JUL 29 1982

MEMORANDUM FOR: Samuel J. Chilk
Secretary of the Commission

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: FEDERAL REGISTER NOTICE: ABNORMAL OCCURRENCE - PRESSURE TRANSIENTS DURING SHUTDOWN AT A NUCLEAR POWER PLANT

The subject Federal Register Notice (FRN), submitted to the Commission in SECY-82-255 on June 17, 1982, was approved with comments by the Commissioners on July 21, 1982. The FRN has been updated and revised accordingly, including the addition of a diagram to enhance the understanding of the event.

The FRN is enclosed for your signature and forwarding for publication in the Federal Register.

Please coordinate with the Office of Congressional Affairs to assure that the appropriate Congressional Committees are informed of our intent to publisn the FRN.

(Signed) T. A. Rehm

for William J. Dircks
Executive Director for Operations

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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NUCLEAR REGULATORY COMMISSION

ABNORMAL OCCURRENCE

PRESSURE TRANSIENTS DURING SHUTDOWN

AT A NUCLEAR POWER PLANT

Section 208 of the Energy Reorganization Act of 1974, as amended, requires the NRC to disseminate information on abnormal occurrences (i.e., unscheduled incidents or events which the Commission determines are significant from the standpoint of public health and safety). The following incidents were determined to be an abnormal occurrence using the criteria published in the Federal Register on February 24, 1977 (42 FR 10950). Example I.D.4 ("For All Licensees") in Appendix A notes that recurring incidents which create a major safety concern can be considered an abnormal occurrence. The following description of the incidents also contains the remedial actions taken.

Date and Place - The licensee, Florida Power and Light Company, reported that on November 28 and 29, 1981, two reactor coolant system pressure transients occurred while the Turkey Point Unit 4 was shutdown. Unit 4 is a Westinghouse designed pressurized water reactor facility located in Dade County, Florida.

Nature and Probable Consequences - In 1976, the NRC noted an increasing number of incidents called "pressure transients" that were occurring in pressurized water reactors.[1/] The term "pressure transients," as used here, refers to incidents where the temperature-pressure limits of the reactor vessel, (included in the facilities' Technical Specifications) were exceeded. The majority of the incidents occurred during startup or shutdown operation when the reactor coolant system was at low temperature. About 30 incidents had occurred; eight occurred in 1976. Concern existed for the possibility of a

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1/ NUREG-0138. Staff discussion of Fifteen Technical Issues Listed in Attachment to November 3, 1976 Memorandum from Director, NRR to NRR Staff. Office of Nuclear Reactor Regulation (Program Support). Dec. 1976.

reactor vessel failing by the brittle fracture mechanism as a consequence of a pressure transient at near ambient temperature (near 100°F), once the reactor vessel material has experienced a reduction in fracture toughness (an upward shift in the nil-ductility transition temperature) due to irradiation effects which gradually accumulate over an extended period of time. In order for a reactor vessel to fail, in addition to the low temperature, high pressure and loss of fracture toughness conditions, it must also have a critical-sized flaw at a high stress location in the embrittled area, i.e., that part of the cylindrical shell of the reactor vessel directly opposite the core (the belt line area). In 1976 many reactor vessels had not yet experienced a significant reduction in fracture toughness and conservatism existed in reactor vessel design and fabrication control to preclude sizeable flaws. However, because of the potential safety significance of such incidents occurring when the reactor vessels became more embrittled, the NRC requested the licensees to upgrade administrative controls in the near term to reduce the likelihood of future pressure transients and to install design modifications by the end of 1977[2/] to further reduce their likelihood of occurrence and mitigate their consequences.

The pressure transients, described below, that occurred at Turkey Point Unit 4 exceeded by a factor of two the temperature-pressure limits stated in the Technical Specifications which are based on Appendix G of 10 CFR Part 50 (which relates to Section III of the ASME Boiler and Pressure Vessel Code). Fracture mechanics analysis indicated, however, that there was no significant impairment of the reactor vessel integrity. Concerns existed because Turkey Point

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2/ NUREG-0090-5, "Report to Congress on Abnormal Occurrences: July-September, 1976", published March 1977.

