UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PENNSYLVANIA 19406-1415

For Action 50-387
50-388
PDR

OCT 10 1991

MEMORANDUM FOR: Jose Calvo, Assistant Director for Region I Reactors
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

FROM: Charles W. Hehl, Director
Division of Reactor Projects
Region I

SUBJECT: PROPOSED TASK INTERFACE AGREEMENT REGARDING THE TECHNICAL ADEQUACY OF SUSQHUEHANNA'S LEVEL/POWER CONTROL ACCIDENT MITIGATION STRATEGY USED IN IMPLEMENTING THE EMERGENCY OPERATING PROCEDURES

Your assistance is requested in determining the technical adequacy of Susquehanna Steam Electric Station's (SSES) accident mitigation strategy for Level/Power Control which differs from the strategy specified by the BWR Owners' Group (BWROG) Emergency Procedure Guidelines (EPGs). The differences between the SSES strategy and the BWROG EPG strategy have been the topic of several meetings between the licensee and NRC headquarters staff.

SSES limits the controlled lowering of RPV water level to -90 inches rather than to the top of active fuel (-161 inches) as specified by the BWROG EPGs. This results in a higher steady state power level being maintained in the anticipated transient without scram (ATWS) condition. SSES also places limits on RPV makeup flow rather than requiring termination and prevention of injection to lower RPV level. The basis for the deviations taken by SSES is to minimize core instabilities.

During the EOP team inspection conducted in April 1990 (Inspection Report Nos. 50-387/90-80 and 50-388/90-80), the inspectors questioned the technical adequacy of the Heat Capacity Temperature Limit (HCTL) curve. The HCTL curve that is used during ATWS conditions was determined based on two loops of suppression pool cooling in service and assumed a time to insert control rods by normal manual insertion. The inspectors questioned whether the curve was appropriate for use with only one loop of suppression pool cooling in service. The inspectors were also concerned that if control rod insertion or boron injection is delayed, the actions identified in the EOPs to reduce pressure may not be sufficient to reduce the energy input into the suppression pool and further reduction in reactor water level may be required.

Enclosed are the sections of the licensee's Plant Specific Technical Guidelines (PSTG) that address the Level/Power Control strategy and the justification for the deviations from the BWROG EPGs. Also enclosed is the HCTL curve used by SSES and the justification provided to the NRC to address the concerns identified during the EOP team inspection.

Memo 4

ADD: Jim Raleigh Ltr. Encl. DF01

The current SSES EOPs are based on Revision 3 of the BWROG EPGs. The licensee plans to implement Revision 4 of the BWROG EPGs in January 1993. We would appreciate your prompt attention to this matter and an assessment by March 31, 1992 so that this concern can be resolved prior to the licensee's implementation of Revision 4 to the BWROG EPGs. The Region I point of contact is Tracy Walker, Senior Operations Engineer, Division of Reactor Safety (FTS 346-5381). This TIA proposal has been discussed with Robert Jones of NRR.

Charles W. Hehl, Director
Division of Reactor Projects

Enclosures:
1. Plant Specific Technical Guidelines (SSES-EPG) and Justification
2. Figure PC-1, Heat Capacity Temperature Limit
3. Justification for HCTL Provided by SSES to NRC

SSES-EPG:C7-1

Control RPV water level subject to the following constraints:

If a conflict exists between the following level and flow steps, the level step will take precedence. In all cases, continue injection from boron injection systems and CRD.

REDUCE MAKEUP FLOW RATE TO
< 5800 GPM ($3x10^6$ LBM/HR) AND
REDUCE RPV WATER LEVEL
UNTIL:
RPV WATER LEVEL IS BETWEEN -60 in. AND -90 in.
OR:
SRVs REMAIN CLOSED

CONTROL RPV WATER LEVEL TO MAINTAIN SRVs
CLOSED BUT ABOVE -90 in.

