GE Nuclear Energy

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

July 21, 1993

Docket No. STN 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: Submittal Supporting Accelerated ABWR Schedule - **I & C Diversity Issue, DFSER Open Item 7.2.6-2**

Dear Chet:

At the request of the staff, operator action histories (operator time lines) for the three different postulated LOCAs, previously evaluated in my June 18, 1993 letter, which required operator action within twenty minutes have been developed. These three accidents; namely, the steam line, feedwater line and shutdown cooling line breaks, are all assumed to occur inside the containment with coincident common mode failure of the SSLC/EMUX. Also, in each of these accidents, it was assumed that the Feedwater Control System was not available.

Tables 1, 2 and 3 summarize the operator time lines for the steam line, feedwater line and shutdown cooling line breaks, respectively.

These accident analyses were performed to determine the maximum time available after accident initiation, in each case, for the operator to initiate RPV makeup water injection in time to keep the peak fuel cladding temperature from reaching the 2200 degree F limit specified in 10CFR Part 50.46.

In the operator time line for each accident, the most important operator action is the initiation of the core makeup water injection. In the case of the steam line break, this action is required to take place seven minutes after initiation of the accident in order to meet the maximum fuel cladding criterion stated above. In the other two cases, initiation of makeup water injection must take place nominally twelve minutes after the accident occurs.

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The HSI design will include the information and control capability which allows the operator to adhere to the time lines illustrated in Tables 1, 2 and 3. The validation of these HSI design features will be entered into the HFE Issue Tracking System.

This closes out the operator time line aspect of the I & C Diversity Issue, DFSER Open Item 7.2.6-2.

Please provide a copy of this transmittal to Clare Goodman.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Alan Beard (GE)
Norman Fletcher (DOE)
Keith Gregoire (GE)
Frank Paradiso (GE)
Umesh Saxena (GE)
Cal Tang (GE)

JF93-233

TABLE 1: STEAMLINE BREAK INSIDE CONTAINMENT

T (Sec)	Scenario Description
< 0.0	The SSLC and/or EMUX is postulated to fail in a worst case common mode such that all four safety divisions (a) are unavailable to perform either automatically or manually initiated control actions, and (b) continue to provide information to the operator which indicates that the plant status is normal irrespective of the actual conditions of the monitored plant parameters.
0.0	Steam line break inside the containment occurs.
~0.1	Fluid discharge through the break causes loud noises and vibrations which are readily sensed by the operators in the main control room. Drywell pressure reaches high level trip alarm setpoint. Although the SSLC/EMUX associated instrumentation would not indicate this (given the worst case common mode failure postulated), the diverse drywell pressure indication and high pressure alarm would bring to the operator's attention the fact that the drywell pressure is not normal. High drywell pressure alarm is an entry condition into the EOPs.
~0.2	The level swell inside the RPV, as a result of the high flow through the break, results in a high sensed water level (Level 8) in the FWCS, which leads to the tripping of the feedwater pumps. For the purpose of these analyses, it is assumed that the Feedwater Control System fails so that the feedwater pumps cannot be restarted. The only vessel water makeup flow which continues to operate is that from a single CRD hydraulic system pump. Also, at Level 8, via a signal diverse from the SSLC and EMUX, the main turbine is tripped and scram initiated.
~3.0	Scram complete 2.8 sec. after initiation.
~10	The RPV water level drops to Level 3. Again, although the displays and alarms which are associated with the SSLC and/or EMUX would continue to indicate normal plant conditions (given the worst case common mode failure conditions postulated for these evaluations), the diverse RPV water level indication and Level 3 alarm would continue to operate properly and bring to the attention of the operator the fact that that the RPV water level is not normal. RPV Level 3 is also an entry condition into the EOPs.
~15	RPV water level drops to Level 2.
~20	RPV water level drops to level 1.5.
~100	Water level continues to drop and the top of the fuel is uncovered. Fuel heatup begins
~190	The entire core is uncovered.
~275	It is probable that, observing that no safety actions have been automatically initiated, the operator determines that manual actions, per the EOPs, are needed.
~311	The operator confirms shutdown condition from SRNM displays which are independent of the SSLC/EMUX.
~347	Following the RPV Control procedure of the EOPs, the operator initiates reactor isolation through operation of the MSIV and CUW line isolation valve controls, which are independent of the SSLC/EMUX.
~404	Reactor isolation complete. After reactor isolation, the next operator action, per the EOPs, is to initiate core makeup water injection, as required to maintain RPV water level above Level 3.
~440	HPCF injection is conservatively assumed to begin 7 minutes after RPV level reaches Level 1.5.
~575	Rising reactor water level reaches bottom of fuel.
~645	Maximum peak cladding temperature 0f 2193 deg. F is reached.
1 hour	Operator goes to RSS and affects cold shutdown of the reactor.

