TECHNICAL EVALUATION REPORT*

MASONRY WALL DESIGN (B-59)

ARKANSAS POWER AND LIGHT COMPANY

ARKANSAS NUCLEAR ONE UNITS 1 AND 2

NRC DOCKET NO. 50-313, 50-368

NRC TAC NO. 42901, 42889

NRC CONTRACT NO. NRC-03-81-130

FRC PROJECT C5506

FRC ASSIGNMENT 6

FRC TASK 161

Prepared by

Franklin Research Center
20th and Race Street
Philadelphia, PA 19103

Author: V. N. Con
N. Subramonian

FRC Group Leader: V. N. Con

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: N. Chokshi

* July 9, 1982

* With modification by NRC staff to remove the reference to "Interim" relative to NRC evaluation criteria.

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[redacted]

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Group Leader

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Department Director

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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 AND SCOPE

The purpose of this review is to provide a technical evaluation of the Licensee's response to Items 2 and 3 of the Nuclear Regulatory Commission's (NRC) IE Bulletin 80-11, "Masonry Wall Design" [1], which required Licensees to present reevaluation criteria with justifications and to submit a written report upon completion of the reevaluation program. The evaluation included a review of any Licensee-proposed modifications of masonry walls and the proposed methods, procedures, and repair schedules.

1.2 PLANT-SPECIFIC BACKGROUND

In response to IE Bulletin 80-11, Arkansas Power & Light Company (the Licensee) provided the NRC with documents describing the status of masonry walls at Arkansas Nuclear One Units 1 and 2 [2]. As a result of the review of these documents, the NRC sent a letter dated January 15, 1982 requesting additional information [3]. In response to this request, the Licensee forwarded answers [4] to all questions raised.

Units 1 and 2, respectively, have 75 and 104 safety-related masonry walls that were classified as follows:

	Unit 1	Unit 2
1. Walls supporting Seismic Category I pipes	19	8
2. Walls supporting Seismic Category I attachments other than pipes	9	19
3. Walls in the proximity of safety-related system	47	77
	75	104

Wall attachments generally are limited to small piping supports, electrical conduits and boxes, instrument lines, and ventilation duct supports.

None of the walls identified were load-bearing walls supporting the building structure in the vertical direction or acting as shear walls in the

horizontal direction. Generally, the walls served as shielding and fire protection devices.

Most of the block walls are shielding walls constructed with heavyweight hollow concrete blocks or cells; all cells are filled with grout. Continuous reinforcement is placed in every other cell. Walls that do not have a shielding function are constructed with standard blocks in which only cells having reinforcement, plumbing, or other embedded items are grouted.

Typical concrete block wall details are shown in Figures 1 and 2 of Appendix D. Vertical reinforcing steel consists of one No. 5 bar of 16-inch spacing in the center of single-wythe walls and one No. 5 bar at 16-inch spacing near each face of multi-wythe walls. Horizontal reinforcement consists of a bond beam with four No. 4 bars at 48-inch spacing in single-wythe walls, and an identical bond beam at each face of multi-wythe walls. In addition, joint reinforcing, consisting of extra-heavy Dur-O-Wall truss steel bars, is placed in alternate horizontal joints (16-inch spacing) of shielding walls and in every horizontal joint (8-inch spacing) of other walls. At shielding walls, No. 2 steel tie bars hooked around vertical reinforcing bars are placed at staggered 32-inch spacing horizontally and 16-inch spacing vertically. Figure 3 of Appendix D illustrates this arrangement and indicates a typical running bonded construction of masonry walls at the plant.

Materials specified for wall construction are as follows:

- Concrete blocks - ASTM C90, Grade PI. Heavyweight units cured and oven-dryed.
- Mortar - ASTM C476, Type PL, 2000 psi compressive strength at 28 days.
- Grout - ASTM C476, 2000 psi compressive strength at 28 days.
- Reinforcing bars - ASTM A615, grade 40.
- Horizontal joint reinforcement - ASTM A82, Dur-O-Wall extra-heavy truss type.

As for the construction practice, the Licensee indicated that general inspection was performed by the experienced Bechtel field engineering personnel [2] to ensure compliance with the required specifications. Bechtel's subcontractor submitted a certificate verifying that all concrete blocks conformed to the required specifications.

2. EVALUATION CRITERIA

The basic documents used for guidance in this review were "SEB Criteria for Safety-Related Masonry Wall Evaluation," [5] developed by the Structural Engineering Branch (SEB) of the NRC (attached as Appendix A to this report), the Uniform Building Code [6], and ACI 531-79 [7].

