Enclosure 2

TECHNICAL EVALUATION REPORT

OVERRIDE AND RESET OF CONTROL CIRCUITRY IN THE VENTILATION/PURGE ISOLATION AND OTHER ENGINEERED SAFETY FEATURE SYSTEMS (B-24)

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ABSTRACT

This report documents the technical evaluation of the design of electrical, instrumentation, and control systems provided in the Davis-Besse plant to initiate automatic closure of valves to isolate the containment. The evaluation was conducted in accordance with NRC criteria, based on IEEE Std 279-1971, for assuring that containment isolation and other engineered safety features will not be compromised by manual overriding and resetting of the safety actuation signals. It was concluded that the electrical, instrumentation, and control systems in the Davis-Besse plant partially conform with the NRC criteria.

FOREWORD

This report is supplied as part of the Review and Evaluation of Licensing Actions for Operating Reactors being conducted by Franklin Research Center (FRC) for the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation, Division of Licensing.

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1. INTRODUCTION

Several instances have been reported at nuclear power plants where automatic closure of the containment ventilation/purge valves would not have occurred because the safety actuation signals were either overridden or blocked during normal plant operations. These events resulted from procedural inadequacies, design deficiencies, and lack of proper management controls. These events also brought into question the mechanical operability of the containment isolation valves themselves. These events were determined by the U.S. Nuclear Regulatory Commission (NRC) to be Abnormal Occurrences (#78-5) and were, accordingly, reported to the U.S. Congress.

As a followup to these Abnormal Occurrences, the NRC staff is reviewing the electrical override aspects and the mechanical operability aspects of containment purging for all operating power reactors. On November 28, 1978, the NRC issued a letter entitled "Containment Purging During Normal Plant Operation" [1]* to all boiling water reactor (BWR) and pressurized water reactor (PWR) licensees. On June 24, 1980 [2], the NRC requested that the Toledo Edison Company, the Licensee for the Davis-Besse Nuclear Power Station, provide further information concerning electrical bypass and reset of engineered safety feature (ESF) signals for the Davis-Besse plant. Toledo Edison submitted a portion of the requested information on July 23, 1980 [3]. Subsequent requests for information resulted in additional partial submittals, and a site visit was arranged to obtain the detailed circuit information required to complete this review. During the period from November 17 to 19, 1981, FRC staff engineers and the NRC lead engineer met with Toledo Edison representatives at the Davis-Besse plant. In a letter dated November 24, 1981 [4], the Licensee responded to various plant re-start issues discussed at a November 18 meeting. Finally, on November 27, 1981 [5], the NRC found the responses by Toledo Edison acceptable for continued operation.

This document addresses the long-term requirements of the electrical, instrumentation, and control design aspects of the containment ventilation isolation (CVI) and other engineered safety features.

*Numbers in brackets refer to citations in the list of references, Section 5.

2. REVIEW CRITERIA

The primary intent of this evaluation is to determine if the following NRC staff criteria are met for the safety signals to all ESF equipment:

- Criterion 1. In keeping with the requirements of General Design Criteria (GDC) 55 and 56, the overriding* of one type of safety actuation signal (e.g., radiation) should not cause the blocking of any other type of safety actuation signal (e.g., pressure) for those valves that have no function besides containment isolation.
- Criterion 2. Sufficient physical features (e.g., key lock switches) are to be provided to facilitate adequate administrative controls.
- Criterion 3. A system-level annunciation of the overridden status should be provided for every safety system impacted when any override is active. (See NRC Regulatory Guide 1.47.)

Incidental to this review, the following additional NRC staff design criteria were used in the evaluation:

- Criterion 4. Diverse signals should be provided to initiate isolation of the containment ventilation system. Specifically, containment high radiation, safety injection actuation, and containment high pressure (where containment high pressure is not a portion of safety injection actuation) should automatically initiate CVI.
- Criterion 5. The instrumentation and control systems provided to initiate the ESF should be designed and qualified as safety-grade equipment.
- Criterion 6. The overriding or resetting+ of the ESF actuation signal should not cause any valve or damper to change position.

