Consumers Power Company

James W Cook
*Vice President - Projects, Engineering and Construction*

General Offices: 1945 West Parnall Road, Jackson, MI 49201 • (517) 788-0453

April 19, 1982


Harold R Denton, Director
Office of Nuclear Reactor Regulation
Division of Licensing
US Nuclear Regulatory Commission
Washington, DC 20555

MIDLAND PROJECT
MIDLAND DOCKET NO 50-329, 50-330
INFORMATION ON SEISMIC CATEGORY I MASONRY WALLS
FOR THE STAFF'S SAFETY EVALUATION REVIEW
FILE: B3.8.1, 0505.16 SERIAL: 16643
REFERENCES: (1) S A VARGA GENERIC LETTER OF APRIL 21, 1980 CONCERNING INFORMATIONAL REQUEST ON CATEGORY I MASONRY WALLS
(2) J W COOK LETTER TO S A VARGA, SERIAL 9406, DATED SEPTEMBER 3, 1980
(3) J W COOK LETTER TO R L TEDESCO, SERIAL 9864, DATED OCTOBER 21, 1980
ENCLOSURES: (1) COMPARISON OF BLOCKWALL CRITERIA
(2) REVISED RESPONSE TO APRIL 1980 NRC QUESTION 5

In April 1980, the NRC forwarded a request for information on Category I masonry walls. This request for information was contained in the enclosure to Reference 1. We responded to this NRC information request with our correspondence of September 3, 1980 (Reference 2) as supplemented by the correspondence of Reference 3. References 2 and 3 contained information on loads and load combinations, applicable codes, and criteria for the attachment of piping and equipment which were used in the analysis and design of Category I masonry walls.

To further assist the NRC Staff in its safety evaluation review of Midland Category I masonry walls, we are forwarding the enclosed comparison. Enclosure 1 contains a comparison of the Midland design criteria for Category I masonry blockwalls with the NRC's interim criteria for safety-related masonry walls contained in Appendix A to the Standard Review Plan (NUREG-0800), Section 3.8.4. The differences identified in this comparison are not significant, and are justified in the notes included in the enclosure.

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In addition to the comparison of Enclosure 1, we are forwarding a revised response to the NRC's Question 5 which we forwarded originally to the NRC with Reference 2. This revised response provides an update on the capacities for anchors in blockwalls which support small piping and equipment.

The enclosed information along with the information previously forwarded by References 2 and 3 provides a complete response to the safety evaluation review criteria established in Appendix A to Standard Review Plan 3.8.4. and should allow the Staff to complete its safety evaluation review for blockwalls.

James W. Cook

JWC/RLT/dsb

CC RJCook, Midland Resident Inspector, w/o
RHernan, NRC, w/a
FRinaldi, NRC, w/a

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CONSUMERS POWER COMPANY
Midland Units 1 and 2
Docket No 50-329, 50-330

Letter Serial 16643 Dated April 19, 1982

At the request of the Commission and pursuant to the Atomic Energy Act of 1954, and the Energy Reorganization Act of 1974, as amended and the Commission's Rules and Regulations thereunder, Consumers Power Company submits additional SER-related information concerning Catagory 1 masonry blockwalls. Included as Enclosure 1 is a comparison of the Midland design for Catagory 1 masonry blockwalls with the Staff's criteria contained in Appendix to Standard Review Plan 3.8.4.

CONSUMERS POWER COMPANY

By _____
J W Cook, Vice President
Projects, Engineering and Construction

Sworn and subscribed before me this 19th day of April 1982.

_____
Notary Public
Jackson County, Michigan

My Commission Expires September 8, 1984

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# COMPARISON OF BLOCKWALL CRITERIA