In general, the materials, testing, analysis, design construction, and inspection of safety-related concrete masonry walls should conform to the SEB criteria [5]. For operating plants, the loads and load combinations for qualifying the masonry walls should conform to the appropriate specifications in the FSAR for the plant. Allowable stresses are specified in Reference 7 and the appropriate increase factors for abnormal and extreme environmental loads are given in Reference 5.

3. TECHNICAL EVALUATION

This evaluation is based on the Licensee's earlier response [2] and subsequent response [4] to the request for additional information [3]. The Licensee's criteria [2] were evaluated with regard to design and analysis methods, loads and load combinations, allowable stresses, construction specification materials, and relevant test data. In addition, the Licensee's modifications and response to the request for additional information [Appendix B for Unit 1 and Appendix C for Unit 2] will be evaluated.

3.1 EVALUATION OF LICENSEE'S CRITERIA

The Licensee has reevaluated the masonry walls using the following criteria [2]:

- Allowable stresses for analysis of masonry walls were based on Uniform Building Code (UBC) specifications [6].
- Loads and load combinations used were those specified in the plant Safety Analysis Report.
- Boundary conditions were determined by considering one-way or two-way spans with hinged, fixed, or free edges, as appropriate.
- A 3% damping for operating basis earthquake (OBE) and 5% for design basis earthquake (DBE) were assumed.
- A collar joint strength of zero was assumed.

In general, the Licensee's criteria are in compliance with the SEB criteria [5]. The Licensee has responded to all of the questions (listed in Appendix B for Unit 1 and Appendix C for Unit 2) in the request for additional information [3]. These responses [4] are reviewed below:

Question 1 (applicable to Units 1 and 2)

In response to this question, the Licensee clarified that the frequency of concrete masonry walls is dependent on the type of analysis (one-way beam or two-way plate), boundary conditions, and section movement of inertia, as

well as the wall dimensions. This explains why the frequencies of walls with comparable dimensions vary widely. The Licensee's response is considered adequate.

Question 2 (applicable to Units 1 and 2)

In this question, the Licensee was requested to justify the use of the average acceleration rather than the envelope of the response spectra for walls supported by two floors. The Licensee considered the seismic response of a simply supported, uniform beam simulating a strip of the wall panel with unit width to justify the use of the average acceleration. The equation of motion of an undamped, simply supported beam was solved, and the results indicate that the use of the average of two-floor acceleration response spectra to calculate the modal response of a wall panel is satisfactory.

Question 3 (applicable to Units 1 and 2)

In response to this question, the Licensee conducted a parametric study on walls with various thicknesses. The top and bottom edges of the walls were assumed to be fixed so that the out-of-plane interstory drift effect can be evaluated. The resulting stresses indicated that this effect is insignificant as compared to the capacity of the masonry walls. The response is considered adequate.

Question 4 (applicable to Units 1 and 2)

To demonstrate the adequacy of using only the fundamental mode in the analysis, the Licensee selected two sample walls in order to analyze the effects of higher modes. One wall was treated as a cantilever beam, and the other wall was treated as a plate with four simply supported edges. The dynamic analysis was carried out using computer program STARDYNE. The resulting moment and shear at the center and at the base of these walls were extracted for the fundamental mode and multi-mode SRSS combination. The comparison illustrated that the fundamental mode results are less than those calculated using SRSS combinations by only 0.15% for moments and 1.97% for

shears. This indicates that the use of the fundamental mode alone in the analysis is sufficiently accurate.

Question 5 (applicable to Unit 2 only, Appendix C)

In response to this question, the Licensee has provided a description of the bracing system installed for two Unit 2 cantilever walls and indicated that out-of-plane drift effects due to bracing are negligible. This response is satisfactory.

Question 6 (Unit 2, Appendix C, or question 5 of Unit 1, Appendix B)

In response to this question, the Licensee provided brief descriptions of several techniques used in the analysis:

a. Verification by Curves

The purpose of this method is to determine the adequacy of Seismic Class I block walls by grouping masonry walls with similar parameters such as boundary conditions, floor elevations, and wall thicknesses and heights. The curves for different wall groups (types) were generated using the criteria presented in the original submittal [2]. The following types of curves have been generated: vertically spanned beam, horizontally spanned beam, and plate. The wall is considered adequate if it falls within the allowable range of the appropriate curves. Otherwise, a more refined analysis is used.

b. Effective Inertia Analysis

For some walls, the effective moment of inertia was used to account for the partially cracked condition. An iterative procedure was introduced to obtain the effective moment of inertia.

c. Dynamic Analysis

The dynamic analysis was used to verify those walls which were not qualified by simple static analysis. In the dynamic analysis, a modal response was obtained considering multi-mode combination.

The Licensee's response to this question is intended to clarify several techniques employed in the analysis and is considered to be adequate.