In this review, Criterion 6 applies primarily to other related ESF systems, because implementation of this criterion for containment isolation has been reviewed by the Lessons Learned Task Force, based on the recommendations in NUREG-0578, Section 2.1.4. Automatic valve repositioning

*Override: The signal is still present, and it is blocked in order to perform a function contrary to the signal.

+Reset: The signal has come and gone, and the circuit is being cleared in order to return it to the normal condition.

upon reset may be acceptable when containment isolation is not involved. The acceptability of repositioning upon reset will be determined on a case-by-case basis. Acceptability will be dependent upon system function, design intent, and suitable operating procedures.

3. TECHNICAL EVALUATION

3.1 DESCRIPTION OF CONTAINMENT VENTILATION SYSTEM DESIGN

3.1.1 Generalized System Design

The containment ventilation system valves at the Davis-Besse plant are controlled by a solid-state safety features actuation system (SFAS). The SFAS also controls the containment isolation valves and other ESF systems. Although this section analyzes only the containment ventilation system, the same analysis and conclusions apply to all SFAS-actuated systems.

3.1.2 Logic Circuits for Reset, Seal-in, and Trip

The containment ventilation system consists of the containment ventilation purge valves and the containment ventilation pressure and vacuum relief valves. The isolation signals for CVI are provided by the SFAS, as part of Incident Level 1, and are initiated by the following:

1. Automatic Isolation Signals

   a. Containment radiation high (2 of 4)
   b. Reactor coolant pressure low (2 of 4)
   c. Containment pressure high (2 of 4)

2. Manual Signals (manual trip initiates - Incident Levels 1, 2, 3, 4)

   a. Manual initiation push button - Train 1
   b. Manual initiation push button - Train 2.

The normal signal flow for the SFAS is such that the output relays are energized and maintain contacts closed in the individual valve control circuits. This allows the valves to be placed in a non-accident position. When a minimum of two instrument channels, of any of the automatic isolation signals, are in the tripped state, the associated 2-of-4 logic unit is turned off, deenergizing the output relays. The output signals from each of the instrument channels provide trip signal inputs to each of four actuation logics. A simplified logic diagram of this arrangement is shown in Figure 1. When the output relays are deenergized, associated contacts in the valve control circuits are opened, causing the valve solenoids to deenergize and move the valves to the safe position. The contacts of the actuation logic output relays are configured in an "and" arrangement so that two actuation logic channels must trip to deenergize the valve control solenoids controlled by those actuation logics. Actuation logics 1 and 3 actuate ESF equipment in the ESF actuation system Train 1, and logics 2 and 4 actuate equipment in the ESF actuation system Train 2.

If there is a requirement to reposition a valve with the initiation signal still present, a "block" (i.e., override) switch for that individual piece of equipment can be depressed, causing a logic 1 to be applied to the output relays. This override signal will be locked in by a seal-in loop in the block circuit. Even though only one block switch is depressed, several valves can now be repositioned because each ESF actuation logic controls the output relays of a family of valves. The block switches for each family of valves are in parallel. While the block exists, if any other automatic or system-level manual initiation signal occurs, no actuation will take place. In order to clear the block signal, the local or remote reset must be depressed. This causes the seal-in loop in the block circuit to "drop out" and allows any actuation signal to pass. After an initiation signal has cleared, the system is restored to normal by resetting the actuation logics as well as the individual instrument bistables.

Indication of SFAS actuation is provided by the safeguards actuation monitoring (SAM) system. Individual SAM indicating lights are provided for each component operated by the SFAS. When a SFAS actuation has occurred, a dim amber indicating light comes on for each component. When a block is initiated, the amber light becomes bright, and when the component is operated to other than its "safe" position, the bright amber light flashes. No annunciation of the blocked (i.e., overridden) status is provided. Computer alerts are provided to indicate either of two types of "trouble": (1) at least two of four instrument channels have tripped, but an actuation logic trip has not occurred; (2) the required actuation logic trip has occurred, but some component has not gone to its safety actuation position. If a "block" has been applied, a "trouble" alert of the first type will occur because the actuation logic will no longer be tripped.

