CENTRAL FILES

DUKE POWER COMPANY

POWER BUILDING

422 SOUTH CHURCH STREET, CHARLOTTE, N. C. 28242

WILLIAM O. PARKER, JR.
VICE PRESIDENT
STEAM PRODUCTION

November 4, 1980

TELEPHONE: AREA 704
373-4083

Mr. James P. O'Reilly, Director
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, Suite 3100
Atlanta, Georgia 30303

Re: RII:JPO
50-269, -270, -287
IE Bulletin 80-11

Dear Mr. O'Reilly:

Pursuant to Item 4 of your letter of May 8, 1980, please find attached Duke Power Company's response to Items 2b(i) and 2b(ii). In addition, a partial response to Item 2b(iii) is provided. My letter of October 28, 1980 addressed the problems encountered in attempting to provide a full response to this item by the specified deadline, and requested an extension of the Bulletin schedule requirements. As stated in that letter, Duke Power Company expects to submit the information requested by Item 2b(iii) by December 31, 1981.

Very truly yours,

William O. Parker, Jr.

William O. Parker, Jr.

FTP:scs
Attachment

cc: Office of Inspection & Enforcement
Division of Reactor Operations Inspection
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

DUKE POWER COMPANY
OCONEE NUCLEAR STATION
UNITS 1, 2, 3

USNRC I & E Bulletin 80-11
Masonry Wall Design

Response to Item 2.b

November 4, 1980

(I) Describe in detail, the function of the masonry walls, the configurations of these walls, the type and strengths of the materials of which they are constructed (mortar, grout, concrete and steel), and the reinforcement details (horizontal steel, vertical steel, and masonry ties for multiple wythes).

The function of the masonry walls are best described by the areas in which they are used. They are: 1) office areas 2) stairways 3) in-fill panels 4) fire barriers 5) radiation barriers. The walls are single and multi-wythe, constructed of hollow or grouted concrete blocks or solid concrete bricks. All masonry walls are non-structural and constructed on a structural support system. These walls extend from the top of the supporting structural floor to the bottom of the next structural floor. All walls are plane and terminate either at structural wall, column or another masonry wall. Wall edges normally consist of mortar joints except in special cases where supporting angles are provided around the perimeter. The walls are reinforced horizontally with truss reinforcing (Dur-o-wall joint reinforcing, 9 gauge 2 wires) every other course except special cases where dur-o-wall is placed each course. Typical arrangement of these walls are shown in Attachment 1. Attachment 2 outlines the type and strengths of materials used in construction of these walls. Attachment 3 outlines the construction details.

(II) Describe the construction practice employed in the construction of these walls and, in particular, their adequacy in preventing significant voids or other weaknesses in any mortar, grout, or concrete fill.

Masonry walls were constructed according to details and notes on architectural drawings. Other than these drawings there were no written construction procedures specifying the practices used at that time. To establish and document actual practices a series of interviews were conducted with the engineers and craft personnel (masons) involved with the construction of the Oconee masonry walls. The following summarizes the results of these interviews.

Experienced masons were employed as permanent Duke Power Company employees for the express purpose of masonry work. A total of eight masons constructed all the masonry walls. Support personnel such as mortar mixers, material carriers, etc. are not included. An experienced foreman was on the job at all times overseeing the masonry activity. This foreman was responsible for the overall placement of the masonry units, and mortar mixing.

Placement of the masonry units was done in accordance with the requirements delineated on the design drawings. There was no formal inspection program other than inspection by the foreman and field engineers. The field engineers worked with the craft regularly overseeing their work and clarifying drawings and resolving material problems when necessary.

The majority of masonry walls, approximately 97 1/2 percent, are of single wythe construction. These are non structural walls built between structural floor systems as described in the response to (I). The walls are reinforced horizontally with a truss type reinforcing at a minimum of every other course. The blocks were laid with full head and bed joints. Special care was taken to insure full mortar beds as termination points such as columns or walls. The mortar was mixed under the supervision of the mason foreman. There was an undocumented field construction procedure which called for a 3 to 1 (sand to mortar) mix. A mechanical mixer was used to mix the mortar and a cubic foot box was used for measurement of materials. Precast lintels were purchased for many openings. Generally a double angle lintel was fabricated for large openings. Some openings had channel frames specified.