| Description | Midland Design Criteria | NUREG - 0800 Standard Review Plan (SRP) Section 3.8.4 | Remarks |
|---|---|---|---|
| 1. LOAD COMBINATIONS | | | |
| | Normal Conditions | Service Load | |
| | $D + L$ | $D + L$ | |
| | $D + L + W$ | $D + L + W$ | |
| | $D + L + E$ | $D + L + E$ | |
| | | $D + L + T_o + R_o$ | See Note 1 |
| | | $D + L + T_o + R_o + E$ | See Note 1 |
| | | $D + L + T_o + R_o + W$ | See Note 1 |
| | Severe and Extreme Environmental, and Abnormal Conditions | | |
| | $D + L + E'$ | $D + L + T_o + R_o + E'$ | See Note 1 |
| | $D + L + W'$ | $D + L + T_o + R_o + W_t$ | See Note 1 |
| | $D + L + R$ | $D + L + T_a + R_a + 1.5P_a$ | See Notes 2 and 3 |
| | $D + L + R + E$ | $D + L + T_a + R_a + 1.25P_a + 1.0 (Y_r + Y_j + Y_m) + 1.25E$ | See Note 2 See Note 3 for difference in load factors; Also see Notes 4 and 5 |
| | $D + L + R + E'$ | $D + L + T_a + R_a + 1.0P_a + 1.0 (Y_r + Y_j + Y_m) + 1.0E'$ | See Notes 2, 4 and 5 |
| 2. STRESS INCREASES | | | |
| Normal Conditions | No increase of stresses | For wind or operating basis earthquake loads, no increase is allowed (Section 3a). | |
| | Inspection required | Inspection required | |

| Description | Midland Design Criteria | NUREC - 0800 Standard Review Plan (SRP) Section 3.8.4 | Remarks |
|---|---|---|---|
| 2. STRESS INCREASES (continued) | | | |
| | Direct tension perpendicular to bed joints resisted by reinforcement; no unreinforced masonry is used on the project. | Tension perpendicular to bed joints requires testing for unreinforced masonry. For reinforced masonry walls, all the tensile stresses shall be resisted by reinforcement. | |
| Severe and Extreme Environmental, and Abnormal Conditions | | | |
| Axial or flexural compression | 2.5 | 2.5 | |
| Bearing | 2.5 | 2.5 | |
| Shear and bond | 1.33 | 1.3 | |
| Masonry tension parallel to bed joints | 1.5 | 1.5 | |
| Shear and tension at block wythe to concrete or block wythe to grout core interface | 1.33 | None specified | |
| Masonry tension perpendicular to bed joints | 0 | Reinforced masonry 0<br>Unreinforced masonry 1.3 | |
| Reinforcement stress except shear | 2.0 ϕ 0.9 Fy | 2.0 ϕ 0.9 Fy | |
| Shear - Reinforcement | 1.5 | 1.5 | |
| Bolts | 1.5<br>(No increase is allowed for expansion or grouted anchors.) | 1.5 | |

| Description | Midland Design Criteria | NUREC - 0800 Standard Review Plan (SRP) Section 3.8.4 | Remarks |
|---|---|---|---|
| 3. ALLOWABLE STRESSES | | | |
| | As provided in ACI 531-79 with the following additions | As provided in ACI 531-79 | |
| Direct Tension and Shear at: | | | |
| a) Mortor collar joints | 0 | Not specified | |
| b) Block wythe to concrete or block wythe to grout core interface | 12 psi | Not specified | See Note 6 |
| Direct and flexural tension for cell and core concrete acting alone | $2.5\sqrt{f'c}$ | Not specified | See Note 7 |
| 4. DESIGN AND ANALYSIS CONSIDERATIONS | | | |
| Interstory drift effects | Consideration required | Consideration required | |
| Unreinforced masonry walls | None used | Not allowed in new construction | |
| Masonry shear walls | None used | Minimum reinforcement per ACI-531 | |
| Special protection for masonry walls from accident pipe reaction, jet impingement, and missile impact | Considered | Required to meet SRP 3.5.3 | See Note 8 |

NOTES:

1. Thermal effects $T_o$ are not considered in the analysis of masonry walls. Thermal gradient effects do not have a significant effect on reinforced masonry because sustained temperatures are limited to about 150 to 200F. The predicted thermal compressive stresses are conservative because masonry creeps under sustained loads, which reduces the effective modulus and stress. Thermal loads are therefore not be considered in the analysis and design of masonry walls. Piping reactions ($R_o$), including thermal effects, were added into the design live loads (L).

2. Thermal effects $T_a$ are short term transient loads and are not considered in the analysis of masonry walls (see Note 1). Piping reactions ($R_a$), including thermal effects, were added into the design live load (L). $P_a$ is included in R as a pipe break effect.

