UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

MASONRY WALL DESIGN, IE BULLETIN 80-11

FORT CALHOUN STATION

DOCKET NO. 50-285

The findings reported in this Safety Evaluation (SE) are based on the attached Technical Evaluation Report (TER), Attachment 1, prepared by Franklin Research Center (FRC) as a contractor to NRC. This TER contains the details of construction techniques used, technical information reviewed, acceptance criteria, and technical findings with respect to masonry wall construction at Fort Calhoun Station. The staff has reviewed this TER and concurs with its technical findings. The following is our summary of the major technical findings:

1. As indicated in Section 3.1 of the TER, the licensee's criteria, as used in the re-evaluation of the masonry walls at Fort Calhoun, either comply with or meet the intent of the staff acceptance criteria.

2. The licensee has modified seven unmortared shield walls by providing structural restraints to protect the safety-related equipment in their proximity. In addition, the licensee has also committed to install clip angles on both faces of the top boundary of 21 walls to bring walls in compliance with the assumed boundary conditions in the analysis. The licensee has further committed to modify 13 walls, previously qualified by the arching action theory, such that they satisfy the staff acceptance criteria.

The staff finds the licensee's modification program acceptable as the modified walls will be in compliance with the staff's acceptance criteria.

Based on the above findings, the staff concludes that the Items 2(b) and 3 of the IE Bulletin 80-11 have been fully implemented at Fort Calhoun and that there is a reasonable assurance that the safety-related masonry walls at Fort Calhoun, when modified, will withstand the specified design load conditions without impairment of (a) wall integrity or (b) the performance of the required safety functions.

Attachment:
FRC TER

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TECHNICAL EVALUATION REPORT

MASONRY WALL DESIGN

OMAHA PUBLIC POWER DISTRICT

FORT CALHOUN STATION

NRC DOCKET NO. 50-285

FRC PROJECT C5506

FRC ASSIGNMENT 6

NRC CONTRACT NO. NRC-03-81-130

FRC TASK 258

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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

1. INTRODUCTION

1.1 PURPOSE OF REVIEW

The purpose of this review is to provide technical evaluations of licensee responses to IE Bulletin 80-11 [1]* with respect to compliance with the Nuclear Regulatory Commission (NRC) masonry wall criteria. In addition, if a licensee has planned repair work on masonry walls, the planned methods and procedures are to be reviewed for acceptability.

1.2 GENERIC ISSUE BACKGROUND

In the course of conducting inspections at the Trojan Nuclear Plant, Portland General Electric Company determined that some concrete masonry walls did not have adequate structural strength. Further investigation indicated that the problem resulted from errors in engineering judgment, a lack of established procedures and procedural details, and inadequate design criteria. Because of the implication of similar deficiencies at other operating plants, the NRC issued IE Bulletin 80-11 on May 8, 1980.

IE Bulletin 80-11 required licensees to identify plant masonry walls and their intended functions. Licensees were also required to present reevaluation criteria for the masonry walls with the analyses to justify those criteria. If modifications were proposed, licensees were to state the methods and schedules for the modifications.

1.3 PLANT-SPECIFIC BACKGROUND

In response to IE Bulletin 80-11, the Omaha Public Power District (OPPD) provided the NRC with documents [2-5] describing the status of masonry walls at Fort Calhoun Station. The information in these documents was reviewed, and a request for additional information was sent to the Licensee [6], to which the Licensee responded [7]. After the review of these responses, additional questions [8] were sent to the Licensee, to which it also responded [9].

* Numbers in brackets indicate references, which are cited in Section 5.

References 2 and 9 indicated that 29 out of a total of 42 masonry walls were identified as safety-related walls. These walls can be divided into two groups as follows:

- o 22 single-wythe walls
- o 7 shield walls made of solid concrete units stacked with no mortar.

The walls do not act as load-bearing walls, and they serve as partitions or shielding. All of the masonry walls are interior walls located within the auxiliary building.

Some walls are reinforced. However, Reference 9 indicated that all walls were treated as unreinforced walls.

