry. All of the reinforced masonry walls are filled with grout. Of the 55 reinforced walls, only two are multi-wythe. The governing code at the time that Millstone Unit No. 2 was being built was the Uniform Building Code of 1967. All of the reinforced masonry walls at Millstone Unit No. 2 meet the requirements of the 1967 Uniform Building Code.

The vertical reinforcement is the main reinforcement in the masonry walls at Millstone Unit No. 2. All reinforced walls have at least the minimum area of reinforcement in the vertical direction in accordance with the ACI 531-79 Code requirements. Even though the wall sizes varied from 6 inch block up to 12 inch block, all of the walls had at least 0.0007 times the gross cross-sectional area of the wall in the vertical direction.

At Millstone Unit No. 2 the type of horizontal joint reinforcement used was the Dur-o-wall extra heavy weight truss type and it was installed at every other course. The Dur-o-wall was not considered to resist tension in the analysis of the above-mentioned walls; and therefore it need not be evaluated according to the working stress design method. However, the masonry walls that were horizontally reinforced with the extra heavy weight Dur-o-wall meet the minimum requirements of ACI 531-79 as follows:

- 6 inch block walls — horizontal reinforcing meets 100% of the minimum requirements of ACI 531-79

- 8 inch block walls — horizontal reinforcing meets 80% of the minimum requirements of ACI 531-79

- 12 inch block walls — horizontal reinforcing meets 51% of the minimum requirements of ACI 531-79

Forty-one of the fifty-five reinforced masonry walls meet the requirements for combined reinforcement of not less than 0.002 times the gross cross sectional area of the wall. Ten of the walls below the minimum requirement of 0.002 are reinforced at 0.0014 or greater.

Tests have shown that, on horizontally spanning masonry walls, horizontal reinforcement has little influence on the load under which a wall will crack, but will control the cracks and preserve the wall after cracking.(1) The intended purpose of horizontal reinforcing is to reduce and control cracking, and not necessarily increase the strength of the wall. The purpose is adequately met by the horizontal reinforcement in reinforced masonry walls at Millstone Unit No. 2.

In summary, when the masonry walls were evaluated at Millstone Unit No. 2 for Bulletin 80-11, they were not considered to have any horizontal reinforcement. The design modifications were based solely on the vertical reinforcement and, in all cases, the amount of vertical reinforcement was adequate. Based on the above information, we believe the intent of the ACI 531-79 code is met.

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(1) Traverse Strength of Concrete Block Walls, Title No. 54-54 by F. W. Cox and J. L. Ennega, Journal of the American Concrete Institute, May 1958.

QUESTION 2

With respect to tornado load (2), specify all walls subject to tornado load (if applicable) and provide a sample calculation (with any explanation necessary to make it understandable). Also, indicate how the penetration depth, perforation, and spalling along with the overall structural behavior of the wall were evaluated for a tornado missile impact.

RESPONSE 2

Our May 11, 1984 submittal contained information regarding the number of walls that could be subjected to tornado loads as well as some sample calculations of these walls. The following is additional information in response to Question 2.

To give an indication of Millstone Unit No. 2's original design, the following excerpts have been taken from the FSAR, Section 5.2.6.1.2.

Missile protection outside the containment is provided to comply with the following requirements:

a. The containment steel liner plate and penetrations are protected from the loss of function due to damage by tornado borne missiles.

b. All engineered safety features piping which penetrates the containment and which is required to maintain the containment integrity is protected from a loss of function due to tornado borne missiles.

c. All components required to maintain the containment integrity, or whose failure would result in the uncontrolled release of radioactivity, are protected from a loss of function due to damage by tornado borne missiles.

Protection is provided for the following three types of tornado borne missiles.

a. A fir plank, 4 inches by 12 inches by 12 feet, weighing 105 pounds and traveling end on at a speed of 250 mph.

b. A passenger auto (4,000 pounds) impact velocity of 50 mph not more than 25 feet above grade with a contact area of 20 square feet.

c. A 3 inch by 10 foot long (ASA Schedule 40) pipe (72 pounds) traveling end on at a speed of 100 mph at any elevation on the structure.

Analysis of the effect of the impact of the missiles on structures is based on the methods presented in the NavDocks P-51, "Design of Protection Structures--A New Concept of Structural Behavior," published by U.S. Bureau of Yards and Docks, August 1950, Washington, D.C.