3. For concrete structures (strength design), the SRP criteria includes 1.25 $P_a$ and 1.5 $P_a$ under certain load combinations, but the Midland FSAR (Sections 3.8.4.3 and 3.8.6.3.3) does not include these increased load factors. The same condition exists with the masonry walls (ie the masonry walls are designed with a 1.0 Load Factor applied to $P_a$).

4. The 1.25 E load requirement in the SRP load combination for OBE is enveloped by the Midland criteria load combination for SSE, since E' = 2.0 E.

5. Masonry walls shall not be used to resist jet forces or pipe whip restraint supports; therefore, $Y_j$, $Y_r$, and $Y_m$ are not considered.

6. Allowable stress for block wythe to concrete or block wythe to grout core interface: The Midland criteria allows 12 psi; Uniform Building Code, 1979 (Page 180, Table No 24-B) allows 12 psi for a hollow unit net mortar area (unreinforced) and also allows 25 psi for grouted masonry (unreinforced).

7. Stress due to direct flexural tension for cell and core concrete acting alone is considered to be one-third of the value of the modulus of rupture for concrete, which ensures a safety factor of 3. Modulus of rupture for normal weight concrete is $F_y = 7.5 \sqrt{f'c}$ (ACI-318-71).

8. Barriers and/or pipe whip restraints are provided to protect blockwalls from jet impingement, missile, and pipe whip loads when the failure of the blockwalls could prevent other safety related structures, systems, or components from performing their intended safety functions.

# REVISED RESPONSE TO APRIL 21, 1980 NRC QUESTION 5

Question 5

How were the masonry walls and the piping/equipment supports attached to them designed? Provide enough numerical examples including details of reinforcement and attachments to illustrate the methods and procedures used to analyze and design the walls and the anchors needed for supporting piping/equipment (as applicable).

Response:

Items supported by Seismic Category I masonry walls are limited to small piping and light weight equipment. They are attached by expansion anchors, grouted anchors, or through bolts.

The design information for expansion anchors is shown in Attachment 1.

The design information for grouted anchors is shown in Attachment 2.

The design information for through bolts is shown in Attachment 3.

These attachment loads were considered in the design of block walls.

# ALLOWABLE DESIGN LOADS FOR WEDGE AND STUD TYPE ANCHORS IN MASONRY BLOCK WALLS

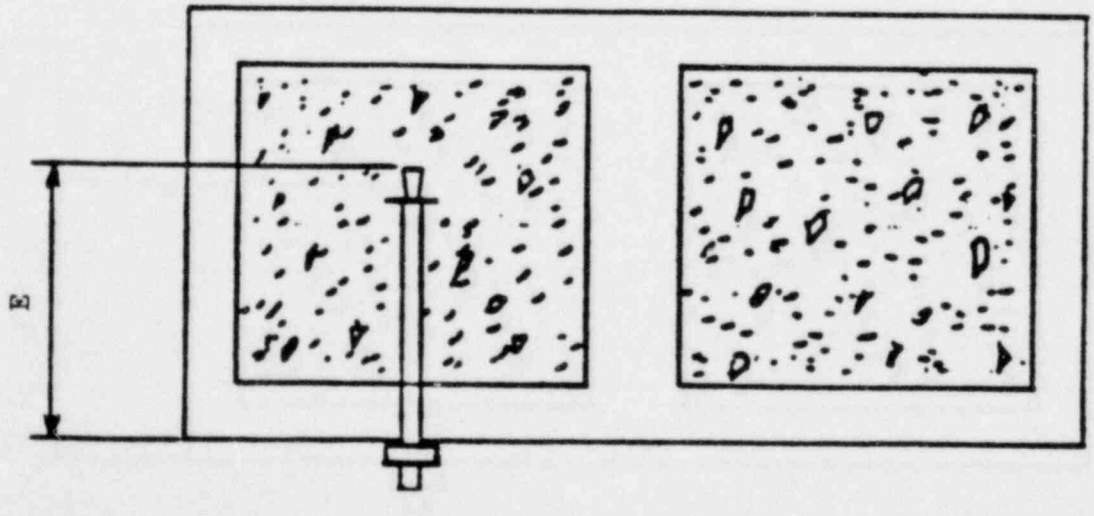
| Anchor Diameter (in.) | Minimum Embedment (E) Before Torquing (in.) | Tension (T) (kips)[1] | Shear (S) (kips)[1] | Spacing (in.) |
|---|---|---|---|---|
| 3/8 | 1-5/8 | 0.4 | 0.5 | 4 |
| 3/8 | 3-1/8 | 0.6 | 0.8 | 4 |
| 1/2 | 2-1/4 | 0.7 | 1.4 | 5 |
| 1/2 | 3-3/4 | 0.8 | 1.6 | 5 |
| 5/8 | 4 | 1.2 | 2.2 | 6 |
| 5/8 | 5-1/2 | 1.6 | 2.4 | 6 |

