September 4, 1985

RULEMAKING ISSUE

SECY-85-163A

(Notation Vote)

FOR: The Commissioners

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: STATION BLACKOUT, UNRESOLVED SAFETY ISSUE (USI) A-44

PURPOSE: To provide the Commission with the staff's evaluation of a Nuclear Utility Group's proposal for the resolution of USI A-44, and additional recommendations regarding issuance of the proposed Station Blackout rule (SECY-85-163).

SUMMARY: The staff has evaluated a May 8, 1985 submittal from the Nuclear Utility Group on Station Blackout (NUGSBO) entitled "Proposal for Resolution of USI A-44 (Station Blackout)". NUGSBO's position is that rulemaking on station blackout is not required to resolve USI A-44 because they conclude that "station blackout does not represent a significant risk to public health and safety." NUGSBO proposes voluntary industry initiatives that would provide improved protection of the capital investment in nuclear power plants by enhancing AC power reliability, and recommends that, as an alternative to rulemaking the Commission issue a policy statement indicating its support of the proposed voluntary industry initiatives. This would be followed by NRC and industry working together to develop and implement within a 2-4 year period "an integrated resolution process for ultimate resolution of station blackout and other power-related issues."

For the reasons discussed below, the staff has concluded that the initiation of the proposed rulemaking should not be further delayed, but that the Notice of Proposed Rulemaking should acknowledge the NUGSBO proposal and encourage further development of industry initiatives during the public comment period.

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BACKGROUND: On May 6, 1985, the staff submitted a proposed rulemaking package (SECY-85-163) to obtain Commission approval for publication of a proposed rule on station blackout. In that Commission paper we noted that a Nuclear Utility Group on Station Blackout (NUGSBO), representing approximately 25 utilities, was preparing an alternative resolution of USI A-44 that would avoid rulemaking because, in their opinion, rulemaking on station blackout is unnecessary. We requested that the Commission not schedule meetings on this matter until the staff received NUGSBO's proposal and forwarded to the Commission its evaluation of the industry's submittal. On May 8, 1985, the staff received NUGSBO's proposal entitled "Proposal for Resolution of USI A-44 (Station Blackout)" (Enclosure 1). The staff met with NUGSBO on May 22, 1985, and requested, at that meeting, that NUGSBO submit the analyses that supported the group's conclusions and recommendations. NUGSBO submitted a draft report on May 23rd and a final report on June 5th entitled "Estimation of Site-Specific Station Blackout Core Damage Frequency Using NRC Staff Methodology" (Enclosure 2). On May 28th representatives of the utility group met with the NRC Executive Director for Operations (EDO) for further discussion, and on July 17th NUGSBO sent a follow-up letter to the EDO that contained some clarification of the group's proposal (Enclosure 3). The staff's evaluation of NUGSBO's proposal is presented below.

DISCUSSION: NUGSBO's position is that rulemaking is not necessary to resolve USI A-44, because they conclude that "station blackout does not represent a significant risk to public health and safety." NUGSBO proposes industry initiatives that would provide improved protection of the capital investment in nuclear power plants by enhancing AC power reliability, and claims that "if such initiatives are embraced by industry, they will also increase the current level of safety associated with station blackout events." At a meeting, on May 22, 1985, NUGSBO presented the technical background for their submittal to the NRC, "Proposal for Resolution of USI A-44 (Station Blackout)." The information discussed at the meeting consisted mainly of four tables (Tables 1, 2, 4 and 5 in Enclosure 2) which presented the frequency of core melt as a result of station blackout for 52 nuclear plant sites. These tables were prepared utilizing the staff's methodology in draft NUREG-1032, "Evaluation of Station Blackout Accidents at Nuclear Power Plants." The four tables are described in the following paragraphs.

Table 1 presents the calculated frequency of core melt for the 52 sites based on the factors proposed by the staff. These factors include diesel generator configuration and reliability; grid, switchyard and weather characteristics for each site; and capability (hours) for coping with a station blackout. Core melt frequencies are presented assuming plants have a 4-hour, 2-hour, or no capability to cope with a station blackout event (e.g., maintain core cooling with AC power unavailable). NUGSBO obtained the diesel generator configuration data for each site from a published staff contractor report (NUREG/CR-2989) and from the licensee responses to Generic Letter 84-15.

The diesel reliability assumed was a site-averaged reliability based on the individual diesel generator reliabilities reported by the licensees in response to Generic Letter 84-15. None of the 52 sites indicated a site-averaged diesel generator reliability of less than 0.95 per demand, although some licensees had reported individual diesel generator reliabilities below this level for the last 100 starts in response to Generic Letter 84-15. In some cases, NUGSBO adjusted the reliabilities upward because licensees made corrections or improvements to their emergency diesel generators. In these cases, NUGSBO used the number of failures in the last 20 starts, instead of the last 100, to represent current reliability levels.

The site-specific grid, switchyard and weather characteristics were obtained from various staff and contractor reports and National Oceanic and Atmospheric Administration climatological reports. Using these inputs, NUGSBO then obtained the core melt frequency estimates from tables containing the results of staff parametric calculations presented in Appendix C of draft NUREG-1032 (Enclosure 4 of SECY-85-163).

For an assumed coping capability of four hours, 12 of the 52 sites have an estimated core melt frequency from station blackout events of greater than 1×10^{-5} per reactor-year. The staff's proposed Regulatory Guide (Enclosure 3 of SECY-85-163) would indicate that such sites should have a coping capability of eight hours to reduce the core melt frequency from station blackout to the desired range. (By reviewing existing probabilistic risk assessment studies for a number of plants, the staff determined that in order to keep station blackout a relatively small contributor to total core melt frequency, core melt frequencies from station blackout events alone should be about 1×10^{-5} per reactor-year

or less. This desired range was based upon a review of operating experience, practically achievable reliability of offsite and onsite emergency AC power systems, variations over time in AC power reliability and from site to site, and the potentially severe consequences of a station blackout because of limited decay heat removal capability and no containment heat removal capability without AC power.) For the remaining 40 sites, a four-hour coping capability would be needed to achieve the desired core melt frequency range from station blackout.

Table 2 of the NUGSBO report is similar to Table 1 with the exception that the "Cluster Group" approach used by the staff in NUREG-1032 to simplify the generic discussion was replaced by an analysis of the specific characteristics for each site. In Table 2 (and subsequent tables) information was presented for only sites 1 through 22 (the primary sites of interest) and sites 35 and 39 (additional data points). Table 2 indicates no significant change in the information presented in Table 1, and would indicate a similar grouping of plants in the four- and eight-hour capability groups.

Table 4 is similar to Table 2 with the exception that slightly revised data, based on an Electric Power Research Institute report ("Loss of Offsite Power at U.S. Nuclear Power Plants - All Years Through 1984," NSAC-85), were used to determine the frequency of losses of offsite power. Some reduction in core melt frequency is noted, but the overall results are not changed significantly from Table 2.

Table 5 presents the main thrust of the information used by NUGSBO to support their position on station blackout. This table is based on using only data for the losses of offsite power for the years 1979 thru 1983. NUGSBO stated that the more recent data indicate there has been a significant improvement in the frequency of losses of offsite power, and that for various reasons, these data are more indicative of the systems today. The industry-average loss-of-offsite-power frequency (only seven events in the five years) was assumed to be applicable to all sites in Table 5. This resulted in almost a decade decrease in the estimated station blackout core melt frequencies for some sites. The following results were obtained using these assumptions:

(1) For an assumed four-hour coping capability, the estimated frequency of core melt from station blackout would be less than 1×10^{-5} per reactor-year for all sites.

(2) For an assumed two-hour coping capability, there are 11 sites in the range from 1.1 to 1.5×10^{-5} per reactor-year. These plants would approximately meet the staff's general objective for core melt frequency from station blackout. The other plants would have smaller frequencies.

(3) Plants with no coping capability would have an estimated core melt frequency greater than 1×10^{-5} per reactor-year. For the 24 plants tabulated, the range is from 2.1 to 9.6×10^{-5} (i.e., the frequency of a station blackout event).

It should be noted that NUGSBO's analysis is based on the methodology and calculations in draft NUREG-1032 which already gives credit for recent reductions in frequency of losses of offsite power, specifically for plant-centered losses. The staff has concluded that there probably has been a decrease in the frequency of these events as operating experience has increased. Therefore, the staff's analysis included about a 30 percent reduction in the frequency of the plant-centered losses compared to the actual observed frequency. Statistical analysis of the data did not show a comparable decrease in grid- or weather-related losses of offsite power.

It is NUGSBO's position, based on the information in Table 5, that rulemaking is not required, since they believe that all plants currently have at least a two-hour coping capability and thus, given the assumptions on loss-of-offsite power and diesel generator reliability in Table 5, would meet the proposed staff target of about 1×10^{-5} per reactor-year.

NUGSBO has proposed voluntary industry initiatives to assure that diesel generator reliability is maintained, and that appropriate procedures are developed together with operator training for restoring AC power and coping with a station blackout event. The NUGSBO proposal does not include a commitment by licensees to assess the capability of their plants to cope with a station blackout for two hours (or any other time). NUGSBO has recommended that the Commission issue a policy statement indicating its support of the

proposed voluntary industry initiatives, rather than a notice of proposed rulemaking.

The staff's view is that NUGSBO's proposal is based on a very optimistic assessment of recent data for losses of offsite power and the assumption that licensees will maintain diesel generator reliability greater than 0.97 per demand for most plants (and in many cases greater than 0.99 per demand) over the 40-year life of the plant. Although the offsite power data for the five-year period from 1979 through 1983 is favorable, there is no assurance that this level will be maintained over the next 20 to 40 years. Also, since construction of new power plants has decreased, it is possible that more losses of offsite power will occur as the grid reserve margins decrease with the overall increase in power demand in future years. An event such as occurred in the Northeast Blackout of 1965 would, in the future, involve many nuclear plants, and the statistics for loss of offsite power could then change dramatically with the occurrence of just one grid failure. The staff has requested comments from the Department of Energy (DOE) and the North American Electric Reliability Council (NERC) on loss-of-offsite-power experience and expectations for future trends in electric transmission system reliability. A copy of the NERC response is provided in Enclosure 4. Their general conclusion is that it is difficult to predict the frequency of grid disturbance in the future based on recent past experience.

Even if the optimistic assumptions used in Table 5 were accepted, most plants would need to have a station blackout coping capability of about two hours to achieve a core melt frequency of about 1×10^{-5} per reactor-year. (The staff recognizes that a few plants with unusually high redundancy configurations of on-site power sources might achieve the objective with coping capabilities of less than two hours.) Without rulemaking, however, there is no basis in NRC's regulations to require a showing of such capability. Based on the generic plant analyses performed for USI A-44, the staff agrees that many licensees should be able to show they have this capability. (In fact, for the value-impact analyses in Enclosure 2 of SECY-85-163, the staff assumed that all plants can cope with a station blackout for two hours.)

The gist of NUGSBO's conclusion regarding rulemaking seems to be that if all plants can withstand a two-hour station blackout event, then the frequency of core melt from such events is acceptably low; and therefore there is no need for the proposed rule. Since the principal thrust of the proposed rule is to require that licensees determine that their plants can withstand blackout events of an acceptable duration, the logic of NUGSBO conclusion seems questionable. The proposed rule does not specify a particular duration. The associated draft Regulatory Guide does present a simple methodology that would lead to selection of either a four- or eight-hour duration, but allows plant-specific justification of shorter durations as well.

As noted above, NUGSBO's conclusion regarding the generic acceptability of a two-hour coping capability depends on projections of recent loss-of-offsite power data that the staff believes are optimistic. The staff is concerned that for many plants a blackout capability of only two hours would leave very little margin for potential degradations in grid reliability or diesel generator reliability that may occur, in spite of good-intentioned voluntary industry initiatives to maintain and improve them. The core melt frequencies in NUGSBO's document are the result of staff "best estimate" calculations and no consideration is given in the NUGSBO document to the uncertainties pointed out by the staff in NUREG-1032. In the proposed rulemaking package, the staff has included a discussion in the Regulatory Analysis (Enclosure 2 of SECY-85-163) of uncertainties and other non-quantified considerations.

NUGSBO proposes that each utility would implement voluntarily a plant-specific program designed to enhance AC power reliability, described as follows (see Enclosure 1).

> "The industry initiatives embodied in each program will include the following actions, as appropriate:
>
> 1. Ensuring the adequacy of practices or procedures and training for the restoration of AC power to necessary systems;
>
> 2. Ensuring the adequacy of procedures and training for operators to cope with plant response to a station blackout event;

3. Post-failure evaluation and correction of the root cause of losses of individual AC power sources;

4. Ensuring the adequacy of severe weather procedures (hurricane and tornado);

5. Reducing the frequency of emergency diesel generator cold fast starts through changes in technical specifications and/or the addition of pre-heat systems;

6. Supporting industry groups regarding development of (1) guidelines designed to improve diesel generator performance (e.g., IEEE) and (2) methods for more accurately and realistically assessing diesel generator reliability in the context of station blackout (e.g., NSAC); and

7. Industry evaluation of significant events relating to AC power reliability."

These proposed voluntary industry initiatives, although lacking in detail, appear to include many of the elements in the staff's proposed resolution of USI A-44, as reflected in the proposed Regulatory Guide (Enclosure 3 of SECY-85-163). Further development of such initiatives should be encouraged.

If NUGSBO, or some other industry organization, were to develop more detailed standards for voluntary programs to improve and maintain diesel generator reliability and ensure the adequacy of procedures and training related to station blackout events that could be endorsed by the staff, and committed to by all licensees, then it might not be necessary to issue those portions of the proposed Regulatory Guide.

The proposed voluntary program does not include an industry commitment to determine the station blackout coping capability for each plant. The staff believes such an assessment (which would be required by the proposed rule) is necessary for the development of meaningful station blackout procedures and evaluation of their adequacy.

In a letter to W. J. Dircks, dated July 17, 1985 (Enclosure 3), NUGSBO reiterated its position and provided some additional comments on three aspects of their proposal. With regard to the extent of industry support of the NUGSBO proposal, they state that the proposal "has been agreed to by all of the nation's nuclear utilities with the exception of three which are still considering it." With regard to the seven suggested industry initiatives (noted above), the NUGSBO letter provides some additional discussion of the objectives of each. With regard to the capability of operating plants to cope with a postulated station blackout, the July 17 NUGSBO letter provides some additional discussion, based in large part on generic discussions in staff and contractor reports, to support NUGSBO's view that "[s]taff analysis and the literature, in general, indicate that the safety functions which need to be provided in a station blackout can be provided reliably for several hours without AC power."

We have recently learned of initiatives within INPO-NUMARC to provide industry support for developing integrated approaches to the problem of station blackout. As the industry initiatives demonstrate broad participation in the industry effort, it would be possible for the NRC to take note of these during the discussions on the rulemaking, and make modifications in whatever form the final rule might take.

<u>RECOMMENDATIONS:</u> After review of the NUGSBO proposal, and for the reasons discussed above, the staff continues to believe that the risk of severe accidents attributable to station blackout events can, and should, be made a relatively small contributor to the total core melt frequency from all causes. We believe that an important ingredient in achieving that objective is to assure that all plants are able to cope with station blackout events of some acceptable duration, and we believe that our regulations should contain such a requirement. The development and implementation of programs for assuring the reliability of onsite emergency power systems and the adequacy of procedures and training related to station blackout events are also important to achieving the objective, and we believe that guidance such as that contained in the proposed Regulatory Guide on Station Blackout (or that could be developed by the industry and endorsed by the NRC) is needed. We believe that further industry initiatives to develop and implement such guidance should be encouraged, but that initiation of the proposed

rulemaking should not be further delayed. An addition should be made to the supplementary information section of the Notice of Proposed Rulemaking to acknowledge the NUGSBO proposal and encourage further development of industry initiatives during the public comment period. A proposed addition is provided in Enclosure 5.

We recommend that the Commission proceed with the proposed rulemaking on station blackout as recommended in SECY-85-163 with the addition of the language of Enclosure 5 to the Notice of Proposed Rulemaking (Enclosure 1 to SECY-83-163).

William J. Dircks
Executive Director for Operations

Enclosures:
1. "Proposal for Resolution of USI A-44 (Station Blackout)", Nuclear Utility Group on Station Blackout, May 8, 1985.
2. NUGSBO-85-003, "Estimation of Site-Specific Station Blackout Core Damage Frequency Using NRC Staff Methodology", Nuclear Utility Group on Station Blackout, May 1985.
3. Letter from C. H. Poindexter and L. G. Kuncl to W. J. Dircks, July 17, 1985.
4. Letter form D. M. Benjamin to T. P. Speis, July 1, 1985.
5. Proposed Addition to Notice of Proposed Rulemaking on Station Blackout.

This paper is scheduled for discussion at an Open Meeting on Wednesday, September 11, 1985.

Commissioners' comments or consent should be provided directly to the Office of the Secretary by c.o.b. Friday, September 20, 1985.

