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NUCLEAR REGULATORY COMMISSION
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MEMORANDUM FOR: Thomas E. Murley, Director
Office of Nuclear Reactor Regulation

FROM: Eric S. Beckjord, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER NO. 160, "EVALUATION OF RISKS ASSOCIATED WITH AOT AND STI REQUIREMENTS AT NPPs"

References:

1. P.K. Samanta, et al., "Evaluation of Risks Associated With AOT and STI Requirements at the ANO-1 Nuclear Power Plant," NUREG/CR-5200, August 1988.
2. EDO Task Group, "Technical Specifications - Enhancing the Safety Impact," NUREG-1024, November 1983.
3. Memorandum from the EDO to Director, NRR, "Report by the Task Group to Study the Design of Surveillance Testing in Technical Specifications (NUREG-1024)," November 14, 1983.
4. Memorandum from the Director, NRR, to T.P. Speis, NRR, "Formation of a Technical Specification Improvement Project," December 31, 1984.
5. D.H. Beckham, et al., "Recommendations for Improving Technical Specifications," NRR Internal Report, September 30, 1985.
6. W.E. Vesely, "Procedures to Define Numerical Criteria to Assess Risks Associated with Technical Specification Modifications," BNL Technical Report, A-3230, 6-5-86, June 1986.
7. Memorandum from R.J. Barrett, NRR/PRAB, to E.J. Butcher, NRR/OTSB, "Surveillance Testing Not At Power," June 17, 1988.

This Research Information Letter transmits a method and an example of an evaluation of technical specifications at nuclear power plants (NPPs) from a risk analysis viewpoint (Ref. 1). In this example, Brookhaven National Laboratory (BNL) used an existing PRA of Arkansas Nuclear One - Unit 1 (ANO-1) and the technical specification analysis methods that BNL developed to evaluate the risk significance of allowed outage times (AOTs) and surveillance test intervals (STIs). Technical specifications exist for the purpose of maintaining plant safety; however, individual requirements for AOTs and STIs do not necessarily contribute equally to the overall level of safety. Through the techniques of risk analysis, individual contributions of specific AOTs and STIs can be quantified and compared, as to relative importance, and possible changes to the technical specifications can be evaluated as to the extent they would increase or decrease a plant's core damage frequency. Detailed results of this study are described in the enclosed NUREG/CR report (Ref. 1).

Regulatory Issue

In August 1983, the Deputy Executive Director for Regional Operations and Generic Requirements created a task group to study the issues of surveillance testing in technical specifications. The purpose of the task group was to identify the scope and nature of problems with current surveillance testing and to develop alternative approaches that would provide better assurance that surveillance testing did not adversely impact safety. The report of the task group (Ref. 2) discussed many problems with the current set of technical specifications, and the EDO assigned to NRR (Ref. 3) the lead to develop and implement a program that would accomplish the intent of the task group's recommendations. In that memorandum, RES was designated to provide technical and analytical support to NRR.

In December 1984, the Director, NRR, chartered (Ref. 4) the Technical Specification Improvement Project (TSIP) to reconsider the entire area of technical specifications to develop recommendations and changes needed to implement the task group recommendations. The TSIP soon expanded the scope of the task group report to include AOTs in addition to STIs, and RES was requested to address the importance of the technical specifications from a risk perspective. Specifically, RES was asked to perform a technical evaluation of a complete set of technical specifications of a plant with an existing probabilistic risk assessment (PRA). The BNL work, summarized below, provided this analysis and the results were incorporated into the TSIP final report (Ref. 5). One of the TSIP primary recommendations was for further research in this area.

Research Results

The impacts for evaluating AOT and STI requirements were calculated using core damage frequency (CDF) as the measure for comparisons. Using the ANO-1 technical specifications as an example, BNL found that, except in a limited number of cases, the PRA risk contributions attributed to the AOT and STI technical specifications were small (generally by at least two or three orders of magnitude) compared to other PRA risk contributions. For example, 79% of the AOTs for maintainable components had yearly averaged 1/ CDF contributions of less

1/ Note: The general insignificance of these contributions to CDF is based on the concept of projected yearly AOT risk, which considers the frequency of occurrence of different downtimes allowed by technical specifications, the different test intervals allowed by technical specifications, and the different component statuses allowed by technical specifications. This concept is similar to the calculations performed in PRAs for average yearly AOT contributions to CDF associated with technical specifications, except that PRAs use average repair times rather than AOTs. This results in slightly lower contributions. In general, the reason for the lack of significance is low frequency of occurrence. Another measure of risk that was explored is that of single downtime AOT contribution to CDF. This is similar to the other two except that it is conditional on the component being out of service (i.e., the frequency of occurrence is set to 1.0), which results in a larger PRA contribution than either of the other two measures.

than 10^{-7}; doubling the AOT of these components only reduced this to 73%. Similarly for STIs, 53% of the surveillance tests had a CDF contribution of less than 10^{-7}/yr; quadrupling the STI of these components only reduced this to 49%.

