REACTOR PROTECTION AND CONTROL
PROCESS INSTRUMENTATION REPLACEMENT PROJECT AT
DONALD C. COOK NUCLEAR PLANT UNITS 1 AND 2

REACTOR PROTECTION SYSTEM FUNCTIONAL DIVERSITY ASSESSMENT

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QUALITATIVE FUNCTIONAL DIVERSITY ASSESSMENT

EXECUTIVE SUMMARY

On April 21, 1992, AEPSC representatives had a meeting with the NRC on the replacement of existing analog reactor protection process instrumentation with digital Foxboro Spec 200/Spec 200 Micro Electronics instrumentation. During this meeting, AEPSC was asked to assume a common mode failure (CMF) of the software of the new digital equipment during a postulated accident and then provide details as to whether operators could mitigate the consequences of the accident.

In response to this request, a functional diversity assessment of each updated FSAR (UFSAR) event assuming a common mode failure of the software has been performed. In this assessment, all the events for both Units 1 and 2 of the Cook Nuclear Plant given in the UFSAR were considered. A review was performed to divide events into potentially affected and not affected. Table-1 lists these events and indicates whether they would be potentially affected or not affected if a CMF were to occur. The potentially affected transients were then individually evaluated qualitatively in light of the FSAR analysis.

Each event evaluation was recorded on a form of the type shown in Appendix A. This form outlines the thought process employed. The first column in Appendix A contains the UFSAR transient number listed in Table-1. The second column includes the name of the transient. The third column depicts the trip/safeguard function for reactor trip. This information was obtained from the UFSAR. The fourth column includes the information on the impact of common mode failure on the reactor trip function. If the trip function is processed outside of the new digital reactor protection system, then the trip is available, e.g., trip on nuclear instrumentation system high flux. If the trip is processed by a function that is a part of the new digital equipment, then the trip/ESF function is assumed to be lost. However, for some functions, alternate indications and/or diverse alarms are available. The alarm/alternate indications that are available to the operator to mitigate the transient are given in the next column. The sixth column lists pertinent diagram numbers. The seventh column summarizes the consequences of the unavailability of diverse alarm. The last column provides the evaluation of the event. In this column, we have discussed the consequences of the operator's response on reactor safety.

Based on this evaluation, we have concluded that the CMF of the new digital equipment has no significant adverse impact on the public safety. Some reactor trips are not affected by the installation of the new digital equipment. Among these trips are neutron high flux and high rate trips, undervoltage and underfrequency trips and reactor trip on turbine trip. However, for events protected by trip actuations affected by the CMF, the operator will be alerted to the event by an alarm. He will then provide the appropriate actuations manually and enter the emergency operating procedures. For some accidents, such as locked rotor, the consequences could be more severe than currently analyzed due to the longer response time for the required actuation. However, our evaluation indicates that the affected unit can be brought to a safe condition and the current LOCA offsite dose evaluation will remain bounding. From these results, it is believed that a CMF of the new digital system would have no adverse effect on the health and safety of the public.

Table-1

UFSAR TRANSIENT #	TRANSIENT	POTENTIALLY AFFECTED (A)/ NOT AFFECTED(NA)
14.1.1	Uncontrolled RCCA Withdrawal from a Subcritical Condition	A
14.1.2	Uncontrolled RCCA Withdrawal at Power	A
14.1.3	Rod Cluster Control Assembly Misalignment	A
14.1.4	RCCA Drop	A
14.1.5	Chemical Volume and Control System Malfunction	A
14.1.6	Loss of Reactor Coolant Flow	A
14.1.7	Startup of an Inactive Reactor Coolant Loop	A
14.1.8	Loss of External Electrical Load	A
14.1.9	Loss of Normal Feedwater Flow	A
14.1.10	Excessive Heat Removal due to Feedwater System Malfunction	A
14.1.11	Excessive Load Increase Incident	A
14.1.12	Loss of All A.C. Power to the Plant Auxiliaries	A
14.1.13	Turbine-Generator Safety Analysis	A
14.2.1	Fuel Handling Accident	A
14.2.2	Accidental Release of Radioactive Liquids	A
14.2.3	Accidental Waste Gases Release	A
14.2.4	Steam Generator Tube Rupture	A
14.2.5	Rupture of a Steam Pipe	A
14.2.6	Rupture of a Control Rod Drive Mechanism Housing (RCCA Ejection)	A
14.2.7	Secondary System Accidents Dose Consequences	A
14.2.8	Major Rupture of a Main Feedwater Pipe	A
14.3.1	Large Break LOCA Analysis	A
14.3.2	Loss of Reactor Coolant from Small Ruptured Pipes or from Cracks in Large Pipes which Actuates the Emergency Core Cooling System	A
14.3.3	Core and Internals Integrity Analysis	NA
14.3.4	Containment Integrity Analysis	A
14.3.5	Environmental Consequences of a Loss of Coolant Accident	A
14.3.6	Hydrogen in the Containment After a Loss of Coolant Accident	A
14.3.7	Long Term Cooling	NA
14.3.8	Nitrogen Blanketing	NA
14.4.2	Postulated Pipe Failure Analysis Outside Containment	NA
14.4.3	Analysis of Emergency Conditions	NA
14.4.4	Stress Calculations	NA
14.4.5	Description of Pipe Whip Analysis	NA
14.4.6	Compartment Pressures and Temperatures	NA
14.4.7	Description of Jet Impingement Load Analysis	NA
14.4.8	Containment Integrity	NA
14.4.9	Plant Modifications	NA
14.4.10	Environment	NA
14.4.11	Electrical Equipment Environmental Qualification	A

APPENDIX A

FSAR TRANSIENT #	TRANSIENT	TRIP/SAFEGUARD FUNCTION FOR RX TRIP FSAR	IMPACT OF COMMON MODE FAILURE (CMF) ON TRIP FUNCTION	ALARM/ALTERNATE INDICATION SYSTEM AVAILABLE	DIAGRAM #	CONSEQUENCES OF UNAVAILABILITY OF DIVERSE ALARM	EVALUATION OF EVENT