Commission Staff Office comments, if any, should be submitted to the Commissioners NLT Wednesday, September 11, 1985, with an information copy to the Office of the Secretary. If the paper is of such a nature that it requires additional time for analytical review and comment, the Commissioners and the Secretariat should be apprised of when comments may be expected.

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Enclosure 1

PROPOSAL FOR RESOLUTION
OF USI A-44 (STATION BLACKOUT)

May 8, 1985

NUCLEAR UTILITY GROUP
ON STATION BLACKOUT
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NUCLEAR UTILITY GROUP ON STATION BLACKOUT
PROPOSAL FOR RESOLUTION OF USI A-44

I. Issue Background

The NRC Staff defines Station Blackout as a complete loss of alternating current (ac) electrical power to the essential and nonessential switchgear buses in a nuclear power plant. The topic was designated as an Unresolved Safety Issue (USI) by the Nuclear Regulatory Commission (NRC) in 1978. In July 1980, the NRC Staff issued Task Action Plan A-44 for resolution of the issue. Subsequent work has focused on three major areas: (1) loss of offsite power experience, (2) reliability of emergency power supplies, and (3) station blackout core damage sequences.

It is our understanding that the NRC Staff has proposed a rule which would (1) designate a station blackout as a design basis event, (2) require plants to determine the maximum duration station blackout that could be handled and analyze the limiting factors governing the duration, and (3) require plants to demonstrate capability (making modifications as necessary) of withstanding a station blackout for specified durations based on specific characteristics of each plant's onsite and offsite power capabilities. A draft Regulatory Guide, which forms part of the Staff's rulemaking package, would interpret the proposed

regulation to require a duration on the order of four or eight hours. To support its rulemaking resolution of Station Blackout, the Staff has also prepared draft NUREG-1032, entitled "Evaluation of Station Blackout Accidents at Nuclear Power Plants, Technical Findings Related to Unresolved Safety Issue A-44," which provides or references, in large measure, the database upon which the proposed regulation is based.

The Staff has presented its proposed rulemaking package to the Committee to Review Generic Requirements (CRGR) and the Advisory Committee on Reactor Safeguards (ACRS) Electrical Systems Subcommittee. The CRGR approved sending the rulemaking package to the Commission for consideration; however, in so doing CRGR recommended that greater emphasis be placed on integrating the resolution of other issues along with Station Blackout and that allowance for a zero hour duration category be included.

By letter to NRC Staff management dated March 12, 1985, the ACRS gave a guarded conceptual endorsement of the resolution of the issue. Specifically, the ACRS recommended that actions considered in the resolution of USI A-44 "be closely coordinated with recommendations which may emerge from ongoing work on USI A-45 'Shutdown Decay Heat Removal Requirements.'" Further, the ACRS stated that "if a better alternative [for resolving A-44] than rulemaking is advanced, we recommend that it be given serious consideration."

II. Overview of Position of Nuclear Utility Group on Station Blackout (NUGSBO)1/

NUGSBO has reviewed the technical record on Station Blackout and has evaluated the implications of the new requirements under consideration by the Staff. NUGSBO's review has included the following topics:

1. Loss of offsite power (LOOP) experience as it pertains to the level of reliability which is currently demonstrated by normal ac power sources.

2. Diesel generator failure experience as it pertains to the existing level of diesel generator reliability.

3. Station blackout accident sequence assessment as it pertains to quantifying the level of risk posed by station blackout events.

4. Estimated costs associated with implementing a design basis station blackout capability.

5. Implications of other safety issues which are related either to the probability of station blackout events or the capability to withstand a station blackout.

1/ A number of nuclear utilities interested in the resolution of Station Blackout formed the Nuclear Utility Group on Station Blackout in the spring of 1984. NUGSBO currently represents 25 nuclear utilities, with several others considering membership or otherwise expressing support. The objective of the Group is to achieve a reasonable resolution of USI A-44 and related issues.

NUGSBO has discussed these issues with the NRC Staff and has monitored the pertinent efforts of industry organizations such as AIF, NSAC, IEEE, IDCOR, and ANS. In addition, NUGSBO is carefully examining the Staff's generic risk model (draft NUREG-1032) and its implications when applied to actual plant sites in an effort to quantify and characterize the risk associated with Station Blackout.

As a result of its review and analysis, NUGSBO has reached the following conclusions:

1. Station blackout has not been shown at this time to exhibit sufficient generic safety concern to warrant rulemaking. Indeed, the Staff has stated that it is primarily concerned with only a relatively small number of plants.

2. The overall level of safety in the industry is demonstrably high when measured in terms of ac power system reliability.

3. The Staff's database for diesel generator failures is presently not appropriate for use in station blackout risk assessment. While the Staff's database for loss of offsite power events appears to be accurate, a few discrepancies are currently under investigation by NUGSBO.

4. The approach adopted by the Staff's proposed rule is undesirable because it does not allow for recognition and continued assurance of high ac system reliability as a means for resolving the issue.

5. The Staff has underestimated the potential cost of implementing the proposed rule.

6. The Staff has not demonstrated that its approach will provide substantial additional protection to the health and safety of the public.

7. The Staff resolution does not adequately consider the related aspects of a number of other generic safety issues.

In short, the Staff's technical record does not currently support substantial generic concern regarding the risk of station blackout and, therefore, the large expenditure of resources that would result from the proposed rule cannot be justified on the basis of safety considerations. The Staff's current rulemaking effort is premature (and in the long term may not be needed at all) and resolution of the issue should proceed in a coordinated fashion with the resolution of aspects of the several other power-related issues now before the Staff. (Several of NUGSBO's concerns regarding the Staff's efforts are addressed in more detail in Section III.)

In light of NUGSBO's conclusions, the central issue of Station Blackout appears to be potential economic risk rather than potential risk to public health and safety. In this regard, NUGSBO is aware of initiatives of various utilities designed to protect their power plant investment from station blackout accident sequences which could lead to core damage. Such measures directed toward achieving economic goals would also offer additional safety benefits. NUGSBO believes that, as an alternative to current Staff rulemaking efforts, industry's endorsement of such initiatives could lead to further reduction of the minimal

risk for <u>all</u> plants, including <u>those few which may be of</u> Staff concern. These initiatives, included in the NUGSBO alternative proposal, maintain emphasis on the reliability of ac power sources and recognize the highly plant-specific nature of the station blackout issue and other related issues. With such initiatives in place, the risk to the public health and safety from station blackout will be even further reduced and final resolution of the station blackout issue can proceed in an orderly and integrated fashion with the resolution of several other power-related issues. NUGSBO believes that the inherent synergism offered by such a coordinated approach will yield economic and safety benefits which exceed those provided by resolving related issues independently. (NUGSBO's alternative proposal is addressed in more detail in Section IV.)

NUGSBO strongly endorses the concept of issue integration as a framework for achieving an orderly and timely resolution of interrelated issues. To this end, NUGSBO supports the recommendation made by ACRS stressing coordination of the Station Blackout resolution with the resolution of related issues. Similar observations have been made by CRGR. The "Minutes of CRGR Meeting Number 60", May 8, 1984, reflect CRGR consideration of the need for coordination among the resolutions of generic issues. At page 2, the Minutes state:

> The Staff's proposed resolution of USI A-44 appeared to the CRGR to confront the

> currently evolving Commission Policy on Severe Accidents and the resolution of other closely related generic issues. This resolution of A-44 also appeared to foreclose, or at least discourage licensee arguments that the overall reliability of their ac power systems was sufficient (or could be made so) to allow a specified ac blackout duration of less than 4 hours (e.g., zero). The CRGR explored these severe accident concerns and the interrelationships to other issues in arriving at their conclusions and recommendations to the EDO on the proposed resolution of USI A-44.

In sum, CRGR concluded, at page 4:

> . . . that the time was ripe to recommend to the EDO that a major effort be undertaken by NRR/RES to develop a plan that would better integrate the resolutions of major generic issues now pending. This should strive to order and to better manage the means to achieve the most cost-beneficial implementation and resolution of those separate generic issues now in progress or envisioned for the near future.

On October 12, 1984, NUGSBO submitted to the NRC Staff a proposed integrated resolution process for Station Blackout and power-related aspects of other generic issues. NUGSBO tentatively identified six generic safety issues whose eventual resolution could have a bearing either on the likelihood of a station blackout event or the capability of the plant to mitigate such an event. It is NUGSBO's position that with appropriate industry and Staff involvement, the integration process provided in NUGSBO's October 12 submittal could be used to develop a plan to achieve an orderly and timely resolution of these six

issues. To support this position, NUGSBO has prepared an example of such a plan (Attachment B). While this plan has not received the requisite industry and NRC Staff coordinated review to support its adoption, it does provide a substantial framework from which a final integration plan could be developed.

To amplify NUGSBO's general conclusions noted above, Section III addresses in some detail several of the issues giving rise to NUGSBO's concerns regarding the adequacy of the record supporting the Staff's rulemaking initiatives. Section IV provides an alternative to the Staff's proposed rule.

III. NUGSBO's Assessment of the Technical Record Supporting the Staff's Rulemaking Effort

The initial impetus for considering the station blackout issue emerged from early risk studies and the loss of offsite power experience of the 1970's. These considerations suggested that further study was necessary to determine the nature and extent of the risk which may exist at operating plants. The Commission identified Station Blackout as an Unresolved Safety Issue in 1978 and initiated a substantial research program which has only recently been concluded. This program has incorporated recommendations from NSAC and IEEE concerning the appropriate analysis and classification of LOOP events. In addition, the Staff and its consultants reviewed a spectrum of generic plant analyses performed (primarily) by the NSSS vendors concerning the coping capability of operating plants. Finally, emergency diesel generator reliability experience provided further input to the Staff's proposals.

NUGSBO does not believe that the technical record published to date provides a sufficiently well-founded basis for concluding that a generic safety problem exists. In fact, to the contrary, the record indicates that (1) onsite and offsite power system reliability has significantly improved since attention was first drawn to the station

blackout issue, and (2) a substantial blackout mitigation capability exists which will be even further enhanced with the resolution of other power-related issues. The record on its face does not support the Staff's rulemaking initiatives. While NUGSBO is continuing its review of the record, several of NUGSBO's concerns regarding the technical basis for the Staff's actions are discussed below.

The first concern regarding the Staff's record involves consideration of the LOOP experience. This database represents the significant joint efforts of the Staff, its consultants, IEEE, and NSAC, and covers all reported events experienced through December 1983. A statistical analysis of this data indicates a direct correlation between declining event frequency as reported by NSAC and the Staff, and the continued growth in overall industry operating experience. (See Figure 1.) In fact, since 1976, both the frequency and the total number of LOOP events have declined markedly. (See Figure 2.) A variety of statistical tests and measures all support the conclusion that the Staff/NSAC database indicates a declining trend in the LOOP frequency.

NUGSBO concludes from its analysis that the observed reductions in LOOP frequency are due in part to increased operating experience and improvements in design and represent a "learning curve." NUGSBO's analysis of the Staff's database indicates that these improvements are concurrent with a three-fold reduction in the industry

LOSS OF OFFSITE POWER EXPERIENCE 1969 - 1983

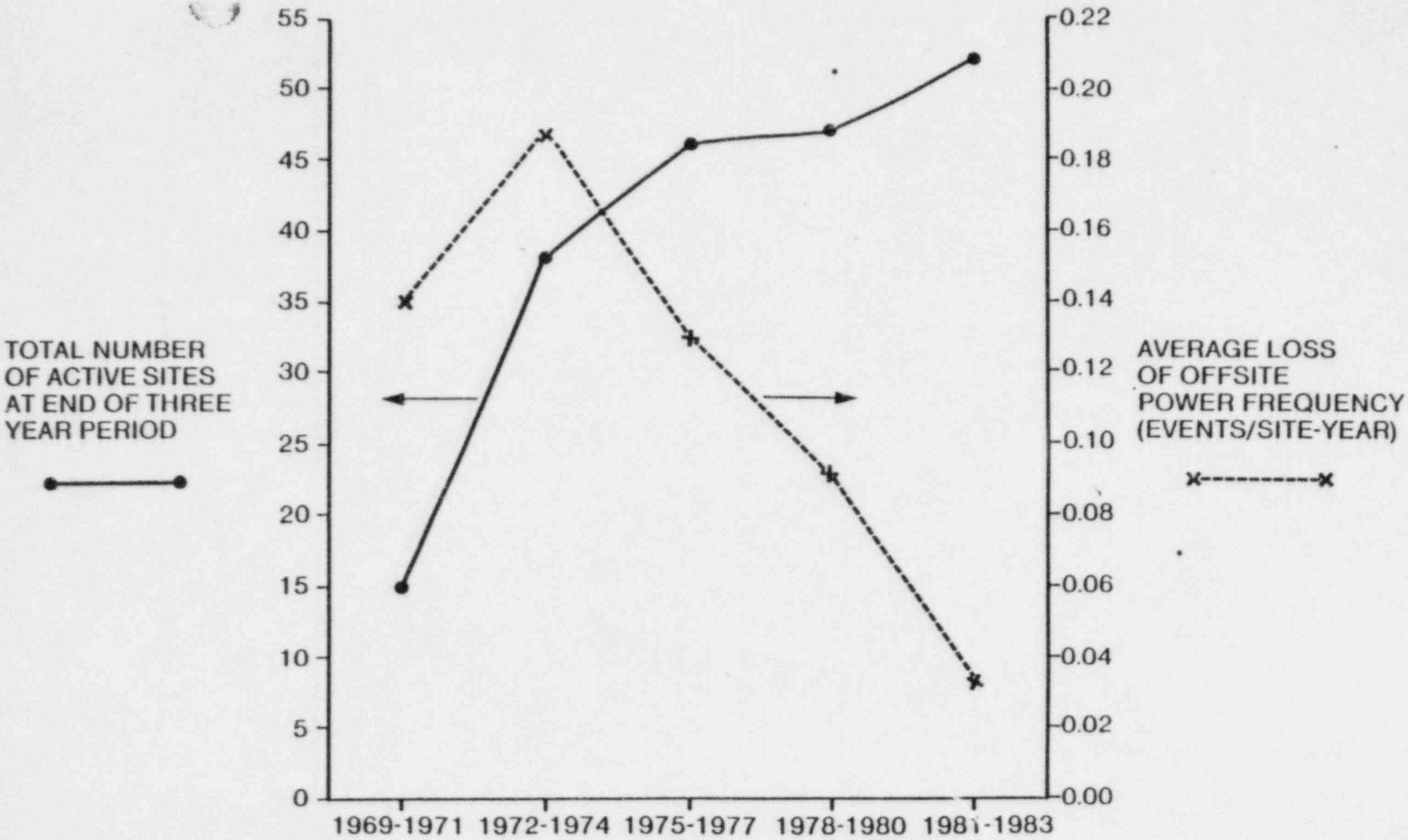

Figure 1

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901-001

OBSERVED DECREASE IN NUMBER AND FREQUENCY OF LONG DURATION LOOP EVENTS FOR RECENT FOUR YEAR EPOCHS

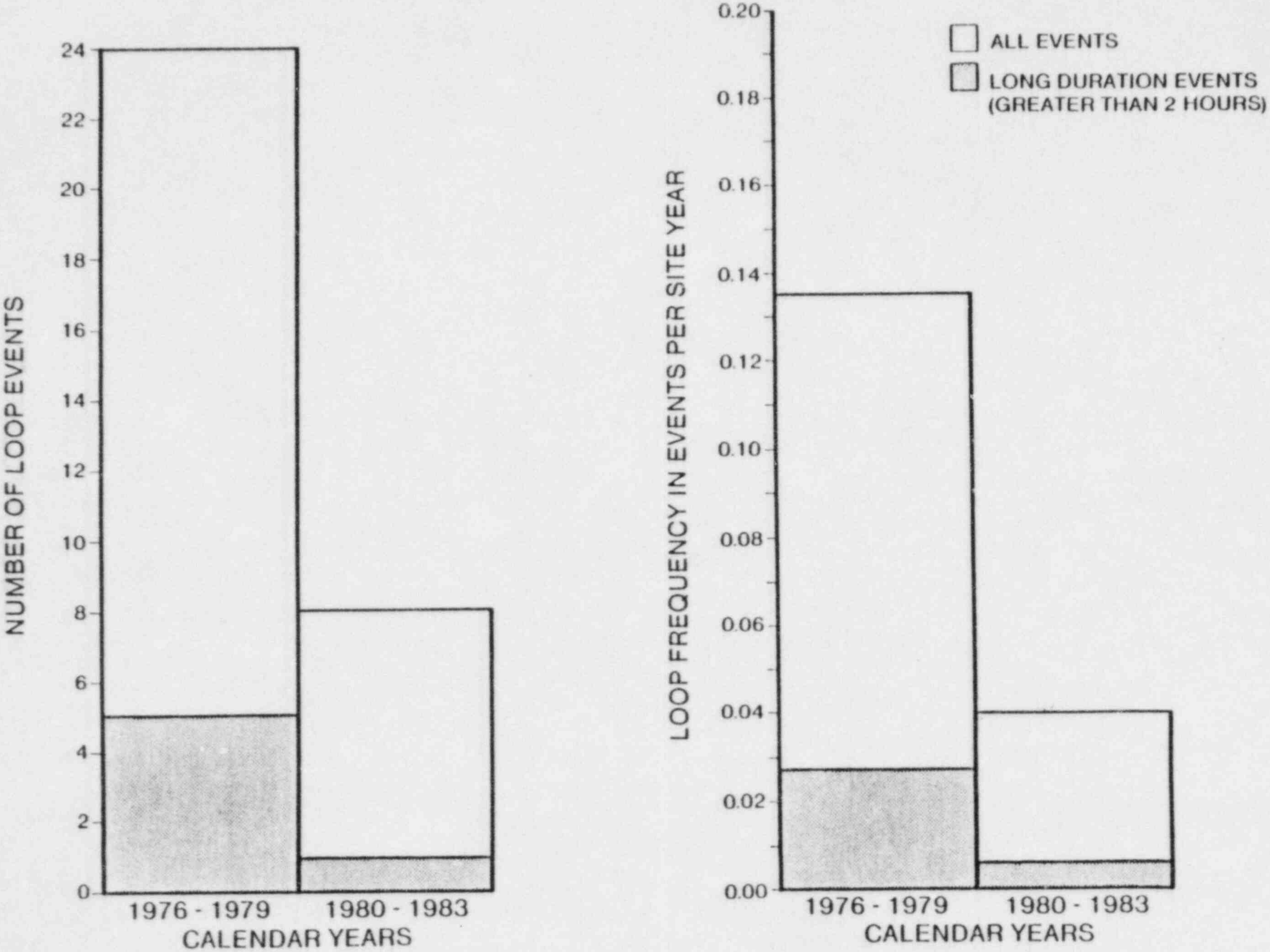

Figure 2

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average for loss of offsite power frequency. In addition to being evident in the NSAC/NRC database, these reductions and their association with operating experience are independently cited in recent Industry Degraded Core Rulemaking Program (IDCOR) studies. See "Nuclear Power Plant Response to Severe Accidents," Technical Summary Report, IDCOR Program (November 1984). IDCOR suggests that this same magnitude of reduction is evident for all transients, including LOOP events. Taken as a whole, the recent experience appears markedly different from the experience apparent to the Staff in 1978 when Station Blackout was identified as an Unresolved Safety Issue.

