UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DUKE POWER COMPANY

MCGUIRE NUCLEAR STATION

DOCKET NO. 50-369 AND 50-370

CATAWBA NUCLEAR STATION

DOCKET NOS. 50-413 AND 50-414

INTRODUCTION

In its letter of December 19, 1995, Duke Power Company (DPC), licensee for McGuire Nuclear Station, Units 1 and 2, and Catawba Nuclear Station, Units 1 and 2, notified the NRC of a change to an approved analysis methodology for the four nuclear units. DPC submitted additional information in its letter dated March 15, 1996. The change relates to the modeling of accumulation in the lifting of the pressurizer safety valves or the main steam safety valves. These safety valves provide overpressure protection of the primary system. Currently, DPC is involved in steam generator replacements at the McGuire and Catawba stations. During reviews of overpressure protection analyses, DPC identified that increases in the heat transfer area of replacement steam generators result in higher peak secondary pressures following turbine trip. The higher peak pressures would require setpoints of safety valves to be lowered. DPC found, however, that with the change in accumulation modeling, the setpoints of the valves may remain consistent with those setpoints currently in the plant technical specifications.

VALVE INFORMATION

The specific valves are listed below:

McGuire Nuclear Station:

Main Steam Safety Valves

1/2SV 2,3,8,9,14,15,20,21: 6" x 8" Crosby Style HA-65-FN, Built to ASME Section III, 1971 Edition, Winter 1971 Addenda

1/2SV 4,5,6,10,11,12,16,17,18,22,23,24: 6" x 10" Crosby Style HA-65-FN, Built to ASME Section III, 1974 Edition, Winter 1975 Addenda (originally purchased for the Marble Hill Nuclear Plant), and recertified to ASME Section III, 1971 Edition, Winter 1971 Addenda.

ENCLOSURE

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Pressurizer Safety Valves

Size 6M6 (6" inlet, "M" orifice, 6" outlet) Crosby Style HB-BP-86. Valves originally installed with loop seals, but modified in 1992 to drain the loop seal and modify valve internals for sealing against steam. The valves were built to ASME Section III, 1971 Edition, addenda through the 1972 Addenda.

Catawba Nuclear Station:

Main Steam Safety Valves

Dresser Model 3787, built to ASME Section III, 1974 Edition, Summer 1975 Addenda.

Pressurizer Safety Valves

Dresser Model 31749A, built to ASME Section III, 1974 Edition, Summer 1975 Addenda. These valves do not have loop seals.

MODELING METHODOLOGY

The current Final Safety Analysis Report (FSAR) Chapter 15 analyses that support the McGuire units and the Catawba units are detailed in the topical report DPC-NE-3002-A, "FSAR Chapter 15 System Transient Analysis Methodology." The NRC-approved methodology says that the pressurizer safety valves and the main steam safety valves are modeled with lift, accumulation, and blowdown assumptions which maximize the pressurizer pressure or minimize the secondary (main steam system) pressure. Lift is the actual travel of the valve disc away from the closed position when the valve is relieving. Accumulation is the pressure increase in the system pressure over the actual valve set pressure, frequently referred to as "overpressure," and is usually expressed as a percentage of set pressure. Blowdown is the difference between actual lift pressure of a safety valve and actual reseating pressure, usually expressed as a percentage of set pressure. The requirements of Section III of the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (the Code), 1971 Edition, and similar in later editions, paragraph NB-7614, gives the operating requirements for Class 1 safety valves (pressurizer safety valves) as follows:

> **NB-7614.1 Anti-Chattering and Lift Requirements.** Safety valves shall be designed and constructed without chattering and to attain full lift at a pressure no greater than 3 percent above their set pressures.
>
> **NB-7614.2 Blow Down Requirements.** Safety valves shall be set and adjusted to close after blowing down at a pressure not lower than 5 percent of the set pressure. The valves shall be adjusted, sealed and marked by the Manufacturer.

> **NB-7614.3 Popping-Point Tolerance.** The popping-point tolerance shall not exceed 1 percent, plus or minus, of the set pressure for pressure over 1000 psi.

The similar design and operating requirements for Class 2 safety valves (main steam safety valves) given in paragraph NC-7614 are as follows:

> **NC-7614.1 Lift and Blowdown.** Safety valves shall operate without chattering and to attain full lift at a pressure no greater than 3 percent above their set pressure. After blowing down, all valves shall close at pressures not lower than 95 percent of their set pressures . . .
>
> **NC-7614.2 Popping-Pressure Tolerance.** (a) The popping-pressure tolerance (plus or minus) from the set pressure of safety valves shall not exceed the following: . . . 1 percent for pressures over 1000 psi.