Unit 4 has a reactor vessel with sufficient radiation exposure to reduce the fracture toughness of the reactor vessel at low temperatures, and the pressure transients had the potential for brittle fracture of the reactor vessel if significant flaws were present and the transients had not been promptly terminated by operator action. These transients highlight the importance of properly operating overpressure mitigation systems to reduce the potential for brittle fracture of the reactor vessel. Though the frequency of pressure transients has decreased, the possibility of affecting a reactor vessel's integrity remains as a safety concern. Any event which impacts on the integrity of the reactor vessel is a significant safety matter and would likely require significant actions such as an in-service-inspection prior to further operation with additional surveillance, repair, and annealing of the vessel, as necessary.

Conditions Prior to the Pressure Transients

The reactor was shut down and preparations were underway to restart from a refueling outage. The plant operators were performing OP 0202.1 - Reactor Startup - Cold Condition to Hot Shutdown Conditions. The Reactor Coolant System (RCS) had been filled solid with water. The letdown path was via the Residual Heat Removal (RHR) system suction valves MOV-4-750 and 751, which close at 465 psig to prevent overpressurizing the RHR system. The RHR system was cross-connected to the letdown portion of the Chemical and Volume Control System (CVCS) downstream of the RHR heat exchangers at valve HCV-4-142. Letdown flow control to the Volume Control Tank and consequently, RCS pressure, was controlled by pressure control valve PCV-4-145 in the letdown portion of the CVCS. One of three positive displacement charging pumps was in operation providing both makeup into the RCS and Reactor Coolant Pump seal injection flow. RCS temperature was about 110°F and pressure was about 340 psig.

With the plant alignment described above, any flow blockage in the letdown path would cause an immediate increase in RCS pressure because the charging pump would be charging into a water solid system. Overpressure mitigating devices installed include an alarm at 400 psig warning of impending overpressure mitigating system (OMS) protective action and two independent OMS channels designed to both alarm and operate power operated relief valves (PORVs) on the pressurizer at 415 psig (at low temperature) and prevent an unacceptable pressure excursion. Figure 1 shows a schematic of the Turkey Point Unit 4 pressure control system, together with a schematic of the overpressure mitigating system.

At the time of the incidents, however, one OMS train was known to be inoperable, i.e., the PORV block valve was shut. Maintenance was being conducted on the high pressure controls for the PORV of that train. Unknown at the time, a blown fuse in the OMS comparator output rendered inoperable the alarm that signals a need for primary OMS protective action at 415 psig. Also unknown at the time, the backup OMS train was inoperable because (1) the root isolation valve for its pressure transmitter, PT-4-405, was shut which rendered the system inoperable during the first event, and (2) the temperature summator for the train had failed high rendering the train inoperable.

Description of the Pressure Transients

On November 28, 1981, at 10:55 p.m., the 4B Reactor Coolant Pump (RCP) was started to begin RCS heatup. The Reactor Control Operator noticed that RCS pressure was approximately 500 psig and increasing. Though it is common for the RCS pressure to surge momentarily following RCP startup, the operator noted that conditions persisted and were thus abnormal. He also noticed that valve PCV-4-145 was in the fully closed position and attempted to open it automatically by lowering the control setpoint. When this attempt failed,