NUGSBO recommends that the Staff review the LOOP experience in view of these recent trends. Due credit for improvements evident in the recent experience should provide a significant reduction in the perceived risk of station blackout. Based on consideration of these trends, NUGSBO submits that the risk due to station blackout is currently not substantial, and is not the same as was previously perceived. In fact, an updated evaluation of risk could well yield results comparable to the level of safety sought by the Staff in its rulemaking proposal.

The reliability of onsite power sources has also been recently shown to be better than previously assumed. The earlier assumptions were derived from historical diesel generator experience documented by utility data and recorded

(generally) under the guidelines of Regulatory Guide 1.108. To update this state of knowledge, the NRC requested plant-specific information about the reliability of emergency diesel generators in Generic Letter 84-15. The responses demonstrated that over half of all diesels have reliabilities greater than 99% and almost 90% have reliabilities in excess of 95%. There were only three machines with reliabilities less than 90%. These machines have since been upgraded to better than 95% based on the last 20 successive tests reported to the NRC.

It is also possible that the reported performance of these three (and other) machines may be more a result of irrelevant failure criteria than a true measure of their reliability. Specifically, Generic Letter 84-15 asked for reliability data to be reported in accordance with Regulatory Guide 1.108, i.e., identification of failures based on the ability to meet the fast start criteria for loss of coolant accidents. While important to the basis for satisfying Regulatory Guide 1.108 (i.e., for satisfying LOCA response criteria), achieving rated load in a 10 to 15 second time period (as opposed to a longer period) is irrelevant to station blackout risk assessment.

Some utilities took exception to Regulatory Guide 1.108 when responding to Generic Letter 84-15; others did not. For those utilities which did not, some reported reliability data which was based on reported failures attributed solely

to failure, by a few seconds, of the diesels to assume rated load in a 10-15 second time period. The application of a more appropriate failure criterion to the database would reveal that the contribution to station blackout risk from diesel generator failures is even smaller than assumed as a result of the Generic Letter 84-15 response.

The current method of determining diesel generator reliability is also unnecessarily pessimistic in counting all failures yet omitting many "successful" demands that are terminated in less than one hour. In this regard, efforts are currently underway at NSAC to provide a method for more accurately and realistically assessing diesel generator reliability in the context of station blackout.

As has been the case with increasing offsite power system reliability, it can be anticipated that diesel generator reliability will continue to improve. Several factors point to this conclusion:

1. Cold fast starts, which are recognized as being harmful to reliable diesel generator operation, are being reduced in frequency or eliminated through changes in technical specifications and the addition of pre-heat systems.

2. Industry groups, such as IEEE, are developing standards aimed at improving diesel generator performance.

3. As more focus is put on diesel generator performance, root cause identification will enable the industry to remedy problems through constructive modifications to

equipment and procedures, rather than through more frequent potentially destructive testing to demonstrate reliability.

4. Industry is implementing a program for the collection and trending of diesel generator reliability data.

Thus, NUGSBO submits that with regard to Station Blackout, actual diesel generator reliability is understated by current evaluation methods and should be expected to improve as the industry continues to acquire greater experience.

Despite the clear evidence in the technical record of a pattern of decreasing station blackout risk, one concern which has been raised by the Staff is that such improvements will be evident only in those areas subject to industry remedies. The Staff maintains that the residual risk from weather-related LOOP events may be less subject to improvement. These types of events are classified by the Staff as uncontrollable events, as distinguished from equipment reliability events which are largely controllable by licensees. The Staff contends that the frequency of these uncontrollable events has not been shown to be declining. Contrary to the Staff's view, however, NUGSBO's review of the database indicates that improvements have indeed occurred in the frequency of weather-related LOOP events. In fact, the improvement seen in the so-called uncontrollable event frequency is comparable to that observed in the equipment-related category. This

improvement suggests that station blackout risk can be reduced as a result of industry initiatives. NUGSBO believes that additional steps can be taken to further reduce the risk of a station blackout initiated by severe weather, without substantial plant modifications or rulemaking. These initiatives are part of NUGSBO's alternative proposal and are described in Section IV, Part A.

To obtain a better understanding of the Staff's perception of the station blackout risk, NUGSBO conducted a review of operating sites using the assumptions, data, and methodology discussed in NUREG-1032. A secondary goal of this review was to understand the value and limitations of the methodology as a tool for assessing the nature of the station blackout risk at actual plants. In this regard, despite its stated assumption that a small number of sites are at risk from station blackout, the Staff has notably failed to demonstrate this risk by the analysis of any actual sites.

The conclusion of NUGSBO's analysis is that the Staff's methodology fails to identify any plant which constitutes a significant public health and safety risk due to station blackout. In addition, the analysis (using the Staff's assumptions and methodology) indicates that overall station blackout risk is not significant. Finally, the blackout mitigation measures of the type currently under

consideration by the Staff fail to offer significant potential improvements to the public health and safety - an essential step to proposing a backfit. This latter finding is especially important because the implementation of the Staff's proposed backfits could consume an inordinate amount of Staff and industry resources.

Notwithstanding NUGSBO's conclusion that the Staff's methodology and assumptions fail to identify any plant which poses a significant public health and safety risk due to station blackout, NUGSBO conducted a further investigation of the plants which the Staff's methodology determined to be most vulnerable. Significantly, NUGSBO's investigation revealed considerations at each site not factored into the analysis that provide a further and substantial decrease in the risk of core damage due to station blackout, e.g., the availability of other ac power sources, recently improved diesel generator reliability, the capacity to enhance effective diesel generator redundancy, a dedicated diesel, or improved grid reliability.

It should be emphasized that the Staff's methodology appears to be useful only as a screening test and is very conservative. For example, the governing criterion of concern is core damage rather than core melt or radioactive release frequency. Given the Staff's "risk" criterion, the potential reduction or elimination of important containment failure modes or the revision of the source term have no

impact on the assessment of station blackout risk. Further, sufficient credit is not given for either alternative power sources on-site (e.g., a fossil unit, IC turbine, or other non-safety source of ac power) or recent improvements to offsite power sources. Taken together, these considerations further reduce the station blackout risk by margins comparable to or greater than that offered by the proposed modifications. Yet, even as a screening test, NUGSBO concludes that the Staff's analysis fails to support classifying Station Blackout as either a generic or site-specific design basis safety issue, and clearly does not support generic rulemaking.

IV. NUGSBO's Proposed Resolution

NUGSBO's proposed alternative was developed based in large measure upon consideration of three relevant factors:

1. The Staff's technical record fails to support its conclusion that blackout is a generic safety issue warranting rulemaking. Rather, NUGSBO concludes that station blackout does not represent a significant risk to public health and safety.

2. There are various ongoing utility initiatives in this area designed to provide greater protection of the capital investment in the plant which provide additional safety benefits. While their focus is primarily economic, NUGSBO believes that if such initiatives are embraced by industry, they will also increase the current level of safety associated with station blackout events.

3. Any resolution of station blackout must proceed in coordinated fashion with the resolution of other power-related issues.

The major elements of NUGSBO's proposal (discussed below) are:

1. Implementation of plant-specific programs designed to enhance ac power reliability;

2. Issuance of a Commission policy statement endorsing this industry program; and

3. Implementation of an integrated resolution process for ultimate resolution of station blackout and other power-related issues.

A. Implement ac Power Reliability Programs

The first step of the NUGSBO proposal is for each utility to implement a plant-specific program embodying industry initiatives designed to enhance ac power reliability. While these programs will be designed primarily to ensure that economic risk from station blackout is acceptable, they will also increase the current level of safety associated with station blackout events. Under this approach utilities will be provided the flexibility to establish a program reflecting specific plant design features and operating practices, and may consider, among other things, administrative controls, and improvements to ac power systems. The industry initiatives embodied in each program will include the following actions, as appropriate:

1. Ensuring the adequacy of practices or procedures and training for the restoration of ac power to necessary systems;
2. Ensuring the adequacy of procedures and training for operators to cope with plant response to a station blackout event;
3. Post-failure evaluation and correction of the root cause of losses of individual ac power sources;
4. Ensuring the adequacy of severe weather procedures (hurricane and tornado);

5. Reducing the frequency of emergency diesel generator cold fast starts through changes in technical specifications and/or the addition of pre-heat systems;

6. Supporting industry groups regarding development of (1) guidelines designed to improve diesel generator performance (e.g., IEEE) and (2) methods for more accurately and realistically assessing diesel generator reliability in the context of Station Blackout (e.g., NSAC); and

7. Industry evaluation of significant events relating to ac power reliability.

While at present primarily NUGSBO member utilities have been involved in developing and supporting these initiatives, NUGSBO is actively working to gain industry acceptance. To further these initiatives, NUGSBO is committed to assuring the development of guidelines for implementation.

B. Issue a Commission Policy Statement

In view of the clear and significant trends in LOOP events and diesel generator reliability and the industry initiatives noted above, NUGSBO maintains that (1) the perceived risk to the public health and safety from Station Blackout has decreased substantially since it was declared a USI, and (2) such risk will decrease further in the future. Further, NUGSBO submits that to avoid potentially unnecessary and wasteful expenditure of both Staff and industry resources on piecemeal resolution of related

issues, all power-related issues should be resolved in an integrated fashion. Accordingly, NUGSBO recommends that the Commission issue a policy statement which would endorse the above-noted industry initiatives regarding this issue and recognize that the substantial reduction in risk from Station Blackout provides interim resolution pending an orderly and deliberate integrated resolution of all power-related issues. Further, NUGSBO recommends that the policy statement conceptually embrace and provide active support for the integrated resolution. A proposed policy statement is provided in Attachment A to this document.

C. Implement a Process to Achieve an Orderly Resolution of Power-Related Generic Issues

NUGSBO submits that with the implementation of industry intiatives noted above, the NRC Staff will have further assurance of the low risk to public health and safety from Station Blackout such that a more deliberate and integrated resolution of this issue can proceed in conjunction with the several other power-related issues of concern.2/ NUGSBO

2/ Widespread use of the term "integration" in other nuclear licensing contexts may lead to misinterpretation of this Group's intent. NUGSBO is not suggesting an integrated resolution process which would conclusively lead to a single, universally-applied backfit to resolve station blackout and related issues. In the proposed application, the term integration refers to a process by which the information needed to support the resolution of a set of related generic issues is identified and gathered in a timely fashion. Evaluation of the resulting information then leads to a reasonable and mutually consistent resolution for each of the related

(Footnote 2 continued on next page)

maintains that sound regulatory practice mandates such an integrated resolution. Such an integrated resolution will minimize the potential for near-term over-commitments of industry and Staff resources which in the long-term may prove to be either unnecessary or unjustified on a cost/benefit basis. Further, an orderly and integrated resolution of related issues will minimize disruptive and potentially unwarranted impacts on plant operations that could result from piecemeal resolution of the related issues.

In an October 12, 1984 submittal to the Staff, NUGSBO provided two screening criteria to identify power-related issues subject to integrated resolution. Further, NUGSBO suggested a five-step framework for the actual integration of those issues. NUGSBO contends that, using these criteria and framework, the NRC and industry could work together to develop and implement an integrated task action plan leading to ultimate resolution of all power-related issues within a 2-4 year period. (Implementation of activities associated with the resolution of the various related issues may proceed in staggered fashion as each issue is resolved.)

(Footnote 2 continued from previous page)
issues. Any new performance criteria or recommendations resulting from this resolution could then be issued concurrently, and addressed by individual utilities in an orderly fashion. The regulatory stability inherent with this approach will enhance plant reliability by limiting disruptive changes to hardware and procedures and allowing for more efficient expenditure of resources by each utility.

While the development of any integration plan must have full coordination and input from both the NRC and the various industry groups associated with the related issues, NUGSBO provides as Attachment B a sample plan for the resolution of power-related issues in order to provide an example of how such a process would work. The sample plan contains a listing of power-related generic issues and relevant technical considerations, a matrix reflecting the sequenced resolution of such issues, a task action plan for implementation, and a discussion of organizational considerations associated with resolution. While the sample plan in Attachment B contains substantial detail and may reflect many industry and NRC Staff views on the integrated resolution of power-related issues, NUGSBO reiterates that prior to adopting any such plan a full and complete review by both the NRC Staff and other industry groups would be necessary. To that end, NUGSBO reaffirms the suggestion made in its October 12 submittal that an NRC/industry workshop should be held to address the elements of this integrated resolution plan. NUGSBO would commit to sponsor or co-sponsor such a workshop.

V. Conclusion

NUGSBO's proposal represents (1) a program of plant-specific initiatives designed to provide further short-term enhancement of ac power reliability and (2) combined NRC and industry efforts designed to provide, in a timely and integrated fashion, long-term resolution of the several power-related generic issues. Notwithstanding the substantial concerns regarding the adequacy of the Staff's technical record to support its rulemaking initiatives, NUGSBO maintains that its proposed alternative is preferable to the Staff's proposal for several reasons.

First, the alternative proposal will yield safety benefits faster than the Staff's approach, because the NUGSBO proposal focuses on ac power system reliability. The Staff's proposal, on the other hand, emphasizes backfitting mitigation capability to protect against core damage. The ultimate realization of such mitigation benefits is limited by the long lead times for equipment design, procurement, installation, and refinement.

Second, NUGSBO's proposal provides for the timely and integrated resolution of several issues. As a result, industry and NRC resources will be focused to accomplish the resolution of necessary tasks and the potential for wasted resources, which history teaches will occur absent the integrated approach envisioned by NUGSBO's proposal, will be substantially reduced.

Third, NUGSBO's proposal will provide greater assurance that the overall cost/benefit of coordinated resolutions is maximized. Piecemeal resolutions of related issues, as currently advanced by the Staff, promote substantial inefficiencies which will result in a reduced cost/benefit.

Fourth, focusing on core damage, the Staff's technical record fails to support Station Blackout as a safety issue at any plant. The Staff's analysis, however, does raise the potential concern that Station Blackout may be an economic issue at some plants. Economic issues are within the jurisdiction of, and should be resolved by, the utility industry, rather than the NRC. Furthermore, utilities are better staffed and equipped to analyze and manage such issues. Notwithstanding the good intentions of Staff proposals in this area, utility-initiated actions are clearly preferable.

Finally, NUGSBO's proposal is based on industry initiatives. This approach is clearly in support of the NRC's goal of fostering independent action by industry. Such an approach has the added benefit of providing a mechanism whereby both industry and the NRC can work together to resolve a number of generic issues in a coordinated fashion. If successful, these initiatives may provide a model for more efficient and timely resolution of other generic issues.