The materials used in the construction of masonry walls were specified as follows:

Concrete masonry units	ASTM C90
Mortar	ASTM C270, Type N
Joint reinforcement	Truss type, 3/16-in-diameter side wires and No. 9 diagonal wires, galvanized, 16 inches on center
Vertical bars	ASTM 615-68, Grade 40
Bond type	Running bond construction

With regard to the wall modification, the Licensee indicated [9] that 21 of the 22 single-wythe walls will be strengthened with clip angles at the top of both faces to assure that shear transfer will take place. One wall (south wall of the control room) already has clip angles installed on both faces of the wall at the top.

Structural restraints have been installed for the seven shield walls where solid concrete units were stacked with no mortar.

2. EVALUATION CRITERIA

The basic documents used for guidance in this review were the criteria developed by the Structural and Geotechnical Engineering Branch (SGEB) of the NRC (attached as Appendix A to this report), the Uniform Building Code [10], and ACI 531-79 [11].

The materials, testing, analysis, design, construction, and inspection of safety-related concrete masonry structure should conform to the SGEB criteria. For operating plants, the loads and load combinations for qualifying the masonry walls should conform to the appropriate specifications in the Final Safety Analysis Report (FSAR) for the plant. Allowable stresses are specified in Reference 11 and the appropriate increase factors for abnormal and extreme environmental loads are given in the SGEB criteria (Appendix A).

3. TECHNICAL EVALUATION

This evaluation is based on the Licensee's earlier responses [2-5] and subsequent responses [7, 9] to the requests for additional information [6, 8]. The Licensee's criteria were evaluated with regard to design and analysis methods, loads and load combinations, allowable stresses, construction specifications, and materials. The Licensee's response to the request for additional information was also reviewed.

3.1 EVALUATION OF LICENSEE'S CRITERIA

The Licensee reevaluated the masonry walls using the following criteria:

- Allowable stresses were based on the Uniform Building Code [10] for walls constructed without special inspection.
- Load combinations were based on the plant FSAR which includes dead load, live load, and seismic loads.
- The working stress design method was used.
- Critical damping values of 2% and 4% were used for the operating basis earthquake (OBE) and the safe shutdown earthquake (SSE), respectively.
- The typical analytical procedure is summarized below:
  - Calculate the wall's fundamental frequency based on one-way or two-way behavior and appropriate boundary conditions.
  - Obtain inertial loading from the envelope of the floor response spectra.
  - Compare computed stresses with the allowable stresses.

The Licensee's criteria have been reviewed and found to be adequate and in compliance with the SGEB criteria. The review of the Licensee's response to the request for additional information follows.

Question 1

With respect to the reevaluation of masonry walls at Fort Calhoun Station, the Licensee stated in Reference 3 that only seismic loads were considered in the analysis. However, according to Section 5.11.3.1 of the Fort Calhoun Final Safety Analysis Report (FSAR), wind loads as well as tornado loads should be considered in the analysis. Explain and justify this deviation from the FSAR.

Response 1

The Licensee's response indicated that all of the walls in question are non-load-bearing interior partitions. There is no potential for developing a pressure differential on the walls as a result of a tornado. Since all the walls are interior partitions, the Licensee's response has resolved this issue.

Question 2

With regard to Response 2 of Reference 7, the Licensee indicated that arching action was used to qualify some walls. It should be noted that the NRC position on this issue states that the use of the arching action theory to qualify the unreinforced masonry walls is not acceptable; these walls should be repaired so that they can be qualified based on the SGEB criteria.

In view of this, the Licensee is requested to identify all affected walls.

Response 2

In the earlier response, the Licensee stated that arching action was used to qualify some walls [7]. However, in a later response [9], the Licensee indicated that all masonry walls were reevaluated based on the working stress approach and that 13 walls were found to be unqualified by the working stress design method. The Licensee further indicated that these walls will be modified to satisfy the working stress design method and that no arching action will be used. Based on this information, it is concluded that the concern associated with the arching theory has been resolved.

Question 3

With respect to the seismic analysis, in Reference 3, the Licensee introduced a formula of the Uniform Building Code to evaluate the lateral forces. Section 3.7.2 of the Standard Review Plan (SRP) states that either a dynamic analysis or an equivalent static analysis could be performed. If the latter method is used, the equivalent static load of a structure, equipment, or component can be obtained by applying a factor of 1.5 to the peak acceleration of the applicable floor response spectrum. In view of this, the Licensee is requested to discuss the method of seismic analysis especially when the walls are supported by several floors.

