Westinghouse Electric Corporation Energy Systems

Box 355
Pittsburgh Pennsylvania 15230-0355

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: T. R. QUAY

SUBJECT: AP600 RESPONSE TO REQUESTS FOR ADDITION INFORMATION

Dear Mr. Quay:

Enclosed are the Westinghouse responses to NRC requests for additional information pertaining to the AP600 RTNSS initiating event evaluation. Specifically, responses are provided for RAIs 720.366 through 720.370.

These responses close, from the Westinghouse perspective, the RAIs. The NRC should review these responses and inform Westinghouse of the status to be designated in the "NRC Status" column of the OITS. The OITS numbers associated with these RAIs are 4985 through 4989.

Please contact Cynthia L. Haag on (412) 374-4277 if you have any questions concerning this transmittal.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

Enclosure

cc: J. Sebrosky, NRC (enclosure)
W. Huffman, NRC (enclosure)
N. J. Liparuio, Westinghouse (w/o enclosure)

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Enclosure to Westinghouse
Letter NSD-NRC-97-5114

May 7, 1997

Question: 720.366

Westinghouse uses three criteria (p. 3-2) for selecting non-safety-related SSCs, which contribute to initiating event frequencies, for RTNSS. Only those non-safety-related SSCs which satisfy all three criteria will be considered for RTNSS. These criteria are applied to each of the initiating event categories documented in the baseline PRA. Criterion 1 is clear, it simply states that an SSC which was not considered in the calculation of any initiating event frequency will not be considered for RTNSS. Criterion 2 states that an SSC which does not contribute significantly to the frequency of any initiating event will not be considered for RTNSS. Criterion 3 states that an SSC which has a "significant" contribution to any initiating event frequency (determined by Criterion 2) but it does not significantly affect the focused PRA core damage frequency (CDF) and large release frequency will not be considered for RTNSS. The staff have concerns regarding criteria 2 and 3.

a. The word "significantly" in criterion #2 should be defined in terms of CDF and large release frequency (i.e., connected to criterion #3). This is necessary to prevent screening out important SSCs before criterion #3 is applied.

b. Criterion # 3 has been revised (relaxed). The criterion for deciding whether an SSC (found to have a "significant" contribution to an initiating event frequency) significantly affects the focused PRA CDF or large release frequency, has been changed to require 10 percent contribution (instead of 1 percent). This change is justified, according to Westinghouse, based on "risk significance definitions suggested by EPRI and those that are used in maintenance rule applications" and the fact that ".... the nonsafety-related system failure probabilities are already modeled conservatively in the AP600 PRA.." The staff cannot endorse this definition, particularly that nonsafety-related system failure probabilities are already modeled conservatively in the AP600 PRA. Since the screening criteria was originally established at 1 percent, Westinghouse should explain what impact relaxing the criteria has on the screening of potential RTNSS SSCs.

c. Usually "significance" is quantified using more than one importance measures. The reliability/availability of nonsafety-related systems, such as the Chemical and Volume Control System, the AC power and the CCW/SW systems, could be lower than that of same systems at operating plants (failure rates used in the AP600 PRA for these systems are from operating plant histories where such systems are safety related). If it is assumed that a particular SSC (contributing to be frequency of an initiating event) has high reliability/availability, then it may not be as a "significant" contributor to the focused PRA CDF and large release frequency but still be important to plant risk. An example is the RCS leak event followed by failure of the CVCS. As the CVCS reliability/availability (assumed in the PRA) increases the contribution of the RCS leak to the CDF and large release frequency decreases. Therefore, while it can be argued that the contribution to the CDF (or large release frequency) is not significant, it cannot be concluded that maintaining the assumed reliability/availability of CVCS is not important. Please address this issue in screening SSCs, contributing to initiating event frequency, for RTNSS.

d. The criteria proposed by Westinghouse do not account for cumulative effects. In determining "risk importance," the contribution of a nonsafety-related SSC to the total (i.e., from all initiating events) focused PRA CDF should be considered and not individual initiating event contributions.

Response:

a. The RTNSS evaluation was performed without a quantitative threshold for criterion 2. In performing this evaluation, the expectation was (and still is) that any effect on reliability of nonsafety-related SSCs resulting from a degree of regulatory oversight less than that for safety systems would be relatively small. A combination of small (e.g., much less than one hundred percent increase) effects of SSCs on initiating event frequencies (criterion 2) combined with small (ten percent or less increase) effects of initiating event frequencies on CDF/LRF (criterion 3) will always result in relatively small CDF/LRF impacts.

