Omaha Public Power District
444 South 16th Street Mall
Omaha, NE 68102-2247

October 21, 2013
LIC-13-0149

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, D.C. 20555

References:
1. Docket No. 50-285
2. Letter from OPPD (L. P. Cortopassi) to NRC (Document Control Desk), "Fort Calhoun Station – Exigent License Amendment Request 13-08 Revise Current Licensing Basis of Pipe Break Criteria for High Energy Piping Outside of Containment," dated October 6, 2013 (ML13280A089) (LIC-13-0146)
3. Email from NRC (J. Sebrosky) to OPPD (B. R. Hansher), "Request for Additional Information (RAI) for Fort Calhoun's Station (FCS) Exigent License Amendment Request (LAR) To Revise Current Licensing Basis of Pipe Break Criteria for High Energy Piping Outside of Containment," dated October 9, 2013 (ML13290A002)
4. Letter from OPPD (L. P. Cortopassi) to NRC (Document Control Desk), "Response to Request for Additional Information (RAI) for Fort Calhoun Station (FCS) Exigent License Amendment Request (LAR) to Revise Current Licensing Basis of Pipe Break Criteria for High Energy Piping Outside of Containment," dated October 15, 2013 (ML13291A127) (LIC-13-0148)

SUBJECT: Supplemental Response to Request for Additional Information (RAI) for Fort Calhoun Station (FCS) Exigent License Amendment Request (LAR) to Revise Current Licensing Basis of Pipe Break Criteria for High Energy Piping Outside of Containment

On October 6, 2013, pursuant to 10 CFR 50.90 and 10 CFR 50.91(a)(6), the Omaha Public Power District (OPPD) submitted an exigent license amendment request (LAR) (Reference 2) proposing to amend Fort Calhoun Station (FCS), Unit No. 1, Renewed Facility Operating License No. DPR-40 by revising the current licensing basis (CLB) pertaining to pipe break criteria for high-energy piping outside of containment. On October 9, 2013, teleconferences between representatives of OPPD and NRC Staff were held to discuss the LAR. Following the phone call, the NRC emailed (Reference 3) a request for additional information (RAI) to which OPPD responded in Reference 4.

On October 18, 2013, an additional teleconference between representatives of OPPD and NRC Staff was held to discuss the Reference 4 response. OPPD agreed to supplement its Reference 4 responses to Mechanical and Civil Engineering Branch (EMCB) RAIs 4, 5, 6, and 10.

The supplemental responses are attached to replace those provided in Reference 4.

No commitments to the NRC are contained in this submittal.

If you should have any additional questions or require additional information, please contact Mr. Bill Hansher at (402) 533-6894.

I declare under penalty of perjury that the foregoing is true and correct; executed on October 21, 2013.

Sincerely,

Louis P. Cortopassi
Site Vice President and CNO

LPC/SPQ/brh

Attachments:
1. Supplemental Response to Request for Additional Information (RAI) for Fort Calhoun Station (FCS) Exigent License Amendment Request (LAR) to Revise Current Licensing Basis of Pipe Break Criteria for High Energy Piping Outside of Containment
2. USAR Markup Pages
3. USAR Clean Pages

c: M. L. Dapas, NRC Regional Administrator, Region IV
J. M. Sebrosky, NRC Senior Project Manager
L. E. Wilkins, NRC Project Manager
J. C. Kirkland, NRC Senior Resident Inspector
Director of Consumer Health Services, Department of Regulation and Licensure, Nebraska Health and Human Services, State of Nebraska

Supplemental Response to Request for Additional Information (RAI) for Fort Calhoun Station (FCS) Exigent License Amendment Request (LAR) to Revise Current Licensing Basis of Pipe Break Criteria for High Energy Piping Outside of Containment

By letter dated October 6, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13280A089) Omaha Public Power District (the licensee) submitted for Nuclear Regulatory Commission (NRC) approval a license amendment request that would revise the Fort Calhoun Station Updated Safety Analysis Report for pipe break criteria for high energy piping outside of containment. The proposed amendment would allow the use of U.S. Nuclear Regulatory Commission guidance provided in Branch Technical Position Mechanical Engineering Branch 3-1 Revision 2, which allows for the exemption of specific piping sections from postulated failures if certain criteria are met.

Based on a review of the submittal, the NRC staff has determined that the following additional information (RAIs) are required in order to complete its review. The request for additional information was discussed with you on October 9, 2013. It was agreed that a response to these RAIs would be provided by October 15, 2013. Should the NRC determine that these RAIs are no longer necessary prior to the scheduled date, the request will be withdrawn. If circumstances result in the need to revise the requested response date, please contact me at (301) 415-1132 or via e-mail at joseph.sebrosky@nrc.gov. The NRC staff has determined that no security-related or proprietary information is contained herein.

