CURRENT EVENTS

POWER REACTORS

UNITED STATES NUCLEAR REGULATORY COMMISSION

THIS COMPILATION OF SELECTED EVENTS IS PREPARED TO DISSEMINATE INFORMATION ON OPERATING EXPERIENCE AT NUCLEAR POWER PLANTS IN A TIMELY MANNER AND AS OF A FIXED DATE. THESE EVENTS ARE SELECTED FROM PUBLIC INFORMATION SOURCES. NRC HAS, OR IS TAKING CONTINUOUS ACTION ON THESE ISSUES AS APPLICABLE, FROM AN INSPECTION AND ENFORCEMENT, LICENSING AND GENERIC REVIEW STANDPOINT.

1 MARCH - 30 APRIL 1978

(PUBLISHED JUNE 1978)

LOSS OF NONNUCLEAR INSTRUMENTS

At the Rancho Seco nuclear plant on March 20, 1978, a light bulb was inadvertently dropped into the open light assembly cavity during replacement of a burned-out bulb in a backlighted push button switch on the control console. This created a short in the "Y" portion of the 24-volt DC Non-Nuclear Instrumentation (NNI) buses. During the resulting current surge the current-limiting and undervoltage protection for the DC power supplies actuated, causing approximately two-thirds of the NNI signals (pressure, temperature, level, flow, etc.) to provide faulty information to the control room and Integrated Control System (ICS). The ICS, attempting to match equipment output to the erroneous signals, reduced feedwater flow to zero. This reduction caused the Reactor Coolant System (RCS) pressure to increase, with a reactor trip occurring when pressure reached the reactor protective system trip setting.

Following the trip, the operators were hampered by the lack of available instrumentation and by equipment responding to the inaccurate signals. Temperatures slowly increased while pressure decayed, maintaining approximately 2060 psig. At the loss of NNI-Y DC power, the "A" steam generator level signal drifted to zero and the "B" signal drifted full-scale during the first nine minutes after the trip. At this time feedwater began to enter the "A" Once-Through Steam Generator (OTSG). The auxiliary feedwater pump had started on the loss of feedwater flow; however, the auxiliary feedwater valves remained closed during this initial nine-minute period in response to the erroneous OTSG startup level signals. When the level indication for the "A" OTSG drifted below the low level setpoint, the ICS opened the auxiliary feedwater valves admitting water to the shell side of the steam generator. (Actual plant conditions showed that both OTSGs went dry during this period.) This flow of water created a heat sink

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which resulted in depressurization of the RCS, initiating the Safety Features Actuation System (SFAS) at the 1600 psig setpoint. The operators also may have increased the main feed pump flow at this time, providing another source of water to the "A" steam generator.

On the SFAS signal both auxiliary feedwater bypass valves opened, and water flowed to both steam generators. The operators continued the injection of water that was started by the SFAS signal, maintaining pressure as well as possible utilizing the pressurizer level indications and the available RCS pressure indicator. Control was obtained by adjusting high pressure injection flow. The pressurizer heaters were not available due to the NNI power loss. The continuous injection of auxiliary feedwater resulted in complete filling of both steam generators, after which water began to enter the steam lines.

Throughout this period, the operators were unaware of the RCS temperature. When the NNI-Y DC power supplies were restored one hour and ten minutes into the transient, the RCS temperature had dropped to about 285°F (beyond the technical specification limits). The operators took immediate action to return the system to within the operating limits by spraying the pressurizer to reduce pressure, keeping three Reactor Coolant Pumps operating to increase temperature, shutting off auxiliary feedwater flow, and draining the OTSGs. The unit remained shut down while data was gathered and sent to B&W for analysis. Further investigations were made at the plant.

The short caused by the light bulb drew excessive current through the 24-volt DC power supplies servicing components in NNI cabinets 5, 6 and 7. The power supplies for these cabinets, designated NNI-Y, are operated current-limited with a setpoint of 7.5 amps. The subsequent reduction in voltage caused an undervoltage monitor to operate, opening the two shunt breakers through which AC power from the inverters is supplied to the DC power supplies. Loss of these power supplies meant that every component in cabinets 5, 6 and 7 operating on DC power was not functioning properly. An NNI signal could have been affected in two ways between its source and the receiving component. The signal could have been interrupted completely due to a contact opening on being deenergized. Because most of the signals are -10 volts to +10 volts, this could have resulted in a mid-scale reading (or in some cases, a reading anywhere between ±10 volts), being transmitted to the indicator or sent to the ICS as an actual plant parameter. If a signal conditioning component (buffer amplifier, square root extractor) was affected, this meant that the desired conditioning would not be performed on the signal, or that the component might not pass the true signal, resulting in the erroneous values being sent to the indicator or to the ICS. Since signal paths in the NNI are not restricted to either the X or Y cabinets, about two-thirds of the signals passed through at least one component in cabinet 5, 6 or 7 and were rendered invalid.

These spurious readings had several effects. Given the changing plant conditions and the wide variety of possible errors introduced, it was difficult for the operators to ascertain which of their indications were valid. The plant had to be controlled using the select few parameters that were known. Another effect was that the equipment was operated automatically, without regard to actual conditions, since the spurious signals were fed into the ICS. The first indication of this was the runback of the main feed pumps to zero, causing the reactor trip. Later, the automatic actions involved with adding feedwater to the dry steam generators hindered operator actions, and precipitated the rapid depressurization leading to the SFAS initiation.

Power was finally restored to the NNI-Y when the operators remedied the open shunt breakers situation. The NNI was then returned to operation, permitting proper operator response to the plant condition.

Babcock and Wilcox analyzed the consequences of the temperature transient imposed upon the primary coolant system. It was concluded that the reactor could be returned to power, provided limits were placed on maneuvering during the first startup, surveillance of loose parts monitors was increased for the first week of operation, an operability check of on-line and redundant NNI was completed, and a week-long, daily surveillance check for leaking components in the primary and secondary radiochemistry was performed. In addition, a 2255 psig leak test was performed on the RCS, the overvoltage trip setpoints on the NNI-DC power supplies were increased from 27 volts to 29 volts to prevent spurious trips, and the casualty procedures were rewritten to provide required operator actions for restoration of NNI power following a trip similar to that experienced. A procedure was also written providing operator instructions if the NNI power could not be restored.[1, 2]

DIESEL MODIFICATIONS

On four different occasions in January 1978, the D. C. Cook Unit 2 diesel generator tripped on overspeed during preoperational testing. The health and safety of the general public was not threatened since the unit was in the preoperational phase.

The trips resulted from a spurious activation of the overspeed trip device (Dynalco - Model RT-2339 Relay Tachometer), caused by the switching noise on the 250 volt DC power supply system. A design change was implemented, adding capacitors from the power input terminals of RT-2339 to ground. The change seemed to attenuate the "glitch" being fed into the tachometer, but additional testing resulted in another overspeed trip. A different filter scheme was tried without success.