APPENDIX 10A

10A HIGH ENERGY PIPE RUPTURES OUTSIDE CONTAINMENT

10A.0 INTRODUCTION

In 1972, the Nuclear Regulatory Commission (NRC) determined that additional information was needed to evaluate our compliance with General Design Criteria 4 regarding pipe ruptures outside containment. They issued a letter to Calvert Cliffs (Reference 1) describing the types of analyses and information that were needed to ensure compliance with the General Design Criteria. This Appendix responds to that request for information.

The NRC listed 21 items that needed to be evaluated by the licensee. Each section of Appendix 10A is, therefore, broken down into 21 corresponding sections. Below are listed the basic requirements for each item. A complete copy of the NRC request can be found on the Electronic Docket or in the Nuclear Regulatory Matters Unit. The text of the letter is also contained in Appendix B of Branch Technical Position SPLB 3-1 (Standard Review Plan 3.6.1).

1. Identify the systems which must be restrained for pipe whip. Systems do not need to be restrained if any of the following conditions exist: the service temperature is less than 200°F and the design pressure is less than or equal to 275 psig; the piping is physically separated from systems, structures and components (SSCs) important to safety; following a break, the whipping pipe cannot impact any SSC important to safety; or the internal energy of the whipping pipe is low enough that it does not impair the safety function of any SSC.
2. Design basis break locations must be determined for ASME Code Class 1, 2 and 3 piping. In general, break locations are at the terminal ends and some intermediate locations. In addition, critical cracks are postulated to determine the effects of jet impingement on SSCs important to safety. The critical crack size is one-half the pipe diameter in length, and one-half the wall thickness in width.
3. The orientation of the pipe break is as follows: longitudinal breaks in pipe 4" and larger, and/or circumferential breaks exceeding 1" in size.
4. A summary should be provided of the dynamic analyses which determines the loadings on Category I piping as the result of a postulated pipe break.
5. A description should be provided of the measures to protect against pipe whip, blowdown jet and reactive forces. This description could include pipe restraints, physical separation and other measures.
6. Describe the procedures that are used to evaluate the structural adequacy of Category I structures. Those procedures should include the method of evaluating stresses, the allowable design stresses, the load factors and load combinations.
7. The structural design loads, i.e., pressure, temperature, dead, live, equipment, static, dynamic and dynamic loads should be described.
8. Seismic Category I structural elements, such as floors, interior walls, exterior walls, building penetrations and the whole building should be analyzed for load reversal.
9. If new openings are made in existing structures, the load bearing capability of the modified structure should be demonstrated.
10. Verify that structural failure will not cause failure of any other structure in a manner that adversely affects the ability to mitigate the consequence of the accident, and the capability to bring the unit to cold shutdown.
11. Verify that the pipe rupture will not result in the loss of required redundancy in any portion of the protection system, Class 1E electrical system, engineered safety feature (ESF) equipment, cable penetrations or their interconnecting cables that are required to mitigate the consequences of that accident and place the unit in cold shutdown. Verify that the pipe rupture will not result in environmentally-induced failures which do not

result in a protective action, but does disable a protective function. In this case, a loss of redundancy is permitted, a loss of function is not.

12. Assurance that the Control Room or the alternate shutdown panel will be habitable and its equipment functional after a feedwater line or steam line break.
13. Environmental qualification should be demonstrated by test for electrical equipment required to function following a high energy line break. The information should include the following: identification of all electrical equipment necessary to meet the requirements of Item 11, above (the time after the high energy line break in which they are required to operate should be given); the test conditions and the results of the test data for environmental qualification; the results of a jet impingement study; an evaluation of the safety-related equipment in the Control Room; and an evaluation that the onsite power distribution system will remain operable.
14. Provide design drawings of the steam and feedwater lines which show the elevations of the pipe, the safety-related equipment, including ventilation equipment, intakes and ducts.
15. Discuss the potential for flooding due to a high energy line break.
16. Describe the quality control programs and inspection programs that are used for piping systems outside containment.
17. If leak detection equipment is used, a discussion of its capabilities should be provided.
18. Describe the emergency procedures that would be followed after a pipe rupture, including automatic and manual operations required to place the reactor unit in cold shutdown. The estimated times following the accident for all equipment and personnel actions should be included in the procedure summary.
19. Describe the seismic and quality classification of the high energy piping systems (including steam and feedwater piping) which run near SSCs important to safety.
20. Describe the assumptions, method and results of analyses used to calculate pressure and temperature transients in compartments, pipe tunnels and buildings following a pipe rupture in these areas. The equipment assumed to function in the analyses should be identified. The capability of systems required to function to meet a single active failure should be described.
21. Describe the methods or analyses performed to demonstrate that there will be no adverse effects on the primary Containment Structure due to a pipe rupture outside the containment.