Provisions to tie down all slabs, blocks, or partitions outside of containment which are potential seismic or tornado missiles are described as follows:

1. Slabs and Blocks. Slabs and blocks which are potential seismic or tornado missiles are those items which fall into the category of hatch covers or removable partitions and lie within the Class I structures in areas containing Class I equipment or components.

All removable wall panels are tied structurally to the building by retaining members and reinforcing within the wall panel. In all cases, removable wall panels are designed to remain in place and intact sustaining seismic or pressure loadings appropriate to the elevation within the buildings. Hatch covers which do not serve as vents during buildup and decay of pressures which would possibly occur during a tornado, are secured with fastening devices which will resist all design forces due to such loading. Hatch covers which serve as vents are designed to open to relieve internal pressures but are provided with mechanical retaining devices which prevent the element from becoming a missile during seismic or tornado occurrences.

2. Partitions. The partitions and walls that are located within areas housing Class I equipment or components are reinforced vertically and horizontally and are anchored around the perimeter of the elements to the building structure. All partitions within these areas are constructed of either reinforced concrete or reinforced concrete masonry units. The design provides structural adequacy to sustain appropriate seismic or differential pressures resulting from a tornado occurrence.

As stated in the previous submittal, tornado missiles were evaluated in accordance with the criteria in Appendix 5.D of the Millstone Unit No. 2 FSAR. This evaluation concluded that the impact factor is much higher at lower elevations than at high elevations. It was also stated that due to the effective drag area for an object thrown into a tornado, only the wooden plank type missile could be sustained in the air. None of the other missiles could be sustained above the 10 foot elevation. Note that the Standard Review Plan criteria will be addressed later in this response.

Even though localized impact, as well as penetration effects of missiles, were evaluated as part of the original design calculations of the plant, these effects are of low probability due to the physical locations of the walls in question. Five of the ten walls evaluated for tornado loads are interior walls (Attachment 3). This would mean that a wall outside of the wall in question would have to be blown away before the interior wall could be impacted. The five exterior walls are located at elevations 25'-6" (8.22, 8.29, and 8.31) and 54'-6" (6.1 and 6.2). The Standard Review Plan (SRP), Section 3.5.1.4, states that the utility pole and automobile missiles need only be considered at elevations up to 30 feet above site grade. The four remaining missiles described in the SRP are the wood plank, the 6-inch schedule 40 pipe, the 1-inch steel rod, and the 12-inch schedule 40 pipe. Because walls 6.1 and 6.2 are located at such a high elevation (40 feet above site grade), it is unlikely a missile would reach that elevation and still retain sufficient force to penetrate the wall. Walls 8.22, 8.29, and 8.31 are located in the cable vault area which is protected on the north side by the turbine building (Attachment 4). All of the walls that were evaluated for tornado loads are reinforced and have adequate boundary conditions.

In summary, all of the walls listed in the May 11, 1984 submittal as being subjected to tornado loads were designed to withstand a 360 mph wind load as well as a 3 psi depressurization load as shown in the calculations. The auxiliary and turbine buildings at Millstone Unit No. 2 were considered to resist wind and tornado loads according to Section 5.4.3.1.6 of the FSAR and the design wind

pressure is in accordance with the ASCE Paper 3269, "Wind Forces on Structures." These walls were also evaluated for localized impact as well as penetration effects from missiles even though the scenario is not credible. Due to the location of exterior walls, it has been determined that the overall structural behavior due to tornado missile impact, as defined in the Standard Review Plan, Section 3.5, need not be evaluated.

QUESTION 3

Regarding Responses 3 and 4 of Reference 2, identify walls that would not be qualified if the SGEB increase factors for allowable stresses (3) were to be used. It should be noted that for the OBE loading case, the SGEB criteria do not allow any increase factor, whereas the licensee used a factor of 1.33. Also, specify the percentage of exceedance for OBE, SSE, and other accident load cases. Explain all conservative measures (if any) used in the analysis to justify a higher increase factor.

RESPONSE

The stress allowables used in the Millstone Unit No. 2 masonry wall I&E Bulletin 80-11 evaluation differed from the SGEB allowables in the following cases.

1. For OBE load combinations, SGEB criteria allow no increase in stress allowables while a 1.33 increase factor was used in the Millstone Unit No. 2 evaluation. The I&E Bulletin 80-11 calculations have been reviewed to compare calculated OBE stresses to SGEB allowables. All walls meet the SGEB criteria with the exception of wall 1.23.