For most initiating events there is no reasonable way to quantify an increase in frequency due to an arbitrarily assumed unavailability of nonsafety-related systems that are necessary for plant operation. The data used for the focused PRA analysis is the same data used for the baseline PRA analysis, and is based upon extensive plant operating experience and industry data. The AP600 initiating event frequencies for events affected by nonsafety-related SSCs are based on this current plant experience with systems similar to those in the AP600. Historical experience for such nonsafety-related SSCs encompasses a range of operating and maintenance practices at current plants. While it could be argued that some of these practices, whether driven by capacity and availability considerations or by regulatory oversight, might result in better SSC availability than may be seen in AP600 without regulatory oversight, it is certainly the case that other current practices result in lower SSC availability. In fact, AP600 SSCs have been designed with the intent of improving on current generation SSCs, based on experience with these systems.

Hence, there is no basis for assigning a penalty factor to initiating event frequencies that are affected by nonsafety-related SSCs, or to otherwise change the focused PRA initiating event frequency evaluation.

The approach taken in the focused PRA was to arrive at a reasonable estimate of the effect of nonsafety-related SSCs on the CDF and LRF through a step-wise logic approach that reflects the pedigree of available initiating event experience data. If unavailability of a SSC is identified as potentially causing an increase in an initiating event, the contribution of the initiating event to CDF and LRF is checked for significance. If the initiating event is not a dominant contributor to CDF or LRF, then it is reasonable to conclude the following: only an extremely large increase in the initiating event frequency could result in a sufficiently large increase in CDF or LRF to affect the ability of AP600 to meet the regulatory goals for RTNSS.

A review of the initiating event analysis submitted in 1993 and again in 1996 shows that only two initiating events received "no" answers to criterion 2. That is, the SSC was screened out based on criterion 2 in only two instances. The basis for the decisions made are stated in the analysis for each event (pages 3-3 and 3-9 to 3-10 of the revised RTNSS initiating event frequency evaluation provided in Westinghouse letter NSD-NRC-96-4869, dated November 4, 1996).

The methodology used in the initiating event analysis is valid based on existing guidance and significant experience to "determine those non-safety SSCs needed to maintain initiating event frequencies at the comprehensive baseline PRA levels." as required by SECY-94-084. Moreover, if the reliability of the important SSCs (those which are significant as defined in the maintenance rule) is found during operations to be less than what is modeled in the PRA, the maintenance rule, which will be applicable to the AP600, will require that

action be taken for the SSCs to restore their reliability. This already existing regulatory oversight helps to keep the contribution of the SSCs to the CDF at the level modeled in the PRA, and helps to "maintain the initiating event frequencies at the comprehensive baseline PRA levels." Additional criteria beyond what has been done for the initiating event evaluation does not provide any additional reduction of risk or other benefit.

Important SSCs are determined with the methodology used in the initiating event analysis submitted to the NRC in WCAP-13856 (September 1993). They are also shown in the reliability assurance program (RAP). The RAP will be used to support the maintenance rule for the operating AP600. The maintenance rule imposes existing regulatory requirements on the reliability of the important SSCs. Thus, there is no further analysis needed to prevent screening out important SSCs before criterion 3 is applied. There are no additional conclusions or insights to be gained from further analysis on the screening criteria. The important SSCs have been presented in the initiating event analysis.

b. The criterion for screening of nonsafety-related SSCs has been established based upon guidance from the industry, judgement based upon extensive experience, and an understanding of the PRA models. Note that the focused PRA CDF is on the order of 10^{-5} per reactor-year, significantly less than the NRC safety goal of 10^{-4} per reactor-year. A 1 percent contribution to focused PRA CDF is thus on the order of 10^{-7} per reactor-year, three orders of magnitude lower than the safety goal. The focused PRA LRF is on the order of 10^{-6} per reactor-year, close to the LRF goal discussed in SECY-95-132. A 1 percent contribution to focused PRA LRF is thus on the order of 10^{-8} per reactor-year. (Note that the AP600 CDF and LRF without credit for nonsafety-related SSCs are lower than the typical corresponding measures for current plants with credit for nonsafety-related systems.) There is no reasonable justification for requiring regulatory treatment of nonsafety-related systems whose contribution is this small. This was recognized during the focused PRA revision, and the criterion 3 screening value was established at 10 percent. This screening value still results in small values of CDF and LRF, given that there are few events in the PRA with the potential for such a contribution.