Question 3.1 (Reference 6)

With respect to the seismic analysis method, the Licensee used a formula of the Uniform Building Code to evaluate the lateral forces. In Response 4 [7], the Licensee indicated, however, that a dynamic analysis was being performed to validate the proposed static analysis. Provide the results of the dynamic analysis along with description of its approach. Indicate whether the input motion used for this dynamic analysis is based on the acceleration of a floor response spectrum. If not, provide justification.

Responses 3 and 3.1

In this response, the Licensee confirmed that seismic analysis was performed using the following steps:

- The natural frequency of the wall was determined.
- The floor response spectra at the bottom of the wall or at the next higher elevation (whichever yielded the maximum response within the frequency range) was determined.
- The seismic accelerations were increased by a factor of 1.05 to account for the participation of higher modes.

An equivalent static analysis has been performed and the higher modes have been accounted for by a factor of 1.05. It has been found, in many cases at other plants, that the first mode usually contributes 95% or more to the total responses. Therefore, for all practical purposes, the first mode should adequately cover the total responses of the walls.

Based on the above information, it is concluded that the Licensee's approach is adequate and in compliance with the SGEB criteria.

Question 4

Provide any increase factors that may have been used for allowable stresses under abnormal conditions. If the increase factors are higher than those listed in the SGEB criteria, provide justification and indicate the number of affected walls. The SGEB factors are listed below by type of stress:

Axial or flexural compression	2.5
Bearing 2.5	
Reinforcement stress except shear	2.0 but not to exceed 0.9 fy
Shear reinforcement and/or bolts	1.5
Masonry tension parallel to bed joint	1.5
Shear carried by masonry	1.3
Masonry tension perpendicular to bed joint	
reinforced masonry	0
unreinforced masonry	1.3

Response 4

The Licensee stated that for the abnormal loading conditions, the allowable increase factors are in compliance with the SGEB criteria; therefore, this question has been resolved.

Question 5

Indicate the boundary conditions used for evaluating masonry walls and provide justification.

Question 5.1 (Reference 8)

Regarding the boundary conditions, the Licensee indicated in Reference 7 that a shear transfer at the top of a simply supported wall is achieved by the wedging action of the wall with mortar bond between the masonry wall and the underside of the slabs. However, it has been discovered during a recent inspection that the mortar bonds with the underside of the slabs are separated. It is strongly recommended that the Licensee modify these walls to assure shear transfer will take place (i.e., clip angles could be installed). Specify the intended action for these walls.

Responses 5 and 5.1

A simple support was assumed at the top and bottom of the walls. Plain mortar joint at the bottom support provided the necessary shear transfer. There are 22 walls in which the mortar bonds with the underside of the slabs are separated. For these walls, the Licensee will install clip angles at the top of both faces of 21 of 22 walls to assure a shear transfer mechanism. One wall (the south wall of the control room) already has clip angles installed on both faces of the wall at the top.

Based on the above information, it can be concluded that the Licensee's response is adequate and satisfactory.

Question 6

Indicate if any walls are subject to impact or suddenly applied loads. If so, provide sample calculations for impact analysis.

Response 6

The Licensee stated that none of the concrete masonry walls are subjected to impact or suddenly applied loads. Therefore, this question has been resolved.

Question 7

With regard to the block pullout analysis, even though the walls are not subjected to any impact or suddenly applied loads, as explained in Reference 7 the Licensee should consider the case when the block could be pulled out by attachments under seismic loads. Provide a sample calculation illustrating how this case is handled.

Response 7

In this response, the Licensee stated that it was concluded during the reevaluation program that there are no attachments on the masonry walls which could cause a block pullout under seismic loads. The Licensee also indicated that the only attachments on the masonry walls are some lightweight non-safety-related equipment. Since this is the case, the Licensee's response is adequate and in compliance with the SGEB criteria.

Question 8

A total of 20 walls are identified as being stacked by blocks with no mortar. However, as indicated in Reference 7, only seven locations on five unreinforced walls were provided with structural restraints. Indicate whether restraints were also provided for other walls. If not, provide the technical basis and justification (i.e., based on available

test data) as to why no restraint is required. It is strongly recommended that restraints should be installed for all of these walls.