NOTES

1) Values based on "Report on the Testing of Concrete Expansion Anchors in Masonry Blockwalls" at Midland Michigan.

2) When an anchor is subjected to both tension and shear loads, the following method of combination shall be used to assess anchor capacity:

$$\frac{S_{applied}}{S_{allowable}} + \frac{T_{applied}}{T_{allowable}} \leq 1.0$$



# ALLOWABLE DESIGN LOADS FOR GROUTED ANCHOR BOLTS IN MASONRY BLOCKWALLS

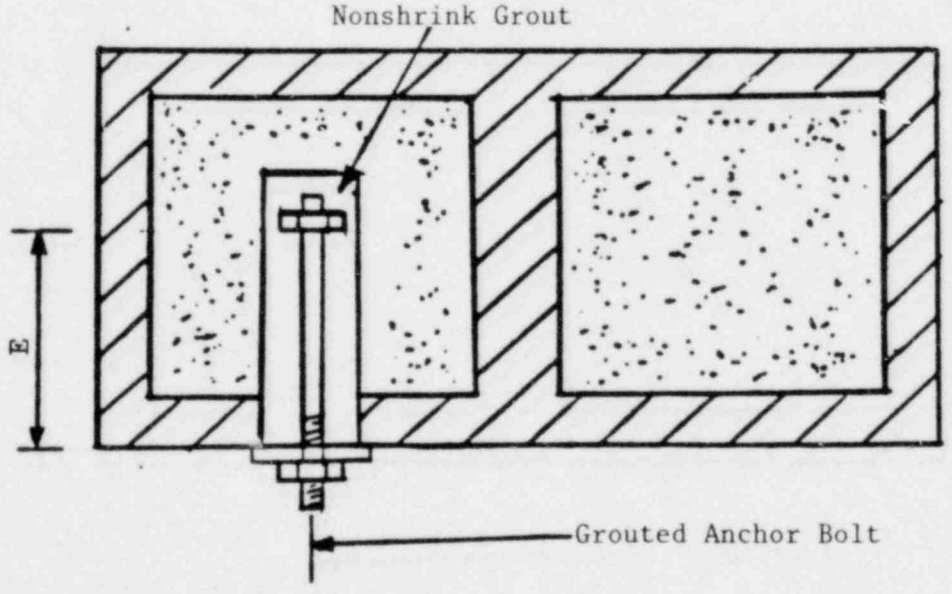
| Anchor Diameter (d) (in.) | Embedment E (in.) | Hole Size D = 2d + 1/2" (in.) | Tension (T) (kips)[1] | Shear (S) (kips)[1] |
|---|---|---|---|---|
| 5/8 | 6 | 1-3/4 | 2.2 | 3.0 |

NOTES

1) Values are based on testing of grouted anchors in concrete block walls at Midland, Michigan

2) When an anchor is subjected to both tension and shear loads, the following method of combination shall be used to assess anchor capacity:

$$\frac{T_{applied}}{T_{allowable}} + \frac{S_{applied}}{S_{allowable}} \leq 1$$



# ALLOWABLE DESIGN LOADS FOR THROUGH BOLTS IN MASONRY BLOCK WALLS

| Anchor Diameter (d) (in.) | Tension Capacity (T) (kips) | Shear Capacity (S) (kips) |
|---|---|---|
| 5/8 | 2.5 | 2.5 |

NOTE

1) When an anchor is subjected to both tension and shear loads, the following method of combination shall be used to assess anchor capacity:

$$\frac{T_{applied}}{T_{allowable}} + \frac{S_{applied}}{S_{allowable}} \leq 1$$