The statement regarding "conservatism" in the modeling of nonsafety-related system failure probabilities in the PRA was intended to note that system modeling assumptions were, in general, pessimistic, and that more realistic PRA models would, in general, be expected to result in lower failure probabilities than those applied in the PRA. However, any conservatism, or lack thereof, is not the real issue in regard to criterion 3, and it is not necessary for the staff to endorse this "definition" in order for criterion 3, or the methodology in general, to be valid.

Inspection of PRA Tables 52-5 and 52-12 shows the dominance of the ATWS event in the focused PRA and the relatively low importance of the other initiating events, many of which have CDF contributions of only 2 percent or 3 percent. Further consideration of Tables 52-5 and 52-12 indicates that the nonsafety-related SSCs of interest to the significant events are needed to keep the plant running. The reliability of these SSCs will be maintained through the existing regulatory oversight imposed by the maintenance rule, and, more importantly, the need to keep the plant running with high capacity/availability factors.

c. Westinghouse has not concluded, nor implied, that maintaining the assumed reliability/availability of the CVS is not important. While such a conclusion might be reached if the PRA were the only supporting evidence, it cannot be (and has not been) reached, in light of the requirement to operate the plant safely with a high capacity and availability. The CVS is an important system used for RCS makeup at the plant. If the reliability of this system is not maintained, the plant will not be able to operate reliably. The CVS reliability in the PRA is based upon data from existing plants which have similar systems (even though such similar systems were not designed and improved in light of the experience from many years of plant operation, as the AP600 systems have been).

Similar considerations hold for the other nonsafety-related systems noted in the RAI. All are required for power operation with high plant availability and power generation capacity. Maintaining the reliability/availability of each of these systems is important to the operation of the plant, and lack of such maintenance is not a credible scenario.

The relative importance of nonsafety-related systems to AP600 plant risk has been demonstrated in the focused PRA, for which the CDF and LRF without credit for nonsafety-related systems is significantly lower than that for current plants with credit for nonsafety-related systems.

The AP600 PRA includes several different measures of risk importance for systems and components, as well as a number of sensitivities and an uncertainty analysis, to identify the various relationships between the reliability of various systems and components and plant risk. The following additional sensitivity is presented in response to the specific example cited in this RAI.

If the CVS were assumed to be inoperable (i.e., a failure probability of 1.0) upon occurrence of an RCS leak event, then the initiating event frequency would be the same as the modeled leak frequency, or 1.2E-02/year. This event leads to a reactor trip and a challenge to the safety-related systems in the focused PRA models. In this example the at-power focused PRA core damage frequency would then become 1.05E-05 /year, which is an increase of 2.83E-06/year from the frequency reported in the focused PRA (7.67E-06/year). In this case, 27% of the at-power core damage frequency would be due to the RCS leak event. In contrast, the focused PRA results indicate that RCS leak contributes a small amount to CDF/LRF. The contribution could be somewhere in between, but the assumed availability of CVS does not change the need for CVS to be available while the plant is operating.

This hypothetical case illustrates the fallacy in the assumption that additional insight or conclusions can be gained by assuming that a system like CVS, which is required for plant operation, is unavailable in the definition of the initiating event category. The AP600 CVS will need to be operational during plant operations (when an RCS leak could occur). The CVS will be operated in a manner similar to that of the high pressure makeup system in current plants. Thus, the reliability calculated from the historical data is applicable and the failure probability stated in the PRA is a reasonable estimate of the AP600 CVS. As mentioned before, the AP600 CVS is simpler in design than the comparable systems in current plants.

The system modeling, the initiating event definition and resulting significance associated with CVS, and the other nonsafety-related systems, are appropriate and reasonable representations of the AP600 nonsafety-related systems as presented in the AP600 PRA model. An assumption of less reliability for nonsafety-related systems is not supported by the data nor the system design.

d. As explained in other sections of this RAI response, potential contributions to CDF from nonsafety-related SSCs screened by the initiating event frequency evaluation process are expected to be small. The grouping of the initiating events as used in the process is such that particular nonsafety-related SSCs are unlikely to contribute to more than one or two such event groupings. Given these conditions, it is unlikely that the process would miss a potentially significant cumulative contribution from a nonsafety-related SSC screened via the process for each of two different event groups.