EMCB-RAI-4

MEB 3-1, Rev 2 provides a definition for a terminal end. Neither the Giambusso letter nor the FCS's licensing basis provide a specific definition for terminal end. MEB 3-1, Rev 2, defines that for piping which is maintained pressurized during normal plant conditions for only a portion of the run up to a closed valve, a terminal end is the piping connection to the closed valve and, therefore, a break postulation is required at that location. The SRP is specific on this item, see MEB 3-1 Rev 2 last sentence in footnote 3. To exclude a break in such a location, described above, the proposed LAR on page seven proposes that this location is not a terminal end based on the terminal end definition of ANSI/ANS-58.2-1988, which has been withdrawn by ANS. The staff has reviewed the ANSI/ANS-58.2-1988 terminal end definition and has determined that it does not provide a definition for a terminal end for the situation of partial pipe run pressurization described above by MEB 3-1 Rev 2. The proposed LAR requests to utilize the MEB 3-1 to exclude breaks required by the CLB. The staff requests that the licensee properly implement MEB 3-1 and postulate a terminal end HELB for this type of situation as described above.

OPPD REVISED RESPONSE

OPPD will define terminal ends using MEB 3-1 Revision 2 footnote 3. The definition will include a supplemental note for normally closed valves. Appendix M, Table M-2-2, Section B.1.c(2)(a) of the USAR will be updated with the following to define terminal ends:

Extremities of piping runs that connect structures, components (e.g., vessels, pumps, valves) or pipe anchors that act as rigid constraints to piping motion and thermal expansion. A branch connection to a main piping run is a terminal end of the branch run, except where the branch run is classified as part of a main run in the stress analysis and is shown to have a significant effect on the main run behavior. In piping runs which are maintained pressurized during normal plant conditions for only a portion of the run (i.e., up to the first normally closed valve) a terminal end of such runs is the piping connection to this closed valve.

Supplemental Note: A normally closed valve is not considered a terminal end in the specific case where the valve is both not supported as an anchor and is shown to have an insignificant effect on the piping stress analysis (after accounting for required design loads including seismic and thermal).

MEB 3-1 Revision 2 footnote 3 with the above supplemental note is consistent with the station's current licensing basis which includes the Giambuso Letter dated December 28, 1972. Although that letter does not specifically define terminal ends, it does define piping runs and infers that the ends of those runs are terminal ends. Section 2 on page 2 of the attachment to the letter describes the criteria used to determine the design basis piping break locations. Footnote 3 of that section defines a piping run as follows:

A piping run interconnects components such as pressure vessels, pumps, and rigidly fixed valves that may act to restrain pipe movement beyond that required for design thermal displacement. A branch run differs from a piping run only in that it originates at a piping intersection, as a branch of the main pipe run.

This footnote focuses on areas of potential high stress including rigidly restrained valves. Valve position was not a consideration for defining terminal ends.

EMCB-RAI-5

The licensee is requested to consider including MEB 3-1, Rev 2 footnote 3 in the proposed LAR. This will provide a clear definition of a terminal end and, thus, avoid complications in determining terminal ends.

OPPD REVISED RESPONSE

OPPD will define terminal ends as described in the revised response to EMCB-RAI-4.

EMCB-RAI-6

The proposed LAR requests to add to the CLB MEB 3-1, Rev 2 Section B.1.c(3), which states:

Breaks in seismically analyzed non-ASME Class piping are postulated according to the same criteria as for ASME Class 2 and 3 piping above.

The licensee is requested to incorporate the intent of Footnote 4 which is part of Section B.1.c(3) or provide a justification and basis for omitting it.

OPPD REVISED RESPONSE

OPPD agrees with the request (note that the Standard Review Plan (SRP) is not applicable to Fort Calhoun Station). For consistency with Section 5.2.3B2.b of Procedure PED-MEI-7, "Current Practice Pipe Modeling,"B.1.c(3) Footnote 4 was revised as shown below to require the piping model to extend through a minimum of two rigid supports in each of the three orthogonal directions beyond the safety related boundary for non-Category I piping systems attached to Category I piping systems. This footnote will be added to USAR, Appendix M, Table 2-2, Section B.1.c(3) to meet the intent of Footnote 4:

B.1.c(3) Footnote 4 (as modified)

Footnote 4: Each non-Category I piping system should be designed to be isolated from any Category I piping system by either a constraint or barrier or should be located remotely from the seismic Category I piping system. If isolation of the Category I piping system is not feasible or practical, adjacent non-Category I piping systems should be analyzed similarly to seismic Class I piping. For non-Category I piping systems attached to Category I piping systems, the piping model shall extend through a minimum of two rigid supports in each of the three orthogonal directions beyond the safety related boundary. Extending the model farther may be required to provide effective boundary conditions for load cases at the safety / non-safety break point and conservative support loads on the first restraint beyond the class split. Where an anchor is used for isolation, loads from the non-safety side shall be considered for the anchor qualification. Typically, the analysis model will be extended at least two supports beyond the anchor. More conservative or accurate modeling details, decoupling and enveloping criteria, and Stress Intensity Factors (SIFs) may also be used when revising existing stress models.