In sum, the NUGSBO alternative to the Staff's proposed rule is a preferable method for addressing the Station Blackout issue and should receive strong NRC consideration. Moreover, should the NRC choose to pursue the Staff's proposed rule through notice and comment rulemaking, the NUGSBO alternative resolution could form the basis for an option published concurrently for comment with the proposed rule. This latter approach was accomplished successfully in the recent ATWS rulemaking.

Attachment A

Proposed Commission Policy Statement

A. Background

The Commission declared Station Blackout, defined as a complete loss of alternating current (ac) electrical power to the essential and non-essential switchgear buses in a nuclear power plant, an unresolved safety issue in 1978. In July 1980, the NRC Staff issued Task Action Plan A-44 to address the issue. The NRC Staff has been working on this issue since that time, focussing upon three major areas: 1) loss of offsite power; 2) reliability of onsite backup systems; and 3) station blackout core damage sequences. During this time, the Commission has sponsored a number of studies and the Staff has issued the following reports: NUREG/CR-2989, NUREG/CR-3226, NUREG/CR-3840, NUREG/CR-3992, and most recently, draft NUREG-1032.

The results of these studies reflect that the reliability of the two major ac power sources at each site (i.e.,

offsite power and onsite emergency diesel generators) has improved substantially during the past several years and all indications reflect that this reliability will continue to improve. Further, without taking into consideration the positive impact of source term reevaluation, these studies do not demonstrate that Station Blackout constitutes a significant risk to the public health and safety.

The Commission is aware that the power-related aspects of other unresolved and generic safety issues remain outstanding. The CRGR and ACRS Subcommittee on Electrical Systems have expressed interest in having the resolution of Station Blackout integrated with other power-related issues. The Commission endorses the concept of integrated resolution of related issues.

The Commission has recently issued a Policy Statement endorsing industry initiatives regarding training and qualification of nuclear power plant personnel and considers a similar approach applicable for the resolution of Station Blackout (USI A-44).

B. Policy Statement

The Commission recognizes that the industry has made progress in improving ac power reliability. In addition, the Commission recognizes that the initiatives proposed by the Nuclear Utility Group on Station Blackout will further enhance the reliability of ac power systems. In this

regard, the Commission realizes the importance of industry's initiatives and wishes to encourage further self-improvement. Subject to the success of these programs, the Commission will refrain from new rulemaking in the area of station blackout. Although the Commission is deferring rulemaking in this area in recognition of the industry efforts, the NRC can only exercise this flexibility as long as the industry initiatives produce the desired results. In addition, it remains the continuing responsibility of the NRC to independently evaluate applicants' and licensees' ac power reliability to determine the success of these initiatives and to evaluate the possible need for further NRC action.

The NRC policy with respect to licensees' and applicants' programs for ac power reliability is presented below.

The Commission expects that, pursuant to the guidance contained herein, each licensee or applicant for operating license will implement a plant-specific program designed to further enhance ac power reliability.

Each program will include the following actions, as appropriate:

1. Ensuring the adequacy of practices or procedures and training for the restoration of ac power to necessary systems;

2. Ensuring the adequacy of procedures and training for operators to cope with plant response to a station blackout event;

3. Post-failure evaluation and correction of the root cause of losses of individual ac power sources;

4. Ensuring the adequacy of severe weather procedures (hurricane and tornado);

5. Reducing the frequency of emergency diesel generator cold fast starts through changes in technical specifications and/or the addition of pre-heat systems;

6. Supporting industry groups regarding development of (1) guidelines designed to improve diesel generator performance (e.g., IEEE) and (2) methods for more accurately and realistically assessing diesel generator reliability in the context of Station Blackout (e.g., NSAC); and

7. Industry evaluation of significant events relating to ac power reliability.

C. Enforcement

The NRC retains authority to use the full range of enforcement actions for regulatory violations involving ac power reliability as specified in the Commission's Enforcement Policy, 10 C.F.R. Part 2, Appendix C. Enforcement actions for violations related to the availability of onsite and offsite ac power will be based upon Commission regulations and individual license conditions. The Commission, however, in recognition of industry initiatives involving ac power sources, will exercise some discretion in selecting cases appropriate for enforcement.

Attachment B

Sample Plan For Coordinated Resolution of Power-related Issues

In its October 12 submittal, NUGSBO proposed an integrated resolution process which involved the following five steps:

1. Identify the generic power-related issues which are candidates for integrated resolution.
2. Identify the technical considerations underlying the related issues which must be addressed in the integrated resolution process.
3. Develop an integrated task action plan to prioritize and coordinate analysis of the technical considerations necessary to ultimately resolve the issues.
4. Execute the integrated task action plan in order to develop a full database from which to choose possible resolutions.
5. Select and implement final resolutions for related issues in a timely fashion.

In that submittal, a trial application of the first step was performed. Generic issues were reviewed to identify those that were related to the reliability or availability of ac power using the following screening criteria:

(1) the issue bears on the likelihood or duration of a total loss of ac power; or

(2) the issue relates to the ability of a plant to withstand or cope with a total loss of ac power.

This review produced seven "power-related" issues as candidates for a coordinated resolution. Issues of primary importance in this category are: (1) "Diesel Generator Reliability" (Generic Issue B-56), (2) "Reactor Coolant Pump Seal Failures" (Generic Issue 23), and (3) "Shutdown Decay Heat Removal Requirements" (USI A-45). Issues which have relationships of lesser importance to Station Blackout, but which should also be considered, include "Adequacy of Safety-Related DC Power Supplies" (GI A-30) and "Probability of Core Melt Due to Component Cooling Water System Failures" (GI 65). (One of the seven issues, USI A-47, "Safety Implications of Control Systems," has since been dropped from the list because of its specific focus on accident sequences not related to station blackout.)

In performing the second step in the process, NUGSBO identified a number of technical considerations within each of the power-related issues which are related to station

blackout. These issues are listed in Table 1 and their specific relationship to ac power reliability/availability is shown diagrammatically in Figure 1.

Using Figure 1 as a template, it is now possible to perform the third step in the integrated resolution process; i.e., to propose a task action plan for development of complete data from which to select and implement appropriate resolutions. The initial emphasis in such a plan would be to review the status of each issue to determine those which have already been sufficiently studied and those which are the subject of ongoing NRC or industry research.

An industry organization should be established with overall responsibility for implementing the integrated task action plan. This organization would monitor the progress of relevant activities ongoing within the NRC and the industry.

A preliminary task action plan is set forth in Table 2. The task action plan will, if implemented, result in an orderly resolution of USI A-44, GI B-56, GI A-30, GI 23, and GI 65. USI A-45 will only be partially resolved, but its ultimate resolution should be coordinated to ensure consistency with this proposed integrated resolution.

Table 1

List of Generic Issues and
Relevant Technical Considerations

1. Station Blackout (USI A-44)

 1.1 Event Likelihood and Duration

  1.1.1 Offsite (normal) ac source reliability (precursors/causes, frequency, time to restore).

  1.1.2 Onsite (emergency) ac source reliability.

   1.1.2.A Emergency diesel generator reliability (failure modes, failure rates, time to restore).

   1.1.2.B Emergency diesel generator configuration.

  1.1.3 Presence of Enhanced Recovery (backup ac power sources onsite or close by).

 1.2 Ability to Withstand or Cope With a Station Blackout Event

  1.2.1 Ability to maintain sufficient RCS inventory.

  1.2.2 Ability to remove decay heat.

  1.2.3 Equipment support/survivability under station blackout conditions.

2. Diesel Generator Reliability (B-56) - direct impact on reliability of ac power

3. Safety-Related dc Power Supplies (A-30):

 3.1 Reliability of dc power supplies - may affect reliability of ac power through inability to start a diesel or operate switchyard relays.

Table 1 (continued)

3.2 Battery capacity during total loss of ac power - affects ability to deal with station blackout events through loss of instrumentation or DHR equipment support function.

4. RCP Seal Integrity Without AC Power (GI 23) - related to ability to maintain RCS inventory when makeup capability not present due to total loss of ac power:

   4.1 Hydrostatic seal designs (failure mechanisms, leakrate and timing).

   4.2 Hydrodynamic seal designs (failure mechanisms, leakrate and timing).

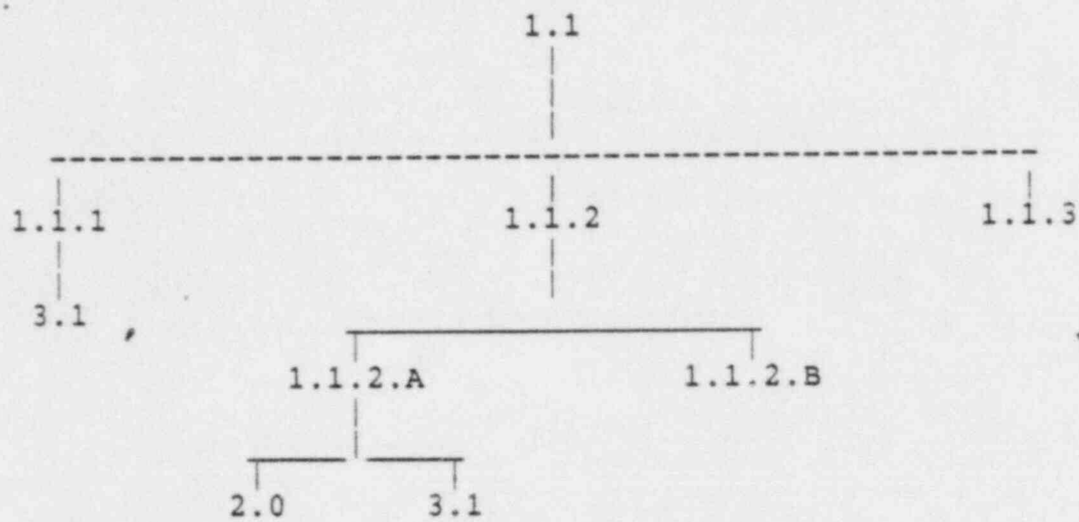
5. CCW Reliability (GI 65) - related to likelihood and severity of RCP seal failure during total loss of ac power.

6. Shutdown Decay Heat Removal Systems (USI A-45) - Reliability of ac-independent DHR systems influences ability to cope with a total loss of ac power.

Figure 1

Relationship of Generic Issues and
Technical Considerations

Reliability of ac Power



Ability to Cope With a
Total Loss of ac Power

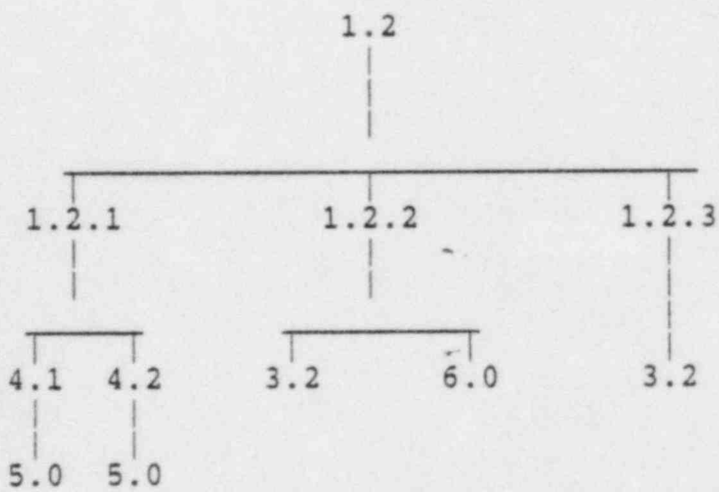


Table 2

TASK ACTION PLAN FOR RESOLUTION OF POWER-RELATED GENERIC ISSUES (PRELIMINARY)

TASK I: DEVELOP A COMPLETE DATABASE

A. Determine the Present Reliability of ac Power Systems (1.1)

1. Offsite Power Reliability (1.1.1)

a. Verify long duration LOOP event data;

b. Re-review LOOP database to examine feasibility or appropriateness of "rectifying" prior data to reflect past corrective actions by utilities;

c. Refine "learning curve" effects model to determine whether a correlation exists between number of plant sites and the experienced reduction in LOOP frequency and duration; and

d. Examine relevant industry experience to identify significant precursors to a LOOP event (*e.g.*, dc bus failures).

2. Onsite Power Reliability (1.1.2)

a. Develop method for measuring diesel generator reliability (EDGR) in a manner appropriate for station blackout concern (2.0);

b. Reassess EDGR from utility responses to NRC Generic Letter 84-15, or develop a clearer information request and send to utilities. Data obtained is used to measure current EDGR (2.0) and;

c. Assess whether dc system failures are significant contributors to overall diesel generator unavailability (3.1).

3. Enhanced Recovery Capability (1.1.3)

a. Establish criteria for allowing credit for backup ac power sources; and

Table 2 (continued)

b. Review each site for the presence of enhanced recovery capability, including restoration procedures.

B. Evaluate Ability to Withstand a Total Loss of ac Power (1.2)

1. Ability to Maintain RCS Inventory (1.2.1)

a. By test or engineering evaluation, identify RCP seal failure mode (if any), leakrate, and timing for hydrostatic seal design (4.1); and

b. Same as (a) for hydrodynamic seal design (4.2).

2. Ability to Remove Decay Heat (1.2.2)

a. Assess the reliability of ac-independent DHR systems, identify failure mode and timing (6.0); and

b. Evaluate impact of dc system failures on DHR performance during station blackout due to insufficient battery capacity (3.2).

3. Equipment Support/Survivability (1.2.3)

a. Realistically establish credible conditions that may result from a station blackout that have an adverse effect on required equipment.

TASK II: REASSESS RISK ASSOCIATED WITH AC POWER LOSS EVENTS

Under this task, the results of Task I would be employed in a reassessment of risk posed by station blackout.

TASK III: ESTABLISH PERFORMANCE GOALS

An ac power reliability/performance goal should be established. If from the results of TASK II the existing level of protection is deemed to be acceptable, then this level of protection is translated into a performance goal and measures can then be taken to ensure that this performance is maintained in the future. If the existing level of protection is deemed inadequate, then a goal may be established in terms of improved reliability.

Table 2 (continued)

TASK IV: SELECT RESOLUTION/IMPROVEMENTS FROM AVAILABLE OPTIONS

A. Suggestions to Consider for Improved Reliability of ac Power Sources

1. Offsite Power Reliability:

   a. Examine relevant industry experience to identify switchyard problems which could lead to LOOP events;

   b. Develop "weather-related" procedures which minimize the likelihood of a total loss of ac power events which have hurricanes or tornadoes as precursors; and

   c. Continue tracking and analysis of LOOP events industrywide.

2. Onsite Power Reliability

   a. Develop a means for continued assurance of high EDGR by analyzing failure mechanisms, applying corrective maintenance, minimizing or eliminating unnecessary testing, and implementation of good preventive maintenance practices; and

   b. Implement an industry-wide EDGR trending program.

NOTE: These suggestions, if implemented, resolve GI B-56.

3. DC Power System Reliability

   a. Assure that dc power system design and operational features do not compromise ac power availability; and

   b. Assure that test and maintenance activities required for battery operability include preventive maintenance procedures on bus connections, procedures to demonstrate dc power availability from the battery to the bus, and administrative controls to reduce

Table 2 (continued)

battery damage during testing, maintenance, and charging.

NOTE: These suggestions, if implemented, resolve GI A-30.

B. Suggestions With Regard to Demonstrating Ability to <u>Withstand a Total Loss of AC Power</u>

1. Improvements to reactor coolant pump seals (if shown to be necessary) and proper operating and maintenance practices (NOTE: This resolves GI 23 and 65);

2. Procedures for restoration of ac power sources; and

3. Procedures and training for coping with station blackout events which promote understanding of event and minimize likelihood of human error.

TASK V: <u>Implementation of Resolution</u>

The resolution options selected under Task IV will then be implemented on a plant-specific basis in a timely, coordinated fashion.

Enclosure 2

NUGSB-85-003
May 1985

ESTIMATION OF SITE-SPECIFIC STATION BLACKOUT CORE DAMAGE FREQUENCY USING NRC STAFF METHODOLOGY

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NUGSB-85-003
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ESTIMATION OF SITE-SPECIFIC STATION BLACKOUT CORE DAMAGE FREQUENCY USING NRC STAFF METHODOLOGY

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1.0 INTRODUCTION

The primary objective of this study was to examine the site-specific station blackout core damage frequency for each operating nuclear plant in the United States using a methodology developed by the NRC Staff. A secondary objective was to examine the impact of modifying the loss of offsite power database to reflect industry improvements in AC power reliability.

The methodology used in this analysis is based on NUREG-1032 (NRC [1985]), "Evaluation of Station Blackout Accidents at Nuclear Power Plants, Technical Findings Related to Unresolved Safety Issue A-44." The details of the Staff's methodology and its application in this analysis are discussed in Section 2.0 of this report. The analysis required data concerning plant location, AC power equipment configuration, diesel generator reliability, local weather experience, and plant transient response. Where possible, documented site-specific information was used. Assumptions made for purposes of the analysis are identified in the subsequent sections of this report.

