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TECHNICAL EVALUATION OF THE ELECTRICAL, INSTRUMENTATION, AND CONTROL DESIGN ASPECTS OF THE OVERRIDE OF CONTAINMENT PURGE VALVE ISOLATION AND OTHER ENGINEERED SAFETY FEATURE SIGNALS FOR THE ST. LUCIE NUCLEAR GENERATING PLANT

(DOCKET 50-335)

by

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ABSTRACT

This report documents the technical evaluation of the electrical, instrumentation, and control design aspects of the override of containment purge valve isolation and other engineered safety feature signals for the St. Lucie Nuclear Generating Plant. The review criteria are based on IEEE Std-279-1971 requirements for the safety signals to all purge and ventilation isolation valves.

FOREWORD

This report is supplied as part of the Selected Electrical, Instrumentation, and Control Systems Issues (SEICSI) Program being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Operating Reactors, by Lawrence Livermore National Laboratory, Field Test Systems Division of the Electronics Engineering Department.

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TABLE OF CONTENTS

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1. INTRODUCTION

Several instances have been reported where automatic closure of the containment ventilation/purge valves would not have occurred because the safety actuation signals were either manually 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 an Abnormal Occurrence (#78-5) and were, accordingly, reported to the U.S. Congress.

As a follow-up on this Abnormal Occurrence, the NRC staff is reviewing the electrical override aspects and the mechanical operability aspects of containment purging for all operating power reactors. On November 29, 1978, the NRC issued a generic letter entitled "Containment Purging During Normal Plant Operation" [Ref. 1], to all boiling water reactor (BWR) and pressurized water reactor (PWR) licensees. In a letter dated January 5, 1979 [Ref. 2], and a letter dated February 1, 1979 [Ref. 3], the Florida Power and Light Company (FPL), licensee for the St. Lucie Nuclear Generating Plant, replied to the NRC generic letter.

This document addresses only the electrical, instrumentation, and control (EI&C) design aspects of the containment ventilation isolation (CVI) and other engineered safety features (ESFs).

2. EVALUATION OF ST. LUCIE NUCLEAR GENERATING PLANT

2.1 REVIEW CRITERIA

The primary intent of this evaluation is to determine that the following requirements are met for the safety signals to all ESF equipment.

(1) Criterion no. 1--In keeping with the requirements of GDC 55 and 56 [Ref. 4], 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.

(2) Criterion no. 2--Sufficient physical features (e.g., keylock switches) are to be provided to facilitate adequate administrative controls.

(3) Criterion no. 3--The system-level annunciation of the overridden status should be provided for every safety system impacted when any override is active (see R.G. 1.47).

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

(1) Criterion no. 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.

(2) Criterion no. 5--The instrumentation and control systems provided to initiate the ESF should be designed and qualified as safety-grade equipment.

*The following definition is given for clarity of use in this evaluation:
Override: The signal is still present, and it is blocked in order to perform a function contrary to the signal.

(3) Criterion no. 6--The overriding or resetting* of the isolation actuation signal should not cause the automatic reopening of any isolation/purge valve.

Criterion 6 in this review applies primarily to related ESF systems because implementation of this criterion for containment isolation systems will be reviewed by the Lessons Learned Task Force, based on the recommendations in NUREG 0578, Section 2.1.4 [Ref. 5]. Automatic valve repositioning upon reset may be acceptable when containment isolation is not involved; consideration will be given on a case-by-case basis. Acceptability would be dependent upon system function, design intent, and suitable operating procedures.

2.2 CONTAINMENT VENTILATION ISOLATION CIRCUITS DESIGN DESCRIPTION

The containment purge valves are situated in two separate flow paths (FCV-25-1,-2,-3 inlet and FCV-25-4,-5,-6 exhaust). These valves are closed through de-energization of the control solenoids associated with each valve upon initiation of the containment isolations signal (CIS) in Train A or Train B by the Engineered Safety Feature Actuation System (ESFAS).

The ESFAS provides two (2) independent (physically and electrically isolated) actuation paths to initiate and complete containment isolation. These paths are CIS "A" and CIS "B". CIS "A" de-energizes the solenoids, thereby causing them to vent and to close valves FCV-25-1,-3,-5. At the same time, CIS "B" de-energizes the solenoids, causing valves FCV-25-2,-4,-6 to close in a similar fashion. Operation of either the "A" or the "B" train will effect the isolation of both containment purge paths.