EMCB-RAI-10

The proposed LAR requests to add to the CLB MEB 3-1, Rev 2 Section B.1.c(2) (b)(ii) and Section B.1.c(3). The licensee is requested to add Section B.1.c(4) which is applicable to B.1.c(2) and B.1.c(3).

OPPD REVISED RESPONSE

As noted above, the SRP is not applicable to Fort Calhoun Station and thus Section B.1.c(4) will be included as modified below:

B.1.c(4) (as modified)

If a structure separates a high energy line from an essential component, that separating structure should be designed to withstand the consequences of the pipe break in the high-energy line which produces the greatest effect at the structure.

USAR MARKUP PAGES

USAR - Appendix M

Appendix M

Postulated High Energy Line Rupture Outside the Containment

Rev ~~14~~

Safety Classification: Safety

Usage Level: Information

Change No.:	
Reason for Change:	
Preparer:	
Sponsor:	
Issued:	

Fort Calhoun Station

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This submittal deals with the analyses performed for the study and their results. It also defines and describes the modifications which were completed prior to the completion of the first refueling.

Subsequent to the study, NRC Generic Letter 87-11 was issued, which eliminated the requirement to postulate arbitrary intermediate pipe ruptures. A reanalysis of the non-safety-related portions of the Main Steam and Feedwater piping was performed applying the Generic Letter 87-11 criteria and resulted in fewer postulated pipe rupture locations. Hardware associated with certain previously-identified pipe ruptures is, therefore, not necessary, but provides an additional margin of safety and need not be removed.

2.2 Identification of High Energy Systems

All systems outside the containment whose ~~design~~ service temperatures exceed 200°F or whose design pressures exceed 275 psig are considered to be high energy systems. For the purposes of this study, those systems which are not normally pressurized were excluded from consideration. Table M.2-1 lists those systems which were investigated.

Ruptures in pipes containing high energy fluid, up to and including the circumferential break of the pipe, were considered for those systems where the service temperature of the fluid exceeds 200°F and the design pressure exceeds 275 psig. Only the "critical" crack was assumed to occur in the piping of those systems where the service temperature of the fluid exceeds 200°F or the design pressure exceeds 275 psig. The size of the "critical" crack was assumed to be one-half the pipe diameter in length and one-half the wall thickness in width.

Table M-2-1 - Systems Outside Containment Exceeding 200°F Service Temperature and/or 275 psig Design Pressure

System	**Service Temperature, °F**	**Design Pressure, psig**	**Maximum Line Size, in.**
Main Steam	550	985	36
Feedwater	438 438	1335 985	20 16
Charging	130	2735	2 1/2
Letdown	550 550	2485 650	2 2 1/2
Auxiliary Steam	365	150	10
Condensate Return	212	10	6
~~Steam Generator~~			
Steam Generator Blowdown	550	985	5
Sampling	600	2485	3/8
Nitrogen	100 ~~100~~	2400 ~~275~~	1/2 ~~1 1/2~~
Hydrogen	100	2400	1/2

2.3 Identification of Essential Structures and Equipment

A review was completed identifying the essential structures and equipment outside of the containment which would be required to place and maintain the plant in a cold shutdown condition following a postulated rupture outside the containment of a pipe containing high energy fluid with the simultaneous loss of off-site power. These structures and equipment consist of the following:

1. Control Room
2. Room 81 of the Auxiliary Building
3. Auxiliary Feedwater System
    a. Auxiliary Feedwater Panel, AI-179
    b. Emergency Feedwater Tank
    c. Auxiliary Feedwater Pumps
    d. Piping, valves, etc.
4. Cable Spreading Room
5. Switchgear Area
6. Electrical Penetration Area
7. Diesel Generators
8. Regulating and Shutdown Control Element Assemblies
9. Main Steam Isolation Valves
10. Main Steam Safety Valves
11. Safety Injection System
12. Raw Water system
13. Pressurizer Pressure and Level Control
14. Steam Generator Blowdown Isolation Valves

2.4 Revised NRC Line Break Criteria

For high energy fluid piping systems the criteria for determining the location of pipe ruptures will be as provided in NRC Generic Letter 87-11. In addition, portions of Branch Technical Position MEB 3-1 Revision 2 dated June 1987, “Postulated Rupture Locations in Fluid System Piping Inside and Outside Containment” which was enclosed with the NRC transmittal of Generic Letter 87-11 is used for determining the location of pipe ruptures for the CVCS charging and letdown, main steam supply to AFW pump FW-10, and steam generator blowdown systems. The applicable sections of MEB 3-1 are identified in Table M-2-2.