   The original analysis conducted in response to I&E Bulletin 80-11 contained several conservatisms. First, each wall was analyzed as a one-way strip, even though most walls exhibit two-way action due to their width to height ratios. Second, piping and equipment loads were applied simultaneously to the one-way strip even if they were distributed over a large area. Also, the inherent building damping values used in the generation of floor response spectra were 3% for OBE and 5% for SSE, while Regulatory Guide 1.61 recommended damping values of 4% for OBE and 7% for SSE. Compared to actual behavior of such walls the calculated response has another conservatism. The working stress method was used and this does not consider any ductile response of the walls when there is actually some unquantified ductility.

   Wall 1.23 is composed of two sections, 12" thick reinforced section governed by SSE and a 6" thick reinforced section governed by OBE. The 12" thick section meets the SGEB criteria. For the 6" thick section the calculated compressive stress in the masonry was 526 psi which exceeds the SGEB allowable (446 psi) by 18%. It is our judgment, based on conservatisms in the calculation method, that the actual stresses for the OBE load combination would be less than the SGEB criteria and therefore the intent of the SGEB criteria are met. More important, however, is that the walls meet the SGEB criteria and will remain intact for SSE loading conditions, which ensures the walls will remain intact for the OBE loading condition.

2. For SSE load combinations, the allowable increase factors for SGEB and those used in the I&E Bulletin 80-11 evaluation are:

Type of Stress	SGEB	Millstone Unit 2 80-11 Evaluation
Axial or flexural comp.	2.5	2.5
Bearing	2.5	2.5
Reinforcement stress except shear	2.0 not to exceed 0.9 fy	0.9 fy
Shear reinforcement and/or bolts	1.5	
Masonry tension parallel to bed joint	1.5	1.67
Shear carried by masonry	1.3	1.67
Masonry tension perpendicular to bed joint		
For reinforced masonry	0	0
For unreinforced masonry	1.3	1.67

Reinforcement stress applies to reinforced masonry walls while masonry shear and tension, both parallel and perpendicular to bed joints, apply to unreinforced masonry walls.

The SSE allowable for steel stress used in the 80-11 evaluation was 54 ksi (0.9 fy) which is higher than the SGEB allowable of 48 ksi (2 x 24 ksi). The calculated steel stresses for reinforced walls were all below the SGEB allowable, with the exception of wall 10.3 where the calculated steel stress was 48.6 ksi. In light of the conservatisms in the I&E Bulletin 80-11 analysis, it is judged that the actual stresses would be significantly less than the SGEB criteria and therefore the intent of the criteria is met. For unreinforced walls, all calculated stresses were less than SGEB allowables.

Based on the information above, we conclude that the Millstone 2 masonry walls have adequate margins of safety with respect to stress increase factors.

QUESTION 4

With regard to the nonlinear analysis technique (energy balance technique and arching action theory), please note the following and provide the information requested.

a. Arching Action: The NRC position on this issue states that the use of the arching action theory to qualify unreinforced masonry walls is not acceptable. These walls should be repaired so that they can be qualified based on the SGEB criteria (3). (The NRC position is attached.) In view of this, indicate your intended actions and schedule to bring the affected walls in compliance with the staff position.

b. Energy Balance Technique: The NRC is currently preparing a position statement regarding this technique, which will be forwarded to the licensee in the near future.

RESPONSE

During the evaluation conducted in response to I&E Bulletin 80-11 a total of 18 walls were qualified using arching action techniques. Of these walls, 11 have safety-related attachments and 7 have safety-related equipment in proximity of the wall (II/I situation). All these walls are multi-wythe walls with no vertical reinforcing. Walls with 4 or more wythes have horizontal reinforcement in the form of extra heavy Dur-o-wall trusses staggered at every course. Blocks are solid concrete masonry units conforming to ASTM C-145, Type 1, Grade P-1. Mortar conforms to ASTM C-270, Type S.

In some cases, the original analysis used assumptions which were overconservative. These walls have been reanalyzed in accordance with the SGEB criteria. The methodology employed in this study and a discussion of results for walls with safety-related attachments are included herein. The remaining walls (II/I) are currently under investigation, the results of which will be supplied by January 3, 1985.

Analysis

The walls have been reanalyzed using linear elastic working stress methods. Two computer programs were used in the evaluation.