Response 8

The Licensee's response indicated that all of the 20 shield walls were inspected in accordance with the requirements of IE Bulletin 80-11. These are removable walls in which the solid masonry units are stacked with no mortar. These walls were originally modified by structural restraints. However, the reevaluation program identified only seven out of these 20 walls as having safety-related equipment in their proximity. As a result of the reevaluation program, additional structural restraints were installed to qualify these seven walls for seismic loading. These restraints were installed as a part of a modification program which was completed in January 1982.

Because structural restraints were originally installed for all 20 walls and then additional structural restaints were installed for seven safety-related walls, it can be concluded that the Licensee's approach has resolved the concern associated with these walls (see Section 3.2 for further details).

Question 9

Since no quality control was used during the construction, the Licensee is requested to confirm the existence of reinforcement in the walls as specified in the design drawings.

Response 9

The Licensee indicated that no credit was taken for any reinforcement in the analysis. Therefore, this question has been resolved.

Question 10

In Table 1 of Reference 2, the Licensee identified some vertically reinforced single-wythe hollow concrete masonry units. If there is no grout, explain how the reinforcement can develop its resisting strength.

The ACI 531-79 Code specifies that the minimum area of reinforcement in a wall in either direction, vertical or horizontal, shall be 0.0007 (0.07%) times the gross cross-sectional area of the wall and the

minimum total area of steel, vertical and horizontal, shall not be less than 0.002 (0.2%) times the gross cross-sectional area. In view of this, the Licensee is requested to clarify whether the reinforced walls at this plant meet the above requirements.

Response 10

In this response, the Licensee stated that it could not verify whether the walls meet the reinforcing requirements of ACI 531-79; therefore, no credit was taken for any wall reinforcing. Since vertical reinforcement was not used to qualify the walls, the Licensee's response has resolved this question.

Question 11

With reference to the joint reinforcement, the Licensee is requested to provide the following information:

- Indicate if any joint reinforcement was used as a tensile resisting element to qualify the wall. If so, provide the number of affected walls.
- The primary function of joint reinforcement is to control cracks associated with thermal or moisture expansion or contraction. Provide technical basis (i.e., test data) to substantiate its use as a tensile resisting element.
- Provide verification to assure proper anchorage of joint reinforcement at the boundary and proper bonding between the reinforcement and motar.

Response 11

The Licensee stated that joint reinforcement was not used as a tensile resisting element to qualify any of the walls. Therefore, this issue is considered to be resolved.

3.2 EVALUATION OF LICENSEE'S APPROACH TO WALL MODIFICATIONS

As indicated in Responses 2, 5, and 8 of Section 3.1, the modification program can be divided into two groups as follows:

1. For 22 single-wythe walls

   Clip angles will be installed at the top of both faces of 21 masonry walls to assure a shear transfer mechanism (see Response 5 for more details).

   A total of 13 walls were found to be unqualified (see Response 2 for more details) by the working stress design method, and these walls will be modified to satisfy the SGEB criteria.

2. For 7 shield walls

   As indicated in Response 8, structural restraints were originally installed for these walls, but only two of them were designed for seismic loading. The remaining five walls required modifications in order to be qualified for seismic loading. The original restraints for these five walls consisted generally of a number of horizontal structural members (three 1/4-inch by 2-inch bars in the case of wall 3 as shown in Appendix B), which span the wall face at regular intervals and are attached at the ends to steel angles embedded in the concrete at the sides of the wall. The new restraints typically involved vertical channels added to the face of the wall, their webs perpendicular to the wall, and bolted to the floor and to the existing concrete above the wall (see the drawings of wall 3, Appendix B, for an example of the restraints for unmortared block walls). Wall 3 also has an additional horizontal member near the top of the south face, a structural steel angle attached to the existing embedded vertical angles at each end. The modifications were completed in January 1982.

For Group 1, it is evident that the modification will enable the walls to satisfy the SGEB criteria.

For Group 2, in addition to originally installed restraints, structural restraints were added to assure the safety function of these walls. This approach is judged to be adequate and satisfactory.

4. CONCLUSIONS

A detailed review was performed to provide a technical evaluation of the masonry walls at Fort Calhoun Station. Review of the Licensee's criteria and additional information provided by the Licensee led to the conclusions given below.