EPG:C7-1

If:

1. Reactor power is above (3% (APRM downscale trip)) or cannot be determined, and

2. Suppression pool temperature is above (110°F (Boron Injection Initiation Temperature)), and

3. Either an SRV is open or opens or drywell pressure is above (2.0 psig (high drywell pressure scram setpoint)),

lower RPV water level by terminating and preventing all injection into the RPV except from boron injection systems and CRD until either: #26

1. Reactor power drops below (3% (APRM downscale trip)), or

2. RPV water level reaches (-164 in. (top of active fuel)), or

3. All SRVs remain closed and drywell pressure remains below (2.0 psig (high drywell pressure scram setpoint)).

DIFFERENCES AND JUSTIFICATION

The intent of Contingency #7 is to give vessel injection guidance during the Anticipated Transient without Scram (ATWS) scenario that will minimize boron dilution, prevent cold water injection into the core and promote boron mixing. The intent is also to control vessel injection to minimize thermal loading of the containment if the main condenser cannot be utilized as the sole heat sink for reactor power. This is accomplished by reducing RPV water level, thereby reducing the driving head for natural circulation core flow. Reduced core flow will result in increased voiding in the core region, thereby reducing reactor power.

The dual intent of the EPG guidance is maintained by the performance of SSES: C7-1 and C7-2. The difference between the two guidelines is the SSES-specific priority attached to the individual elements of the EPG intent and the extent to which these elements are exercised in the SSES-EPG. Source document 1 was utilized as a guide in this risk/benefit analysis.

The lower limit for level reduction is raised by 71 inches to -90 in. instead of Top of Active Fuel (TAF). This still allows a level reduction of 125 inches from normal water level. This level reduction is 63% of the EPG level reduction and will result in a substantial portion of the proposed reduction of reactor power. Several reasons contributed to limiting level reduction to Level 1. First, source document 2 and related analysis indicate that further level reduction to TAF will result in an additional power reduction of only a few percent. Second, maintaining a higher level will promote increased boron mixing (further diminishing the importance of the "lost" few percent of reactor power decrease). Finally, maintaining the higher level precludes containment isolations and ECCS initiations which would occur at -129 in., including MSIV closure and loss of drywell cooling. Both of these events would seriously impair efforts to prevent containment heatup.

Makeup flow should not be reduced to allow operation below the levels identified above for the following reasons:

- At about -110" the downcomer free area reduces from about 300 ft^2 to 88 ft^2 ($\approx$ 1/3) due to shroud head. This aggravates concerns over Limit Cycle operation. Instrument tolerance and inaccuracy cause the selection of -90" as low end of the band.

- Wide range level instrument goes downscale below -150". Only fuel range indication is left below this level and it is not calibrated for this condition.

- At some level above -129" Drywell Isolations and MSIV Isolation signals will be generated. It is undesirable to receive these isolations because it increases the challenge to Primary Containment and increases the demands on operator action in a critical time period.

The guidance to lower level in a controlled manner to between -60 in. and -90 in. is conservative in the event that predicted core instabilities and level and pressure oscillations do occur. It is anticipated that as level is lowered below -90 in., these instabilities will increase, making it difficult for the operator to control RPV water level and pressure. These instabilities are expected to be well dampened, but uncertainties exist. Therefore, by giving a band in which to control level, containment heatup can be reduced as much as prudent while still maintaining adequate control of the plant.

The second of the three EPG prerequisites to perform the level reduction was deleted. Guidance to lower level (and thus reduce containment heatup) is appropriate even before suppression pool temperature reaches 110°F. This is permissible as the SSES level reduction step is a more controlled evolution than the EPG guidance (terminating all injection) and the operator will not be challenged to maintain MSIVs open. The intent of the other two prerequisites is contained in the instructions which direct the operator to this contingency (SSES-EPG: RC/L-1 Box, Contingency #1 Box, and Contingency #4 Box).

Direction is given to lower RPV water level below -60 in. in all cases where Contingency #7 is entered. This level reduction of 95 inches does allow a substantial reduction of reactor power and suppression pool heatup rate. This level reduction still provides good margin to adequate core cooling and the level at which RPV water level and pressure instabilities are expected to occur.