3.1.3 Individual Valve Control Circuits

The individual valve control circuits contain contacts from the actuation logic output relays, channels 1 and 3 or channels 2 and 4 in parallel, as seen in Figure 2. This arrangement provides a logic "and" gate between two actuation logic outputs, as both sets of contacts must open to deenergize the valve control solenoid. Opening of the KA and KB contacts is accomplished by removal of the +24 V dc SFAS signal to the KA and KB relays. Manual valve operation is accomplished by use of momentary push button open/close switches. Valves will not change position upon system reset because of the KA/KB seal in contacts in the +24 V dc control system. Valve position indication is provided via limit switches.

3.2 EVALUATION OF CONTAINMENT VENTILATION SYSTEM DESIGN

The circuit description in Section 3.1.2 shows that the capability to override an initiation signal in all the SFAS circuits exists, and once that override has been established, any further initiation signals (automatic or system-level manual) will not cause SFAS actuation. This design capability for the SFAS-controlled CVI system and other ESF systems is not in conformance with Criterion 1. In Reference 4, the Licensee committed to provide a design change at the first refueling outage following January 1, 1983, which will allow system-level manual actuation with an override present. As an interim measure, Toledo Edison has prepared a Special Order, which will be issued to operating personnel and posted on the control board, that provides precautions concerning the use of an ESF block and instructions for reactivation following a block. However, additional modifications are needed to comply with Criterion 1 as it pertains to the blocking of automatic actuation signals.

The "block" push buttons on the SFAS initiation panel (i.e., SAM panel) are not provided with any special physical features to facilitate administrative controls; therefore, they do not meet the requirements of Criterion 2.

System-level annunciation is not provided as required by Criterion 3. However, as described in Section 3.1.2, it is felt that sufficient indication of the bypass condition is provided so that the intent of Criterion 3 is met.

The CVI section of the SFAS is initiated by containment high radiation, containment high pressure, and reactor coolant low pressure; therefore, the diversity requirement of Criterion 4 is satisfied at the Davis-Besse plant.

The Licensee has indicated that the SFAS was designed and purchased as safety-grade equipment. Therefore, Criterion 5 is satisfied for the purpose of this review.

The overriding or resetting of any actuation signal will not cause any valve or damper to change position. Therefore, it is concluded that Criterion 6 is satisfied.

3.3 OTHER ENGINEERED SAFETY FEATURE SYSTEM CIRCUITS

To provide a complete evaluation of the ESF system circuits, an audit of the steam and feedwater line rupture control system (SFRCS) was also conducted.

3.3.1 Description of the SFRCS Design

The SFRCS will, in the event of a main steam line rupture, shut the main steam line isolation valves and all main feedwater control and stop valves when the pressure in the main steam line drops to less than 600 psig. The auxiliary feedwater (AFW) system is also initiated, and both AFW pumps are aligned to the unaffected steam generator. Also, in the event of a main feedwater line rupture, the SFRCS closes both main steam isolation valves and both main feedwater control and stop valves, and initiates the AFW system when the steam generator pressure exceeds main feedwater pressure by 197.6 psig.

The isolation functions are accomplished through a solid-state logic system and are designed as a failsafe (deenergize to trip) system. Actuation of the various functions will be initiated when one of two initiation signals is received. The SFRCS consists of two identical redundant and independent channels.

There are two "operating bypass" features associated with the SFRCS. One bypass will allow manual control of the AFW system; however, this "operating bypass" is inoperative until the low steam generator pressure trip signal has cleared. The second "operating bypass" will allow the operator to bypass each channel to prevent initiation under normal cooldown when steam generator pressure drops below 650 psig in both steam generators. This bypass is automatically reset by a one-out-of-two logic when the steam generator pressure exceeds 650 psig.

3.3.2 Evaluation of the SFRCS System Design

No cases were found in which the bypasses provided in the SFRCS will block any safety actuation. Therefore, the SFRCS is in conformance with the requirements of Criterion 1.

The requirements of Criteria 2 and 3 do not apply because the bypasses provided do not override any safety actuation signals.