It is important to note that the use of the Staff's methodology in this report should not be construed as an endorsement of this particular approach to the determination of station blackout risk. Rather, the frequency estimates indicate how actual sites compare with the generic assessment the Staff has reported in NUREG-1032.

2.0 SITE-SPECIFIC CORE DAMAGE FREQUENCIES USING STAFF METHODOLOGY

2.1 Overview

In NUREG-1032, the Staff summarizes its findings concerning the likelihood and consequences of station blackout events at nuclear power plants. These findings include a generic assessment of the expected frequency of core damage from station blackout events. In the Staff's methodology, the core damage frequencies are dependent on a number of plant design and location factors. When all the various factors are combined, the resulting core damage frequency categories number in the hundreds and represent a frequency range of nearly six orders of magnitude. The Staff states that the expected core damage frequency range extends from 10^{-6} to greater than 10^{-4} per site-year.

In this report, the Staff's methodology is applied to all sites with operating licenses issued prior to the end of 1983 in order to determine the range and distribution of expected core damage frequencies represented by the nuclear industry.

2.2 Staff Methodology

2.2.1 Site Attributes

The focus of NUREG-1032 in estimating station blackout risk is the estimated frequency of core damage. In Table C.4 of NUREG-1032, the Staff presents the expected core damage frequencies from station blackout as a function of four attributes:

(1) emergency diesel generator configuration;
(2) emergency diesel generator reliability;
(3) loss of offsite power susceptibility; and,
(4) station blackout coping capability.

Each of these site attributes are discussed in the following subsections. Table C.4 is reproduced herein as Appendix A.

2.2.2 Emergency Diesel Generator Configuration

The emergency diesel generator (EDG) configuration is a combination of two parameters:

(1) The minimum number of EDGs needed to meet AC power load requirements for a design basis accident (DBA); and,

(2) The number of EDGs available.

The configuration is described in NUREG-1032 and this report by the notation "x/y", where "x" is the number of EDGs needed and "y" is the number of EDGs present onsite. The Staff's analysis accommodates only three different configurations: 1/2, 2/3, and 1/3. It is assumed that other configurations found at some sites (i.e., 2/5, 3/8) are bracketed (in terms of redundancy) by the three configurations analyzed.

2.2.3 Emergency Diesel Generator Reliability

The NUREG-1032 methodology requires the determination of individual EDG failure likelihood based on a site average. In this case, an EDG failure is defined as a failure to start and properly assume load. The Staff's analysis considers both independent and common-cause failures to start. In addition, independent and common-cause failure-to-run rates are factored into the analysis.

The models developed by the Staff for diesel generator reliability permit the evaluation of a 1/2, 2/3, or 1/3 onsite AC system with arbitrary failure-to-start probabilities and failure-to-run rates. However, the generic core damage frequency analysis in NUREG-1032 and in this analysis was limited to independent failure-to-start likelihood values of 0.10, 0.05, 0.025 and 0.01. For each configuration, average values for the common-cause failure-to-start probability and the independent and common-cause failure-to-run rates were used.

2.2.4 Loss of Offsite Power Susceptibility

Loss of offsite power (LOOP) susceptibility is the most complicated of the four station blackout risk characteristics provided in NUREG-1032. In the Staff's analysis, LOOP susceptibility is composed of four factors, representing:

(1) Frequency and duration of "plant-centered" LOOP events;

(2) Frequency and duration of "grid-related" LOOP events;

(3) Frequency and duration of "severe weather" LOOP events; and

(4) Frequency and duration of "extremely severe weather" LOOP events.

Each of the four factors are subdivided into several categories representing ranges of susceptibility to the particular type of LOOP event. The categories within each of the four LOOP susceptibility factors are as follows:

(1) "I" - Four categories of offsite power system designs;

(2) "GR" - Seven categories consisting of (a) expected frequency of LOOP events due to grid loss, and (b) existence of enhanced recovery capability;

(3) "SR" - Six categories of severe weather LOOP susceptibility depending on: (a) expected frequency of LOOP events due to severe weather, and (b) existence of enhanced recovery capability; and

(4) "SS" - Five categories of extremely severe weather LOOP susceptibility.

The LOOP susceptibility of a given site is then characterized by the assignment of an appropriate category for each of the four LOOP factors. Various combinations of the four LOOP factor categories result in similar expected LOOP frequencies and durations. NUREG-1032 reports that the Staff performed a statistical "cluster analysis" to group together those combinations which yield similar overall LOOP susceptibilities. This analysis yielded nine cluster groups that include all the relevant combinations of the four factors and thus span the range of LOOP susceptibilities.

The tables from NUREG-1032 defining the LOOP factor categories are reproduced in Appendix B of this report. The actual cluster group definitions of NUREG-1032 are provided in Appendix C.

Although the Staff identified seven categories of grid-related events, only three are used. According to NUREG-1032, two sites are assigned to GR7. The rest are assigned to either GR1 or GR2.

Under the Staff's methodology, determination of the appropriate severe weather parameter for a given site requires the compilation of local data and the estimation of three weather hazard factors:

(1) The average frequency of hurricanes and other winds exceeding 75 miles per hour (mph);

(2) The average number of tornadoes per square mile per year; and,

(3) The average inches of snowfall per year.

As a first step, industry average proportionality factors are determined based on the number of actual LOOP events associated with the given type of weather. Summing each weather hazard factor for all sites and all years provides a cumulative weather hazard factor. The site-specific expected severe weather LOOP frequency is then calculated by multiplying the three site-specific weather hazard factors by the corresponding industry average proportionality factor and summing the results.

The final category of "extremely severe weather" LOOP events is meant to include those events in which the damage to transmission lines, towers, etc. is postulated to be so severe that the restoration time is of the order of 12 to 24 hours. The frequency of these LOOP events is assumed to be equal to the expected frequency of occurrence of extremely severe weather events ("great" hurricanes, multiple tornadoes). An event is "extremely severe" if it produces wind speeds in excess of the design basis. The Staff assumes that snow/ice storms do not contribute to the frequency of "extremely severe weather" LOOP events.

2.2.5 Station Blackout Coping Capability

The final site attribute contributing to the expected core damage frequency in the Staff's methodology is coping capability, expressed in terms of 0, 2, 4, 8, or 16 hours. Coping capability is assumed to be a function of both early and longer term AC-independent decay heat removal (DHR) capabilities. The frequency of core damage due to early failures is modeled as a function of EDG configuration and reliability, LOOP cluster group, and DHR system reliability.

Staff analyses presented in NUREG-1032 indicate that core damage results within one to two hours of a station blackout event with the unlikely concurrent failure of AC-independent DHR systems and/or loss of reactor coolant system (RCS) integrity. The expected core damage frequencies due to such early failures are included in the total core damage frequency estimates of Table C.4. A generic DHR system reliability is presumably assumed for the analysis, though its value is not reported.

The longer term component of the Staff's core damage frequency estimates represents the limits of plant coping capability given that DHR systems function as designed. Plant coping capability is assumed to be potentially limited by the depletion of support features such as DC power, cooling water, or compressed air. The onset of core damage is estimated to follow within one or two hours of the loss of coping capability. Thus,

the "Coping and Recovery Capabilities" of Table C.4 should be interpreted as the "time sufficient for core damage to occur because decay heat removal capability limits are exceeded during an extended station blackout." (Page C-5, NUREG-1032)

2.3 Assumptions and Sources of Data

This analysis applied the Staff's methodology to actual plant sites in order to determine the site-specific core damage frequency estimates the Staff's methodology would provide. Accordingly, the methodology was followed as closely as possible, including the use of Staff data sources where possible. The actual sources of data, the conventions adopted for the use of the data, and any assumptions made in the analysis are discussed in the remainder of this section. Figure 1 summarizes the basic structure of the Staff's methodology and identifies the data sources used in this analysis.

Site-specific EDG configurations were obtained from two sources: NUREG/CR-2989 (Battle and Campbell [1983]) and licensee responses to NRC Generic Letter 84-15 (Eisenhut [1984]). Since the Staff's analysis only included 1/2, 2/3, and 1/3 configurations, other configurations such as 2/5 and 3/8 were handled by interpolation between 1/2 and 1/3 configurations. A 2/4 configuration was taken to be equivalent to a 1/2 configuration.

Site-specific EDG failure rate data was obtained from licensee responses to Generic Letter 84-15. In most cases, the reported number of failures in the last 100 starts for each EDG was used to obtain a site-average failure-to-start rate. In a few cases, licensees discussed corrections and improvements to their EDGs resulting in apparent recent improvements in EDG reliability. In these cases, the number of failures in the last 20 starts was taken as representative of current reliability levels.

In many cases, licensee responses took exception to the Regulatory Guide 1.108 criteria and provided a more detailed description of their EDG failures. When it was clear that a reported failure was not meaningful with respect to the station blackout context, the failure was not counted in the site EDG reliability calculation.

The Staff's generic risk analysis described in NUREG-1032 considers discrete EDG reliabilities: 0.90, 0.95, 0.975, and 0.99. Consequently, as with EDG configurations, some interpolation of reported reliability was performed when the site-specific values were not approximately equal to one of the four levels of Table C.4.

The determination of the appropriate LOOP cluster group for each site required a variety of sources of information. Offsite power design features were obtained from NUREG-1032 and NUREG/CR-3992 (Battle [1985]). The site-specific grid reliability values were based upon both NUREG-1032 and discussions with the Staff.

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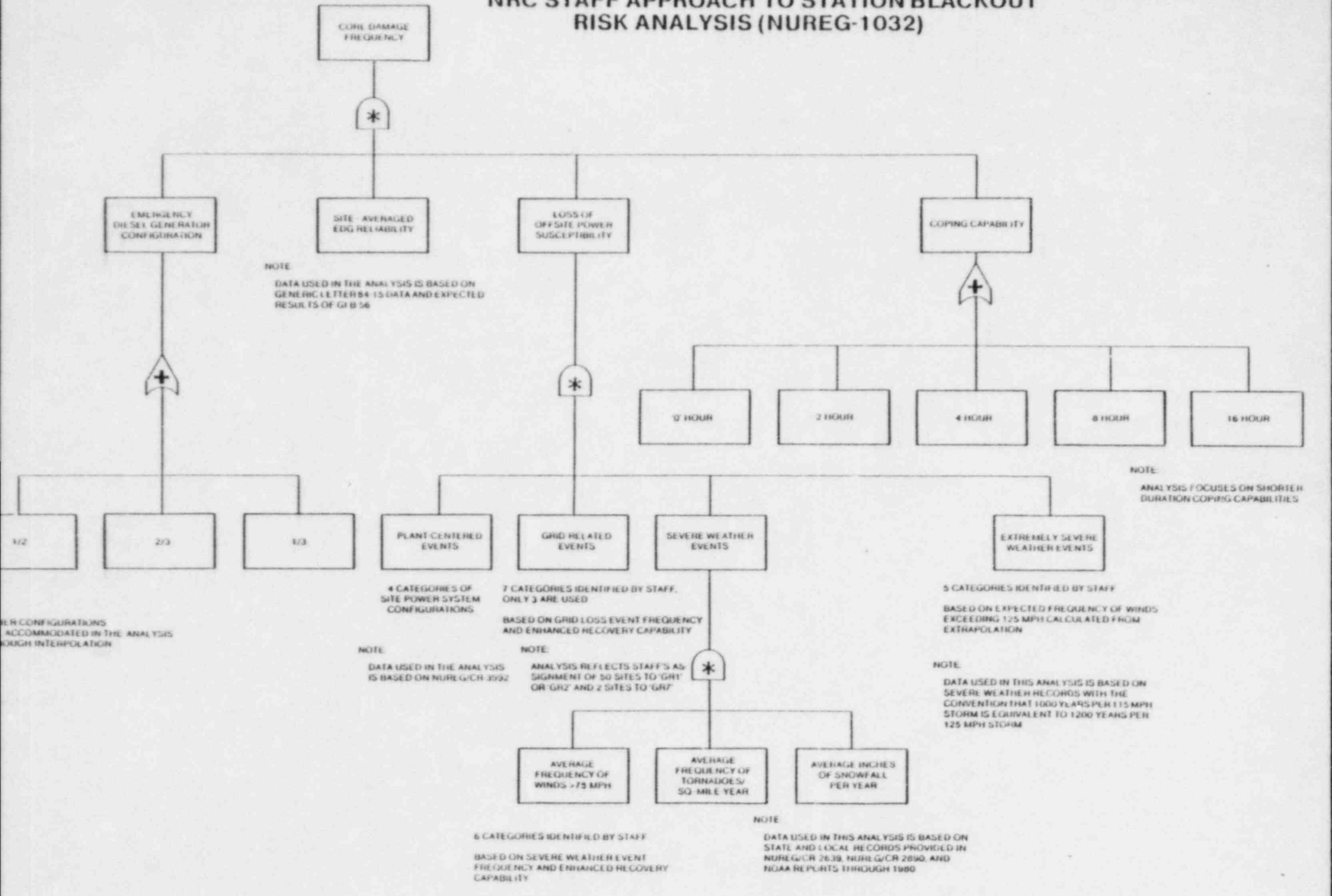

FIGURE 1

The site-specific weather data used in the analysis is derived from several sources: NUREG/CR-2639 (Changery [1982]) NUREG/CR-2890 (Changery [1982a]), "Climatological Data - NOAA [1980], National Summary" (NOAA [1980]), and "Comparative Climatic Data" (NOAA [1981]). For western, mid-western, and some southeastern sites, the hurricane/high wind data referenced by the Staff was not applicable to certain sites. In those cases, average frequencies were used. The tornado hazard factor for all sites was assumed to be the average value for the state in which the site is located. Snowfall data from nearby weather stations was used for all sites.

For assigning severe weather categories, enhanced.recovery capability was not assumed to exist except in a few cases where it was known to be available. Thus, the severe weather categories may be conservative for some of the sites analyzed.

The data sources for extremely severe weather were the same as for severe weather. The frequency of storms exceeding 125 miles per hour was used as the measure of expected frequency of LOOP events due to extremely severe weather. In order to have a consistent application of the data to the Staff's frequency ranges (see Table A.9, Appendix B), a convention of the equivalence of 1000 years per 115.0 mph storm to 1200 years per 125 mph storm was adopted.

2.4 Results

The results of the application of the Staff's methodology to operating reactor sites are summarized in Table 1. In some cases, missing information and/or the need to interpolate between categories necessitated the specification of a core damage frequency range rather than a single value. The values given in Table 1 represent a conservative statement of site-specific core damage risk. An additional value of these results is in identifying relative risks in light of the methods and assumptions of NUREG-1032.

The 52 sites analyzed show a wide range of station blackout core damage frequencies. For a two-hour coping capability and restoration time, the range is 8.7×10^{-5} to 1.8×10^{-6} per site year. For a four hour coping capability and restoration time, the range is 4.0×10^{-5} to 6.5×10^{-7} per site-year. In both cases, approximately two orders of magnitude separate the highest and lowest frequencies.

The two sites in Table 1 with the highest core damage frequency (Sites 1 and 2) merit special attention because of their unique categorization by the Staff. Unlike the other fifty sites, the LOOP factors and cluster group assignments for Sites 1 and 2 are given implicitly in NUREG-1032. Thus, the core damage frequencies given in Table 1 for Sites 1 and 2 reflect the Staff's site-specific risk assessment as well as its generic methodology. Since the objective of this analysis is to determine the site-specific core damage frequencies using the methodology and data of NUREG-1032, the Staff's categorizations of Sites 1 and 2 are used.

