Roger Mattson

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

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MEMORANDUM FOR: Roger J. Mattson, Director
Division of Systems Integration

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

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

By memorandum dated January 7, 1983, we documented the need for source range flux, reactor coolant temperature, and steam generator pressure indication at an alternate location (remote to the control room). That document was requested by DL in anticipation of the need to issue orders to some of the licensees to obtain compliance with Appendix R.

Since that time, those utilities which obtained copies of our January 7, 1983 memorandum, provided feedback with respect to plant specific considerations, among them, the use of exit core thermocouples (ECTs) versus hot leg temperature RTD's. In addition, we have consulted with various personnel at the Chattanooga Reactor Training Center regarding the staff position. As a result of these discussions, we conclude that the use of ECTs is an acceptable alternative to the use of hot leg temperature RTDs.

Enclosed is the revised staff position regarding the acceptability of ECTs. Other changes are principally editorial in nature.

L. S. Rubenstein

L. S. Rubenstein, Assistant Director
for Core and Plant Systems
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Enclosure:
As stated

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I agree.

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XA Copy Has Been Sent to PDR

Enclosure

## 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 a direct indication of the reactor shutdown condition. The monitoring of other process variables would provide an inferred answer only. With regard to the fission process, changes in neutron flux provides the quickest 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, the provision for post fire source range flux monitoring is necessary to meet Section III.L.2 of Appendix R.

### 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, subcooling and pressurized thermal shock concerns.

(1) Natural Circulation: In the natural circulation mode of operation, the hot leg temperature, cold leg temperature and the difference between the hot leg and cold leg temperatures, ($T_H - T_C$), provide indication by which natural circulation conditions can be determined. In order to verify that natural circulation has been established, normal plant procedures require the operator to use cold leg temperature $T_C$. It has been suggested that the saturation temperature corresponding to the secondary side steam generator pressure $T_{sat}$, will approximate $T_C$. The staff

acknowledges that such a condition can exist if natural circulation is occurring; however, the converse cannot be assumed. Cooldown is usually achieved by the operator controlling the steam generator pressure and auxiliary feedwater flow to the steam generators. Due to the inherent lag in response between the secondary and primary side, $T_C$ cannot be inferred from $T_{sat}$. Natural circulation is normally determined by knowing $T_H$, $T_C$, observing that $T_H$ and $T_C$ are constant or decreasing, and by monitoring ($T_H$-$T_C$). Since normal control room procedures require the use of $T_C$ in confirming natural circulation, emergency procedures should not deviate from this practice. Thus the provision for post fire cold leg temperature, $T_C$ wide range indication is necessary for meeting Section III.L.2 of Appendix R.

(2) Upper Vessel Voiding: (Deleted)

(3) Subcooling: The bulk fluid temperature $T_H$ provides a reliable indication of the degree of RCS subcooling when used in conjunction with the RCS pressure. $T_H$ is also used as a means of verifying natural circulation. It has been suggested that exit core thermocouples (ECTs) provide temperature indications equivalent to $T_H$. ECT readings provide local temperature conditions above the core, and can give representative equivalent $T_H$ provided the individual ECTs are judiciously selected, since ECT readings are dependent not only upon radial positioning, but also local flow rates past the ECTs. Thus, the provision for wide range ECTs is an acceptable alternate to wide range $T_H$ loop RTDs for meeting Section III.L.2 of Appendix R, provided that the licensee demonstrates that their selection of ECTs will result in averaged temperature readings representative of $T_H$. Also, the licensees should demonstrate that under conditions where the reactor vessel upper head void is expanding thus, bringing higher temperature fluid into the outlet plenum and hot legs, the ECTs give a conservative indication of outlet plenum temperature.

(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 and steam generator pressure) on the primary coolant temperatures, and the inherent lag beteen 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 "hot shutdown" mode to "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 the monitoring of secondary system heat removal, two secondary system parameters should be known: level (inventory), and pressure. Thus, provisions for post fire steam generator pressure and level 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 for 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." Thus the monitors for the above listed parameters need not be "safety grade" in order to meet the requirements of Appendix R.

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.

Based on the above, the revised list of instrumentation needed for PWRs is:

a) pressurizer pressure and level,
b) reactor coolant hot leg temperature or exit core thermocouples, and cold leg temperature,
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).

The instrumentation needed for BWRs is unchanged.

| WBS | PROJECT | TA NUMBER | SCHEDULED COMPLETION | STATUS |
|---|---|---|---|---|
| 16.10.001<br>16.12.001 | File Merging and Data Entry Enhancements for Technology Transfer Division<br><br>1. Merge the Reader Service Card file (RPC/RSC) and the NASA Tech Brief Mailing List file (RPC/TTD) into a single file (RPC/TU).<br>2. Implement changes to the data entry program for the new combined file RPC/TU similar to those detailed in Facility report "Improved Data Entry for Technology Transfer Division," February 19, 1982. | 83-24 | 12-28-83 | We are on schedule with the Analysis phase. In the process of establishing routines to readily identify the names in the RSC file to the names in the Tech Brief Mailing List. |
| 16.11.001 | UTS-400 Enhancements<br><br>This task will provide the design and development of software modifications for both RECON and UTS-400 to enhance the previously designed STACKING, STORING, QUERY ALTER/CREATE, and SELECT FORMAT FOUR commands. | 83-11 | COMPLETED | All design and development work on these enhancements has been completed. |
| 16.13.001 | AIAA Data Entry Support<br><br>This task will provide programming support for entry of AIAA data into the IAA file through NOIPS. This support will include any effort incident to the procurement of the necessary equipment for AIAA. | 81-2 | UNKNOWN | This system is production status. The use of the system is being delayed pending a meeting with AIAA personnel. |