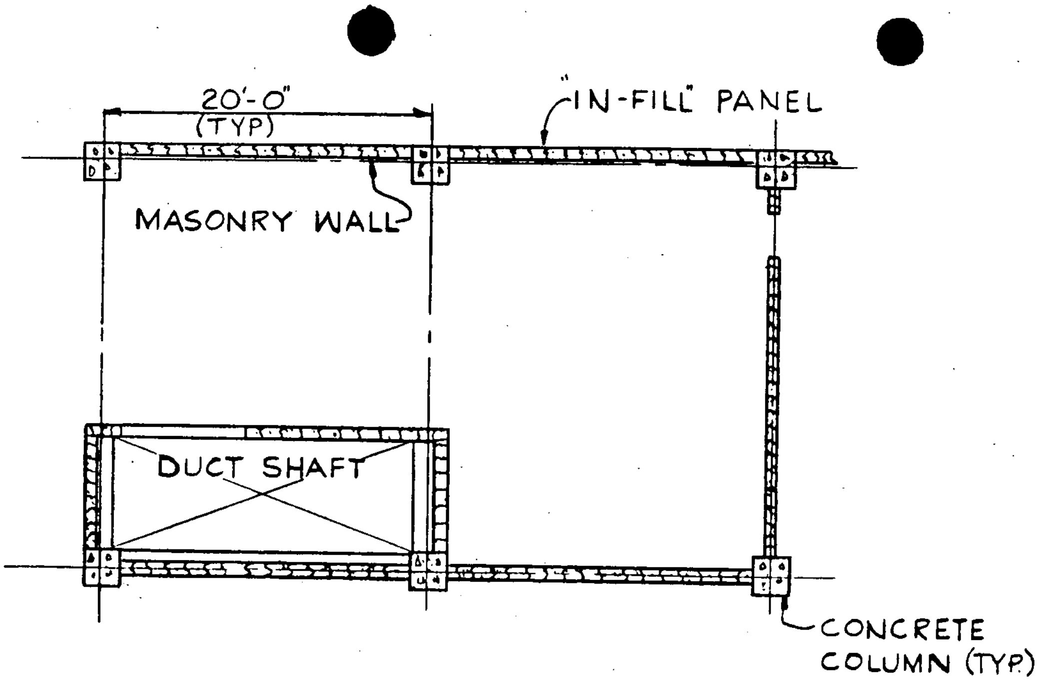
In construction of the multi-wythe walls special care was exercised at the intersection of wythes. Wythes were constructed simultaneously. For block, one block face was plastered with mortar, the other was mortared up on all faces and pressed together firmly. Collar joints were then rodded vertically to fill any voids.

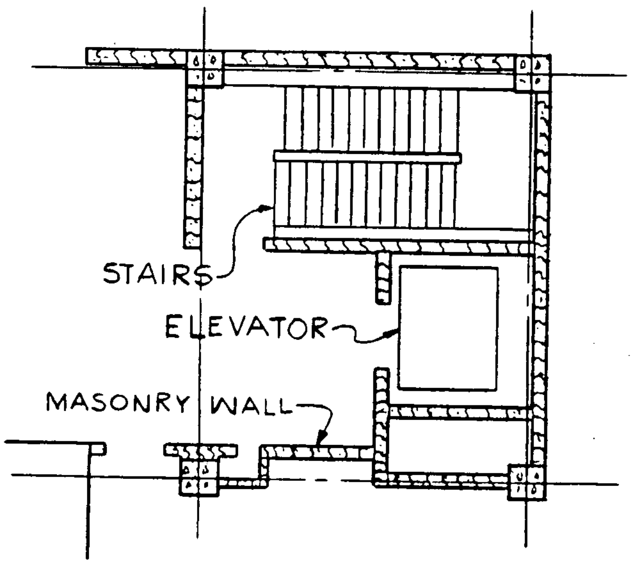
Masonry walls were constructed only under favorable weather conditions. Work was stopped in extreme cold weather. At other times heaters were used to achieve acceptable conditions.

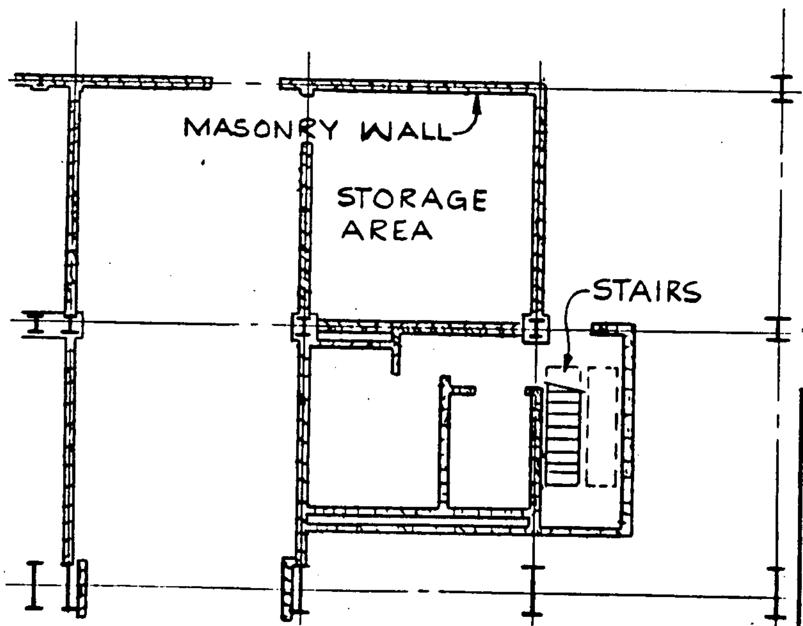
(III) The re-evaluation report should include detailed justification for the criteria used. References to existing codes or test data may be used if applicable for the plant conditions.