The diversity requirement of Criterion 4 only applies to the containment ventilation system and therefore does not apply to the SFRCS.

The Licensee has stated that the SFRCS was designed and purchased as safety-grade equipment; therefore, Criterion 5 is satisfied for the purpose of this review.

An audit of the SFRCS valve control circuits uncovered no valve control circuits where overriding or resetting would cause any valve to change position. Therefore, the SFRCS is in conformance with Criterion 6.

4. CONCLUSIONS

The electrical, instrumentation, and control design aspects of the engineered safety feature systems for the Davis-Besse plant were evaluated using NRC design criteria.

Containment Ventilation Isolation System Circuits

The containment ventilation isolation portion of the safety features actuation system (SFAS) circuit design, as well as the SFAS in general, is evaluated as follows:

- o The circuit design is not in conformance with the requirements of Criterion 1. Satisfaction of the requirements will require circuit design modifications.
- o Circuit design is not in conformance with the requirements of Criterion 2. However, final evaluation of this criterion will be made when the design modifications required for Criterion 1 are submitted.
- o System-level annunciation is not provided as required by Criterion 3; however, it is felt that sufficient indication of the bypass condition is provided so that the intent of Criterion 3 is satisfied.
- o Criteria 4, 5, and 6 are satisfied in the SFAS at the Davis-Besse plant.

Other Engineered Safety Feature System Circuits

An audit performed on the steam and feedwater line rupture control system (SFRCS) circuit design indicates that the SFRCS is in conformance with the requirements of all criteria.

5. REFERENCES

1. NRC
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meeting of November 18, 1981
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5. J. F. Stolz (NRC)
Letter to R. P. Crouse (Toledo Edison)
Subject: Evaluation of Information Presented in Reference 4
NRC, 27-Nov-81