1. "EWALL, a finite element program for analysis of masonry walls," Version 5, Cygna Energy Services, October 1981.

2. "SAP IV (R&D), Structural Analysis Program for Static and Dynamic Response of Linear Systems," Version 1.0 by Klaus-Jurgen Bathe, Edward L. Wilson, and Fred E. Peterson, Earthquake Engineering Research Center, Report No. EERC 73-11, revised August 1980.

EWALL is a pre and post processor for SAP IV.

Assumptions

- All components other than piping supported on or near masonry walls are considered rigid and therefore do not impose amplified loads or impact loads on the wall due to seismic displacement. The added mass is included in the analysis.

- o Piping reaction loads are statically applied and added absolutely to inertial loads. The mass of the attached piping is also included in the inertial case.

- o Surface mounted attachments which project no further from the wall surface than the wall thickness contribute only in-plane loads to the wall.

- o Support conditions for masonry walls are considered pinned when shear transfer mechanisms are present; otherwise, a free edge is assumed.

- o Multi-wythe walls with horizontal ties between wythes are analyzed as composite, otherwise they are analyzed as multiple single wythe walls taking no credit for collar joint mortar shear capacity.

- o A dynamic load factor (DLF) of 2 was used to amplify jet impingement loads.

The above assumptions were reviewed against the walkdown packages performed for the IE Bulletin 80-11 analysis.

Procedure

The analysis was conducted for seismic and transient pressure loadings as applicable.

First, the geometry of the wall was defined for the finite element model. The mass of attached equipment and piping was added to the appropriate node points. A response spectrum analysis was performed using the calculated average of the seismic spectra at the top and bottom of the wall. Damping values used for the walls were 4 percent of OBE and 7 percent for SSE.

Next, piping reaction loads and pipe break pressure loads, if any, were applied in a static analysis. Care was exercised with respect to signed loads that they were applied in a conservative manner. Stresses from the dynamic and static analyses were then combined absolutely and compared to the appropriate allowables.

Allowable Stresses

The allowable stresses used in this analysis, as provided in ACI 531-79 with the increase factors specified in the SGEB criteria, are as follows:

		OBE	SSE	
Compression				
Axial	0.22 f'm	297 psi	(x 2.5)	742.5 psi
Flexural	0.33 f'm	446 psi	(x 2.5)	1115.0 psi
Bearing	0.25 f'm	338 psi	(x 2.5)	845.0 psi
Shear				
Out of Plane	1.5 f'm	55 psi	(x 1.3)	72.0 psi
M/Vdr 1	0.9 f'm	33 psi	(x 1.3)	43.0 psi
M/Vdr = 0	2.0 f'm	73 psi	(x 1.3)	95.0 psi
Tension				
Normal to bed joints	1.0 M_o	42 psi	(x 1.3)	55.0 psi
Paral. to bed joints	1.5 M_o	64 psi	(x 1.5)	96.0 psi

Load Combinations

All walls analyzed are within the auxiliary building. Loads and load combinations as specified in the FSAR for concrete design, section 5.4.3.2 for the auxiliary building are as follows:

D + L
D + L + E
D + L + E'
*D + L + Hw
*D + L + T + E
*D + L + T + E'
D + L + Fp + E'
*D + L + Fr + E'

where:

D = dead loads
L = live loads
E = operating basis earthquake
E' = design basis earthquake
Fp = pipe whipping restraint
Fr = pipe restraint loads
Hw = hydrostatic pressure
T = thermal loads

* Not applicable to walls reviewed

Results and Conclusions

The above-described reanalysis evaluated the walls in light of the latest criteria using correct placement of loads and openings.

Walls 1.21, 1.31, 1.36, 1.49, 1.7, 3.23, 5.12, and 5.13 were analyzed as multiple single wythe walls and have been shown to meet the SGEB criteria.

Walls 3.30, 3.31, and 4.21 have horizontal reinforcement tying the wythes together in the form of No. 12 extra heavy Dur-o-wall trusses staggered at every course. These walls were analyzed as multiple wythes acting compositely and comply with the SGEB criteria.

Based on the information above, we conclude that all eleven walls that have safety-related attachments conform to the SGEB criteria and do not require modification. As mentioned above, seven additional walls that could fall on safety-related equipment are being evaluated, the results of which will be supplied by January 3, 1985.