   Further, the focused PRA evaluation does account for cumulative effects of nonsafety-related SSCs by modeling a fictitious scenario involving the simultaneous failure of the nonsafety-related plant systems. This modeling increases the overall CDF by a factor of about 40, from 2.3E-07/year to 9.1E-06/year. While this is a significant increase, it does not cause the overall focused PRA CDF (or LRF) to exceed the established targets. Since the initiating event screening process adequately captures nonsafety-related SSCs which could have a significant impact on plant risk, there is no need (and, in fact, no acceptable method) for attempting to quantify an overall nonsafety-related SSC risk importance in terms of effect on initiating event frequency. The appropriate nonsafety-related SSC risk importance and insights have been derived and presented in the focused PRA and the baseline PRA.

PRA Revision: None.

Question: 720.367

Westinghouse's implementation of the proposed approach for the RCS leak initiating event (page 3-4) indicates that RCS leaks are not an important contributor to the focused PRA CDF or large release frequency (criterion #3). Although this is in agreement with what is reported in the latest revision (Revision 8) of the focused PRA, it is a major change from the previous focused PRA results (which showed the RCS leak initiating event to be a very important contributor to CDF). Please explain the reason and bases for this change.

Response:

The RCS leak initiating event category was incorporated into the focused PRA, submitted to the NRC in September 1993. In that version of the AP600 PRA, the failure of CVS was shown as an event tree node and subsequently assumed failed in the focused PRA. Thus, the initiating event frequency for RCS leak for that version of the focused PRA erroneously did not include CVS failure as part of the initiating event frequency.

Later it was recognized that this initiating event definition is not consistent with the other initiating event definitions in the PRA. That is, the initiating event does not occur unless the CVS is not functioning. Consistent with the definition of RCS leak, there will be no reactor trip due to this event unless the CVS is unable to provide sufficient makeup. (RCS leakage in excess of the capability of the CVS is accounted for within the small LOCA initiating event category.) If there is no reactor trip following an RCS leak, because the CVS functioned as expected to provide RCS makeup, there is no initiating event.

The error in the initiating event definition was corrected in the focused PRA, and the failure of the CVS was included in the definition of the RCS leak initiating event. This made the RCS leak event definition consistent with the other initiating event category definitions, in which an initiating event is considered one which leads to a reactor trip or shutdown. If the RCS leak category definition were not revised, it would have distorted the risk profile of the focused PRA by assigning this event an undeserved dominance in the focused PRA core damage frequency. This would mask the true dominant contributors, contrary to the intent of the focused PRA. Moreover, it would have been inconsistent with the other initiating event categories, as discussed above.

This was not a "major change," it was simply the correction of an error which was discovered in the model.

PRA Revision: None.

Question: 720.368

In reference to nonsafety-related SSC contribution to LOCAs, it is stated (page 3-5) that "the contribution of DAS to spurious ADS actuation is much less than that of PMS." Please explain the reason and bases for this statement by referring to design features and related analyses. In addition, the qualitative "much less" statement must be quantified in order to show that DAS-related spurious ADS actuations are not significant contributors to the focused PRA CDF and large release.

Response:

Spurious actuation of ADS leading to Large LOCA is modeled as follows in the focused PRA:

Spurious ADS due to PMS:	4.4 E-05 /year
Spurious ADS due to DAS:	1.0 E-05 / year
Spurious ADS leading to Large LOCA:	5.4 E-05 /year

The PMS contribution to spurious ADS actuation was modeled using a fault tree. The DAS contribution was estimated based on the following:

1. The design specification for DAS requires that no single credible failure shall cause an inadvertent reactor trip or inadvertent ESF safeguards actuation.

2. The design specification for DAS requires that switches used for the DAS manual actuation will be protected from accidental operation by design features.

3. The probability of an operator error resulting in DAS actuation during normal plant operation is judged to be very small, since actuation of multiple switches by the operators is required.

4. A DAS spurious signal due to multiple failures of switches and wires are relatively low probability events. One scenario envisioned as possibly resulting in spurious ADS actuation by DAS is through shorts in DAS components, creating an actuation signal in both lines.

5. Since the DAS is a considerably simpler system in function and design than PMS, consisting primarily of power supply, wires, and switches, spurious actuation of ADS by DAS, if calculated using a fault tree approach, would be expected to have a lower frequency than that of PMS.

Given these observations, it is reasonable to expect that the DAS contribution to spurious ADS would be smaller than the PMS contribution. A value of roughly one-fourth the PMS contribution was used. Using a "same order of magnitude" value for DAS as was calculated for PMS, when the anticipated DAS contribution is small relative to the already low PMS contribution, provides a reasonable level of comfort that the conclusions of the evaluation will not be sensitive to the final DAS design.