TABLE 1

ASSESSMENT OF STATION BLACKOUT CORE DAMAGE FREQUENCY AT OPERATING NUCLEAR POWER PLANTS
RESULTS BASED ON STAFF'S CLUSTER GROUPS

SITE NUMBER	EDG CONFIGURATION	EDG RELIABILITY	LOOP FACTORS GR	I	SR	SS	CLUSTER GROUP	FREQUENCY, EVENTS/SITE-YEAR, FOR COPING CAPABILITY OF 0 HOURS	2 HOURS	4 HOURS
1	1/2	0.988	7	3	5	4	8	2.7×10^{-4}	8.7×10^{-5}	4.0×10^{-5}
2	1/2	0.990	7	3	5	4	8	2.7×10^{-4}	8.7×10^{-5}	4.0×10^{-5}
3	2/3	0.975	2	3	6	2	7	2.4×10^{-4}	5.8×10^{-5}	2.3×10^{-5}
4	2/3	0.975	2	3	6	3	4	2.2×10^{-4}	6.9×10^{-5}	3.6×10^{-5}
5	1/2	0.950	2	4	6	2	7	2.0×10^{-4}	4.6×10^{-5}	1.8×10^{-5}
6	1/2	0.955	2	3	6	3	7	2.0×10^{-4}	4.6×10^{-5}	1.8×10^{-5}
7	1/2	0.950	2	3	6	2	7	2.0×10^{-4}	4.6×10^{-5}	1.8×10^{-5}
8	1/2	0.950	2	1	6	2	7	2.0×10^{-4}	4.6×10^{-5}	1.8×10^{-5}
9	1/2	0.950	2	4	6	3	4	1.6×10^{-4}	5.3×10^{-5}	2.7×10^{-5}
10	1/2	0.955	2	1	6	3	4	1.6×10^{-4}	5.3×10^{-5}	2.7×10^{-5}
11	1/2	0.960	2	1	6	3	4	1.6×10^{-4}	5.3×10^{-5}	2.7×10^{-5}
12	1/2	0.950	2	3	4	3	6	1.4×10^{-4}	1.4×10^{-5}	6.6×10^{-6}
13	1/2	0.960	2	3	5	3	6	1.4×10^{-4}	1.4×10^{-5}	6.6×10^{-6}
14	1/2	0.950	2	3	4	2	3	1.4×10^{-4}	2.1×10^{-5}	7.6×10^{-6}
15	2/3	0.990	2	3,4	5	2	3,7	$0.94\text{-}1.3 \times 10^{-4}$	$1.4\text{-} 3.1 \times 10^{-5}$	$0.5\text{-} 1.3 \times 10^{-5}$
16	2/3	1.000	2	4	5	2	7	1.3×10^{-4}	3.1×10^{-5}	1.3×10^{-5}
17	1/2	0.965	2	4	6	2	7	1.1×10^{-4}	$3\text{-} 4 \times 10^{-5}$	1×10^{-5}
18	1/1*	0.975	2	4	6	2	7	8.9×10^{-5}	2.1×10^{-5}	8.4×10^{-6}
19	1/2	0.975	2	3	6	2	7	8.9×10^{-5}	2.1×10^{-5}	8.4×10^{-6}
20	1/2	0.978	2	1	6	2	7	8.9×10^{-5}	2.1×10^{-5}	8.4×10^{-6}
21	1/2	0.980	2	4	6	2	7	8.9×10^{-5}	2.1×10^{-5}	8.4×10^{-6}
22	1/2	0.980	2	1	6	2	7	8.9×10^{-5}	2.1×10^{-5}	8.4×10^{-6}
23	1/2	0.962	2	7	5	2	2,3	$5\text{-} 9 \times 10^{-5}$	$0.7\text{-} 1.2 \times 10^{-5}$	$2.5\text{-} 5.5 \times 10^{-6}$
24	1/2	0.980	2	2	2	3	6	6.4×10^{-5}	6.6×10^{-6}	3.1×10^{-6}
25	1/2	0.981	2	7	5	2	3,7	$2\text{-} 7 \times 10^{-5}$	$0.7\text{-} 1.5 \times 10^{-5}$	$2.8\text{-} 6.7 \times 10^{-6}$

* HAS DC POWERED TRAIN, CONSIDERED EQUIVALENT TO 1/2

TABLE I

ASSESSMENT OF STATION BLACKOUT CORE DAMAGE FREQUENCY AT OPERATING NUCLEAR POWER PLANTS
RESULTS BASED ON STAFF'S CLUSTER GROUPS

SITE NUMBER	EDG CONFIGURATION	EDG RELIABILITY	LOOP FACTORS GR	T	SR	SS	CLUSTER GROUP	FREQUENCY, EVENTS/SITE-YEAR, FOR COPING CAPABILITY OF 0 HOURS	2 HOURS	4 HOURS
26	1/2	0.985	2	7	6	2	7	5.2×10^{-5}	1.2×10^{-5}	4.9×10^{-6}
27	1/2	0.986	2	4	4	2	7	5.2×10^{-5}	1.2×10^{-5}	4.9×10^{-6}
28	1/2	0.989	2	2	6	2	7	5.2×10^{-5}	1.2×10^{-5}	4.9×10^{-6}
29	1/2	0.990	2	3	6	3	7	5.2×10^{-5}	1.2×10^{-5}	4.9×10^{-6}
30	1/2	0.990	2	2	6	2	7	5.2×10^{-5}	1.2×10^{-5}	4.9×10^{-6}
31	1/2	1.000	2	3	6	2	7	5.2×10^{-5}	1.2×10^{-5}	4.9×10^{-6}
32	1/2	0.988	2	3,4	5	2	3,7	$3.6- 5.2 \times 10^{-5}$	$0.6- 1.2 \times 10^{-5}$	$2.1- 5.6 \times 10^{-6}$
33	1/2	0.985	2	4	6	3	4	4.1×10^{-5}	1.5×10^{-5}	7.6×10^{-6}
34	1/2	0.990	2	3	6	3	4	4.1×10^{-5}	1.5×10^{-5}	7.6×10^{-6}
35	1/2	0.990	2	3	6	3	4	4.1×10^{-5}	1.5×10^{-5}	7.6×10^{-6}
36	1/2	0.990	2	4	4	3	4	4.1×10^{-5}	1.5×10^{-5}	7.6×10^{-6}
37	2/5	0.976	2	3	6	2	7	4.0×10^{-5}	1×10^{-5}	$< 6 \times 10^{-6}$
38	1/2	0.986	2	2	5	2	3	3.6×10^{-5}	5.6×10^{-6}	2.1×10^{-6}
39	1/2	0.990	2	2	5	2	3	3.6×10^{-5}	5.6×10^{-6}	2.1×10^{-6}
40	1/2	0.993	2	3	5	2	3	3.6×10^{-5}	5.6×10^{-6}	2.1×10^{-6}
41	1/2	0.985	2	3	5	2	3	3.6×10^{-5}	5.6×10^{-6}	2.1×10^{-6}
42	1/2	0.987	2	7	4	2	2,3	$2.4- 3.6 \times 10^{-5}$	$3- 5 \times 10^{-6}$	$0.8- 1.4 \times 10^{-6}$
43	2/5	0.986	2	4	5	2	7	3.0×10^{-5}	$4- 8 \times 10^{-6}$	$2- 5 \times 10^{-6}$
44	**	0.990	2	1	2	2	2	2.4×10^{-5}	2.6×10^{-6}	9.5×10^{-7}
45	3/8	0.986	2	1	5	2	3	$1.5- 2.5 \times 10^{-5}$	$2- 4 \times 10^{-6}$	$0.7- 1.4 \times 10^{-6}$
46	2/5	0.994	2	4	5	2	7	2.0×10^{-5}	$4- 8 \times 10^{-6}$	$2- 5 \times 10^{-6}$
47	2/5	0.995	2	3	6	2	7	2.0×10^{-5}	$4- 8 \times 10^{-6}$	$2- 5 \times 10^{-6}$
	1/3	0.997	2	4	6	2	7	1.5×10^{-5}	3.3×10^{-6}	1.3×10^{-6}
49	1/4	0.998	2	1	6	2	7	$< 1.5 \times 10^{-5}$	$< 3.3 \times 10^{-6}$	$< 1.3 \times 10^{-6}$
50	1/3	0.971	2	3	5	2	3	1.3×10^{-5}	1.8×10^{-6}	6.5×10^{-7}
51	1/3	0.974	2	7	5	2	3	1.3×10^{-5}	1.8×10^{-6}	6.5×10^{-7}
52	1/3	1.000	2	4	3	3	4	1.3×10^{-5}	3.7×10^{-6}	1.9×10^{-6}

** HAS NO EDGS. USES HYDROELECTRIC DAM, ASSUMED EQUIVALENT TO 1/2

Given that the LOOP factors and cluster group assignments for Sites 1 and 2 were pre-determined by the Staff, flexibility in the determination of their core damage frequencies was not possible. As a result, the frequencies for Sites 1 and 2 shown in Table 1 are somewhat inconsistent with those for the other fifty sites. For example, a consistent categorization of Sites 1 and 2 would place both in a more favorable grid reliability category, including enhanced recovery capability. In addition, one of the sites would be given credit for severe weather enhanced recovery capability. The net effect of these changes would be to reduce the absolute and relative core damage frequencies of Sites 1 and 2. These changes in LOOP factors are reflected in all subsequent analyses in this report.

The Staff's analysis in NUREG/CR-3226 (Kolaczkowski and Payne [1983]) indicates that power plants are capable of mitigating a station blackout of at least two hours duration (see also ACRS [1985] at pp. 43,115). Thus, in many respects, the two hour duration represents the Staff's perception of the present risk of station blackout (note that some sites have already demonstrated greater than two hours coping capability). It also appears that the Staff's proposed rule would require all sites to have at least a four hour coping capability. For all 52 operating sites, the average risk reduction gained by going from a two hour to a four hour mitigation capability is approximately 2.4.

3.0 ALTERNATIVE ANALYSES OF STATION BLACKOUT FREQUENCY

3.1 Direct Calculation Using NRC LOOP Database

The first alternative analysis involved a direct calculation of the site-specific station blackout frequencies using the Staff's LOOP database and curves but omitting the cluster groups. This direct calculation methodology is based on the station blackout frequency equations of NUREG-1032, Appendix B. The alternative analysis is considered superior to the cluster-based analysis of Section 2.0 for the following reasons:

(1) The direct analysis allows any EDG reliability to be used, obviating the need for interpolations.

(2) The direct analysis allows for the frequency of any duration station blackout to be calculated.

(3) Sensitivity studies showed that the cluster groups are less accurate for the durations of interest (i.e., 0, 2 and 4 hours).

The results of this analysis are summarized in Table 2. The expected frequencies of station blackout events exceeding 0, 2, and 4 hours were calculated for Sites 1 through 22 (the primary sites of interest), and Sites 35 and 39 (additional data points). It should be noted that translating these station blackout frequencies into core damage frequencies (as presented in Table 1) would further reduce the indicated site-specific values.

The range of frequencies calculated for all station blackout events extends from 3.5 X 10^{-4} to less than 5.9 x 10^{-5} per site-year (note that the low frequency sites were omitted from the analysis). For station blackout durations exceeding two hours, Table 2 shows an expected frequency range of 6.9 X 10^{-5} to less than 3.5 x 10^{-6} per site-year for the sites analyzed. Thus, the frequency ranges are similar to the core damage frequencies obtained with the cluster groups.

3.2 Direct Calculation Using Revised LOOP Curves

In this analysis, the Staff's LOOP database was revised to reflect industry corrections to LOOP data for the period 1959 through 1983. The industry LOOP database was based on NSAC-85 (Wyckoff [1985]). The removal of several events from the database required the fitting of new curves for the four plant-centered LOOP event categories and the six severe weather categories. Table 3 summarizes the LOOP events omitted from the database and the reasons for their omissions.

Table 4 summarizes the results of this analysis. The expected site-specific frequencies for all station blackout events ranged from 3.0 X 10^{-4} to less than 5.5 X 10^{-5} per site-year. For station blackout durations exceeding two hours, the frequency range is 4.2 X 10^{-5} to less than 3.0 X 10^{-6}. These frequencies are, in general, lower than those of Table 2.

TABLE 2

ASSESSMENT OF STATION BLACKOUT FREQUENCY AT OPERATING NUCLEAR POWER PLANTS
DIRECT CALCULATION USING STAFF'S LOOP CURVES

SITE NUMBER	EDG CONFIGURATION	EDG RELIABILITY	LOOP FACTORS GR	I	SR	SS	FREQUENCY, EVENTS/SITE-YEAR, OF BLACKOUT DURATIONS EXCEEDING: 0 HOURS	2 HOURS	4 HOURS
1	1/2	0.988	7	3	5	4	1.9×10^{-4}	1.9×10^{-5}	7.6×10^{-6}
2	1/2	0.990	3	3	3	4	1.8×10^{-4}	1.3×10^{-5}	5.9×10^{-6}
3	2/3	0.975	2	3	6	2	3.2×10^{-4}	4.8×10^{-5}	2.1×10^{-5}
4	2/3	0.975	2	3	6	3	3.3×10^{-4}	5.7×10^{-5}	2.6×10^{-5}
5	1/2	0.950	2	4	6	2	3.4×10^{-4}	6.3×10^{-5}	2.8×10^{-5}
6	1/2	0.955	2	3	6	3	2.9×10^{-4}	4.3×10^{-5}	2.1×10^{-5}
7	1/2	0.950	2	3	6	2	3.3×10^{-4}	4.4×10^{-5}	1.9×10^{-5}
8	1/2	0.950	2	1	6	2	3.2×10^{-4}	3.0×10^{-5}	1.5×10^{-5}
9	1/2	0.950	2	4	6	3	3.5×10^{-4}	6.9×10^{-5}	3.2×10^{-5}
10	1/2	0.955	2	1	6	3	2.8×10^{-4}	3.1×10^{-5}	1.8×10^{-5}
11	1/2	0.960	2	1	6	3	2.3×10^{-4}	2.7×10^{-5}	1.5×10^{-5}
12	1/2	0.950	2	3	4	3	2.9×10^{-4}	2.5×10^{-5}	1.1×10^{-5}
13	1/2	0.960	2	3	5	3	2.1×10^{-4}	2.3×10^{-5}	1.0×10^{-5}
14	1/2	0.950	2	3	4	2	2.8×10^{-4}	1.9×10^{-5}	6.4×10^{-6}
15	2/3	0.990	2	3,4	5	2	$1.3 - 1.4 \times 10^{-4}$	$1.4 - 2.5 \times 10^{-5}$	$0.5 - 1.1 \times 10^{-5}$
16	2/3	1.000	2	4	5	2	1.0×10^{-4}	1.9×10^{-5}	7.9×10^{-6}
17	1/2	0.965	2	4	6	2	2.0×10^{-4}	3.9×10^{-5}	1.7×10^{-5}
18	1/1*	0.975	2	4	6	2	1.4×10^{-4}	2.8×10^{-5}	1.2×10^{-5}
19	1/2	0.975	2	3	6	2	1.3×10^{-4}	1.9×10^{-5}	8.2×10^{-6}
20	1/2	0.978	2	1	6	2	1.1×10^{-4}	1.2×10^{-5}	6.4×10^{-6}
21	1/2	0.980	2	4	6	2	1.1×10^{-4}	2.3×10^{-5}	1.0×10^{-5}
22	1/2	0.980	2	1	6	2	1.0×10^{-4}	1.1×10^{-5}	6.0×10^{-6}
35	1/2	0.990	2	3	6	3	7.5×10^{-5}	1.3×10^{-5}	6.2×10^{-6}
39	1/2	0.990	2	2	5	2	5.9×10^{-5}	3.5×10^{-6}	1.6×10^{-6}

* HAS DC POWERED TRAIN; CONSIDERED EQUIVALENT TO 1/2

3.3 Direct Calculation Using LOOP Data From 1979 Through 1983

This analysis shows the impact of considering only the recent industry LOOP experience as indicative of current LOOP likelihood. The industry-average frequency of LOOP events has declined significantly since the mid-1970's based, in part, on improvements to plant designs and operating practices. Therefore, using twenty-five years of LOOP data (as in NUREG-1032) overestimates the current expected LOOP frequency.

The small LOOP frequency in recent years prevents establishing statistically meaningful subdivisions. Accordingly, a single industry-average frequency-duration curve was used for all sites in calculating the expected station blackout frequency.

Table 5 summarizes the expected station blackout frequencies for durations exceeding 0, 2, and 4 hours. The frequency range for all blackout events is 9.6×10^{-5} to less than 2.1×10^{-5} per site-year. The frequency range for durations exceeding two hours is 1.5×10^{-5} to less than 3.2×10^{-6} per site-year. These frequencies represent a significant reduction (a factor of 3 to 10) over those shown in Table 2.