ATTACHMENT #1

THAMES PERMACRETE CORPORATION
UNCASVILLE, CONNECTICUT 06382 • Telephone (203) 848-9206
FORMERLY THAMES BLOCK COMPANY 442-4974

January 27, 1972

Millstone Point, Co.
Bechtel Corporation
P.O. Box 303
Waterford, Conn. 06365

Re: Millstone Atomic Plant #2
Waterford, Conn.

Gentlemen:

This is to certify that the concrete masonry units we are furnishing to the above captioned job shall conform to the following requirements:

a. Normal weight and lightweight hollow concrete masonry units, of size shown on the design drawings, shall confrom to ASTM C-90 and C-129 Grade P-1, smooth faced with linear shrinkage limited to 0.05%.

b. Heavy weight hollow concrete masonry units, of sizes shown on the design drawings, shall conform to ASTM C-90 Grade P-1, smooth faced with linear shrinkage limited to 0.05% except that the density of the cured and oven dryed units used for radiation shielding shall not be less than 140 pounds per cubic foot. If solid concrete masonry units are used they shall conform to ASTM C-145, Type I, Grade P-1.

We further certify that all concrete masonry units have been properly and thoroughly cured at the plant before shipment and shall be manufactured and cured according to these specifications at all times, specification 7604-A-1.

Very truly yours,

Richard W. Kirsch

Richard W. Kirsch, Vice-President
THAMES PERMACRETE CORPORATION
RWK/eq

Date: 2C Nov 71
P.O. #7604-F-23185
Quantity: 2500-6x8-12 Solid Hi Density
Delivery: ASAP

NCMA
CMI

ATTACHMENT #2 PG. 1

USS Universal Atlas Cement
Division of United States Steel Corporation
600 GRANT STREET
PITTSBURGH, PENNSYLVANIA 15230
412: 433-7519

February 15, 1972

Mr. Richard Kirsch (5)
Thames Permacrete Corporation
P. O. Box 382
Uncasville, Connecticut 06382

Job: Millstone Nuclear Power Station Unit 2
Waterford, Connecticut

Dear Mr. Kirsch:

We are writing to you at the request of our Boston Sales office concerning the use of Atlas Type I portland cement on the above job.

This is to certify that the Atlas portland cement, Type I shipped to you in bags from our Hudson, New York plant conforms to the requirements of Paragraph 11.2a Cementitious Materials - Portland Cement of Specification No. 7604-A-1 for the above job in that the cement conforms to the regular requirements for Type I portland cement of Standard Specification for Portland Cement, ASTM Designation: C150-71.

Very truly yours,

E. E. Seward

E. E. Seward
Staff Engineer-Sales Engineering

EES:kom

Sworn to and subscribed before me this 15th day of February, 1972.

Margaret Buday

MARGARET BUDAY, Notary Public
PITTSBURGH, ALLEGHENY COUNTY, PA.
MY COMMISSION EXPIRES
SEPTEMBER 2, 1975

Date: 25 Oct 71
P.O. 7604-F-4303
Quantity: 100 Bags ATLAS Portland Cement
Delivery: 29 Oct 71

ATTACHMENT #2 PG. 2

Universal Atlas Cement

Division of United States Steel Corporation

Date Shipped 10-26-74

Cement Atlas Type I

Shipped From Hudson Plant

Laboratory Test Report

To Thames Permacrete Corporation

105 Pink Row

Uncasville, Connecticut 06382

Manufacture Date: 10/17/74

Consigned To

Car/Truck No. 2820

Cwt. 465.50

The data given below is average of bin from which cement was shipped.

CHEMICAL

	%
SiO_2	22.3
Al_2O_3	4.58
Fe_2O_3	3.26
CaO	63.8
MgO	1.3
SO_3	2.9
Loss On Ignition	1.6
Insoluble Residue	0.16
C_3S	47.0
C_3A	6.7

PHYSICAL

Fineness

Specific Surface – Sq. Cm./g

Wagner	1766
Blaine	3786
Soundness, Autoclave Exp. %	0.00
Time Of Setting, Hr.: Min Initial	3:25
Final	5:45
Air Content – %	9.7
Compressive Strength, psi – 1 Day	
3 Day	2980
7 Day	3780

This cement complies with applicable ASTM and Federal Specifications.