*The following definition is given for clarity of use in this evaluation:
Reset--The signal has come and gone, and the circuit is being cleared in order to return it to the normal condition.

The ESFAS control train signals are combined as logic or functions of the trip signals as follows:

(1) Automatic Signals
(a) High containment pressure
(b) High containment radiation

(2) Manual Signal
(a) Containment isolation

The valve control logic incorporates a latch, so that if a trip occurs and the system is subsequently reset, the system will remain isolated until each train is individually reset. The valves are also controlled manually at the train level. Indicator lights are provided for each control train, as are indicator lights for each valve position indication.

When a monitored plant condition calls for isolation, a trip occurs in ESFAS train A and/or B and the trip contacts open in the control logic causing drop-out of relays 4A1, 4A2, 4B1, 4B2. Trip contacts also open in the valve control causing de-energizing of solenoid valves SE-25-2,-3,-4,-6 -7, and -8. The air control valves close, removing air from the containment isolation valves, which close by spring force.

2.3 CONTAINMENT VENTILATION ISOLATION SYSTEM DESIGN EVALUATION

In response to this issue, the licensee for St. Lucie has committed to minimizing the number and duration of purges, most of which are performed on an interim basis when the plant is at or below the hot standby condition.

The containment ventilation isolation system (CIS) has no overrides and no signals are blocked. We conclude that criterion No. 1 is satisfied.

There is no override of containment ventilation isolation. We conclude that NRC criterion Nos. 2 and 3 are satisfied.

CIS is initiated by high reactor building pressure and high radiation only and lacks diversity. In a letter dated March 13, 1980 [Ref. 6], the licensee agreed to add the safety injection actuation signal (SIAS), and with the addition of the SIAS criterion No. 4 will be met.

In the letter dated March 13, 1980, attachment paragraph 1e [Ref. 5], the licensee states that the instrumentation and control systems provided to initiate engineered safeguards are designed and qualified as safety-grade equipment. Paragraph 1f of the attachment to the letter [Ref. 6] also states that resetting of the isolation signal will not cause automatic motion of any ESF valve. Review of the control circuitry verifies this feature.

We conclude that criteria No. 5 and No. 6 are satisfied.

2.4 OTHER ENGINEERED SAFETY FEATURE (ESF) SYSTEM CIRCUITS.

In the course of this review, other ESF systems were audited for compliance with the criteria previously listed. The information provided by the licensee was reviewed for compliance with the criteria. This information covered the containment purge isolation system, the control room air conditioning, and the emergency filtration fan system. Results of this audit were applied to the containment purge valve review.

The licensee for St. Lucie stated in the letter of March 13, 1980 [Ref. 6], that the safety actuation signals (SAS) have blocks that are keylock-operated and that they provide for orderly accomplishment of normal plant functions, such as shutdown. Blocks to the SAS can be applied only if limiting conditions for operation are met. The blocks are annunciated at the system level and are automatically removed. Blocking of any one signal does not block any other signal.

The March 13, 1980 letter [Ref. 6] also states that the instrumentation and control systems that initiate the ESF are designed and qualified as safety-grade equipment. The licensee stated that resetting of the isolation signal will not cause the automatic motion of any ESF valve.

3. CONCLUSIONS

The EI&C design aspects of containment purge valve isolation and other ESF signals for St. Lucie Nuclear Generating Plant were evaluated using those design criteria stated in section 2.1 of this report.

We conclude that the design of the CVI system meets the NRC staff criteria.

We also conclude that the other ESF circuit designs audited meet the NRC staff criteria.

REFERENCES

1. NRC/DOR letter (T. Ippolito) to FPL, "Containment Purging During Normal Operation," dated November 29, 1978.

2. FPL letter (R. E. Uhrig) to NRC, "Docket No. 50-335, Containment Purging," dated January 5, 1979.

3. FPL letter (R. E. Uhrig) to NRC, "St. Lucie Unit 1, Docket No. 50-335, Containment Purging," dated February 1, 1979.

4. U.S. Nuclear Regulatory Commission, Standard Review Plan, "Containment Isolation System," NUREG 75/087, Rev. 1, Section 6.2.4.

5. U.S. Nuclear Regulatory Commission, "TMI-2 Task Force Short-term Recommendations," NUREG 0578, July 1979.

6. FPL letter (R.E. Uhrig) to NRC, "ST. Lucie Unit 1, Docket No. 50-335, Containment Purge", dated March 13, 1980.

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Enclosure 2

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, the staff finds 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.