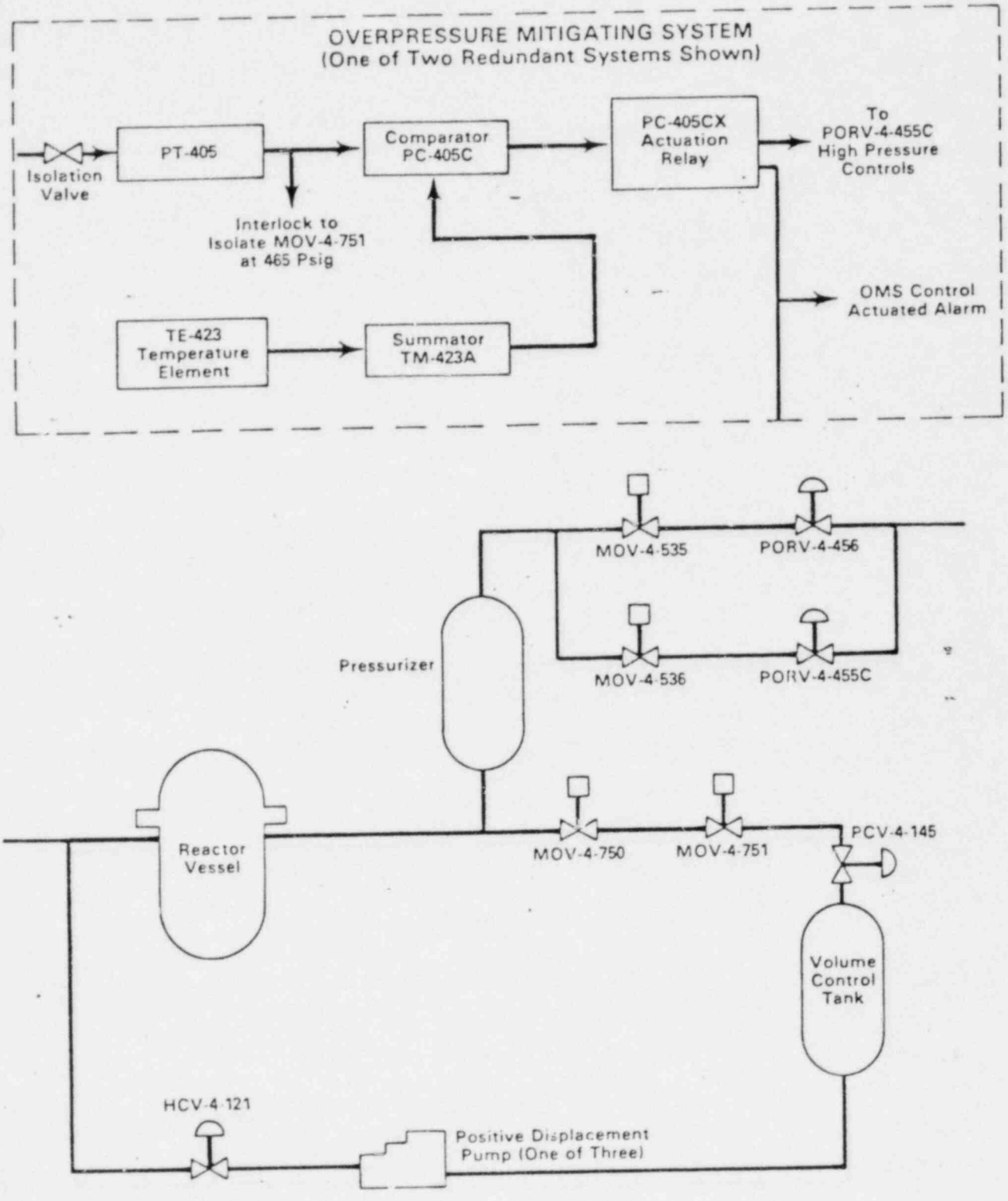

Figure 1. Turkey Point Unit 4 - Schematic of Pressure Control System

the valve was opened using the manual control mode, and the 4B RCP, 4A charging pump, and the pressurizer control heaters were shut off. One Power Operated Relief Valve (PORV-4-455C) was opened by the operator to reduce RCS pressure. The other PORV (PORV-4-456) was isolated and out-of-service for maintenance on the high pressure controls for the PORV. An RHR isolation valve (MOV-4-750) was found in the closed position and was immediately opened by the operator. PCV-4-145 was returned to auto-control and the 4A charging pump was restarted. The RCS pressure was then maintained constant at approximately 335 psig.

The RCS peak pressure during the transient was 1100 psig. Duration of the overpressure condition was approximately two minutes.

The pressure transient was initially diagnosed as initiating from misoperation of valve PCV-4-145. The root isolation valve for PT-4-405 was also found closed which made the backup OMS train inoperable. The root isolation valve was opened; valve PCV-4-145 was returned to auto-control and RCS pressure was maintained constant.