Question 7 (Unit 2, Appendix C, or question 6 of Unit 1, Appendix B)

In response to this question, the Licensee clarified that the stresses in the in-plane direction due to seismic loads were insignificant since none of the masonry walls at the plant were either load-bearing or shear walls. Seismic loads due to out-of-plane direction were combined absolutely with vertical seismic loads in the analysis. The Licensee clarified that equipment and pipe weights were accounted for in the analysis. The Licensee's response to this question is adequate.

Question 8 (Unit 2, Appendix C, or question 7 of Unit 1, Appendix B)

In this response, the Licensee provided values for allowable stresses in axial compression, bearing, and tension parallel and normal to the bed joint. These allowables are satisfactory because they are in compliance with ACI 531-79 codes. Furthermore, the Licensee clarified that all seismic Category I masonry block walls for the plant are reinforced. Thus, the allowables given were used only to indicate if the wall were cracked or uncracked at the bed joint. This clarification is considered adequate.

Question 9 (Unit 2, Appendix C, or question 8 of Unit 1, Appendix B)

The Licensee indicated in the original submittal [2] that an increase factor of 1.67 was used for shear and tension parallel and normal to the bed joint, instead of 1.5 for shear and tension parallel to the bed joint and 1.3 for tension normal to the bed joint as specified in the SEB criteria [5]. In response to this question, the Licensee indicated that ACI 531 code allowable stresses [Reference 7, Chapter 10.1 of Commentary] are generally associated with a factor of safety of 3. It is identified, however, that all masonry walls at this plant are reinforced; hence, the increase factor for tensile stresses does not apply to this plant.

In addition, it is identified that none of the walls of this plant are used as shear walls; thus, the increase factor for shear stress is not applicable to this plant.

This question has been resolved satisfactorily.

Question 10 (Unit 2, Appendix C, or question 9 of Unit 1, Appendix B)

In this question, the Licensee was requested to indicate the present status of walls which were inaccessible and excluded from the original field survey. Four walls of Unit 1 were involved in this case. The Licensee indicated that, for walls 6-B-44 and 6-B-42, a field survey will be performed during the present unit outage and, should the survey determine anything which would require further attention, NRC will be notified. Wall 4-B-66 is in a high radiation area (3 Rem minimum), and based on a drawing review and previous analysis, it has been determined that the potential radiation exposure does not warrant a survey of this wall. Wall 4-B-169 is inside a closed pipe chase and will never be accessible without significant removal of existing structure. No survey is planned for this wall.

For Unit 2, the inaccessible walls will be surveyed in the next refueling outage. ALARA reviews will be performed to ensure that radiation exposure is minimized.

However, in a conference call with the NRC on June 30, 1982, the Licensee informed the NRC that walls 6-B-42 and 6-B-44 of Unit 1 have been surveyed. For walls 4-B-66 and 4-B-169, the Licensee indicated that drawing reviews show no substantial items attached to these walls, and that the analysis demonstrated that these walls satisfy the design criteria. For Unit 2, the Licensee will survey all inaccessible walls beginning September 1982. Again, analysis showed that these walls satisfy the design criteria.

The response to this question is considered adequate.

3.2 EVALUATION OF LICENSEE"S APPROACH TO WALL MODIFICATIONS

The Licensee has completed modifications for two walls at Unit 2. A simple bracing system was designed and installed for these walls and the reanalysis indicated that modifications brought the responses of these walls within the acceptable level. Locations and configurations of these bracing systems are shown in Figures 1 and 2 of Appendix E.

The Licensee's approach with regard to wall modifications is satisfactory.

4. CONCLUSIONS

A detailed study was performed to provide a technical evaluation of the masonry walls at Arkansas Power One Units 1 and 2. Review of the Licensee's criteria and additional information provided by the Licensee led to the conclusions given in Sections 4.1 through 4.3 below. In addition to these conclusions, it should be noted that the following confirmatory action should be conducted:

- As indicated in the conference call with NRC on June 30, 1982, the Licensee will forward a letter to the NRC to confirm that walls 6-B-42 and 6-B-44 of Unit 1 have been surveyed; that drawing reviews show no substantial items attached to walls 4-B-66 and 4-B-169; and that calculations showed that these walls satisfy the design criteria. For Unit 2, all inaccessible walls will be surveyed beginning September 1982; calculations indicate that these walls satisfy the design criteria.

4.1 LICENSEE'S CRITERIA

The criteria used for reevaluation of the masonry walls, along with the additional information provided by the Licensee, indicate that their provisions are in compliance with the SEB criteria and are found to be satisfactory.