The criteria used for reevaluation of the masonry walls, along with the additional information provided by the Licensee, indicate that the Licensee's criteria are in compliance with the SGEB criteria.

With regard to wall modifications, as indicated in Section 3.2, the modification approach was reviewed and judged to be adequate and satisfactory.

5. REFERENCES

1. "Masonry Wall Design"
NRC, May 8, 1980
IE Bulletin 80-11

2. W. C. Jones (OPPD)
Letter to K. V. Seyfrit, NRC
Subject: IE Bulletin 80-11, Masonry Wall Design
Omaha Public Power District
July 7, 1980

3. W. C. Jones (OPPD)
Letter to K. V. Seyfrit, NRC
Subject: IE Bulletin 80-11, Masonry Wall Design
Omaha Public Power District
November 4, 1980

4. W. C. Jones (OPPD)
Letter to K. V. Seyfrit, NRC
Subject: IE Bulletin 80-11, Masonry Wall Design
Omaha Public Power District
January 28, 1981

5. W. C. Jones (OPPD)
Letter to J. T. Collins, NRC
Subject: IE Bulletin 80-11, Masonry Wall Design
Omaha Public Power District
January 4, 1982

6. R. A. Clark (NRC)
Letter to W. C. Jones, OPPD
Subject: Request for Additional Information, IE Bulletin 80-11, Masonry Wall Design
January 7, 1983

7. W. C. Jones (OPPD)
Letter to R. A. Clark, NRC
Subject: IE Bulletin 80-11, Masonry Wall Design
April 15, 1983

8. J. R. Miller (NRC)
Letter to W. C. Jones, OPPD
Subject: Request for Additional Information, IE Bulletin 80-11, Masonry Wall Design
February 6, 1984

9. W. C. Jones (OPPD)
Letter to J. R. Miller, NRC
Subject: IE Bulletin 80-11, Masonry Wall Design
March 9, 1984

10. Uniform Building Code
International Conference of Building Officials, 1979

11. Building Code Requirements for Concrete Masonry Structures
American Concrete Institute, Detroit, 1979
ACI 531-79 and ACI 531R-79

APPENDIX A

SGEB CRITERIA FOR SAFETY-RELATED MASONRY WALL EVALUATION (DEVELOPED BY THE STRUCTURAL AND GEOTECHNICAL ENGINEERING BRANCH [SGEB] OF THE NRC)

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1. General Requirements

The materials, testing, analysis, design, construction, and inspection related to the design and construction of safety-related concrete masonry walls should conform to the applicable requirements contained in Uniform Building Code - 1979, unless specified otherwise, by the provisions in this criteria.

The use of other standards or codes, such as ACI-531, ATC-3, or NCMA, is also acceptable. However, when the provisions of these codes are less conservative than the corresponding provisions of the criteria, their use should be justified on a case-by-case basis.

In new construction, no unreinforced masonry walls will be permitted. For operating plants, existing unreinforced walls will be evaluated by the provisions of these criteria. Plants which are applying for an operating license and which have already built unreinforced masonry walls will be evaluated on a case-by-case basis.

2. Loads and Load Combinations

The loads and load combinations shall include consideration of normal loads, severe environmental loads, extreme environmental loads, and abnormal loads. Specifically, for operating plants, the load combinations provided in the plant's FSAR shall govern. For operating license applications, the following load combinations shall apply (for definition of load terms, see SRP Section 3.8.4II-3).

(a) Service Load Conditions

(1) D + L

(2) D + L + E

(3) D + L + W

If thermal stresses due to T_o and R_o are present, they should be included in the above combinations as follows:

(1a) $D + L + T_o + R_o$

(2a) $D + L + T_o + R_o + E$

(3a) $D + L + T_o + R_o + W$

Check load combination for controlling condition for maximum 'L' and for no 'L'.