The re-evaluation of the design adequacy of the masonry walls identified in Item 1 of the July 7, 1980 response is currently underway. Thus far the re-evaluation is complete on 146 of 172 Priority I walls. The re-evaluation criteria is outlined in Attachment 4.

At this time re-evaluation has not started on Priority II or III walls due to considerations discussed in Mr. W. O. Parker's letter to Mr. J. P. O'Reilly, dated October 28, 1980. The final re-evaluation report (which will be submitted at a later date) will include the detailed justification for the criteria used.

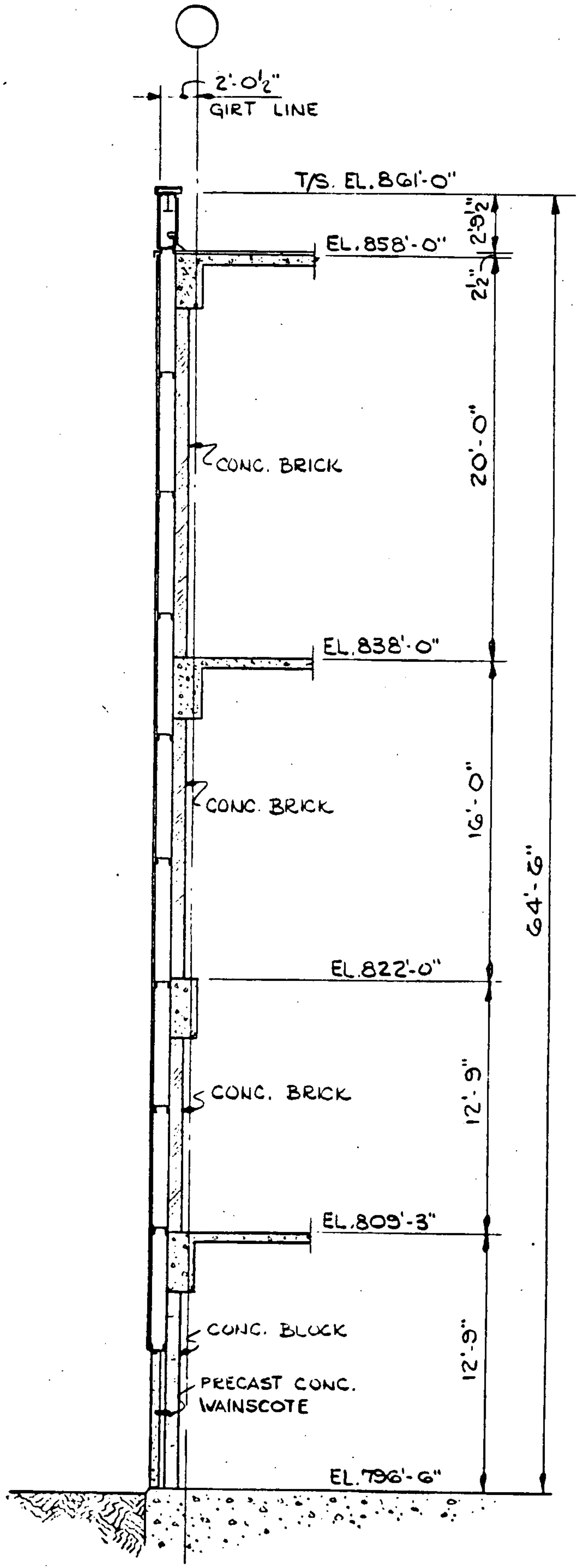




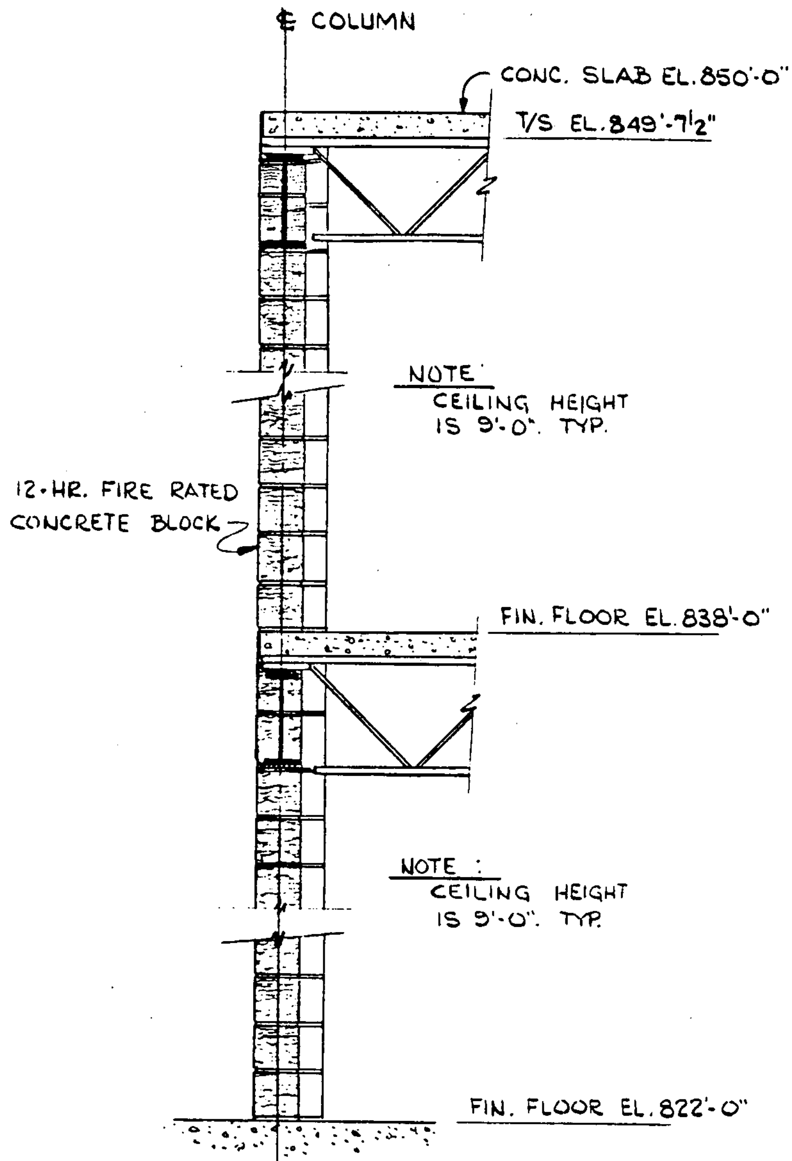


ATTACHMENT 1

OCONEE NUCLEAR STATION
TYPICAL ARRANGEMENT OF
MASONRY WALLS
SHEET 1 OF 2



TYPICAL WALL SECTION
AUXILIARY BUILDING



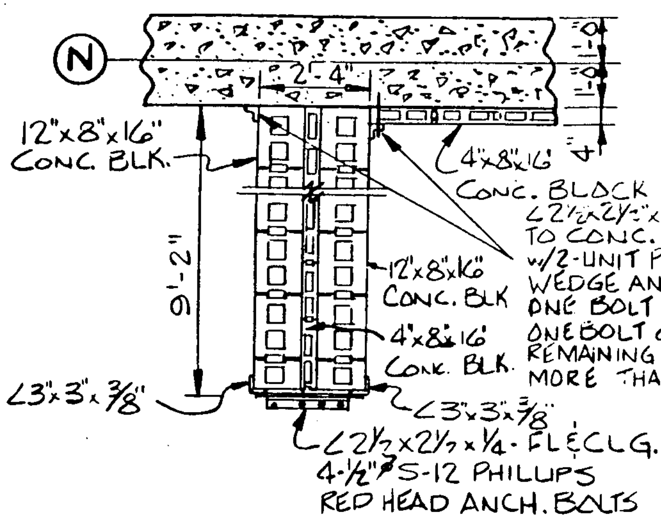
TYPICAL WALL SECTION
TURBINE BUILDING

ATTACHMENT I

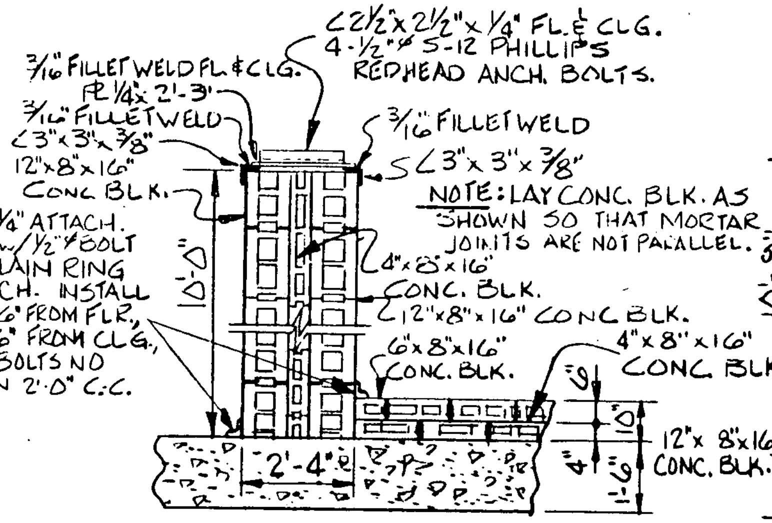
OCONEE NUCLEAR STATION
TYPICAL ARRANGEMENT O
MASONRY WALLS
SHEET 2 OF 2

Attachment 2
Type and Strength of Masonry Materials