4.2 WALL MODIFICATIONS

The Licensee's modifications are adequate since two walls at Unit 2 were reanalyzed after modifications and found satisfactory. Sketches of wall modifications are provided in Appendix E.

4.3 MODIFICATION SCHEDULE

The Licensee has already completed all modifications.

5. REFERENCES

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

2. D. C. Trimble (Arkansas Power and Light Company)
Letter and attachments for Units 1 and 2 to K.V. Seyfrit (NRC).
January 29, 1981

3. J. F. Stolz (NRC)
Letter to D. A. Rueter (Arkansas Power & Light Company).
Subject: Request for Additional Information, AP & L's Submittal on IE Bulletin 80-11
January 15, 1982

4. D. A. Rueter (Arkansas Power & Light Company)
Letter with attachments to J. F. Stolz (NRC).
Subject: Responses to the Request for Additional Information
April 30, 1982

5. " Criteria for Safety-Related Masonry Wall Evaluation"
NRC, July 1981

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

7. ACI 531-79 and Commentary ACI 531R-79
"Building Code Requirements for Concrete Masonry Structures"
American Concrete Institute, 1979

APPENDIX A

CRITERIA FOR SAFETY-RELATED MASONRY WALL EVALUATION

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SEB CRITERIA FOR SAFETY-RELATED MASONRY WALL EVALUATION

The purpose of this appendix is to provide minimum design considerations and criteria for the review of safety-related masonry walls.

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 to this criteria.

The use of other industrial 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 these interim 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 applying for operating licenses 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 load, 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 3.8.4, subsection II.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 containment, as follows:

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

(1b) $D + L + T_o + R_o + E$

(1c) $D + L + T_o + R_o + W$

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

(b) Extreme Environmental, Abnormal, Abnormal/Severe Environmental, and Abnormal/Extreme Enviromental 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 of 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 considering 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 NRC 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, no unreinforced masonry wall is permitted; also, all grout in concrete masonry walls shall be compared by vibration.

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

(i) Special construction (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 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 specificiations (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 of SRP Section 3.5.3 shall apply. Any deviation from SRP Section 3.5.3 shall be reviewed and approved 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

NRC REQUEST FOR ADDITIONAL INFORMATION FOR ARKANSAS NUCLEAR ONE UNIT 1

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Based on the Licensee's submittal [2], a technical review was conducted. Before a final technical evaluation report can be issued, the Licensee is required to provide the following information.

1. Explain why the frequencies of some of the walls presented in Tables 4, 5, and 6 of Reference 2 are widely different from the frequencies of other walls of comparable dimensions. Also explain why some of the frequencies in these tables are indicated as OBE or DBE.

2. With reference to Section 6.1.4, Appendix A [2], justify using the average acceleration rather than the envelope of the response spectra for walls supported by two floors.

3. With reference to Section 5.8 [2], justify neglecting out-of-plane interstory drift in the analysis and explain whether the predicted in-plane interstory drift of 0.0006 in/ft of height applies to confined or unconfined walls.

4. With reference to Section 6.1.2, Appendix A [2], provide sample calculations to show that analysis using only the fundamental mode is adequate and is comparable to a multimode analysis.

5. With reference to Table 5 [2], briefly describe the techniques used for (a) verification by curves, (b) effective inertia analysis, and (c) dynamic analysis. Also clarify whether pipe reactions due to thermal expansion are considered in the analysis.

6. Provide more information on seismic analysis in different directions and explain how the equipment weights and pipe weights were accounted for.

7. With reference to Section 5.0, Appendix A [2], provide the values for allowable stresses in axial compression, bearing, tension normal to the bed joint, and tension parallel to the bed joint.

8. With reference to Section 5.2.1 of Appendix A [2], justify the proposed increase factor of 1.67 for shear, bond, tension normal to the bed joint, and tension parallel to the bed joint. The SEB criteria [3] suggest an increase factor of 1.3 for masonry shear, 1.5 for masonry tension parallel to the bed joint, and 1.3 for unreinforced masonry tension normal to the bed joint.

9. Indicate the present status of walls which were inaccessible and hence excluded from the original field survey.

REFERENCES

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

2. D. C. Trimble (Arkansas Power and Light Company)
   Letter and attachments for Unit 1 to K. V. Seyfrit (NRC)
   January 29, 1981

3. "Criteria for Safety-Related Masonry Wall Evaluation"
   NRC, July 1981

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

5. ACI 531-79 and Commentary ACI 531R-79
   "Building Code Requirements for Concrete Masonry Structures"
   American Concrete Institute, 1979

6. ATC 3-06
   "Tentative Provisions for the Development of Seismic Regulations for Buildings"
   Applied Technology Council, 1978

7. "Specification for the Design and Construction of Load-Bearing Concrete Masonry"
   National Concrete Masonry Association (NCMA), August 1979

APPENDIX C

NRC REQUEST FOR ADDITIONAL INFORMATION FOR ARKANSAS NUCLEAR ONE UNIT 2

Franklin Research Center
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The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

Based on the Licensee's submittal [2], a technical review was conducted. Before a final technical evaluation report can be issued, the Licensee is required to provide the following information.