The implication of this finding is that technical specifications can be relaxed in many areas with little adverse effect on CDF. However, even though in most cases the CDF contributions associated with AOT and STI technical specifications may be small, in some individual cases the projected CDF contributions can be significant. For example, when reviewing a Commonwealth Edison submittal requesting changes to the Byron technical specifications, some of the projected CDF contributions from AOTs for diesel generators and pumps (e.g., essential service water and auxiliary feedwater) were calculated to be on the order of 10^{-4}/yr. A similar situation was observed concerning AOTs for the Limerick HPCI and RCIC pumps. For ANO-1, 10 to 15% of the AOTs and STIs were significant CDF contributors. It should be noted that the PRA models used in this study to evaluate the CDF contributions were from the 1982 Interim Reliability Evaluation Program Analysis of ANO-1, and more up-to-date plant models could give somewhat different results. Even so, these findings imply that in individual cases the CDF contributions associated with technical specifications, particularly from allowed downtimes, can be significant. Preliminary criteria have been developed by BNL for staff evaluation to discriminate those technical specifications (current and/or proposed) which have the potential for high CDF contributions from those which have relatively low CDF contributions (Ref. 6).

Another closely allied finding was that different components that have the same technical specification AOT and STI requirements can also vary in their CDF contributions by large amounts of four or five orders of magnitude. In fact, the study developed a histogram that clearly shows the distribution of technical specifications over this range. This finding supports a growing perception that there is a broad inconsistency among the individual technical specifications with regard to their risk control. The reason components exhibit greatly varying CDF contributions is because of the greatly varying risk importances of similar components in different applications. Since present technical specifications do not reflect the risk importances of components, both plant-specific technical specifications and standardized technical specifications could be improved to make them more effective and consistent from a risk perspective. Efforts to consummate this are being pursued under the leadership of NRR's Technical Specification Branch (OTSB).

Regulatory Implications

The results of the example based on the ANO-1 PRA show that the CDF contributions from present AOTs and STIs can vary by large factors of from 10,000 to 100,000. This wide range of variation indicates the wide range of the risk importance of present AOTs and STIs. The CDF contributions from specific AOTs and STIs can be used to prioritize those components which should be focused on for inspection activities, personnel training, and reliability program activities that are involved with surveillance testing and corrective maintenance.

For regulatory applications, it is especially important that for maintainable components with low contributions to CDF, all three measures of AOT contributions to CDF (i.e., single downtime, projected yearly, and average yearly) due to repair are low. This implies that the increase in CDF when any of these components are down is insignificant and other parameters (e.g., repair time and maintenance frequency) cannot cause the risk to be significant. Recently, the enclosed report was used by NRR and its contractors to address the question of surveillance testing at power. The ANO-1 report shows that about 35% of the required STIs contribute so little to improving risk that it would make little sense to conduct surveillance at power and possibly cause inadvertent scrams. It also shows, however, that the CDF contributions associated with testing of much of the large equipment (including diesel generators) is around 10^{-5}/yr; and NRR/PRAB estimated (Ref. 7) that if the STIs for such equipment were extended to 18 months (to avoid testing at power), the risk contribution would increase to a value of about 10^{-4}/yr. Thus the report and methodology described here is directly applicable to current regulatory issues.

This methodology also has other applications. For example, the TSIP concluded that the AIF/NUMARC deterministic criteria to establish the scope and content of the technical specifications were not sufficient. Risk analysis studies clearly showed that the AIF/NUMARC criteria originally proposed needed to be augmented to include some additional systems. OTSB and all four owners' groups are currently involved in rewriting the standard technical specifications, based on the augmented AIF/NUMARC deterministic criteria, as well as risk-based methods for establishing some STIs.

Further Work

This study is one aspect of the scope of the Procedures for Evaluating Technical Specifications (PETS) project in RES, which was established in response to an EDO memorandum that RES provide support to NRR to assist them in carrying out the task group recommendations in NUREG-1024 (Ref. 2). NUREG/CR-4810 was published in May 1987 and stated that the current method of adaptive (accelerated) testing concerning emergency diesel generator STIs is generally counterproductive. [This finding was pursued under another RES program that developed technical guidelines for emergency diesel generator reliability programs, NUREG/CR-5078.] Updated reports will soon be published on the following subject areas: (a) technical guidelines for preparing and reviewing licensee AOT and STI submittals, (b) a methodology manual for evaluation of AOTs from a risk and reliability standpoint, and (c) a synthesis of regulatory implications in establishing allowed cumulative outage times for components.

Two main activities are underway during the current fiscal year. One of these involves development of methodology and criteria for a real-time risk-based configuration control system, to better regulate the risk associated with various component outage configurations during plant operations. This activity is being carried out in cooperation with NRR/OTSB, which is exploring the long-range feasibility of converting the fundamentally prescriptive nature of the current technical specifications to more flexible regulation through performance-based principles. The other main activity is directed toward methodology development and example application of an integrated (plant-wide) surveillance program, using insights gained from previous PETS efforts - including the enclosed report. As indicated above, the PETS project will be working closely with OTSB throughout the duration of research in this area.

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Enclosure:
As stated