(b) Extreme Environmental, Abnormal, Abnormal/Severe Environmental, and Abnormal/Extreme Environmental Conditions

(4) $D + L + T_o + R_o + E$

(5) $D + L + T_o + R_o + W_t$

(6) $D + L + T_a + R_a + 1.5\ P_a$

(7) $D + L + T_a + R_a + 1.25\ P_a + 1.0\ (Y_r + Y_j + Y_m) + 1.25\ E$

(8) $D + L + T_a + R_a + 1.0\ P_a + 1.0\ (Y_r + Y_j + Y_m) + 1.0\ E'$

In combinations (6), (7), and (8) the maximum values of P_a, T_a, R_a, Y_j, Y_r, and Y_m, including an appropriate dynamic load factor, should be used unless a time-history analysis is performed to justify otherwise. Combinations (5), (7), and (8) and the corresponding structural acceptance criteria should be satisfied first without the tornado missile load in (5) and without Y_r, Y_j, and Y_m in (7) and (8). When considereing these loads, local section strength capacities may be exceeded under these concentrated loads, provided there will be no loss of function of any safety-related system.

Both cases of L having its full value or being completely absent should be checked.

3. Allowable Stresses

Allowable stresses provided in ACI-531-79, as supplemented by the following modifications/exceptions, shall apply.

(a) When wind or seismic loads (OBE) are considered in the loading combinations, no increase in the allowable stresses is permitted.

(b) Use of allowable stresses corresponding to special inspection category shall be substantiated by demonstration of compliance with the inspection requirements of the SEB criteria.

(c) When tension perpendicular to bed joints is used in qualifying the unreinforced masonry walls, the allowable value will be justified by test program or other means pertinent to the plant and loading conditions. For reinforced masonry walls, all the tensile stresses will be resisted by reinforcement.

(d) For load conditions which represent extreme environmental, abnormal, abnormal/severe environmental, and abnormal/extreme environmental conditions, the allowable working stress may be multiplied by the factors shown in the following table:

Type of Stress	Factor
Axial or Flexural Compression[1]	2.5
Bearing	2.5
Reinforcement stress except shear	2.0 but not to exceed 0.9 fy
Shear reinforcement and/or bolts	1.5
Masonry tension parallel to bed joint	1.5
Shear carried by masonry	1.3
Masonry tension perpendicular to bed joint	
for reinforced masonry	0
for unreinforced masonry[2]	1.3

Notes

(1) When anchor bolts are used, design should prevent facial spalling of masonry unit.

(2) See 3(c).

4. Design and Analysis Considerations

(a) The analysis should follow established principles of engineering mechanics and take into account sound engineering practices.

(b) Assumptions and modeling techniques used shall give proper considerations to boundary conditions, cracking of sections, if any, and the dynamic behavior of masonry walls.

(c) Damping values to be used for dynamic analysis shall be those for reinforced concrete given in Regulatory Guide 1.61.

(d) In general, for operating plants, the seismic analysis and Category I structural requirements of FSAR shall apply. For other plants, corresponding SRP requirements shall apply. The seismic analysis shall account for the variations and uncertainties in mass, materials, and other pertinent parameters used.

(e) The analysis should consider both in-plane and out-of-plane loads.

(f) Interstory drift effects should be considered.

(g) In new construction, grout in concrete masonry walls, whenever used, shall be compacted by vibration.

(h) For masonry shear walls, the minimum reinforcement requirements of ACI-531 shall apply.

(i) Special constructions (e.g., multiwythe, composite) or other items not covered by the code shall be reviewed on a case-by-case basis for their acceptance.

(j) Licensees or applicants shall submit QA/QC information, if available, for staff's review.

In the event QA/QC information is not available, a field survey and a test program reviewed and approved by the staff shall be implemented to ascertain the conformance of masonry construction to design drawings and specifications (e.g., rebar and grouting).

(k) For masonry walls requiring protection from spalling and scabbing due to accident pipe reaction (Y_r), jet impingement (Y_j), and missile impact (Y_m), the requirements similar to those of SRP 3.5.3 shall apply. However, actual review will be conducted on a case-by-case basis.

5. References

(a) Uniform Building Code - 1979 Edition.

(b) Building Code Requirements for Concrete Masonry Structures ACI-531-79 and Commentary ACI-531R-79.

(c) Tentative Provisions for the Development of Seismic Regulations for Buildings - Applied Technology Council ATC 3-06.

(d) Specification for the Design and Construction of Load-Bearing Concrete Masonry - NCMA August, 1979.

(e) Trojan Nuclear Plant Concrete Masonry Design Criteria Safety Evaluation Report Supplement - November, 1980.

APPENDIX B

SKETCHES OF WALL MODIFICATIONS

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