1. Explain why the frequencies of some of the walls presented in Tables 4, 5, and 6 of Reference 2 are widely different from the frequencies of other walls of comparable dimensions. Also explain why some of the frequencies in these tables are indicated as OBE or DBE.

2. With reference to Section 6.1.4, Appendix A [2], justify using the average acceleration rather than the envelope of the response spectra for walls supported by two floors.

3. With reference to Section 5.8 [2], justify neglecting out-of-plane interstory drift in the analysis and explain whether the predicted in-plane interstory drift of 0.0006 in/ft of height applies to confined or unconfined walls.

4. With reference to Section 6.1.2, Appendix A [2], provide sample calculations to show that analysis using only the fundamental mode is adequate and is comparable to a multimode analysis.

5. With reference to the cover letter and Table 5 of the attachment [2], provide a description of the bracing system installed for two Unit 2 cantilever walls and indicate whether out-of-plane drift effects were included in the analysis.

6. With reference to Table 5 [2], briefly describe the techniques used for (a) verification by curves, (b) effective inertia analysis, and (c) dynamic analysis. Also clarify whether pipe reactions due to thermal expansion are considered in the analysis.

7. Provide more information on seismic analysis in different directions and explain how the equipment weights and pipe weights were accounted for.

8. With reference to Section 5.0, Appendix A [2], provide the values for allowable stresses in axial compression, bearing, tension normal to the bed joint, and tension parallel to the bed joint.

9. With reference to Section 5.2.1 of Appendix A [2], justify the proposed increase factor of 1.67 for shear, bond, tension normal to the bed joint, and tension parallel to the bed joint. The SEB criteria [3] suggest an increase factor of 1.3 for masonry shear, 1.5 for masonry tension parallel to the bed joint, and 1.3 for unreinforced masonry tension normal to the bed joint.

10. Indicate the present status of walls which were inaccessible and hence excluded from the original field survey.

REFERENCES

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

2. D. C. Trimble (Arkansas Power and Light Company)
   Letter and attachments for Unit 2 to K. V. Seyfrit (NRC)
   January 29, 1981

3. "Criteria for Safety-Related Masonry Wall Evaluation"
   NRC, July 1981

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

5. ACI 531-79 and Commentary ACI 531R-79
   "Building Code Requirements for Concrete Masonry Structures"
   American Concrete Institute, 1979

6. ATC 3-06
   "Tentative Provisions for the Development of Seismic Regulations for Buildings"
   Applied Technology Council, 1978

7. "Specification for the Design and Construction of Load-Bearing Concrete Masonry"
   National Concrete Masonry Association (NCMA), August 1979

APPENDIX D

TYPICAL SKETCHES OF WALL CONSTRUCTION

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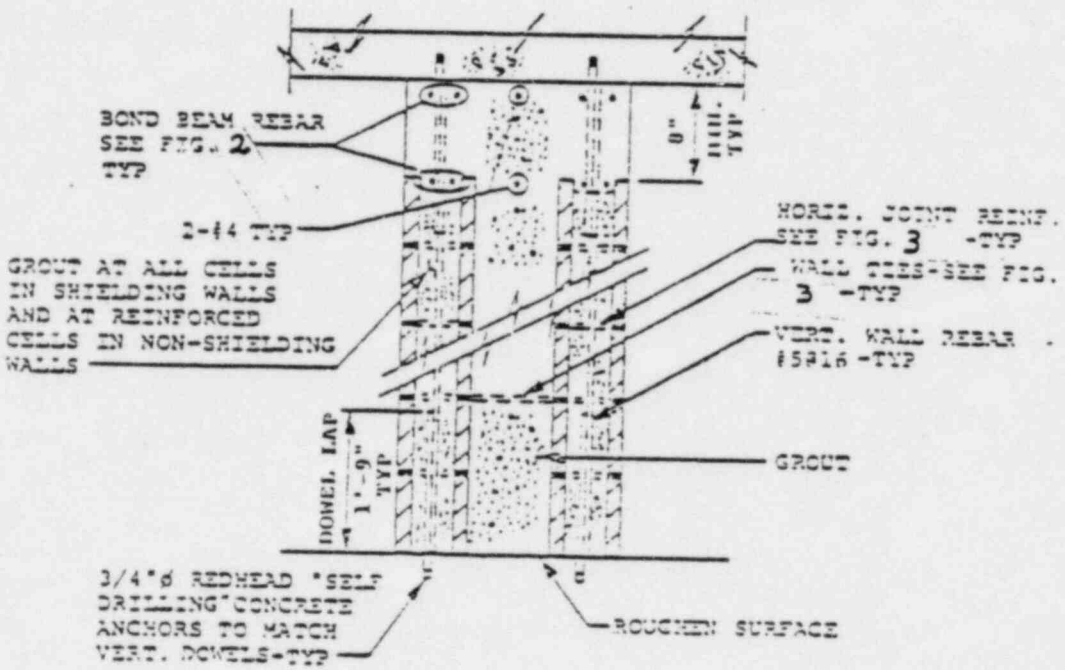
BOND BEAM REBAR
SEE FIG. 2
TYP
2-#4 TYP
GROUT AT ALL CELLS
IN SHIELDING WALLS
AND AT REINFORCED
CELLS IN NON-SHIELDING
WALLS
HORIZ. JOINT REINF.
SEE FIG. 3 -TYP
WALL TIES-SEE FIG.
3 -TYP
VERT. WALL REBAR
#5@16 -TYP
GROUT
DOWEL LAP
1'-9"
TYP
3/4"ø REDHEAD "SELF
DRILLING" CONCRETE
ANCHORS TO MATCH
VERT. DOWELS-TYP
ROUGHEN SURFACE