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.b	Fluid System Piping in Containment Penetration Areas - Breaks and cracks need not be postulated in those portions of piping from containment wall to and including the inboard or outboard isolation valves provided they meet the requirement of the ASME Code, Section III, Subarticle NE-1120 and the following additional design requirements:
B.1.b.(1)(d)	(ASME Class 2 Piping in Containment Penetration Areas) The maximum stress as calculated by the sum of Eqs. (9) and (10) in paragraph NC-3652, ASME Code, Section III, considering those loads and conditions thereof for which level A and level B stress limits have been specified in the System's Design Specification (i.e., sustained loads, occasional loads, and thermal expansion) including an OBE event should not exceed 0.8 ($1.8S_h + S_A$). The S_h and S_A are allowable stresses at maximum (hot) temperature and allowable stress range for thermal expansion, respectively, as defined in Article NC-3600 of the ASME Code, Section III.
B.1.b.(1)(e)	(ASME Class 2 Piping in Containment Penetration Areas) The maximum stress, as calculated by Eq. (9) in NC-3653 under loadings resulting from a postulated piping failure of fluid system piping beyond these portions of piping should not exceed the lesser of 2.25 S_h and 1.8 S_y. Primary loads include those which are deflection limited by whip restraints. The exceptions permitted in (c) above may also be applied provided that when the piping between the outboard isolation valve and the restraint is constructed in accordance with the Power Piping Code ANSI B31.1 (see ASB 3-1 B.2.c.(4)), the piping shall either be of seamless construction with full radiography of all circumferential welds, or all longitudinal and circumferential welds shall be fully radiographed.
B.1.b.(2)	(Fluid System Piping in Containment Penetration Areas) Welded attachments, for pipe supports or other purposes, to these portions of piping should be avoided except where detailed stress analyses, or tests, are performed to demonstrate compliance to the limits of B.1.b.(1).
B.1.b.(3)	(Fluid System Piping in Containment Penetration Areas) The number of circumferential and longitudinal piping welds and branch connections should be minimized. Where guard pipes are used, the enclosed portion of fluid system piping should be seamless construction and without circumferential welds unless specific access provisions are made to permit inservice volumetric examination of the longitudinal and circumferential welds.
B.1.b.(4)	(Fluid System Piping in Containment Penetration Areas) The length of these portions of piping should be reduced to the minimum length practical.

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.b.(5)	(Fluid System Piping in Containment Penetration Areas) The design of pipe anchors or restraints (e.g., connections to containment penetrations and pipe whip restraints) should not require welding directly to the outer surface of the piping (e.g., flued integrally forged pipe fittings may be used) except where such welds are 100 percent volumetrically examinable in service and a detailed stress analysis is performed to demonstrate compliance with the limits of B.1.b.(1).
B.1.b.(6)	(Fluid System Piping in Containment Penetration Areas) Guard pipes provided for these portions of piping in the containment penetration areas should be constructed in accordance with the rules of Class MC, Subsection NE of the ASME Code, Section III, where the guard pipe is part of the containment boundary. In addition, the entire guard pipe assembly should be designed to meet the following requirements and tests: (a) The design pressure and temperature should not be less than the maximum operating pressure and temperature of the enclosed pipe under normal plant conditions, (b) The level C stress limits of NE-3220, ASME Code Section III, should not be exceeded under the loadings associated with containment design pressure and temperature in combination with a SSE. (c) Guard pipe assemblies should be subjected to a single pressure test at a pressure not less than its design pressure. (d) Guard pipe assemblies should not prevent the access required to conduct inservice examination specified in B.1.b.(7). Inspection ports, if used, should not be located in that portion of the guard pipe through the annulus of dual barrier containment structures.
B.1.b.(7)	(Fluid System Piping in Containment Penetration Areas) A 100% volumetric inservice examination of all pipe welds should be conducted during each inspection interval as defined in IWA-2400, ASME Code, Section XI.
B.1.c(2)	With the exceptions of those portions of piping identified in B.1.b, breaks in Class 2 and 3 piping (ASME Code, Section III) should be postulated at the following locations in those portions of each piping and branch run:

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.c(2)(a) (as modified)	At terminal ends Extremities of piping runs that connect structures, components (e.g., vessels, pumps, valves) or pipe anchors that act as rigid constraints to piping motion and thermal expansion. A branch connection to a main piping run is a terminal end of the branch run, except where the branch run is classified as part of a main run in the stress analysis and is shown to have a significant effect on the main run behavior. In piping runs which are maintained pressurized during normal plant conditions for only a portion of the run (i.e., up to the first normally closed valve) a terminal end of such runs is the piping connection to this closed valve. Supplemental Note: A normally closed valve is not considered a terminal end in the specific case where the valve is both not supported as an anchor and is shown to have an insignificant effect on the piping stress analysis (after accounting for required design loads including seismic and thermal).
B.1.c.(2)(b)	At intermediate locations selected by one of the following criteria:
B.1.c.(2)(b)(i)	At each pipe fitting (e.g., elbow, tee, cross, flange, and nonstandard fitting), welded attachment, and valve. Where the piping contains no fittings, welded attachments, or valves, at one location at each extreme of the piping run adjacent to the prospective structure.
B.1.c.(2)(b)(ii)	At each location where stresses calculated[2] by the sum of Eqs. (9) and (10) in NC/ND-3653, ASME Code Section III, exceed 0.8 times the sum of the stress limits given in NC/ND-3653. As a result of piping reanalysis due to differences between the design configuration and the as-built configuration, the highest stress locations may be shifted; however, the initially determined intermediate break locations may be used unless a redesign of the piping resulting in a change in pipe parameters (diameter, wall thickness, routing) is required, or the dynamic effects from the new (as-built) intermediate break locations are not mitigated by the original pipe whip restraints and jet shields. Footnote 2: For those loads and conditions in which Level A and Level B stress limits have been specified in the Design Specification (including the operating basis earthquake).