TABLE 3

CHANGES TO NRC LOOP DATA FOR ALTERNATIVE ANALYSES

SITE	DATE	DURATION, HOURS	CHANGE	REASON
CALVERT CLIFFS	4-13-78	5.83	OMITTED FROM THE ANALYSIS	RECLASSIFIED AS CATEGORY III BY NSAC-85
DAVIS BESSE	11-29-77	0.002	OMITTED FROM THE ANALYSIS	CLASSIFIED AS CATEGORY III BY NSAC-85 AND NUREG/CR-3992
FITZPATRICK	10-4-78	0.004	OMITTED FROM THE ANALYSIS	CLASSIFIED AS CATEGORY IV BY NUREG/CR-3992
FITZPATRICK	3-27-79	0.05	OMITTED FROM THE ANALYSIS	CLASSIFIED AS CATEGORY III BY NSAC-85 AND NUREG/CR-3992
OCONEE	1-4-74	0.013	OMITTED FROM THE ANALYSIS	CLASSIFIED AS CATEGORY III BY NSAC-85 AND NUREG/CR-3992
POINT BEACH	4-27-74	0.02	OMITTED FROM THE ANALYSIS	CLASSIFIED AS CATEGORY III BY NSAC-85 AND NUREG/CR-3992
QUAD CITIES	11-6-77	1.15	OMITTED FROM THE ANALYSIS	RECLASSIFIED AS CATEGORY III BY NSAC-85
QUAD CITIES	6-22-82	0.57	OMITTED FROM THE ANALYSIS	RECLASSIFIED AS CATEGORY III BY NSAC-85
ARKANSAS NUCLEAR ONE	9-16-78	1.48	REDUCED DURATION TO 0.50 HOURS	EVENT REEVALUATED BY LICENSEE
INDIAN POINT	6-3-80	1.75 (0.50)	OMITTED FROM "I1" PLANT-CENTERED CATEGORY	AVOID DOUBLE-COUNTING EVENTS
PALISADES	11-25-77	0.50	INCLUDED IN ANALYSIS	CLASSIFIED AS CATEGORY IA BY NSAC-85 AND NUREG/CR-3992
PALISADES	12-11-77	0.50	INCLUDED IN ANALYSIS	CLASSIFIED AS CATEGORY IA BY NSAC-85 AND NUREG/CR-3992

TABLE 4

ASSESSMENT OF STATION BLACKOUT FREQUENCY AT OPERATING NUCLEAR POWER PLANTS
DIRECT CALCULATION USING REVISED LOOP CURVES

SITE NUMBER	EDG CONFIGURATION	EDG RELIABILITY	LOOP FACTORS GR I' SR' SS	FREQUENCY, EVENTS/SITE-YEAR, OF BLACKOUT DURATIONS EXCEEDING: 0 HOURS	2 HOURS	4 HOURS
1	1/2	0.988	7 3' 5' 4	1.9×10^{-4}	1.6×10^{-5}	6.5×10^{-6}
2	1/2	0.990	3 3' 3' 4	1.8×10^{-4}	1.0×10^{-5}	5.2×10^{-6}
3	2/3	0.975	2 3' 6' 2	2.9×10^{-4}	3.4×10^{-5}	1.4×10^{-5}
4	2/3	0.975	2 3' 6' 3	3.0×10^{-4}	4.2×10^{-5}	2.0×10^{-5}
5	1/2	0.950	2 4' 6' 2	3.0×10^{-4}	3.4×10^{-5}	1.3×10^{-5}
6	1/2	0.955	2 3' 6' 3	2.6×10^{-4}	3.3×10^{-5}	1.5×10^{-5}
7	1/2	0.950	2 3' 6' 2	3.0×10^{-4}	3.2×10^{-5}	1.3×10^{-5}
8	1/2	0.950	2 1' 6' 2	3.0×10^{-4}	3.1×10^{-5}	1.3×10^{-5}
9	1/2	0.950	2 4' 6' 3	3.1×10^{-4}	4.0×10^{-5}	1.7×10^{-5}
10	1/2	0.955	2 1' 6' 3	2.6×10^{-4}	3.2×10^{-5}	1.5×10^{-5}
11	1/2	0.960	2 1' 6' 3	2.2×10^{-4}	2.7×10^{-5}	1.3×10^{-5}
12	1/2	0.950	2 3' 4' 3	2.6×10^{-4}	1.3×10^{-5}	7.4×10^{-6}
13	1/2	0.960	2 3' 5' 3	1.9×10^{-4}	1.4×10^{-5}	7.2×10^{-6}
14	1/2	0.950	2 3' 4' 2	2.5×10^{-4}	7.2×10^{-6}	3.0×10^{-6}
15	2/3	0.990	2 3',4' 5' 2	$1.1 - 1.2 \times 10^{-4}$	$7.3 - 8.0 \times 10^{-6}$	3.1×10^{-6}
16	2/3	1.000	2 4' 5' 2	8.5×10^{-5}	5.9×10^{-6}	2.3×10^{-6}
17	1/2	0.965	2 4' 6' 2	1.8×10^{-4}	2.1×10^{-5}	8.4×10^{-6}
18	1/1*	0.975	2 4' 6' 2	1.2×10^{-4}	1.4×10^{-5}	5.5×10^{-6}
19	1/2	0.975	2 3' 6' 2	1.2×10^{-4}	1.4×10^{-5}	5.5×10^{-6}
20	1/2	0.978	2 1' 6' 2	1.0×10^{-4}	1.2×10^{-5}	4.9×10^{-6}
21	1/2	0.980	2 4' 6' 2	9.8×10^{-5}	1.2×10^{-5}	4.6×10^{-6}
22	1/2	0.980	2 1' 6' 2	9.4×10^{-5}	1.1×10^{-5}	4.6×10^{-6}
35	1/2	0.990	2 3' 6' 3	6.8×10^{-5}	9.9×10^{-6}	4.5×10^{-6}
39	1/2	0.990	2 2' 5' 2	5.5×10^{-5}	3.0×10^{-6}	1.4×10^{-6}

* HAS DC POWERED TRAIN; CONSIDERED EQUIVALENT TO 1/2

TABLE 5

ASSESSMENT OF STATION BLACKOUT FREQUENCY AT OPERATING NUCLEAR POWER PLANTS
DIRECT CALCULATION USING 1979-1983 LOOP DATA

SITE NUMBER	EDG CONFIGURATION	EDG RELIABILITY	FREQUENCY, EVENTS/SITE-YEAR, OF BLACKOUT DURATIONS EXCEEDING: 0 HOURS	2 HOURS	4 HOURS
1	1/2	0.988	2.2×10^{-5}	3.5×10^{-6}	3.5×10^{-7}
2	1/2	0.990	2.1×10^{-5}	3.2×10^{-6}	3.3×10^{-7}
3	2/3	0.975	9.4×10^{-5}	1.5×10^{-5}	1.5×10^{-6}
4	2/3	0.975	9.4×10^{-5}	1.5×10^{-6}	1.5×10^{-6}
5	1/2	0.950	9.6×10^{-5}	1.5×10^{-5}	1.5×10^{-6}
6	1/2	0.955	8.1×10^{-5}	1.3×10^{-5}	1.3×10^{-6}
7	1/2	0.950	9.6×10^{-5}	1.5×10^{-5}	1.5×10^{-6}
8	1/2	0.950	9.6×10^{-5}	1.5×10^{-5}	1.5×10^{-6}
9	1/2	0.950	9.6×10^{-5}	1.5×10^{-5}	1.5×10^{-6}
10	1/2	0.955	8.1×10^{-5}	1.3×10^{-5}	1.3×10^{-6}
11	1/2	0.960	6.8×10^{-5}	1.1×10^{-5}	1.1×10^{-6}
12	1/2	0.950	9.6×10^{-5}	1.5×10^{-5}	1.5×10^{-6}
13	1/2	0.960	6.8×10^{-5}	1.1×10^{-5}	1.1×10^{-6}
14	1/2	0.950	9.6×10^{-5}	1.5×10^{-5}	1.5×10^{-6}
15	2/3	0.990	4.3×10^{-5}	6.7×10^{-6}	6.7×10^{-7}
16	2/3	1.000	3.2×10^{-5}	4.9×10^{-6}	4.9×10^{-7}
17	1/2	0.965	5.7×10^{-5}	8.9×10^{-6}	9.1×10^{-7}
18	1/1*	0.975	3.8×10^{-5}	6.0×10^{-6}	6.0×10^{-7}
19	1/2	0.975	3.8×10^{-5}	6.0×10^{-6}	6.0×10^{-7}
20	1/2	0.978	3.4×10^{-5}	5.2×10^{-6}	5.3×10^{-7}
21	1/2	0.980	3.1×10^{-5}	4.8×10^{-6}	4.9×10^{-7}
22	1/2	0.980	3.1×10^{-5}	4.8×10^{-6}	4.9×10^{-7}
35	1/2	0.990	2.1×10^{-5}	3.2×10^{-6}	3.3×10^{-7}
39	1/2	0.990	2.1×10^{-5}	3.2×10^{-6}	3.3×10^{-7}

* HAS DC POWERED TRAIN; CONSIDERED EQUIVALENT TO 1/2

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APPENDIX A

<u>NRC Staff Generic Assessment of Station Blackout Risk</u>

Contents:

Table C.4 of NUREG-1032

Table C.4. Tabulated Estimated Values of Total Core Damage Frequency for Station Blackout Accidents as a Function of Coping and Recovery Capability

1/2 EDG Configuration

EDḠR=0.1

t(hr)	1	2	3	4	5
0	3.2(-4)	2.8(-4)	4.3(-4)	4.8(-4)	7.2(-4)
2	2.3(-5)	2.8(-5)	6.1(-5)	1.5(-4)	2.5(-4)
4	7.3(-6)	1.0(-5)	2.2(-5)	7.6(-5)	1.5(-4)
8	1.4-2.4(-6)	2.2-3.4(-6)	4.5-2.3(-6)	2.5-3.1(-5)	6.4-7.6(-5)
16	1.9-12(-7)	2.9-16(-7)	5.8-34(-7)	3.9-11(-6)	1.4-2.5(-5)

Cluster

t(hr)	6	7	8	9
0	4.4(-4)	5.9(-4)	3.0(-3)	3.3(-3)
2	4.0(-5)	1.3(-4)	9.2(-4)	1.5(-3)
4	1.9(-5)	5.2(-5)	4.1(-4)	8.3(-4)
8	5.7(-6)-7.5(-6)	1.2-1.8(-5)	1.5(-4)	2.8-3.6(-4)
16	9.4-27(-7)	1.4-7.3(-6)	1.3-6.5(-5)	4.6-11(-5)

EDḠR=.05

t(hr)	1	2	3	4	5
0	1.0(-4)	9.2(-5)	1.4(-4)	1.6(-4)	2.5(-4)
2	7.7(-6)	9.7(-6)	2.1(-5)	5.3(-5)	9.1(-5)
4	2.5(-6)	3.5(-6)	7.6(-6)	2.7(-5)	5.5(-5)
8	4.9-8.2(-7)	3.6(-12(-7)	1.6-2.5(-6)	8.9-11(-6)	2.3-2.8(-5)
16	6.5-41(-8)	1.0-5.4(-7)	1.9-11(-7)	1.4-3.7(-6)	5.0-9.1(-6)

t(hr)	6	7	8	9
0	1.4(-4)	2.0(-4)	1.0(-3)	1.2(-3)
2	1.4(-5)	4.6(-5)	3.2(-4)	5.4(-4)
4	6.6(-6)	1.8(-5)	1.4(-4)	3.0(-4)
8	2.1-2.7(-6)	4.0-6.1(-6)	3.8-5.2(-5)	1.0-1.3(-4)
16	3.4-9.7(-7)	4.8-28(-7)	4.6-19(-6)	1.7-4.1(-5)

Table C.4 (continued)

1/2 EDG Configuration

ED$\bar{G}$R=.025

t(hr)	1	2	3	4	5
0	4.6(-5)	4.1(-5)	6.2(-5)	7.0(-5)	1.2(-4)
2	3.5(-6)	4.4(-6)	4.6(-6)	2.5(-5)	4.4(-5)
4	1.2(-6)	1.6(-6)	3.5(-6)	1.3(-5)	2.7(-5)
8	2.3-4.0(-7)	3.5-5.5(-7)	7.3-12(-7)	4.2-5.4(-6)	1.2-1.3(-5)
16	3.1-19(-8)	4.7-25(-8)	8.9-53(-8)	6.8-19(-7)	2.5-4.5(-6)

t(hr)	6	7	8	9
0	6.4(-5)	8.9(-5)	4.6(-4)	5.4(-4)
2	6.6(-6)	2.1(-5)	1.5(-4)	2.6(-4)
4	3.1(-6)	8.4(-6)	6.8(-5)	1.4(-4)
8	9.9-13(-7)	1.9-2.9(-6)	1.7-2.5(-5)	5.0-6.2(-5)
16	1.6-4.6(-7)	2.3-12(-7)	2.2-9.0(-6)	8.0-20(-6)

ED$\bar{G}$R=.01

t(hr)	1	2	3	4	5
0	2.7(-5)	2.4(-5)	3.6(-5)	4.1(-5)	6.9(-5)
2	2.9(-6)	2.6(-6)	5.6(-5)	1.5(-5)	2.7(-5)
4	6.7(-7)	9.5(-7)	2.1(-6)	7.6(-6)	1.6(-5)
8	1.3-2.2(-7)	2.1-3.3(-7)	4.3-6.8(-7)	2.5-3.2(-6)	7.1-8.2(-6)
16	1.8-11(-8)	2.8-14(-8)	5.4-31(-8)	4.1-11(-7)	1.5-2.7(-6)

Cluster

t(hr)	6	7	8	9
0	3.7(-5)	5.2(-5)	2.7(-4)	3.2(-4)
2	3.9(-6)	1.2(-5)	8.7(-5)	1.5(-4)
4	1.9(-6)	4.9(-6)	4.0(-5)	8.5(-5)
8	5.9-7.6(-7)	1.1-1.7(-6)	1.0-1.4(-5)	3.0-3.7(-5)
16	9.8-27(-8)	1.3-6.8(-7)	1.3-5.3(-6)	4.8-12(-6)

Table C.4 (continued)

2/3 EDG Configuration

$EDG\bar{R}$=0.1

t(hr)	1	2	3	4	5
0	9.4(-4)	8.3(-4)	1.3(-3)	1.5(-3)	2.1(-3)
2	6.7(-5)	8.4(-5)	1.8(-4)	4.4(-4)	7.4(-4)
4	2.2(-5)	3.0(-5)	6.5(-5)	2.2(-4)	4.5(-4)
8	4.0-7.1(-6)	6.4-10(-6)	1.3-2.1(-5)	7.3-9.3(-5)	1.9-2.2(-4)
16	5.6-35(-7)	8.5-46(-7)	1.7-9.9(-6)	1.2-3.1(-5)	4.1-7.4(-5)

t(hr)	6	7
0	1.3(-3)	1.7(-3)
2	1.2(-4)	3.9(-4)
4	5.5(-5)	1.6(-4)
8	1.7-2.2(-5)	3.4-5.2(-5)
16	2.8-8.1(-6)	4.1-2.2(-6)

$EDG\bar{R}$=.05

Cluster

t(hr)	1	2	3	4	5
0	3.0(-4)	2.7(-4)	4.1(-4)	5.0(-4)	7.2(-4)
2	2.2(-5)	2.8(-5)	6.0(-5)	1.5(-4)	2.6(-4)
4	7.2(-6)	1.0(-5)	2.2-2.5(-5)	7.8(-5)	1.6(-4)
8	1.4-2.4(-6)	2.2-3.5(-6)	4.5-7.2(-6)	2.5-3.3(-5)	6.8-8.0(-5)
16	1.9-12(-7)	2.9-16(-7)	5.7-33(-7)	4.1-11(-6)	1.5-2.6(-5)

t(hr)	6	7
0	4.1(-4)	5.7(-4)
2	4.1(-5)	1.3(-4)
4	1.9(-5)	5.2(-5)
8	6.0-7.8(-6)	1.2-1.8(-5)
16	9.8-28(-7)	1.4-7.3(-6)

Table C.4 (continued)

2/3 EDG Configuration

EDGR=.025

t(hr)	1	2	3	4	5
0	1.2(-4)	1.1(-4)	1.7(-4)	2.2(-4)	3.2(-4)
2	9.6(-6)	1.2(-5)	2.6(-5)	6.9(-5)	1.2(-4)
4	3.2(-6)	4.5(-6)	9.7(-6)	3.6(-5)	7.6(-5)
8	6.2-11(-7)	9.7-16(-7)	2.0-3.2(-6)	1.1-1.5(-5)	3.2-3.8(-5)
16	8.4-52(-8)	1.4-6.8(-7)	2.5-14(-7)	1.9-4.9(-6)	6.9-13(-6)

t(hr)	6	7
0	1.7(-4)	2.4(-4)
2	1.8(-5)	5.8(-5)
4	8.5(-6)	2.3(-5)
8	2.7-3.6(-6)	5.1-7.7(-6)
16	4.5-13(-7)	6.2-32(-7)

EDGR=.01

t(hr)	1	2	3	4	5
0	6.7(-5)	6.0(-5)	9.4(-5)	1.2(-4)	1.8(-4)
2	5.2(-6)	6.6(-6)	1.4(-5)	3.8(-5)	1.8(-4)
4	1.7(-6)	2.5(-6)	5.3(-6)	2.00(-5)	1.8(-4)
8	3.4-5.7(-7)	5.4-8.3(-7)	1.1-1.7(-6)	6.7-8.4(-6)	1.9-2.2(-5)
16	4.6-28(-8)	7.1-37(-8)	1.4-7.9(-7)	1.1-2.8(-6)	4.1-7.2(-6)

t(hr)	6	7
0	9.3(-5)	1.3(-4)
2	1.0(-5)	3.1(-5)
4	4.8(-6)	1.3(-5)
8	1.6-2.0(-6)	2.8-4.3(-6)
16	2.6-7.2(-7)	3.4-18(-7)

Table C.4 (continued)