Figure 1

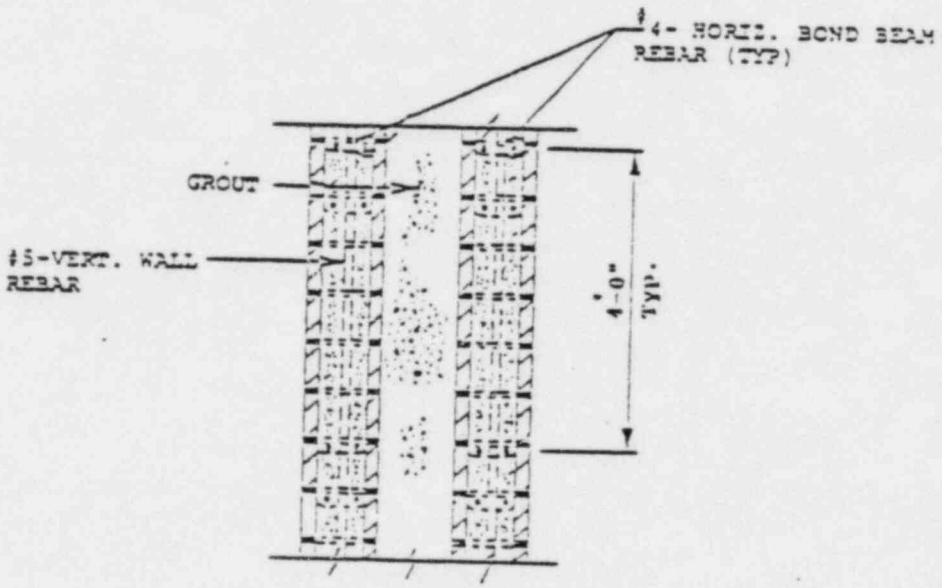

Figure 2

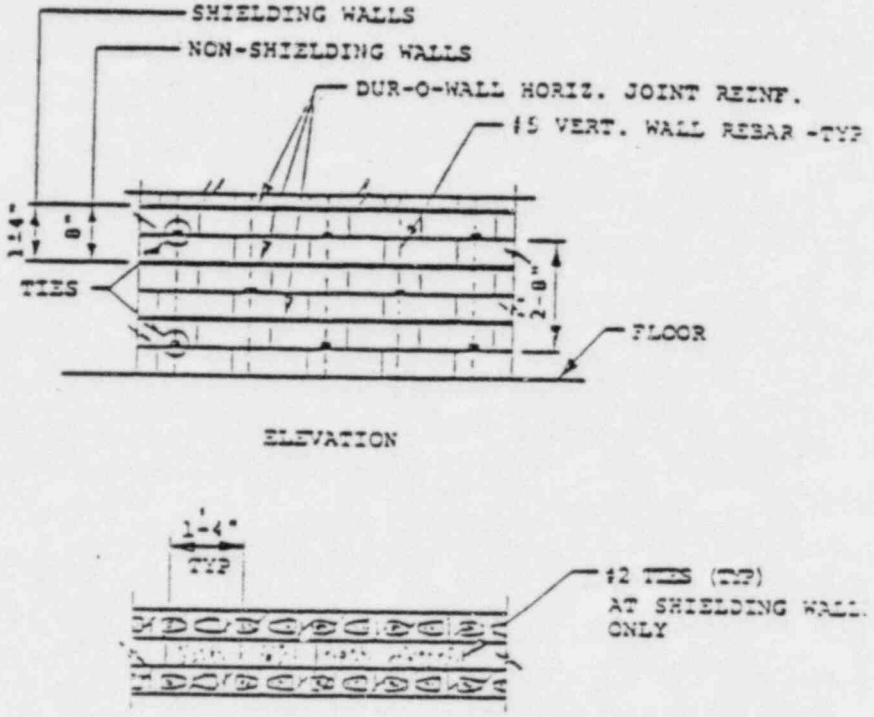
SHIELDING WALLS
NON-SHIELDING WALLS
DUR-O-WALL HORIZ. JOINT REINF.
#5 VERT. WALL REBAR -TYP
1'-4"
1'-0"
TIES
2'-0"
FLOOR
ELEVATION
1'-4"
TYP
#2 TIES (TYP)
AT SHIELDING WALL
ONLY
PLAN