Guidance to terminate and prevent injection was replaced with specific flow guidance. The full power, MSIV closure ATWS case was analyzed in source document 1. Flow from HPCI, RCIC, CRD and SLC (approximately 5800 GPM or 3 x 10^6 lb/hr-see source document 3) resulted in an initially stable reactor power of 28% and a RPV water level of approximately -60 in. This analysis showed that the reactor was shutdown on boron before any primary containment design parameters were exceeded. Thus if vessel makeup flow was reduced to this value for all ATWS scenarios, the end result would be successful. A note was added to ensure that the level guidance takes precedence over the flow guidance.

All aspects of these deviations from the EPG have been analyzed as part of the Safety Evaluation Report given in source document 4.

<u>SOURCE DOCUMENT</u>

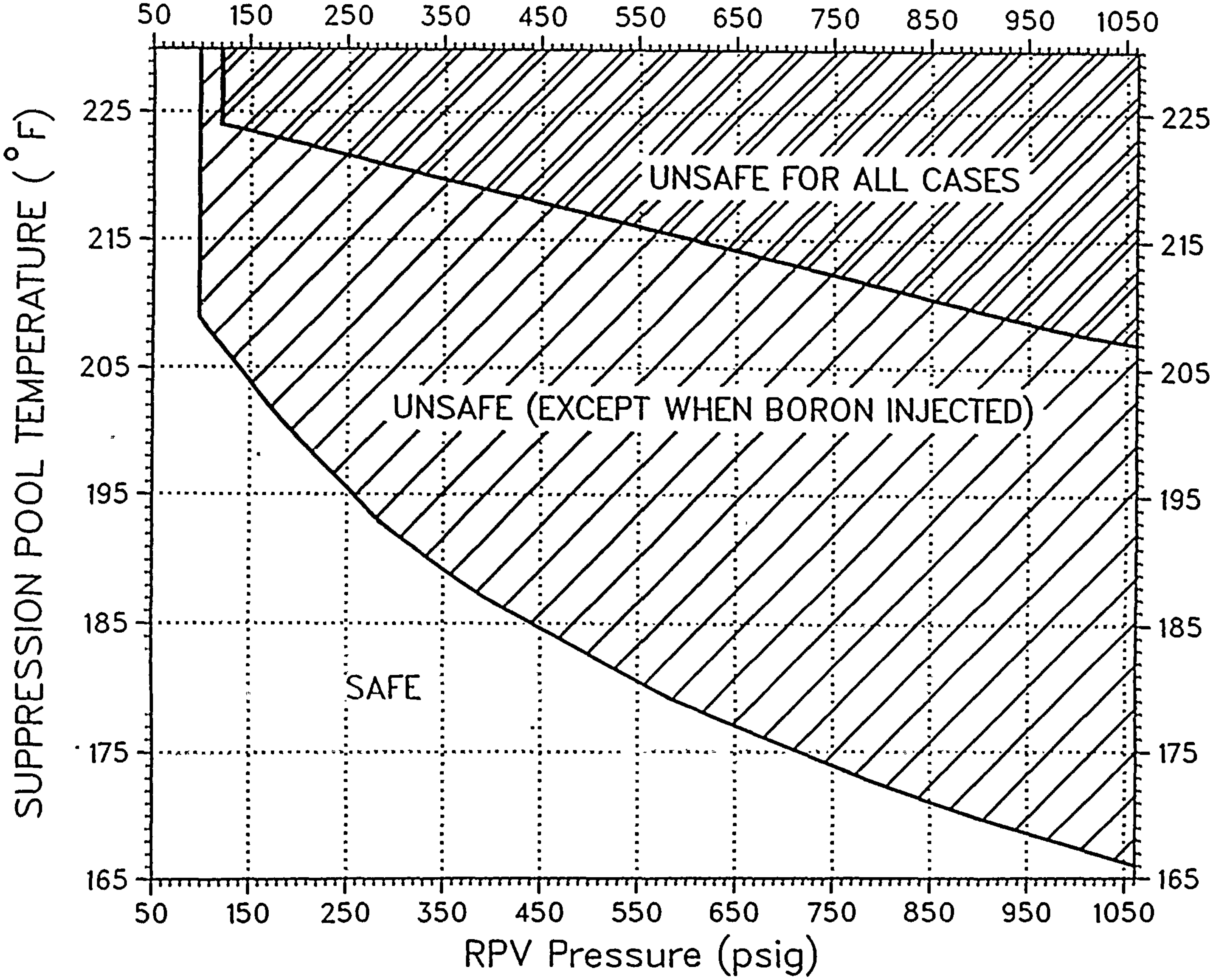
1. P.R. Hill letter PLI-34851, dated 8/13/84