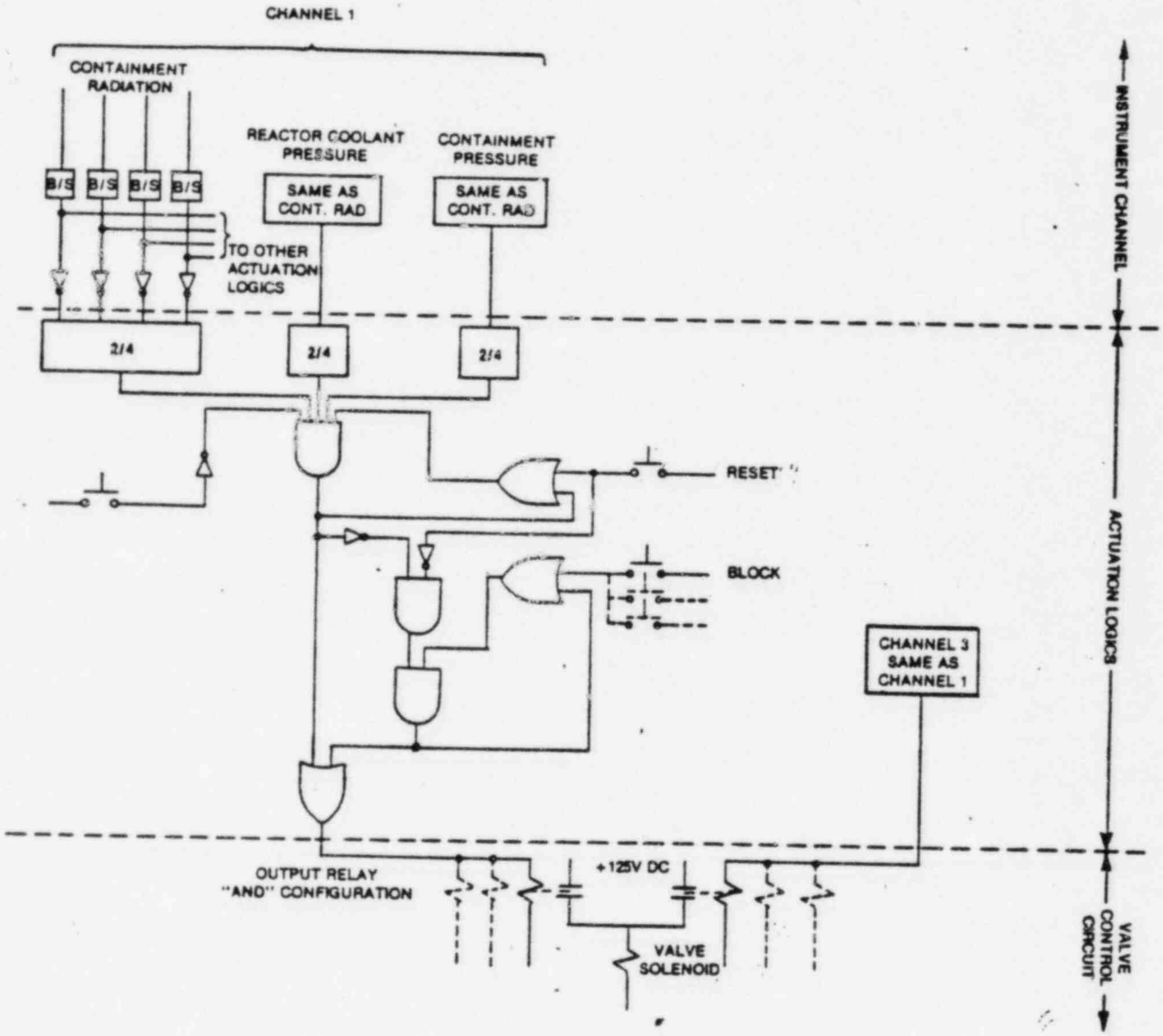

Figure 1. Safety Features Actuation System

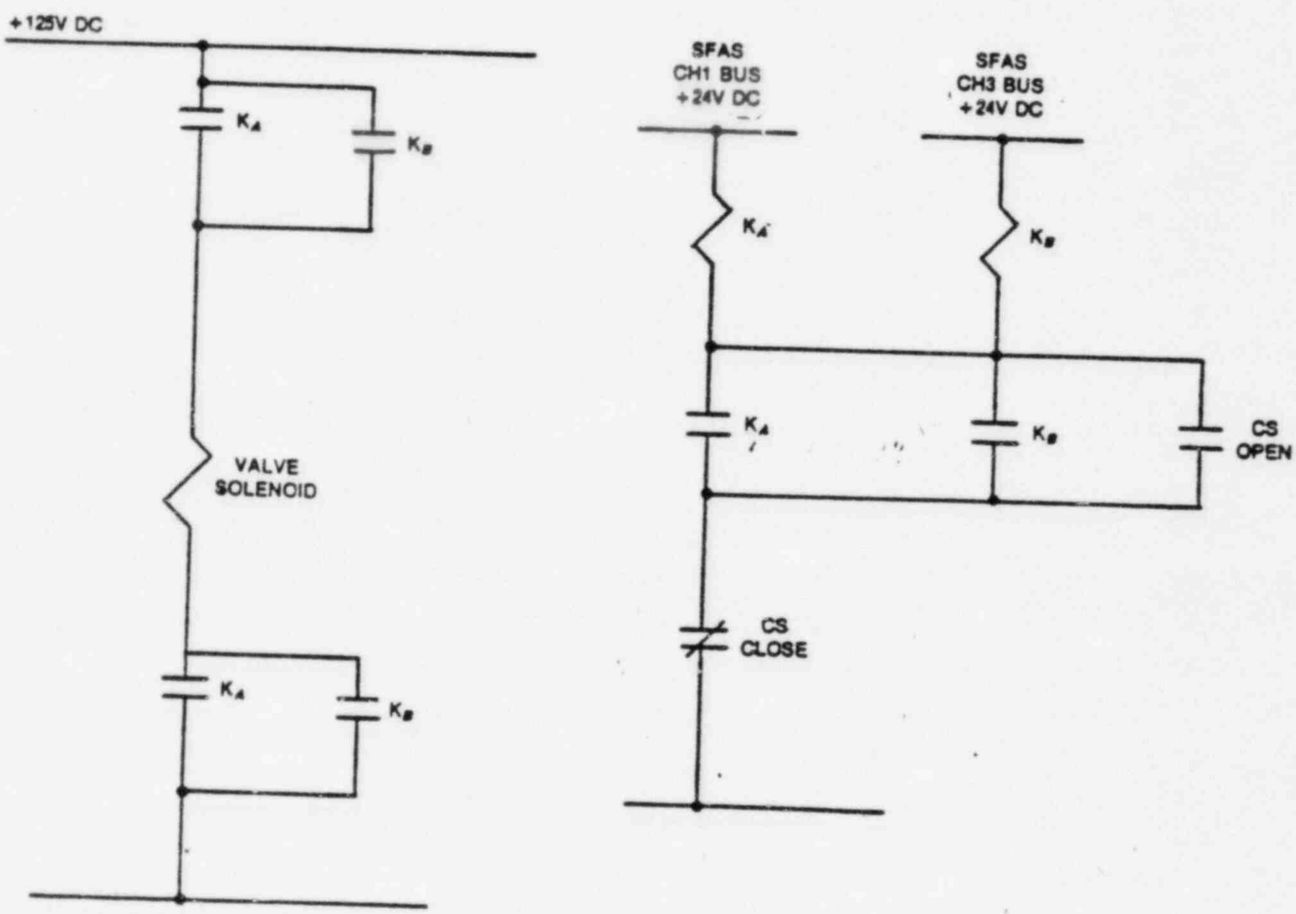

Figure 2. Typical Valve Control Circuit

GENERIC EVALUATION OF THE RADIOLOGICAL CONSEQUENCES OF ACCIDENTS WHILE PURGING OR VENTING AT POWER MULTI PLANT ACTION ITEM B-24

The release of radioactivity through vent or purge valves from a potential large LOCA at power has been considered generically to assure that such events do not constitute an undue hazard to the people residing around operating reactor sites. To evaluate the radiological consequences of such accidents, the following assumptions have been made:

a. vent and purge valve isolation signals, circuitry and purge valve actuation are reliable;

b. purge system isolation valve closure times are generally sufficient to prevent the release of activity associated with fuel failures that could follow a large break (a total accident elapsed time of about 15 seconds or less);

c. maximum allowable coolant iodine equilibrium and spiking activity limits do not exceed those contained in Standard Technical Specifications (STS);

d. fission products generated by pipe breaks are reflective of coolant activity and fuel failures estimated using 10 CFR Part 50, Appendix K, analysis techniques; and

e. radiological consequences of accidents while purging or venting would be bounded by those produced by a large break.

A large number of staff evaluations of the radiological consequences of LOCA's have been performed for construction permit, operating license, operating license amendment, and Systematic Evaluation Program reviews. In addition, a generic assessment of the amount of