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.c(3) (as modified)	Breaks in seismically analyzed non-ASME Class piping are postulated according to the same requirements for ASME Class 2 and 3 piping above[4]. Footnote 4: Each non-Category I piping system should be designed to be isolated from any Category I piping system by either a constraint or barrier or should be located remotely from the seismic Category I piping system. If isolation of the Category I piping system is not feasible or practical, adjacent non-Category I piping systems should be analyzed similarly to Seismic Class I piping. For non-Category I piping systems attached to Category I piping systems, the piping model shall extend through a minimum of two rigid supports in each of the three orthogonal directions beyond the safety related boundary. Extending the model farther may be required to provide effective boundary conditions for load cases at the safety / non-safety break point and conservative support loads on the first restraint beyond the class split. Where an anchor is used for isolation, loads from the non-safety side shall be considered for the anchor qualification. Typically, the analysis model will be extended at least two supports beyond the anchor. More conservative or accurate modeling details, decoupling and enveloping criteria, and stress intensity factors (SIFs) may also be used when revising existing stress models.
B.1.c(4) (as modified)	If a structure separates a high energy line from an essential component, that separating structure should be designed to withstand the consequences of the pipe break in the high-energy line which produces the greatest effect at the structure.
B.1.c(5) (as modified)	Electrical equipment important to safety must be environmentally qualified in accordance with 10CFR50.49. Required pipe ruptures and leakage cracks (whichever controls) must be included in the design bases for environmental qualification of electrical equipment important to safety both inside and outside containment. Mechanical equipment continues to be qualified based on design requirements, procurement specifications, as well as the implementation of maintenance activities.
B.1.d	The designer should identify each piping run he has considered to postulate the break locations required by B.1.c. above. In complex systems such as those containing arrangements of headers and parallel piping between headers, the designer should identify and include all such piping within a designated run in order to postulate the number of breaks required by these criteria.

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.e(2)	With the exception of those portions of piping identified in B.1.b (within Containment Penetrations), leakage cracks should be postulated as follows: For ASME Code, Section III Class 2 or 3 or nonsafety class (not ASME Class 1, 2, or 3) piping, at axial locations where the calculated stress by the sum of Eqs. (9) and (10) in NC/ND-3653 exceeds 0.4 times the sum of the stress limits given in NC/ND-3653.
B.1.e(3)	Non-safety class piping which has not been evaluated to obtain stress information should have leakage cracks postulated at axial locations that produce the most severe environmental effects.
B.3.c(1)	Leakage cracks need not be postulated in 1 inch and smaller piping.
B.3.c(2) (as modified)	For high-energy fluid system piping, the leakage cracks should be postulated to be in those circumferential locations that result in the most severe environmental consequences.
B.3.c(3)	Fluid flow from a leakage crack should be based on a circular opening of area equal to that of a rectangle one-half pipe diameters in length and one-half pipe wall thickness in width.
B.3.c(4) (as modified)	The flow from the leakage crack should be assumed to result in an environment that wets all unprotected components within the vicinity, with consequent flooding in the compartment and communicating compartments. Flooding effects should be determined on the basis of a conservatively estimated time period required to effect corrective actions.

3.6.14 Steam Generator Blowdown Isolation Valves

Due to postulated high energy line breaks in the steam generator blowdown lines outside Containment in Room 13, temperature switches were installed that isolate the steam generator blowdown valves on a high room temperature signal.

4. HIGH ENERGY SYSTEMS OTHER THAN MAJOR HIGH ENERGY SYSTEMS

4.1 Identification of High Energy Systems Other Than Major High Energy Systems

All systems outside the containment whose service temperatures exceed 200°F or whose design pressures exceed 275 psig are considered to be high energy systems. For the purpose of this investigation, those systems which are not normally pressurized were excluded from consideration. The main steam and feedwater systems have already been identified as the major high energy systems since they are the two systems, because of line sizes, fluid energy levels and plant arrangement, which would have the greatest potential to inhibit a safe shutdown of the plant in the event of the postulated pipe rupture incident (see Section M.3). The other high energy systems, because of smaller line sizes, lower fluid energy and plant arrangement, offer a lower potential for hindering a safe shutdown of the facility in the event of the postulated rupture. These other high energy systems are the following:

1. Charging
2. Letdown
3. Auxiliary steam
4. Condensate return
5. Steam generator blowdown
6. Sampling
7. Nitrogen
8. Hydrogen
9. Auxiliary Feedwater System (Non Safety Class Portion)

A study was performed to determine what modifications were necessary to protect essential structures and equipment from a postulated rupture in one of these systems. The results of the study, including the effects of the postulated break, are discussed in Section 4.2 below. Line break criteria are discussed in Section 2.4.