2. M.B. Detamore letter concerning EWR PDSEA202035, dated 1/11/85

3. G.L. Merrill letter PLIS-19009, dated 3/1/85

4. Evaluation of Susquehanna Steam Electric Station Emergency Procedures Relating to ATWS

FIGURE PC-1



HEAT CAPACITY TEMPERATURE LIMIT

Questions have been raised regarding the advisability of the SSES water level strategy during ATWS conditions. Specifically, questions involved the Suppression Pool Temperature Response with less than 2 loops of Suppression Pool Cooling in service and with delayed SBLC injection or delayed manual control rod insertion. It has also been implied that because fewer than 2 loops of Suppression Pool cooling may be available, or because SBLC injection or manual control rod insertion may be delayed, an appropriate strategy might be to reduce RPV water level to TAF in order to reduce heat loads to the suppression pool.

These issues are addressed in section 7.7 of the PP&L IPE which was issued in 1986, and were presented to the NRC in May, 1989. The PP&L strategy regarding level control during ATWS has been to try to preserve both the reactor core and the containment. As was stated on page 7-71 of the 1986 IPE, we are concerned about reactor instability which can be experienced at low RPV water levels, due to the reduced natural circulation flow rate associated with those low levels.

The SSES EOP's require initiation of SBLC before Suppression Pool temperature reaches 110°F. The calculations done for the 1986 SSES IPE indicate that this pool temperature could be reached at T-90 sec. However, even if SBLC is not initiated until T-120 sec. in the worst case situation (i.e., 43 gpm SBLC flow (1 pump) and core bypass), shutdown conditions will be reached before the Suppression Pool reaches the ATWS HCTL (208°F).
In fact, in this worst-case scenario both the PP&L level control and BWROG level control methods allow hot shutdown conditions to be reached with quite a bit of margin to the SSES ATWS HCTL. However, the PP&L strategy also provides additional margin for the reactor stability concern, and PP&L's use of a separate HCTL limit for ATWS conditions reduces the likelihood for depressurizing a critical reactor, which, as is described in the 1986 SSES IPE, is also one of our reactor stability concerns.

Since the 1986 SSES IPE was issued, PP&L has continued to refine its analytical ability in this area. Calculations which were done in support of the latest IPE revision, and which are currently being finalized reveal that even without any suppression pool cooling in service, the PP&L ATWS water level strategy allows hot shutdown conditions to be reached (based on SBLC injection flow of 43 gpm) before the PP&L ATWS HCTL is reached. At this point, a single loop of Suppression Pool cooling will be sufficient to maintain containment parameters below design limits. In the long term, a complete on-going loss of containment heat removal capability will eventually lead to containment failure regardless of which ATWS water level strategy is followed.

In addition, these calculations also show that following depressurization at the SSES ATWS HCTL, reactor power is decreased sufficiently (due to the depressurization) to allow the manual insertion of control rods and thereby achieve hot shutdown prior to reaching containment overpressure conditions.

Item #5: Regarding ATWS water level strategy: It is our understanding that no action is required at the present time.

If you have any further questions on these issues, please let us know.

R. A. Lengel

J. G. Refling

RAL/law