Figure 3

APPENDIX E

SKETCHES OF WALL MODIFICATIONS

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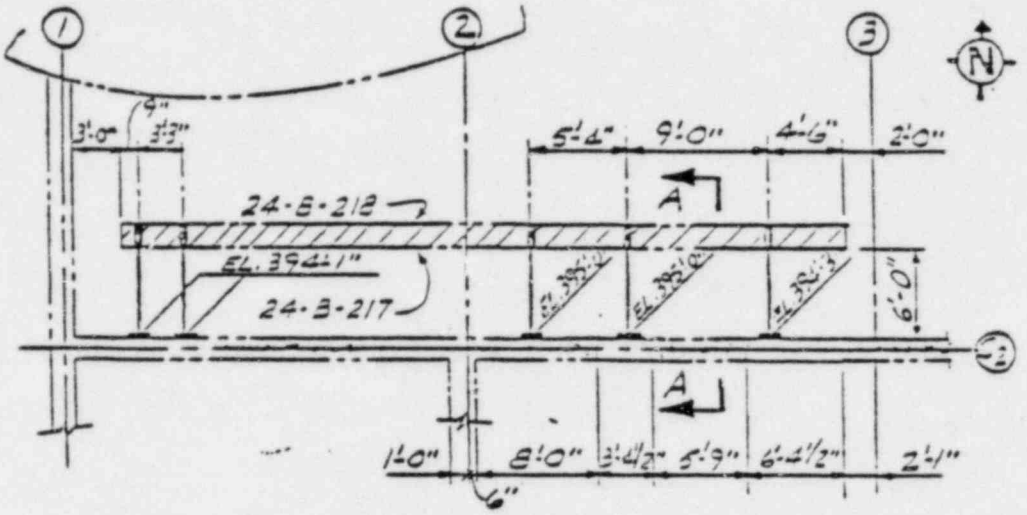
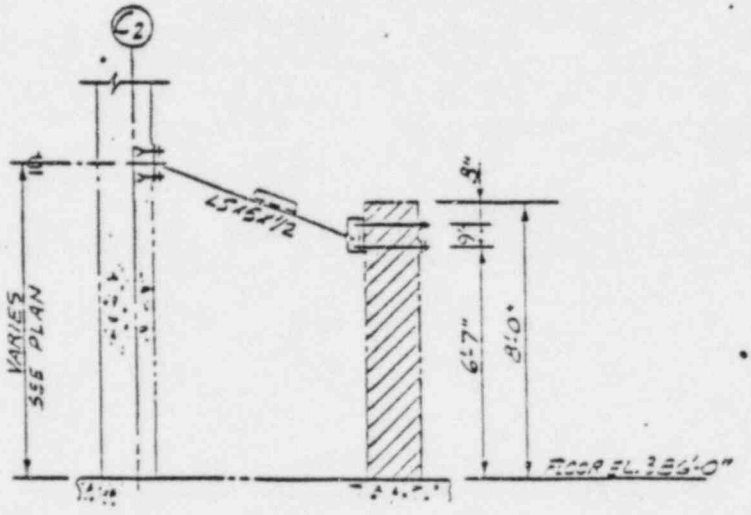
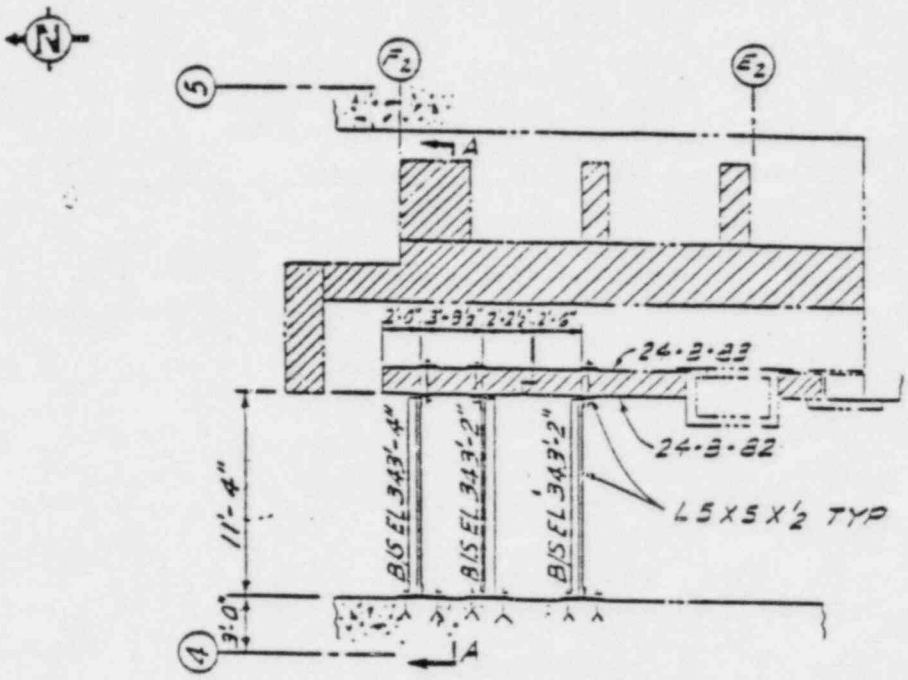