radioactivity that could be released while venting and purging from a spectrum of pipe breaks through the range of purge valve sizes utilized by industry has been made. In virtually all cases, the contribution through vent or purge valves is estimated to be of the order of 2 percent, or less, of the Exclusion Area Boundary (EAB) and outer boundary of the Low Population Zone (LPZ) doses that would occur from a large break LOCA in which a source term indicative of a substantial melt of the core with subsequent release of appreciable quantities of fission products is assumed.* For dose assessments in which only activity in primary coolant systems would be released, or for events in which fuel failures indicative of 10 CFR Part 50, Appendix K, LOCA analyses are indicated, EAB and LPZ dose estimates are substantially less than dose estimates made for a large break LOCA assuming a substantial fuel melt. Since the magnitude of the vent or purge contribution to severe LOCA dose estimates is small compared to other LOCA scenarios within design bases, we conclude that the consequences of such accidents are within applicable dose guidelines.

A generic assessment of the radiological consequences of large break accidents, including a resulting severe LOCA of the type hypothesized for site suitability purposes, while venting or purging at power indicates that the dose contribution through open valves is small. Therefore, we find total accident radiological consequences of such accidents would be less than the dose guidelines of 10 CFR Part 100.

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*Estimates based upon SRP analysis techniques and 10 CFR Part 100.11.