USAR CLEAN PAGES

USAR - Appendix M

Appendix M

Postulated High Energy Line Rupture Outside the Containment

Rev ~~1~~4

Safety Classification: Safety

Usage Level: Information

Change No.:	
Reason for Change:	
Preparer:	
Sponsor:	
Issued:	

Fort Calhoun Station

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This submittal deals with the analyses performed for the study and their results. It also defines and describes the modifications which were completed prior to the completion of the first refueling.

Subsequent to the study, NRC Generic Letter 87-11 was issued, which eliminated the requirement to postulate arbitrary intermediate pipe ruptures. A reanalysis of the non-safety-related portions of the Main Steam and Feedwater piping was performed applying the Generic Letter 87-11 criteria and resulted in fewer postulated pipe rupture locations. Hardware associated with certain previously-identified pipe ruptures is, therefore, not necessary, but provides an additional margin of safety and need not be removed.

2.2 Identification of High Energy Systems

All systems outside the containment whose service temperatures exceed 200°F or whose design pressures exceed 275 psig are considered to be high energy systems. For the purposes of this study, those systems which are not normally pressurized were excluded from consideration. Table M.2-1 lists those systems which were investigated.

Ruptures in pipes containing high energy fluid, up to and including the circumferential break of the pipe, were considered for those systems where the service temperature of the fluid exceeds 200°F and the design pressure exceeds 275 psig. Only the "critical" crack was assumed to occur in the piping of those systems where the service temperature of the fluid exceeds 200°F or the design pressure exceeds 275 psig. The size of the "critical" crack was assumed to be one-half the pipe diameter in length and one-half the wall thickness in width.

Table M-2-1 - Systems Outside Containment Exceeding 200°F Service Temperature and/or 275 psig Design Pressure

System	Service Temperature, °F	Design Pressure, psig	Maximum Line Size, in.
Main Steam	550	985	36
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Charging	130	2735	2 1/2
Letdown	550 550	2485 650	2 2 1/2
Auxiliary Steam	365	150	10
Condensate Return	212	10	6
Steam Generator Blowdown	550	985	5
Sampling	600	2485	3/8
Nitrogen	100	2400	1/2
Hydrogen	100	2400	1/2

2.3 Identification of Essential Structures and Equipment

A review was completed identifying the essential structures and equipment outside of the containment which would be required to place and maintain the plant in a cold shutdown condition following a postulated rupture outside the containment of a pipe containing high energy fluid with the simultaneous loss of off-site power. These structures and equipment consist of the following:

1. Control Room
2. Room 81 of the Auxiliary Building
3. Auxiliary Feedwater System
    a. Auxiliary Feedwater Panel, AI-179
    b. Emergency Feedwater Tank
    c. Auxiliary Feedwater Pumps
    d. Piping, valves, etc.
4. Cable Spreading Room
5. Switchgear Area
6. Electrical Penetration Area
7. Diesel Generators
8. Regulating and Shutdown Control Element Assemblies
9. Main Steam Isolation Valves
10. Main Steam Safety Valves
11. Safety Injection System
12. Raw Water system
13. Pressurizer Pressure and Level Control
14. Steam Generator Blowdown Isolation Valves

2.4 Revised NRC Line Break Criteria

For high energy fluid piping systems the criteria for determining the location of pipe ruptures will be as provided in NRC Generic Letter 87-11. In addition, portions of Branch Technical Position MEB 3-1 Revision 2 dated June 1987, “Postulated Rupture Locations in Fluid System Piping Inside and Outside Containment” which was enclosed with the NRC transmittal of Generic Letter 87-11 is used for determining the location of pipe ruptures for the CVCS charging and letdown, main steam supply to AFW pump FW-10, and steam generator blowdown systems. The applicable sections of MEB 3-1 are identified in Table M-2-2.