PRA Revision: None.

Question: 720.369

The contribution of nonsafety-related SSCs to the focused PRA CDF and large release through their contribution to the frequency of transient initiating events (including "special" initiators, such as loss of CCW/SW and loss of instrument air) was evaluated without accounting for transfers to ATWS and LOCA event trees. In pages 3-9 and 3-10, it is stated that "Since the failure of safety-related SSCs determines if an initiating event develops into an ATWS event, nonsafety-related SSCs do not significantly affect the calculation of the probability of an ATWS...." The staff disagrees with this statement and the rationale used to screen out most transient initiating events. Please re-evaluate the above statement and account for transfers from "transient" to ATWS and LOCA event trees.

Response:

Consequential LOCAs are already accounted for in the initiating event categories they resulted from. These consequential LOCAs are modeled within the intermediate LOCA category. In the PRA models these consequential LOCAs occur as a result of stuck open pressurizer safety valves, after a transient event accompanied by primary valve challenges and subsequent failure to reclose. The frequency of consequential LOCAs is small compared to the frequency of the events they follow from. Further, the consequential LOCA CDF is a small portion of the total CDF. Therefore, given that nonsafety-related SSCs can contribute to consequential LOCA only via the initiating event frequency that causes the challenge to the safety-related pressure safety valves, consequential LOCA is not of concern for this evaluation. Any nonsafety-related SSC contribution of significance is captured via the evaluation for the initiating events.

The ATWS contribution to focused PRA core damage frequency (approximately 90% of the focused PRA at-power total) consists of the summation of contributions from the various initiating event categories. Although an ATWS occurs only if safety-related equipment fails, the rate at which the safety-related equipment is challenged is affected by nonsafety-related SSCs. Unlike the PRA treatment of consequential LOCA, these ATWS contributions are not accounted for in the individual initiating event CDF contributions. The breakdown of initiating event contributions to ATWS from the at-power focused PRA are as noted in Table 720.369-1.

As noted in Table 720.369-1, the response to Criterion 3 is yes for the turbine trip and for loss of 1 or both trains of main feedwater initiating events as a result of their ATWS contributions to focused PRA CDF. Therefore, nonsafety-related SSCs required for keeping the turbine and main feedwater system running for normal at-power operation are important, as measured by the ATWS-related contributions of these initiating events to CDF.

A discussion of proposed regulatory oversight for the nonsafety-related SSCs associated with these events is provided in WCAP-13856.

PRA Revision: None.

Table 720.369-1
Relative Contributions of Initiating Events to ATWS-related Core Damage Frequency in the At-Power Focused PRA

Initiating Event (ATWS Precursor)	% of At-Power Focused PRA CDF Due to ATWS Caused by the Initiating Event	Response to Initiating Event Evaluation Criterion 3	% of At-Power Focused PRA CDF Caused by the Initiating Event from Other than ATWS
Turbine Trip	44.6	Yes	0.60
Loss of MFW	18.3	Yes	0.38
Loss of 1 MFW Train	10.5	Yes	0.22
Loss of CCW/SWS	7.9	No	0.11
Loss of Condenser	6.1	No	0.13
Loss of Compressed Air	1.9	No	0.02
Loss of RCS Flow	1.0	No	0.01
Power Excursion	0.03	No	0.14
Totals:	90.3		1.6

Question: 720.370

The staff believes that the external events risk analyses (fires, floods and seismic) could reveal additional potential important contributors to initiating event frequencies and should be evaluated in identifying candidates for RTNSS.

Response:

The initiating events frequencies for the fire and flood analyses are based on information for which the contribution of safety-related vs. nonsafety-related SSCs cannot be readily determined. Further, these analyses have already demonstrated that potential risk from these events will be very small, even assuming no credit for nonsafety-related SSCs. For the fire analysis in particular, the initiating event frequency evaluation was performed in a scoping manner, such that any initiating event was assumed to affect all equipment located in the area with the fire, with no screening of events based on inability to generate a fire of sufficient size and proximity to affect potential targets. PRA insights related to fire and flooding have been provided to the NRC, and further evaluations would not add new insights.

Seismic events are treated using a seismic margins analysis (SMA), which is not a PRA evaluation. Section 9.0 of WCAP-13856 discusses seismic considerations.

PRA Revision: None.