Material	Applicable ASTM Standard	Strength
Light weight block	C90	fm' = 2000 psi
Light weight brick	C55	fm' = 2500 psi
Masonry cement	C91	900 psi (28 day compressive strength)
Mortar	C270	m_o = 750 psi
Joint Reinforcement	A-82	fy = 70,000 psi



HORIZONTAL WALL SECTION



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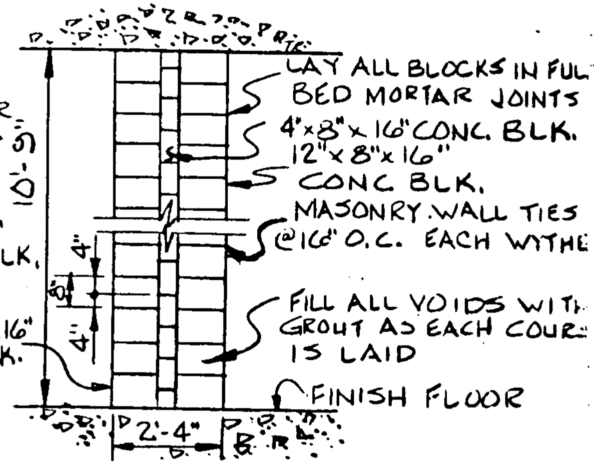
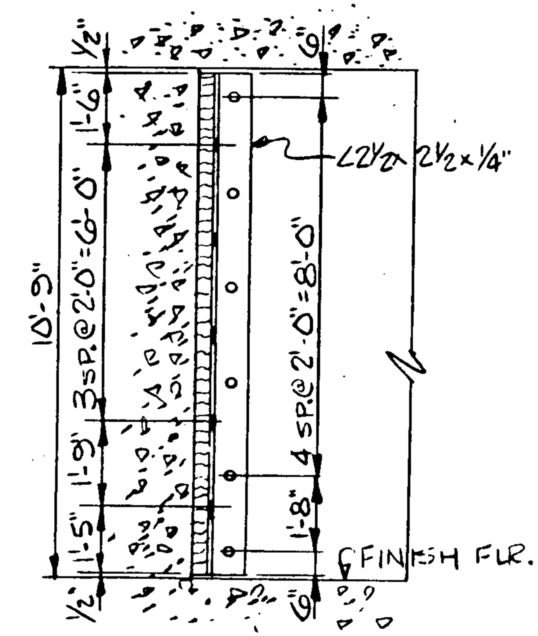


VERTICAL WALL SECTION



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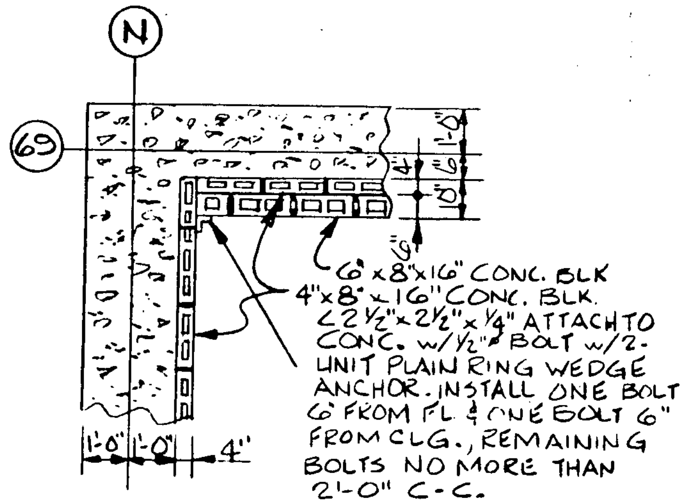


