October 17, 2003

MEMORANDUM TO: Stephen Demback, Chief
Project Directorate, IV-2
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

FROM: Mark P. Rubin, Chief **/RA/**
Safety Program Section
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) REGARDING WCAP-15830-P, REV. 0, MARCH 2003, "STAGGERED INTEGRATED ESF TESTING" (TAC MB9131)

The Probabilistic Safety Assessment Branch (SPSB) has reviewed the subject topical report submitted by the Westinghouse Owners Group. SPSB has identified areas where additional information is needed to complete its review. The Request for Additional Information is provided as an attachment to this memorandum.

ATTACHMENT: As stated.

CONTACT: Martin Stutzke, NRR/DSSA/SPSB
415-4105

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**SPSB REQUEST FOR ADDITIONAL INFORMATION REGARDING WCAP-15830-P, REV. 0, MARCH 2003, "STAGGERED INTEGRATED ESF TESTING"**

1. Section 3.1.2 identifies San Onofre, Units 2 and 3 as having a CE ESFAS design. However, there are no columns in Tables 4.2-1 and 4.3-1 for either of the San Onofre units. Please either provide the missing information or explain why the information has been omitted.

2. Table 4.3-1 summarizes the results of the component classification effort by unit. Explain why the number of components in each of the categories (A-1 through C) varies widely from unit to unit, even among units that have similar ESFAS designs. For example, ANO-2, the Palo Verde units, and Waterford-3 all have CE ESFAS designs according to the information provided in Section 3.1. There are no components in Category A-1 (adjust frequency in PSA model) for ANO-2; however, the Palo Verde units have 22 components each and Waterford-3 has 8 components. Discuss how the level of detail used in modeling affects the results and conclusions.

3. Section 4.5.2.1.1 states "In fact, the only way to derive the value of $\lambda_s$ [standby failure rate] is to have a priori knowledge of the unavailability probability and the test/repair interval." Clarify what is meant by this statement. Both maximum likelihood (e.g., NUREG/CR-4550, Vol. 1, Rev. 1, Chapter 8) and Bayesian methods are commonly used to estimate standby failure rates. NUREG/CR-5485, Table 5-10 provides estimators for standby failure rates specific to common-cause failure.

4. The "intuitive" equation in Section 4.5.2.1.2 (top of Page 4-23) used to describe the average unavailability due to failure-to-start phenomenon assumes that <u>all</u> independent failure events are adequately described using a binomial process (constant failure-on-demand probability) and that <u>all</u> common-cause failure events are adequately described using a Poisson process (standby failure rate). These assumptions are not reasonable and appear to contradict Section 4.5.3, which provides modeling guidance for failure-to-start events for both the "standby model" and the "binomial model." Note that the term Q(t) is not formally defined in the text until Section 4.5.2.1.3. Please clarify what the equation is intended to demonstrate.

5. Please justify the use of a constant failure-on-demand probability (binomial model) for components addressed by the integrated ESF test. The proposed test intervals (up to three years in some cases) seem excessively long and use of a time-dependent probabilistic model (e.g., a Poisson process described with a standby failure rate) may be more appropriate. The justification would be enhanced by either providing or citing relevant statistical studies, engineering analyses, or similar references.

6. Section 4.5.2.1.3 (bottom of Page 4-23) states "Simply testing the ability of the component to start-on-demand without attendant tasks to address latent phenomena eliminates the benefit of the standby failure model." Footnote 1 to this section explains that the term "latent phenomena" includes items such as lubricant hardening, metal fusing, dry out of packing, loosened connections due to vibration, etc. Please clarify what is meant by the statement, considering the following observations:

a. The only outcomes of an integrated ESF test are either “pass” or “fail.” Such tests may detect certain types of degradation (e.g., a diesel generator starts but does not load within the required time); however, test instructions usually provide explicit directions for determining when to treat such degradation as a failure.

b. If the stochastic process leading to failure is characterized using a constant standby failure rate, then that process must be a Poisson process. Since a Poisson process has no memory, there is no difference between the concepts of “good-as-new” and “good-as-old.” The same conclusion holds true for a binomial process. Therefore, neither of the commonly used stochastic models are capable of relating the degree of degradation to the probability of failure.