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.b	Fluid System Piping in Containment Penetration Areas - Breaks and cracks need not be postulated in those portions of piping from containment wall to and including the inboard or outboard isolation valves provided they meet the requirement of the ASME Code, Section III, Subarticle NE-1120 and the following additional design requirements:
B.1.b.(1)(d)	(ASME Class 2 Piping in Containment Penetration Areas) The maximum stress as calculated by the sum of Eqs. (9) and (10) in paragraph NC-3652, ASME Code, Section III, considering those loads and conditions thereof for which level A and level B stress limits have been specified in the System's Design Specification (i.e., sustained loads, occasional loads, and thermal expansion) including an OBE event should not exceed 0.8 ($1.8S_h + S_A$). The S_h and S_A are allowable stresses at maximum (hot) temperature and allowable stress range for thermal expansion, respectively, as defined in Article NC-3600 of the ASME Code, Section III.
B.1.b.(1)(e)	(ASME Class 2 Piping in Containment Penetration Areas) The maximum stress, as calculated by Eq. (9) in NC-3653 under loadings resulting from a postulated piping failure of fluid system piping beyond these portions of piping should not exceed the lesser of 2.25 S_h and 1.8 S_y. Primary loads include those which are deflection limited by whip restraints. The exceptions permitted in (c) above may also be applied provided that when the piping between the outboard isolation valve and the restraint is constructed in accordance with the Power Piping Code ANSI B31.1 (see ASB 3-1 B.2.c.(4)), the piping shall either be of seamless construction with full radiography of all circumferential welds, or all longitudinal and circumferential welds shall be fully radiographed.
B.1.b.(2)	(Fluid System Piping in Containment Penetration Areas) Welded attachments, for pipe supports or other purposes, to these portions of piping should be avoided except where detailed stress analyses, or tests, are performed to demonstrate compliance to the limits of B.1.b.(1).
B.1.b.(3)	(Fluid System Piping in Containment Penetration Areas) The number of circumferential and longitudinal piping welds and branch connections should be minimized. Where guard pipes are used, the enclosed portion of fluid system piping should be seamless construction and without circumferential welds unless specific access provisions are made to permit inservice volumetric examination of the longitudinal and circumferential welds.
B.1.b.(4)	(Fluid System Piping in Containment Penetration Areas) The length of these portions of piping should be reduced to the minimum length practical.

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.b.(5)	(Fluid System Piping in Containment Penetration Areas) The design of pipe anchors or restraints (e.g., connections to containment penetrations and pipe whip restraints) should not require welding directly to the outer surface of the piping (e.g., flued integrally forged pipe fittings may be used) except where such welds are 100 percent volumetrically examinable in service and a detailed stress analysis is performed to demonstrate compliance with the limits of B.1.b.(1).
B.1.b.(6)	(Fluid System Piping in Containment Penetration Areas) Guard pipes provided for these portions of piping in the containment penetration areas should be constructed in accordance with the rules of Class MC, Subsection NE of the ASME Code, Section III, where the guard pipe is part of the containment boundary. In addition, the entire guard pipe assembly should be designed to meet the following requirements and tests: (a) The design pressure and temperature should not be less than the maximum operating pressure and temperature of the enclosed pipe under normal plant conditions, (b) The level C stress limits of NE-3220, ASME Code Section III, should not be exceeded under the loadings associated with containment design pressure and temperature in combination with a SSE. (c) Guard pipe assemblies should be subjected to a single pressure test at a pressure not less than its design pressure. (d) Guard pipe assemblies should not prevent the access required to conduct inservice examination specified in B.1.b.(7). Inspection ports, if used, should not be located in that portion of the guard pipe through the annulus of dual barrier containment structures.
B.1.b.(7)	(Fluid System Piping in Containment Penetration Areas) A 100% volumetric inservice examination of all pipe welds should be conducted during each inspection interval as defined in IWA-2400, ASME Code, Section XI.
B.1.c(2)	With the exceptions of those portions of piping identified in B.1.b, breaks in Class 2 and 3 piping (ASME Code, Section III) should be postulated at the following locations in those portions of each piping and branch run:

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.c(2)(a) (as modified)	At terminal ends Extremities of piping runs that connect structures, components (e.g., vessels, pumps, valves) or pipe anchors that act as rigid constraints to piping motion and thermal expansion. A branch connection to a main piping run is a terminal end of the branch run, except where the branch run is classified as part of a main run in the stress analysis and is shown to have a significant effect on the main run behavior. In piping runs which are maintained pressurized during normal plant conditions for only a portion of the run (i.e., up to the first normally closed valve) a terminal end of such runs is the piping connection to this closed valve. Supplemental Note: A normally closed valve is not considered a terminal end in the specific case where the valve is both not supported as an anchor and is shown to have an insignificant effect on the piping stress analysis (after accounting for required design loads including seismic and thermal).
B.1.c.(2)(b)	At intermediate locations selected by one of the following criteria:
B.1.c.(2)(b)(i)	At each pipe fitting (e.g., elbow, tee, cross, flange, and nonstandard fitting), welded attachment, and valve. Where the piping contains no fittings, welded attachments, or valves, at one location at each extreme of the piping run adjacent to the prospective structure.
B.1.c.(2)(b)(ii)	At each location where stresses calculated[2] by the sum of Eqs. (9) and (10) in NC/ND-3653, ASME Code Section III, exceed 0.8 times the sum of the stress limits given in NC/ND-3653. As a result of piping reanalysis due to differences between the design configuration and the as-built configuration, the highest stress locations may be shifted; however, the initially determined intermediate break locations may be used unless a redesign of the piping resulting in a change in pipe parameters (diameter, wall thickness, routing) is required, or the dynamic effects from the new (as-built) intermediate break locations are not mitigated by the original pipe whip restraints and jet shields. Footnote 2: For those loads and conditions in which Level A and Level B stress limits have been specified in the Design Specification (including the operating basis earthquake).