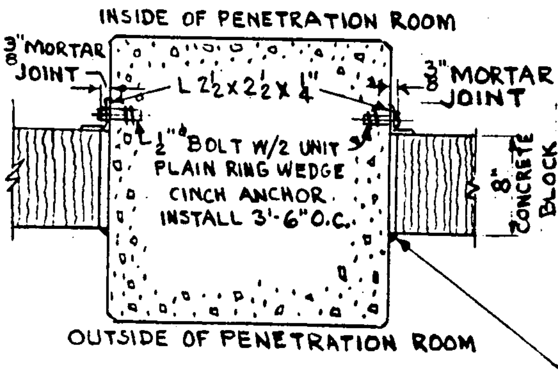
HORIZONTAL WALL SECTION

ATTACHMENT 3

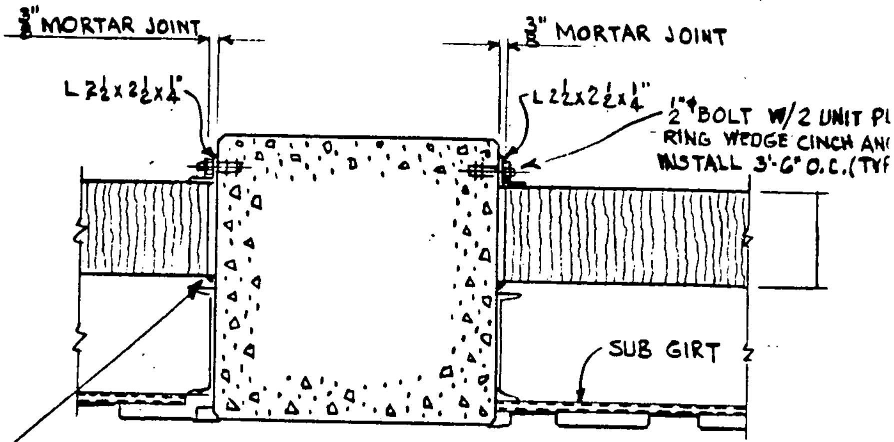
OCONEE NUCLEAR STATION

TYPICAL WALL DETAILS

SHEET 1 OF 3

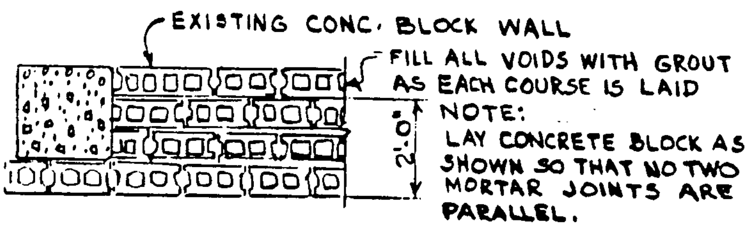


INTERIOR COLUMN DETAIL

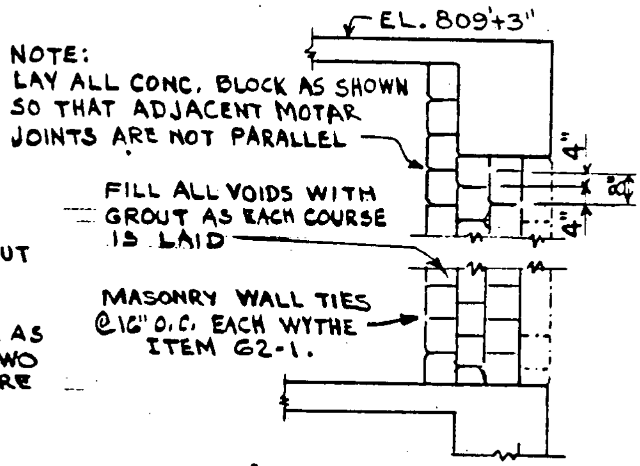


NOTE:
GENERAL ELECTRIC SILICONE SEALANT. INSTALL AT INTERSECTION OF ALL BLOCK OR BRICK WITH CONCRETE COLUMNS, BEAMS OR SLABS BETWEEN EL. 309'+3" AND EL. 333'+0". (APPLY SEALANT BEFORE SIDING IS INSTALLED.