In accordance with Atomic Energy Commission (AEC) criteria, the following systems with changes as summarized below, are considered high energy[1] systems and each is discussed in one of the following sections.

10A.1 **MAIN STEAM (MS):** Encapsulated and restrained at terminal end and high stress points within the Auxiliary Building. Encapsulation along with an added vent stack, limits blowdown from a postulated pipe break to below compartment allowable pressurization. Added walls with watertight doors limit pressurization and flooding to the MS Valve Room and the connecting pipe tunnel to the turbine area. This item was reanalyzed in November 1981, to determine qualification requirements to meet IE Bulletin 79-01B, "Environmental Qualification of Electrical Equipment." This analysis supplements and expands the original analysis. It is discussed where applicable in the above sections.

10A.2 **MAIN STEAM TO AUXILIARY STEAM GENERATOR FEED PUMP TURBINE:** Sleeved and restrained at terminal ends and high stress points. Changed CV-4070 and CV-4071 from open to closed positions and added two gate valves and one globe

1 Pressure greater than 275 psig and/or temperature greater than 200°F.

bypass valve. This item was modified under Facility Change Request (FCR) 89-26 during the addition of 1/2-CV-4070A and 1/2-CV-4071A.

Changed 300 psi gate valves to 600 psi gate valves to protect Auxiliary Steam System from MS pressure. Added 300 psi gate valves outside the Auxiliary Feedwater Pump (AFWP) Room at the auxiliary steam supply header to exempt the auxiliary steam supply line inside the AFWP room from consideration of a pipe rupture.

10A.3 **STEAM GENERATOR BLOWDOWN:** The small pipe used in this system together with the choking behavior of the saturated fluid indicate that a blowdown line rupture is not of sufficient magnitude to adversely affect secondary side inventory. Further, there is no safety-related piping or equipment close enough to the steam generator blowdown piping that can be damaged by pipe whip or fluid impingement if these lines were to rupture. This item was reanalyzed in November 1981 to determine qualification requirements to meet IE Bulletin 79-01B, "Environmental Qualification of Electrical Equipment." This analysis supplements and expands the original analysis. It is discussed where applicable in the above sections. (See Section 10A.3 details for a description of blowdown effects on Unit 2 main steam drains 5 and 6 in the Turbine Building.)

10A.4.1 **MAIN FEEDWATER (MFW) - INSIDE AUXILIARY BUILDING:** Complete sleeving of lines in the Auxiliary Building outside the MS valve room to direct all blowdown to the valve room or Turbine Building. In the valve room, lines are sleeved and restrained at points of high stress. The feedwater check valve is relocated to inside Containment to prevent blowdown from the steam generator.

10A.4.2 **MAIN FEEDWATER AND HEATER DRAIN SYSTEM - INSIDE TURBINE BUILDING:** Pipe whipping restraints and jet impingement barriers are added, as required, to protect the AFWP Room and the common wall between the Turbine and Auxiliary Buildings. (See Section 10A.4.2 details for a description of feedwater effects on main steam drains 5 and 6 in the Turbine Building.)

10A.5 **AUXILIARY FEEDWATER (AFW):** A check valve has been added inside Containment to eliminate the line outside of Containment as a high energy system.

10A.6 **SHUTDOWN COOLING (SDC):** Based on level of quality control, periodic inservice inspection (ISI), low usage factor, the short time the system has high energy and the strict administrative control when system is in use, a break in this system is not considered credible.

10A.7 **CHEMICAL AND VOLUME CONTROL (CVCS):** Encapsulated and restrained at high stress points with an added excess flow check valve inside Containment to terminate flow after a postulated pipe break inside the Auxiliary Building.

10A.8 **SAMPLING:** Line sizes are less than 1", therefore only a pipe crack is postulated. Shielding is added as required to protect ESFs from postulated jet impingement forces.

10A.9 **AUXILIARY STEAM:** Lines operate at low pressure, therefore only a pipe crack is postulated. Shielding is added as required to protect ESFs from postulated jet impingement forces.

10A.0.1 REFERENCES

1. Letter from A. Giambusso (NRC) to J. W. Gore (BGE), dated December 15, 1972, Request for Additional Information Concerning the Consequences of Postulated Pipe Failures Outside the Containment Structure