7. Section 4.5.2.1.3 (top of Page 4-24) states “Without rigorously running as-found tests (as tends to be the case)...” This statement implies that integrated ESF tests are usually conducted only after preventative maintenance (i.e., usually only as-left tests are performed). Appendix A to 10 CFR Part 50 (General Design Criteria 18, 37, 40, 43, and 46) indicates that one of the main purposes of integrated ESF testing is to confirm “...the operability of the systems as a whole and, **under conditions as close to design as practical** [emphasis added], the full operation sequence that brings the systems into operation...” While as-left tests are useful in confirming that maintenance has been correctly performed, they do not indicate that ESF systems would have successfully operated if no preventative maintenance had been performed prior to the test. Does the statement in Section 4.5.2.1.3 reflect the actual policies and practices of one or more of the plants addressed by WCAP-15830-P? It is suggested that the statement be clarified to avoid possible misinterpretations and casting doubts on the efficacy of integrated ESF testing.

8. Section 4.5.2.1.3 (Pages 4-24 through 4-26) concludes that there should be no change in common-cause failure (CCF) probabilities when converting from a sequential (non-staggered) test policy to a staggered test policy. The term “staggered test policy” means testing one, and only one, ESF train during each refueling outage unless the tested train fails, whereupon the remaining trains would also be tested. Perhaps a more revealing description of the proposed testing policy is “staggered-and-stretched” since the time between planned tests of a given train increases. In essence, the staggered-and-stretched test policy is equivalent to deleting some of the tests conducted under a non-staggered test policy.

The conclusion that there should be no changes in CCF probabilities was reached through a two-fold argument. First, given that the standby failure rate model applies, the total component unavailability, $Q_T$, is proportional to the testing interval (e.g., doubling the test interval doubles the total unavailability). Second, the conditional probability of CCF given a single component failure depends on the testing policy. Section 4.5.2.1.3 justifies the second argument by reproducing a demonstration presented in Section A.3 of NUREG/CR-5485. The intent of that demonstration was to illustrate the fact that the test policy (non-staggered or staggered) must be considered when estimating CCF parameters. Specifically, the demonstration concerned a two-train system where CCF is modeled using the beta-factor approach. Statistical estimators (maximum likelihood) of the beta factor were developed for both test policies. The demonstration showed that the ratio of the beta factor estimator for the non-staggered test policy to the beta factor estimator for the staggered test policy is approximately equal to 2. Combining the two arguments (the total unavailability increases by a factor of 2, and the beta factor decreases by a factor of 2) suggests that the CCF probability remains unchanged when adopting the staggered-and-stretched test policy.

The NRC staff believes that the report authors have misinterpreted the demonstration provided in Section A.3 of NUREG/CR-5485. The point of the demonstration was to illustrate how test policy impacts CCF parameter estimators. The demonstration does not prove, nor claim to prove, that adopting a staggered test policy reduces the likelihood of CCF. NUREG/CR-5460 presents engineering oriented methods (cause-defense matrices) for crediting defenses against CCF. This report notes that a staggered test policy is weakly effective at reducing CCF due to certain human-related failures introduced during test and maintenance activities (e.g., repeating an erroneous action on multiple equipment trains). The report also explains why other types of CCF mechanisms (e.g., environmental effects) are not reduced or eliminated by adopting a staggered test policy.

Please provide an engineering oriented rationale for why the CCF potential (and, hence, CCF parameters) should decrease when a staggered-and-stretched test policy is adopted. The cause-defense matrix methodology in NUREG/CR-5460 is one example of an acceptable approach. Relevant data, assumptions, and calculations should be provided for review.

9. Please identify the exact source of CCF data used by each plant addressed in the report. The NRC staff believes that ASME RA-S-2002, Supporting Requirements DA-D6 and DA-D7 for Capability Category II should be addressed.

10. Concerning the load shed and breaker modeling issues discussed in Section 4.6, please address the following items:

    a. Identify by name which plants required adjustments to their PRA logic models to incorporate the diesel generator dependency on the load shed function.

    b. What is the correct interpretation of the base CDFs and LERFs presented in Table 5.2-1? Do these values incorporate modeling changes needed to address the load shed issue?