EXTERIOR COLUMN DETAIL



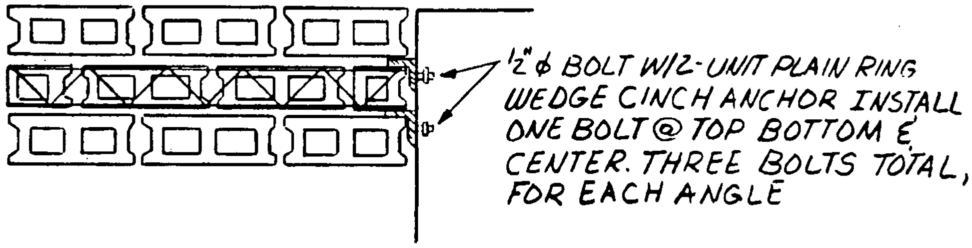
PLAN WALL SECTION

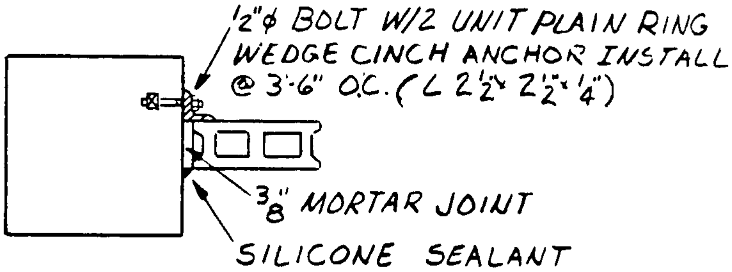


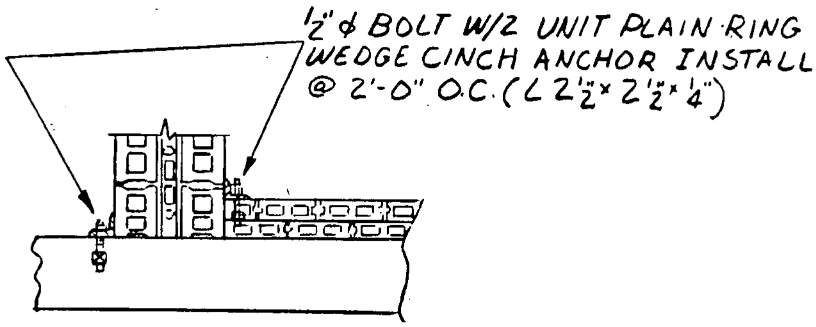
VERTICAL WALL SECTION

ATTACHMENT 3

OCONEE NUCLEAR STATION
TYPICAL WALL DETAILS







ATTACHMENT 3

OCONEE NUCLEAR STATION

TYPICAL WALL DETAILS

SHEET 3 OF 3

DUKE POWER COMPANY
OCONEE NUCLEAR STATION
CRITERIA FOR EVALUATION OF MASONRY WALLS

1.0 GENERAL

1.1 Purpose

This specification is provided in order to establish design requirements and criteria for use in re-evaluating the structural adequacy of masonry walls as required by I & E Bulletin 80-11, Masonry Wall Design, dated May 8, 1980.

1.2 Scope

The re-evaluation shall determine whether the masonry wall will perform their intended function under the loads and load combinations prescribed herein. Verification of wall adequacy shall include a review of local transfer of load from block into into wall, overall response of the wall, and the transfer of load into supports, as applicable.

2.0 GOVERNING CODE

The American Concrete Institute "Building Code Requirements for Concrete Masonry Structures", ACI 531-79, shall be used for all masonry design. Supplemental allowables, as specified herein, shall be used for cases not directly covered in the governing code.

3.0 LOADS AND LOAD COMBINATIONS

Loads and load combinations for masonry walls shall be based on those as specified in the Oconee Final Safety Analysis Report for concrete design with respect to the applicable building.

4.0 MATERIALS

Properties of materials used in the masonry construction have been established by project specification, and ASTM minimum strengths. The type and strength of masonry materials are as follows:

Material	Applicable ASTM Standard	Strength
Light weight block	C90	fm' = 2000 psi
Light weight brick	C55	fm' = 2500 psi
Masonry cement	C91	900 psi (28 day compressive strength)
Mortar	C270	m_o = 750 psi

5.0 DESIGN ALLOWABLES

5.1 Design allowables for load combinations shall be as follows:

5.1.1 Masonry

The allowable tension, compression, shear, bond, and bearing stresses shall be as given in the governing code. The specified 33% increase in stresses for seismic loading will not be allowed in considering the Design Earthquake. A 67% increase in stresses will be allowed for load conditions resulting from the Maximum Hypothetical Earthquake.