Meets ASTM C-150-71 Type I

chief chemist

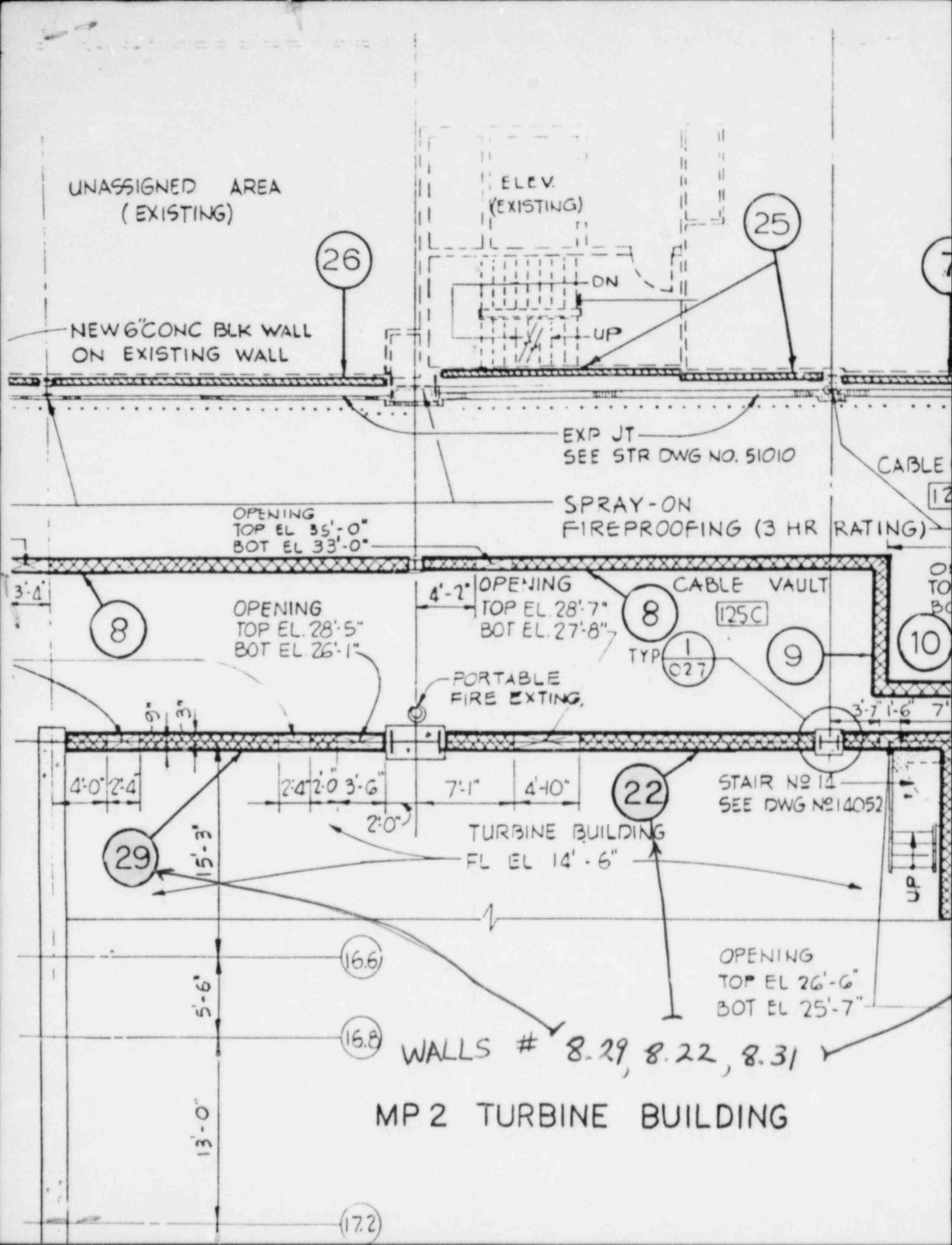
UAC 3110

TORNADO WALLS

SITE GRADE: 14'-6"

WALL	ELEV.	LOCATION	PROTECTED UNPROTECTED
1.32	38'-6"	INTERIOR	PROTECTED
*6.1	54'-6"	EXTERIOR	UNPROTECTED
*6.2	54'-6"	EXTERIOR	UNPROTECTED
7.5	31'-6"	INTERIOR	PROTECTED
7.12	31'-6"	INTERIOR	PROTECTED
8.22	25'-6"	EXTERIOR	PROTECTED
8.29	25'-6"	EXTERIOR	PROTECTED
8.31	25'-6"	EXTERIOR	PROTECTED
10.5	45'-0"	INTERIOR	PROTECTED
10.12	45'-0"	INTERIOR	PROTECTED