PLAN @ EL. 386'-0"

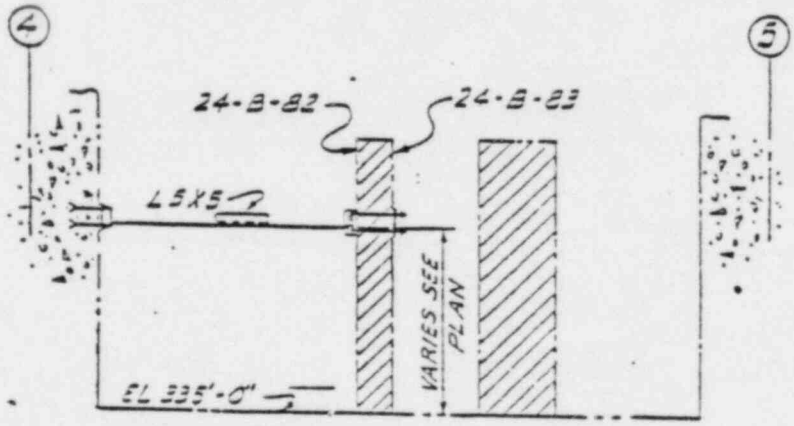


SECTION A-A

Figure 1



PLAN @ EL 335'-0"



SECTION A-A

Figure 2

4.4 SAFETY EVALUATION FINDING

The licensee in the letter dated July 2, 1982 has confirmed the telephone conversation of June 30, 1982 as discussed in Section 3.1. In addition, the licensee has indicated that the Unit 2 walls, which are not surveyed due to inaccessibility as of now, will be surveyed in the fall outage of 1982. All of these walls were analyzed based on drawing surveys and found to meet applicable structural acceptance criteria. Furthermore, the licensee has committed to notify the NRC when the field survey (to identify deviations from the design drawings) is completed and advise if the walkdown yielded any results which impact the structural integrity of Unit 2 block walls.

On the basis of above commitments and the review of referenced documents, the staff concludes the following with the stipulation that the licensee complete the survey of all currently inaccessible walls in the next outage. If the licensee decides to omit any wall from the survey, the NRC staff should be notified.

"The use of (1) the evaluation criteria defined by applicable codes, standards, and specifications, (2) applicable loads and loading combinations and design and analysis procedures, (3) applicable structural acceptance criteria, (4) materials, (5) quality control, and (6) special construction techniques and testing can provide reasonable assurance that, in the event of winds, tornadoes, earthquakes, and various postulated accidents occurring within Category I structures, the safety-related masonry walls will withstand the specified design conditions without impairment of (a) wall integrity or (b) the performance of required safety functions. Conformance with these criteria, codes, specifications, and standards constitutes a satisfactory basis which fulfills, in part, the requirements of General Design Criteria 2 and 4".

These safety evaluation findings form the basis for concluding that Items 2 and 3 of IE Bulletin 80-11 has been fully implemented subject to the above mentioned stipulation.