5.1.2 Collar Joint

When required for structural adequacy, the allowable collar joint shear stress for multi-wythe concrete block construction shall be less than or equal to 12 psi except where a greater value is proved to be conservative by field tests using a factor safety of 3.

5.1.3 Concrete Core or Cell Grout

The allowable tension stresses shall be $2.5\sqrt{f'c}$ or 0.33 times the modulus of rupture as determined by test.

5.1.4 Reinforcing Steel

The allowable tension and compression stresses shall be as given in the governing code, as specified in Section 2.0.

5.1.5 Secondary Effects

Design allowable stresses may be increased by 67% when considering thermal effects or displacement limited loads.

5.1.6 Impact and Suddenly Applied Loads

Load combinations which contain loads due to missile impact, jet impingement or pipe whip may exceed the allowables provided there will be no loss of function of any safety related system.

5.1.7 Stability

Design allowables may be exceeded if it is shown by sound analytical techniques that the masonry wall is stable considering its particular geometric conditions.

5.2 Damping

5.2.1 The damping response spectra values shall be as follows:

a) For uncracked sections use 1% critical for design earthquake and 2% critical for maximum hypothetical earthquake.

b) For cracked sections a damping value of 5% critical shall be used.

5.3 Modulus of Rupture

5.3.1 The extreme tensile fiber stresses in determining the uncracked moment capacity shall be $6\sqrt{f'c}$ or 0.8 times the modulus of rupture as determined by test for the core concrete or cell grout and 3.0 times the allowable flexural tensile stress for masonry.

6.0 ANALYSIS AND DESIGN

6.1 Structural Response of Masonry Walls

6.1.1 Equivalent Moment Inertia (Ie)

To determine the out-of-plane frequencies of masonry walls, the uncracked behavior and capacities of the walls and, if applicable, the cracked behavior and capacities of the walls shall be considered.

6.1.1.1 Uncracked Condition

The moment of inertia of an uncracked wall shall be taken as the gross moment of inertia.

6.1.1.2 Cracked Condition

If the applied moment (Ma) due to all loads in a load combination exceeds the uncracked moment capacity (Mcp), the wall shall be considered to be cracked. In this event, the equivalent moment of inertia (Ie) shall be computed as follows:

$$Ie = \left(\frac{Mca}{Ma}\right)^3 It + \left[1 - \left(\frac{Mcr}{Ma}\right)^3\right] Icr$$

$$Mcr = fr\left(\frac{It}{y}\right)$$

where;

Mcr = Uncracked moment capacity
Ma = Applied maximum moment on the wall
It = Moment of inertia of transformed section
Icr = Moment of inertia of the cracked section
fr = Modulus of rupture
y = Distance of neutral plane from tension force

If the use of Ie results in an applied moment Ma which is less than Mcr, then the wall shall be verified for Mcr.

6.1.2 Modes of Vibration

The effect of modes of vibration higher than the fundamental mode shall be considered if deemed necessary by the structural engineer. For this purpose, a detailed modal analysis may be performed.

6.1.3 Frequency Variations

Uncertainties in structural frequency of the masonry wall due to variations in density, attachments, dimensional tolerances, moment of inertia, modulus of elasticity, and boundary conditions shall be taken into account.

6.1.4 Boundary Conditions

Boundary conditions shall be determined considering one-way or two-way spans with hinged, fixed or free edges as appropriate. Conservative assumptions may be used to simplify the analysis as long as due consideration is given to frequencey variations.

6.1.5 Interstory Drift

The consequences of interstory drift shall be considered on the basis of gross panel shear strain. The ultimate gross panel shear strain for conrete masonry construction is taken to be γ = .0001.

6.2 In-plane and Out-of-plane Effects

The combined effects of in-plane and out-of-plane loads shall be considered.

6.3 Stress Calculations

All stress calculations shall be performed by conventional methods prescribed by the Working Stress Design method. Where required for structural adequacy, the collar joint shear stress shall be determined by the relationship VQ/Ib for uncracked sections and in the compression zone of cracked sections. The effect of cracking shall be appropriately considered in determining sectional properties.

6.4 Analytical Techniques

In general, classical design techniques shall be used in the evaluation. Simplified conservative analytical assumptions may be used. However, more refined methods utilizing computer analyses or dynamic analyses may be used on a case-by-case basis.

7.0 ALTERNATE ACCEPTANCE CRITERIA

Where bending due to out-of-plane or inertial loading causes the wall to exceed the allowable range outlined in Sections 5 and 6, the consequences of wall failure will be evaluated on the basis of the plant technical specifications and appropriate action will be taken