UNITED STATES
NUCLEAR REGULATORY COMMISSION
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MEMORANDUM FOR: Roger J. Mattson, Director, Division of Systems Integration, NRR

FROM: L. S. Rubenstein, Assistant Director for Core and Plant Systems, Division of Systems Integration, NRR

SUBJECT: STATEMENT OF STAFF POSITION REGARDING SOURCE RANGE FLUX, REACTOR COOLANT TEMPERATURE, AND STEAM GENERATOR PRESSURE INDICATION TO MEET APPENDIX R, ALTERNATE SHUTDOWN CAPABILITY

As you are aware the Auxiliary Systems Branch (ASB) completed its review of the operating reactor submittals regarding the requirements of alternate shutdown capability as described by Section III.L of Appendix R to 10 CFR 50 by December 31, 1982. In meeting this date it was necessary in several SERs to use the words "we require that the utility provide...." This was particularly true of instrumentation at an alternate location (remote to the control room).

DL anticipates the need to issue orders to some of the licensees to obtain compliance with Appendix R. With this in mind DL has requested that we document the need for source range flux, reactor coolant temperature, and steam generator pressure indication.

Our position regarding this instrumentation is contained in Enclosure 1. For completeness Enclosure 2 provides a complete listing of instrumentation remote to the control room which is needed to comply with Appendix R.

Unless you indicate otherwise we will provide DL with copies of this memorandum.

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ENCLOSURE 1

STAFF POSITION

Section III.L.1 of Appendix R to 10 CFR 50 requires that alternative shutdown capability shall be able to achieve and maintain subcritical reactivity conditions in the reactor. Section III.L.2 of Appendix R to 10 CFR 50 requires provision for direct readings of the process variables necessary to perform and control the reactor shutdown function.

Among the process variables which are to be monitored are: source range flux, reactor coolant temperature, and steam generator pressure. These three have been controversial so we have set forth our basis for concluding that they are necessary in order to meet Section III.L of Appendix R.

Source Range Flux

Monitoring of core flux provides the only direct indication of the reactor shutdown condition. The monitoring of any other process variable would provide an inferred answer only. With regard to the fission process, changes in neutron flux provide the quickest and only direct means of assessing reactor criticality conditions. Dilution events caused by the postulated spurious operation of valves could result in power excursion which would not be readily detected by interpreting the changes in other process variables (such as reactor coolant temperature or pressure). Periodic sampling of the reactor coolant for boron concentration is considered inadequate for determining "real-time" boron requirements. Additionally, should the operators fail to detect a loss of negative reactivity in a timely manner, the capability to prevent a criticality is indeterminate since components needed for such actions may be unavailable due to fire. Thus, provisions for post fire source range flux monitoring are necessary to meet Section III.L.2 of Appendix R.

Oct. 5, 1982

Reactor Coolant Temperatures

The reactor coolant temperatures, in conjunction with the reactor coolant system (RCS) pressure, are essential parameters necessary for plant cooldown and control and, hence, conformance with Section III.L.2 of Appendix R. The plant control elements which rely on accurate reactor coolant temperature indication are natural circulation, upper vessel head voiding, subcooling and pressurized thermal shock concerns.

(1) Natural Circulation: In the natural circulation mode of operation, the difference between the hot leg and cold leg temperatures, (T_H - T_C), provides a direct indication of when the natural circulation condition is established, and whether it is being maintained.

(2) Upper Vessel Head Voiding: During the cooldown process, and as the RCS is depressurized, the upper head region of the reactor vessel (the reactor coolant water and the pressure vessel mass adjacent to it) may not be cooled adequately due to the absence of adequate bypass flow and mixing. This leads to the reactor coolant in that region staying relatively hotter than the rest of the reactor coolant. Therefore, if the RCS is depressurized below the saturation pressure corresponding to that higher water temperature, the water in the upper vessel region will flash forming a steam bubble. If T_H ceases to

decrease, associated with an erratic behavior of the pressurizer pressure and level, it could be inferred that a steam bubble has been formed outside the pressurizer and consequently, measures should be taken to stabilize the system.

T_H indication provides an early warning to guard against bubble formation. Since the T_H RTDs are located several feet above the top of the core, they indicate temperature variations earlier than the incore thermocouples which are located on top of the core.

(3) Subcooling: The degree of subcooling maintained in the system can be indicated by T_H in conjunction with the RCS pressure.

(4) Pressurized Thermal Shock and Appendix G Considerations: T_C, in conjunction with the RCS pressure, provides a direct indication of the plant condition relative to the plant's pressure/temperature limits as it pertains to the Pressurized Thermal Shock considerations and the low temperature overpressure protection as outlined in Appendix G of 10 CFR 50. Due to the collective effect of the Steam Generator conditions (i.e., feedwater flow, steam generator level, steam flow and steam generator pressure) on the primary coolant temperatures, and the inherent lag between the secondary and primary sides conditions especially during transient conditions, T_C may not be accurately inferred from the secondary side steam conditions.

Steam Generator Pressure

During non-power modes of operation, "control" is effected principally by adjusting secondary system parameters (the parameter usually specified by procedures is pressure) to compensate for variances in primary system performance. Maintenance of level in the steam generators may not be sufficient in itself to control the heat removal rate and thereby maintain a "hot standby" or "hot shutdown" mode, or translate from a "hot shutdown" mode to a "cold shutdown" mode. Improper pressure control may cause an imbalance in heat removal which could result in excessive depressurization, the result of which could be generation of an undesired bubble in the primary system (e.g., upper head for all PWRs or candy cane for B&W designs) or rapid cooldown and potential for violation of vessel pressure/temperature limits. For complete monitoring of secondary system heat removal, three secondary system parameters should be known: level (inventory), pressure, and temperature. Thus, provisions for post fire steam generator pressure monitoring are necessary for meeting Section III.L.2 of Appendix R.

Instrumentation Guidelines

Section III.L.6 requires that, "Shutdown systems installed to ensure post-fire shutdown capability need not be designed to meet seismic Category I criteria, single failure criteria, or other design basis accident criteria, except where required for other reasons, e.g., because of interface with or impact on existing safety systems, or because of adverse valve actions due to fire damage." Since the monitors for the above listed parameters will not interface with or impact on existing safety systems, the monitors need not be "safety grade."

Section III.G.3 requires that, "Alternate or dedicated shutdown capability and its associated circuits, independent of cables, systems or components in the area, room or zone under consideration, shall be provided." For a postulated fire, an electrically independent monitoring capability for the above listed parameters should be provided outside the control room.

ENCLOSURE 2

INSTRUMENTATION NEEDED FOR PWR's

a) pressurizer pressure and level,
b) reactor coolant hot leg temperature and either cold leg temperature or TAVG,
c) steam generator pressure and level (wide range),
d) source range flux monitor,
e) diagnostic instrumentation for shutdown systems, and
f) level indication for all tanks used (e.g., CST).

INSTRUMENTATION NEEDED FOR BWR's

a) reactor water level and pressure,
b) suppression pool level and temperature,
c) emergency or isolation condenser level,
d) diagnostic instrumentation for shutdown systems, and
e) level indication for all tanks used.