The approved models assume that lifting of the safety valves is a linear opening beginning at the setpoint and reaching full open at a pressure corresponding to the setpoint plus a conservatively assumed accumulation of one to three percent of the lift pressure setpoint. For example, a pressurizer safety valve with a setpoint of 2500 psig and three percent accumulation would reach full open at no higher than 2575 psig. DPC asserts that the models are conservative, but that the actual valve performance is not represented. Both sets of safety valves, though different models and different manufacturer, are best characterized as having a popping-open response.

MODELING CHANGE

DPC proposes to use a pop-open modeling approach rather than a linear ramping open approach. The revised modeling assumes that the safety valves pop open to a full-open position in 0.5 seconds after the drifted lift setpoint is reached. The assumption is based on testing and a review of tests that DPC engineering and the valve manufacturers (Crosby and Dresser) conducted.

Pressurizer Safety Valves

The pressurizer safety valves were tested as part of a performance test program conducted by the Electric Power Research Institute (EPRI) to meet action item II.D.1, "Performance Testing of Boiling-Water Reactor and Pressurized-Water Reactor Relief and Safety Valves," of NUREG-0737, "Clarification of TMI Action Plan Requirements." Multiple tests of Dresser Model 31709NA and 31739A and Crosby HB-BP-86 6N8 pressurizer safety valves, varying parameters such as pressurization rate, system media, and ring settings, indicated opening times of less than 0.1 second. Such a rapid opening time is characteristic of a popping-open action. The test results were used by licensees to correlate performance to site-specific similar valves.

Main Steam Safety Valves

DPC tested all of the McGuire Station main steam safety valves at Crosby's high flow test loop to determine unique ring settings for each valve. The tests were to assure blowdown performance within a range less than or equal to ten percent. The test simultaneously recorded (1) inlet pressure, (2) outlet pressure, and (3) spindle position using the Crosby Data Acquisition System. Although determining opening response time was not the purpose of the test, the times were recorded. The opening times ranged from 0.060 second to 0.110 second. Graphs of the opening of several of the valves were included in DPC's letter of March 15, 1996. These graphs show a rapid popping-open action. DPC correlated these tests and the measured opening times with the tests performed by EPRI and concluded that the main steam safety valves would pop open and be fully open within the 0.5 second assumed in the new model for overpressure protection.

The main steam safety valves installed in Catawba Station have not been tested in the same manner as the McGuire Station valves. Therefore, DPC reviewed data for similar valves that were part of the EPRI testing program. Selection of the 0.5 seconds for full opening is over 500 percent slower than the full opening time observed for the pressurizer safety valves. Dresser engineering concurred with the assumption that the Catawba Station Model 3787 main steam safety valves will open in less than 0.5 second.

EVALUATION

Pressure relief valves of various designs can modulate open and closed over the entire or a substantial portion of the lift, or modulate open over only a small portion of the lift and then open suddenly to the fully open position. The pressurizer safety valves and the main steam safety valves installed in the McGuire Station and Catawba Station are of the full-lift type (i.e., they open for a small portion of the lift and then pop open to the full-open position). DPC's determination that the valves will fully open within 0.5 seconds includes conservatism when compared to the test data used to validate the modeling assumption. For safety valve design, the ASME Code, Section III (see above), requires a popping-point tolerance of plus or minus one percent of the setpoint of the valves and requires that the valves be fully open at no greater than three percent above the setpoint.

DPC has demonstrated through testing and correlation of valves not specifically tested that a rapid popping action is characteristic of the valves. For these valves, there will be a short period when the valves first begin to lift where the closing forces are initially greater than the opening forces (i.e., the modulating portion of the lift). As the system pressure continues to act on the disc, the opening forces become greater than the closing forces, and the disc rises sharply. The disc moves to the full open position in a very short period of time, almost instantaneously, by design. Therefore, DPC may use a value of 0.5 second as the time from when the system pressure reaches the setpoint of the valves (adjusted in the model for an assumed drift of three percent) to the full opening and full relieving capacity. In making this change to the model, all requirements of the ASME Code, Section III, must be met.

CONCLUSION

Valve Design Characteristics

An assumption of 0.5 second as the time to reach the full-open position for the pressurizer safety valves and the main steam safety valves is acceptable as it relates to the design characteristics of these valves.

Overpressure Protection Analysis

The licensee stated in its letter dated December 19, 1995, that the proposed change of the safety valve opening characteristics in the methodology for analyzing system transients is needed for McGuire and Catawba plants. The current methodology as documented in DPC-NE-3002-A assumes that the safety valves are opened at their fully open position when the system pressures are corresponding to their lift setpoints plus an accumulation allowance. This is a conservative modeling approach. However, the licensee finds that a change of the safety valve opening characteristics to popping-open of the safety valves at their lift setpoint is needed to accommodate the proposed change of the safety valve allowable setpoint drift and the design of the replacement steam generators at McGuire and Catawba plants. For reasons discussed in the above paragraphs, the staff considers that the proposed change of safety valve opening characteristics in DPC-NE-3002-A is reasonable and acceptable.

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