On November 29, 1981, at 12:55 a.m., the 4B RCP was restarted. An overpressure condition recurred with peak pressure reaching 750 psig. Again the RCP and the charging pump in operation were shut down. PORV-4-455C was manually opened to decrease RCS pressure. Duration of the overpressure condition was approximately one minute.

During both occurrences, the operators took action to stop the charging pumps which were providing the source of rapid pressurization. However, once the letdown flow was significantly reduced or terminated by closure of the RHR system isolation valves, timely operator action would be ineffective because of the rapidity of the transient.

Cause or Causes - A pressure increase occurred when starting the RCP which exceeded the magnitude expected for a normal RCP start. Contributing to the pressure transients were the subsequent automatic closure of the RHR system suction isolation valves and the malfunction of the OMS while operating in a water solid condition. The automatic closures of the RHR system suction isolation valves were attributed to:

(1) RCS pressure transmitter PT-4-403 sensing a high pressure and closing MOV-4-750, due to the pressure interlock at 465 psig during the first event, thus resulting in the charging pump operation overpressurizing the system.

(2) PT-4-405 (the backup OMS input) was reading about 130 psig higher (based on post event testing) than actual RCS pressure when unisolated after the first event. (The transmitter had been relocated and its setpoint may have changed due to hydrostatic testing of the transmitter together with its sensing line.) This variance likely led to MOV-4-751 closing at about 375 psig actual RCS pressure, initiating the second pressure transient.

The reasons the OMS did not operate as designed are:

(1) One train was inoperable for maintenance as permitted by license conditions.

(2) The backup train failure was attributed to:

(a) The root isolation valve to PT-4-405 was shut, isolating PT-4-405, during tne first event. (No procedure was found that aligns RCS instrumentation root valves prior to RCS fill.)

(b) In addition, during both events, the backup OMS temperature summator, which generates the "pressure set point" to which loop pressure is compared to generate the OMS actuation signal, had failed high - about 2335 psig - also rendering the backup OMS inoperable. This condition was unknown because of an inadequate surveillance procedure used to satisfy the technical specification requirement to operationally check each channel. The procedure is OP 1004.4 - Overpressure Mitigating System Functional Test of Nitrogen backup System - dated May 7, 1981. This procedure did not test the summator.

Actions Taken to Prevent Recurrence

Licensee - After the first pressure transient, the root valve to PT-4-405 was reopened. In addition, attempts were made to release the redundant OMS loop from clearance and restore it to operating condition, but this was not accomplished by the time the second pressure transient occurred. The immediate corrective action during both events consisted of reducing the RCS pressure to a value within the Technical Specification limits. Subsequent to the second event, the licensee requested an evaluation of the consequences from the Nuclear Steam System Supplier (Westinghouse) and notified the NRC's Region II of the incidents. The licensee also confirmed that the Unit would not be restarted until the NRC has reviewed the results of the requested analyses.

A fracture mechanics analysis based on the methods of Appendix G to Section III of the ASME Boiler and Pressure Vessel Code was performed by Westinghouse. The analysis showed that the integrity of the reactor vessel was not impaired by these transients. It was further judged that the

fatigue life of the vessel was not significantly affected. An independent licensee consultant reviewed the analysis and concurred with its conclusions. The fact that there was no thermal stress present was a beneficial factor in the analysis.

The licensee responded to the NRC's notice of violation by taking appropriate actions. Procedure changes were made to include additional equipment checks as well as to ensure proper valve line up following any tests prior to releasing the systems to operations. These actions will minimize the probability of component failures similar to the ones that resulted in the OMS operational anomalies.

NRC: The NRC conducted a special safety inspection of the circumstances related to these events. The NRC's Region II reviewed the analysis of the consequences of the events prior to the unit returning to operation. The licensee was cited with a notice of violation for (1) having an inadequate functional testing procedure for the OMS in that the summator circuitry was not tested and (2) not including an alignment check of the instrumentation root valves in station procedures for reactor coolant system fill after refueling or plant startup.

NRC Inspection and Enforcement Information Notice No. 82-17 ("Overpressurization of Reactor Coolant System") was issued to other licensees informing them of these events and their potential significance.

Dated at Washington, D.C. this day of 1982.

Samuel J. Chilk
Secretary of the Commission