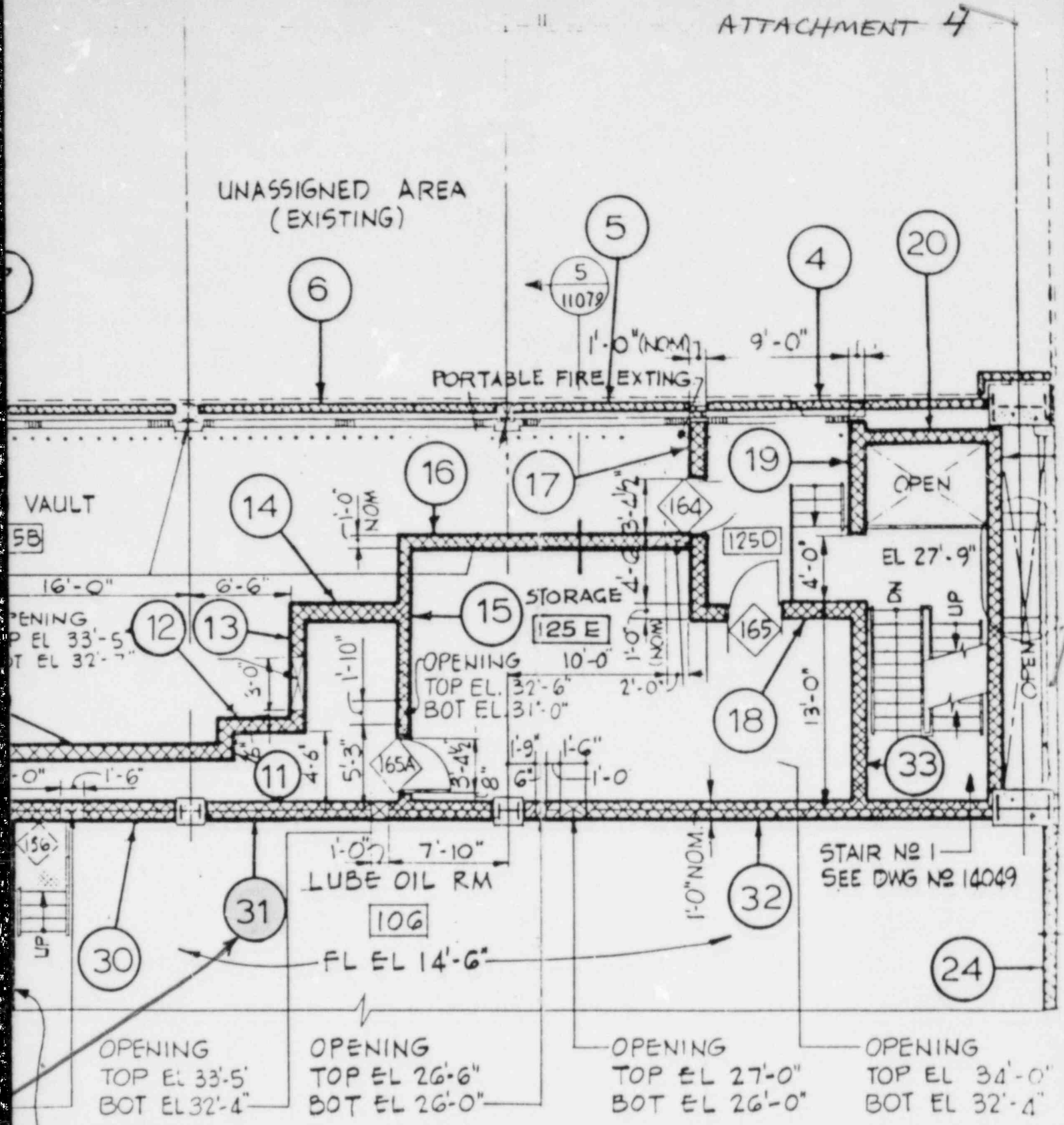
*MORE THAN 30' ABOVE SITE GRADE.



WALLS # 8.29, 8.22, 8.31

MP 2 TURBINE BUILDING

ATTACHMENT 4



8411190541-01

ATTACHMENT 4