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.c(3) (as modified)	Breaks in seismically analyzed non-ASME Class piping are postulated according to the same requirements for ASME Class 2 and 3 piping above[4]. Footnote 4: Each non-Category I piping system should be designed to be isolated from any Category I piping system by either a constraint or barrier or should be located remotely from the seismic Category I piping system. If isolation of the Category I piping system is not feasible or practical, adjacent non-Category I piping systems should be analyzed similarly to Seismic Class I piping. For non-Category I piping systems attached to Category I piping systems, the piping model shall extend through a minimum of two rigid supports in each of the three orthogonal directions beyond the safety related boundary. Extending the model farther may be required to provide effective boundary conditions for load cases at the safety / non-safety break point and conservative support loads on the first restraint beyond the class split. Where an anchor is used for isolation, loads from the non-safety side shall be considered for the anchor qualification. Typically, the analysis model will be extended at least two supports beyond the anchor. More conservative or accurate modeling details, decoupling and enveloping criteria, and stress intensity factors (SIFs) may also be used when revising existing stress models.
B.1.c(4) (as modified)	If a structure separates a high energy line from an essential component, that separating structure should be designed to withstand the consequences of the pipe break in the high-energy line which produces the greatest effect at the structure.
B.1.c(5) (as modified)	Electrical equipment important to safety must be environmentally qualified in accordance with 10CFR50.49. Required pipe ruptures and leakage cracks (whichever controls) must be included in the design bases for environmental qualification of electrical equipment important to safety both inside and outside containment. Mechanical equipment continues to be qualified based on design requirements, procurement specifications, as well as the implementation of maintenance activities.
B.1.d	The designer should identify each piping run he has considered to postulate the break locations required by B.1.c. above. In complex systems such as those containing arrangements of headers and parallel piping between headers, the designer should identify and include all such piping within a designated run in order to postulate the number of breaks required by these criteria.

Table M-2-2 – Portions of Branch Technical Position MEB 3-1 Used

Section	Description
B.1.e(2)	With the exception of those portions of piping identified in B.1.b (within Containment Penetrations), leakage cracks should be postulated as follows: For ASME Code, Section III Class 2 or 3 or nonsafety class (not ASME Class 1, 2, or 3) piping, at axial locations where the calculated stress by the sum of Eqs. (9) and (10) in NC/ND-3653 exceeds 0.4 times the sum of the stress limits given in NC/ND-3653.
B.1.e(3)	Non-safety class piping which has not been evaluated to obtain stress information should have leakage cracks postulated at axial locations that produce the most severe environmental effects.
B.3.c(1)	Leakage cracks need not be postulated in 1 inch and smaller piping.
B.3.c(2) (as modified)	For high-energy fluid system piping, the leakage cracks should be postulated to be in those circumferential locations that result in the most severe environmental consequences.
B.3.c(3)	Fluid flow from a leakage crack should be based on a circular opening of area equal to that of a rectangle one-half pipe diameters in length and one-half pipe wall thickness in width.
B.3.c(4) (as modified)	The flow from the leakage crack should be assumed to result in an environment that wets all unprotected components within the vicinity, with consequent flooding in the compartment and communicating compartments. Flooding effects should be determined on the basis of a conservatively estimated time period required to effect corrective actions.

3.6.14 Steam Generator Blowdown Isolation Valves

Due to postulated high energy line breaks in the steam generator blowdown lines outside Containment in Room 13, temperature switches were installed that isolate the steam generator blowdown valves on a high room temperature signal.

4. HIGH ENERGY SYSTEMS OTHER THAN MAJOR HIGH ENERGY SYSTEMS

4.1 Identification of High Energy Systems Other Than Major High Energy Systems

All systems outside the containment whose service temperatures exceed 200°F or whose design pressures exceed 275 psig are considered to be high energy systems. For the purpose of this investigation, those systems which are not normally pressurized were excluded from consideration. The main steam and feedwater systems have already been identified as the major high energy systems since they are the two systems, because of line sizes, fluid energy levels and plant arrangement, which would have the greatest potential to inhibit a safe shutdown of the plant in the event of the postulated pipe rupture incident (see Section M.3). The other high energy systems, because of smaller line sizes, lower fluid energy and plant arrangement, offer a lower potential for hindering a safe shutdown of the facility in the event of the postulated rupture. These other high energy systems are the following:

1. Charging
2. Letdown
3. Auxiliary steam
4. Condensate return
5. Steam generator blowdown
6. Sampling
7. Nitrogen
8. Hydrogen
9. Auxiliary Feedwater System (Non Safety Class Portion)

A study was performed to determine what modifications were necessary to protect essential structures and equipment from a postulated rupture in one of these systems. The results of the study, including the effects of the postulated break, are discussed in Section 4.2. Line break criteria are discussed in Section 2.4.