TABLE 2
FEEDWATER LINE BREAK INSIDE CONTAINMENT

T (Sec)	Scenario Description
< 0.0	The SSLC and/or EMUX is postulated to fail in a worst case common mode such that all four safety divisions (a) are unavailable to perform either automatically or manually initiated control actions, and (b) continue to provide information to the operator which indicates that the plant status is normal irrespective of the actual conditions of the monitored plant parameters.
0.0	Feedwater line break inside containment occurs. For the purposes of this analysis, it is assumed that the only vessel water makeup flow which continues to operate is that from a single CRD hydraulic system pump.
~0.1	Fluid discharge through the break causes loud noises and vibrations which are readily sensed by the operators in the main control room. Drywell pressure reaches high level trip alarm setpoint. Although the SSLC/EMUX associated instrumentation would not indicate this (given the worst case common mode failure postulated), the diverse drywell pressure indication and high pressure alarm would bring to the operator's attention the fact that the drywell pressure is not normal. High drywell pressure is an entry condition into the EOPs.
~1.0	The RPV water level drops to Level 3. Although the displays and alarms which are associated with the SSLC and/or EMUX would continue to indicate normal plant conditions (given the worst case common mode failure conditions postulated for these evaluations), the diverse RPV water level indication and Level 3 alarm would continue to operate properly and bring to the attention of the operator the fact that that the RPV water level is not normal. RPV Level 3 is also an entry condition into the EOPs.
~2.0	RPV water level drops to Level 2. The ATWS functions (diverse from the SSLC/EMUX) are automatically actuated and initiate an automatic scram.
~4.8	Scram complete 2.8 sec. after initiation.
~5	RPV water level drops to level 1.5.
~170	Water level continues to drop and the top of the fuel is uncovered. Fuel heatup begins.
~550	The entire core is uncovered.
~560	It is probable that, observing that no safety actions have been automatically initiated, the operator determines that manual actions, per the EOPs, are needed.
~596	The operator confirms shutdown condition from SRNM displays which are independent of the SSLC/EMUX.
~632	Following the RPV Control procedure of the EOPs, the operator initiates reactor isolation through operation of the MSIV and CUW line isolation valve controls which are independent of the SSLC/EMUX.
~689	Reactor isolation complete. After reactor isolation, the next operator action, per the EOPs, is to initiate core makeup water injection, as required to maintain RPV water level above Level 3.
~725	HPCF injection is conservatively assumed to begin 12 minutes after RPV level reaches Level 1.5.
~760	Rising reactor water level reaches bottom of fuel.
~980	Maximum peak cladding temperature of 2098 deg. F is reached.
1 hour	Operator goes to RSS and affects cold shutdown of the reactor..

TABLE 3
SHUTDOWN COOLING LINE BREAK INSIDE CONTAINMENT

T (Sec)	Scenario Description
< 0.0	The SSLC and/or EMUX is postulated to fail in a worst case common mode such that all four safety divisions (a) are unavailable to perform either automatically or manually initiated control actions, and (b) continue to provide information to the operator which indicates that the plant status is normal irrespective of the actual conditions of the monitored plant parameters.
0.0	Shutdown cooling line break inside containment occurs. For the purposes of this analysis, it is assumed that the Feedwater Control System fails and that the only vessel water makeup flow which continues to operate is that from a single CRD hydraulic system pump.
~0.1	Fluid discharge through the break causes loud noises and vibrations which are readily sensed by the operators in the main control room. Drywell pressure reaches high level trip alarm setpoint. Although the SSLC/EMUX associated instrumentation would not indicate this (given the worst case common mode failure postulated), the diverse drywell pressure indication and high pressure alarm would bring to the operator's attention the fact that the drywell pressure is not normal. High drywell pressure is an entry condition into the EOPs.
~1.0	The RPV water level drops to Level 3. Although the displays and alarms which are associated with the SSLC and/or EMUX would continue to indicate normal plant conditions (given the worst case common mode failure conditions postulated for these evaluations), the diverse RPV water level indication and Level 3 alarm would continue to operate properly and bring to the attention of the operator the fact that that the RPV water level is not normal. RPV Level 3 is also an entry condition into the EOPs.
~2.0	RPV water level drops to Level 2. The ATWS functions (diverse from the SSLC/EMUX) are automatically actuated and initiate an automatic scram.
~4.8	Scram complete 2.8 sec. after initiation.
~5	RPV water level drops to level 1.5.
~150	Water level continues to drop and the top of the fuel is uncovered. Fuel heatup begins.
~450	The entire core is uncovered.
~539	It is probable that, observing that no safety actions have been automatically initiated, the operator determines that manual actions, per the EOPs, are needed.
~575	The operator confirms shutdown condition from SRNM displays which are independent of the SSLC/EMUX.
~611	Following the RPV Control procedure of the EOPs, the operator initiates reactor isolation through operation of the MSIV and CUW line isolation valve controls which are independent of the SSLC/EMUX.
~668	Reactor isolation complete. After reactor isolation, the next operator action, per the EOPs, is to initiate core makeup water injection, as required to maintain RPV water level above Level 3.
~725	HPCF and condensate pump injection are conservatively assumed to begin 12 minutes after RPV level reaches Level 1.5.
~850	Rising reactor water level reaches bottom of fuel.
~860	Maximum peak cladding temperature of 1988 deg. F is reached.
1 hour	Operator goes to RSS and affects cold shutdown of the reactor..