1/3 EDG Configuration

$EDG\bar{R}=0.1$

t(hr)	1	2	3	4	5
0	4.3(-5)	3.8(-5)	5.9(-5)	7.1(-5)	1.0(-4)
2	3.1(-6)	3.9(-6)	8.5(-6)	2.1(-5)	3.6(-5)
4	1.0(-6)	1.4(-6)	3.1(-6)	1.1(-5)	2.2(-5)
8	2.0-2.4(-7)	3.1-4.7(-7)	6.3-10(-7)	3.5-4.5(-6)	9.2-11(-6)
16	2.6-17(-8)	3.9-20(-8)	4.1-47(-8)	5.6-16(-7)	2.0-3.6(-6)

Cluster

t(hr)	6	7	8	9
0	6.0(-5)	8.1(-5)	4.1(-4)	4.7(-4)
2	5.6(-6)	1.8(-5)	1.3(-4)	2.1(-4)
4	2.6(-6)	7.3(-6)	5.8(-5)	1.2(-4)
8	6.2-11(-7)	1.6-2.4(-6)	1.5-2.1(-5)	4.1-5.1(-5)
16	1.4-4.0(-7)	2.0-10(-7)	1.9-7.7(-6)	6.6-17(-6)

$EDG\bar{R}=0.05$

t(hr)	1	2	3	4	5
0	1.4(-5)	1.3(-5)	2.0(-5)	2.3(-5)	3.4(-5)
2	1.0(-6)	1.3(-6)	2.8(-6)	7.1(-6)	1.2(-5)
4	3.4(-7)	4.7(-7)	1.0(-6)	3.6(-6)	7.4(-6)
8	6.5-11(-8)	1.0-1.6(-7)	2.1-3.4(-7)	1.2-1.5(-6)	3.1-3.7(-6)
16	8.9-5.0(-9)	1.4-7.3(-8)	2.7-15(-8)	1.9-5.0(-7)	6.7-12(-7)

t(hr)	6	7	8	9
0	2.0(-5)	2.7(-5)	1.4(-4)	1.6(-4)
2	1.9(-6)	61.(-6)	4.3(-5)	7.2(-5)
4	8.8(-7)	2.4(-6)	1.9(-5)	4.0(-5)
8	2.7-3.6(-7)	5.4-8.2(-7)	5.0-7.0(-6)	1.4-1.7(-5)
16	4.5-13(-8)	6.5-34(-8)	6.3-26(-7)	2.2-5.5(-6)

Table C.4 (continued)

1/3 EDG Configuration

$\overline{EDGR}$=.025

Cluster

t(hr)	1	2	3	4	5
0	9.4(-6)	8.3(-6)	1.3(-5)	1.5(-5)	2.2(-5)
2	6.7(-7)	8.4(-7)	1.8(-6)	4.5(-6)	7.5(-6)
4	2.2(-7)	3.0(-7)	6.5(-7)	2.3(-6)	4.6(-6)
8	4.1-7.1(-8)	6.4-10(-8)	1.3-2.2(-7)	7.4-9.4(-7)	1.9-2.3(-6)
16	5.6-35(-9)	8.6-46(-9)	1.7-9.9(-8)	1.2-3.2(-7)	4.2-7.6(-7)

t(hr)	6	7	8	9
0	1.3(-5)	1.7(-5)	8.9(-5)	9.9(-5)
2	1.2(-6)	3.9(-6)	2.7(-5)	4.5(-5)
4	5.5(-7)	1.6(-6)	1.2(-5)	2.5(-5)
8	1.8-2.3(-7)	3.4-5.2(-7)	3.2-4.4(-6)	8.7-11(-6)
16	2.8-8.2(-3)	4.1-22(-8)	4.0-17(-7)	1.4-3.5(-6)

$\overline{EDGR}$=.01

t(hr)	1	2	3	4	5
0	5.1(-6)	7.2(-6)	1.1(-5)	1.3(-5)	1.8(-5)
2	5.7(-7)	7.1(-7)	1.5(-6)	3.7(-6)	6.2(-6)
4	1.8(-7)	2.5(-7)	5.5(-7)	1.9(-6)	3.8(-6)
8	3.5-6.0(-8)	5.4-8.6(-8)	1.1-1.8(-7)	6.1-7.8(-7)	1.6-1.9(-6)
16	4.7-30(-9)	7.2-40(-9)	1.4-8.4(-8)	9.7-27(-8)	3.4-6.2(-7)

t(hr)	6	7	8	9
0	1.1(-5)	1.5(-5)	7.5(-5)	8.3(-5)
2	1.0(-6)	3.3(-6)	2.3(-5)	3.7(-5)
4	4.6(-7)	1.3(-6)	1.0(-5)	2.1(-5)
8	1.4-1.9(-7)	2.9-4.4(-7)	2.6-3.7(-6)	7.2-8.9(-6)
16	2.3-6.8(-8)	3.5(-19(-8)	3.3-14(-7)	1.1-2.9(-6)

APPENDIX B

Definition of LOOP Susceptibility Categories:

Tables from NUREG-1032, Appendix A

Contents:

(1) Table A.2, "Definitions of Offsite Power System Design Factors."

(2) Table A.3, "Mean Time to Restore Offsite Power and Statistical Test Values for Plant Design Groupings."

(3) Table A.6, "Grids Reliability/Recovery."

(4) Table A.8, "Severe Weather-Induced Loss of Offsite Power Frequency/Recovery."

(5) Table A.9, "Extremely Severe Weather-Induced Loss of Offsite Power Frequency."

Table A.2 Definitions of Offsite Power System Design Factors

A - Independence of offsite power sources to the nuclear power plant

1. All offsite power sources are connected to the plant through one switchyard

2. All offsite power sources are connected to the plant through two or more switchyards, and the switchyards are electrically connected.

3. All offsite power sources are connected to the plant through two or more switchyards or separate incoming transmission lines, but at least one of the ac sources is electrically independent of the others.

B - Automatic and manual transfer schemes for the Class 1E buses when the normal source of ac power fails and when the backup sources of offsite power fail

1. If the normal source of ac power fails, there are no automatic transfers and one or more manual transfers to preferred or alternate offsite power sources.

2. If the normal source of ac power fails, there is one automatic transfer but no manual transfers to preferred or alternate offsite power sources.

   a. All of the Class 1E buses in a unit are connected to the same preferred power source after the automatic transfer of power sources.

   b. The Class 1E buses in a unit are connected to separate offsite power sources after the automatic transfer of power sources.

Table A.2 Definitions of Offsite Power System Design Factors (continued)

3. After loss of the normal ac power source, there is one automatic transfer. If this source fails, there may be one or more manual transfers of power sources to preferred or alternate offsite power sources.

   a. All of the Class 1E buses in a unit are connected to one preferred power source after the first automatic transfer.

   b. The Class 1E buses in a unit are connected to separate offsite power sources after the first automatic transfer.

4. If the normal source of ac power fails, there is an automatic transfer to a preferred source of power. If this preferred source of power fails, there is an automatic transfer to another source of offsite power.

   a. All of the Class 1E buses in a unit are connected to the same preferred power source after the first automatic transfer.

   b. The Class 1E buses in a unit are connected to separate offsite power sources after the first automatic transfer of power sources.

Table A.3 Mean Time to Restore Offsite Power and Statistical Test Values for Plant Design Groupings

Group Designation	Design Features*	Mean Time to Restore Offsite Power (hrs)
I1	A3 and (B3 or B4)	0.15
I2	A3 and (B1 or B2)	0.29
I3	(A1 or A2) and (B3 or B4)	~~0.44~~ (0.50)
I4	(A1 or A2) and (B1 or B2)	~~1.08~~ (0.97)

Statistical Test Values

	F value	Pr F
A	7.77	0.0094
B	3.93	0.0573
A*B	1.61	0.2150

*A1, A2, A3, B1, B2, B3 and B4 are defined in Table A.2.

Note: Frequency of plant-centered loss-of-offsite-power events was 0.056 per site-year.

Note: Published values incorrect; correct values given in parentheses.

Table A.6. Grid Reliability/Recovery

Grid Reliability(G)

Grid Reliability Groups (G)	Frequency of Grid Loss
G1	Less than 1 per 60 site-years (0.01/
G2	≥ 1 per 60 site-years and < 1 per 20 site-years (0.03/yr)
G3	> 1 per 20 site-years and ≤ 1 per 6 site-years (0.2/yr)
G4	Greater than or equal to 1 per 6 site-years (0.3/yr)

Recovery (R)

Recovery form Grid Blackout Groups (R)	Recovery Capability
R1	Plant has capability and procedures to recover offsite (non-emergency) AC power to the site within 1/2 hour following a grid blackout.
R2	All other plants not in R1.

Grid Reliability/Recovery (GR)

Grid Reliability/Recovery Group (GR)	Grid Reliability Group (G)	Recovery from Grid Blackout Group (R)
GR1	G1	R1
GR2	G2	R1
GR3	G3	R1
GR4	G4	R1
GR5	G1	R2
GR6	G2	R2
GR7	G3	R2

Table A.8. Severe Weather-Induced Loss of Offsite Power Frequency/Recovery

Severe Weather-Induced Loss of Offsite Power Frequency (S)

Frequency Group (S)	Frequency of Severe Weather-Induced Loss of Offsite Power
S1	Less than 1 per 350 site-years (0.002/yr)
S2	≥ 1 per 350 site-years and < 1 per 120 site-years (0.005/yr)
S3	Greater than or equal to 1 per 120 site-years (0.015/yr)

Recovery (R)

Recovery from Severe Weather-Induced Loss of Offsite Power Groups (R)	Recovery Capability
R1	Plant has capability and procedures to recover offsite (non-emergency) AC power to the site within 2 hours following a severe weather-induced loss of offsite power.
R2	All other plants not in R1.

Severe Weather-Induced Loss of Offsite Power Frequency/Recovery (SR)

Severe Weather-Induced Loss of Offsite Power Frequency/ Recovery Group (SR)	Frequency Group (S)	Recovery Group (R)
SR1	S1	R1
SR2	S2	R1
SR3	S3	R1
SR4	S1	R2
SR5	S2	R2
SR6	S3	R2

Table A.9. Extremely Severe Weather-Induced Loss of Offsite Power Frequency

Extremely Severe Weather-Induced Loss of Offsite Power Frequency (SS)

Frequency Groups (SS)	Frequency of Extremely Severe Weather-Induced Loss of Offsite Power
SS1	Less than 1 per 3500 site-years (0.0002/yr)
SS2	≥ 1 per 3500 site-years and < 1 per 1200 site-years (0.0005/yr)
SS3	≥ 1 per 1200 site-years and < 1 per 350 site years (0.002/yr)
SS4	≥ 1 per 350 site-years and < 1 per 120 site-years (0.005/yr)
SS5	Greater than or equal to 1 per 120 site-years (0.015/yr)

APPENDIX C

Definition of LOOP Cluster Groups

Contents:

(1) Output from SAS Fastclus Procedure Defining Clusters 1 through 7.

(2) Table A.10 from NUREG-1032, "Cluster Correlation Factors," Defining Clusters 8 and 9.

GR	I	SR	SS	CLUSTER
1	1	1	1	1
1	1	2	1	1
1	2	1	1	1
1	2	2	1	1
2	1	1	1	1
2	1	2	1	1
2	2	1	1	1
2	2	2	1	1
1	1	1	2	2
1	1	2	2	2
1	1	3	1	2
1	1	4	1	2
1	1	4	2	2
1	2	1	2	2
1	2	2	2	2
1	2	3	1	2
1	2	4	1	2
1	2	4	2	2
1	3	1	1	2
1	3	2	1	2
2	1	1	2	2
2	1	2	2	2
2	1	3	1	2
2	1	4	1	2
2	1	4	2	2
2	2	1	2	2
2	2	2	2	2
2	2	3	1	2
2	2	4	1	2
2	2	4	2	2
2	3	1	1	2
2	3	2	1	2
1	1	3	2	3
1	1	5	1	3
1	1	5	2	3
1	2	3	2	3
1	2	5	1	3
1	2	5	2	3
1	3	1	2	3
1	3	2	2	3
1	3	3	1	3
1	3	3	2	3
1	3	4	1	3
1	3	4	2	3
1	3	5	1	3
1	3	5	2	3
2	1	3	2	3
2	1	5	1	3
2	1	5	2	3
2	2	3	2	3
2	2	5	1	3
2	2	5	2	3
2	3	1	2	3
2	3	2	2	3
2	3	3	1	3
2	3	3	2	3

OBS	GR	I	SR	SS	CLUSTER
57	2	3	4	1	3
58	2	3	4	2	3
59	2	3	5	1	3
60	2	3	5	2	3
61	1	1	1	4	4
62	1	1	2	4	4
63	1	1	3	4	4
64	1	1	4	4	4
65	1	1	5	4	4
66	1	1	6	3	4
67	1	1	6	4	4
68	1	2	1	4	4
69	1	2	2	4	4
70	1	2	3	4	4
71	1	2	4	4	4
72	1	2	5	4	4
73	1	2	6	3	4
74	1	2	6	4	4
75	1	3	1	4	4
76	1	3	2	4	4
77	1	3	3	4	4
78	1	3	4	4	4
79	1	3	5	4	4
80	1	3	6	3	4
81	1	3	6	4	4
82	1	4	1	4	4
83	1	4	2	4	4
84	1	4	3	3	4
85	1	4	3	4	4
86	1	4	4	3	4
87	1	4	4	4	4
88	1	4	5	3	4
89	1	4	5	4	4
90	1	4	6	3	4
91	1	4	6	4	4
92	2	1	1	4	4
93	2	1	2	4	4
94	2	1	3	4	4
95	2	1	4	4	4
96	2	1	5	4	4
97	2	1	6	3	4
98	2	1	6	4	4
99	2	2	1	4	4
100	2	2	2	4	4
101	2	2	3	4	4
102	2	2	4	4	4
103	2	2	5	4	4
104	2	2	6	3	4
105	2	2	6	4	4
106	2	3	1	4	4
107	2	3	2	4	4
108	2	3	3	4	4
109	2	3	4	4	4
110	2	3	5	4	4
111	2	3	6	3	4
112	2	3	6	4	4

BS	GR	I	SR	SS	CLUSTER
13	2	4	1	4	4
14	2	4	2	4	4
15	2	4	3	3	4
16	2	4	3	4	4
17	2	4	4	3	4
18	2	4	4	4	4
19	2	4	5	3	4
20	2	4	5	4	4
21	2	4	6	3	4
22	2	4	6	4	4
23	1	1	1	5	5
24	1	1	2	5	5
25	1	1	3	5	5
26	1	1	4	5	5
27	1	1	5	5	5
28	1	1	6	5	5
129	1	2	1	5	5
130	1	2	2	5	5
131	1	2	3	5	5
132	1	2	4	5	5
133	1	2	5	5	5
134	1	2	6	5	5
135	1	3	1	5	5
136	1	3	2	5	5
137	1	3	3	5	5
138	1	3	4	5	5
139	1	3	5	5	5
140	1	3	6	5	5
141	1	4	1	5	5
142	1	4	2	5	5
143	1	4	3	5	5
144	1	4	4	5	5
145	1	4	5	5	5
146	1	4	6	5	5
147	2	1	1	5	5
148	2	1	2	5	5
149	2	1	3	5	5
150	2	1	4	5	5
151	2	1	5	5	5
152	2	1	6	5	5
153	2	2	1	5	5
154	2	2	2	5	5
155	2	2	3	5	5
156	2	2	4	5	5
157	2	2	5	5	5
158	2	2	6	5	5
159	2	3	1	5	5
160	2	3	2	5	5
161	2	3	3	5	5
162	2	3	4	5	5
163	2	3	5	5	5
164	2	3	6	5	5
165	2	4	1	5	5
166	2	4	2	5	5
167	2	4	3	5	5
168	2	4	4	5	5

BS	GR	I	SR	SS	CLUSTER
69	2	4	5	5	5
70	2	4	6	5	5
71	1	1	1	3	6
72	1	1	2	3	6
73	1	1	3	3	6
74	1	1	4	3	6
75	1	1	5	3	6
76	1	2	1	3	6
77	1	2	2	3	6
78	1	2	3	3	6
79	1	2	4	3	6
80	1	2	5	3	6
81	1	3	1	3	6
82	1	3	2	3	6
83	1	3	3	3	6
84	1	3	4	3	6
85	1	3	5	3	6
86	2	1	1	3	6
87	2	1	2	3	6
88	2	1	3	3	6
89	2	1	4	3	6
90	2	1	5	3	6
91	2	2	1	3	6
92	2	2	2	3	6
93	2	2	3	3	6
94	2	2	4	3	6
95	2	2	5	3	6
96	2	3	1	3	6
97	2	3	2	3	6
98	2	3	3	3	6
99	2	3	4	3	6
00	2	3	5	3	6
01	1	1	6	1	7
02	1	1	6	2	7
03	1	2	6	1	7
04	1	2	6	2	7
05	1	3	6	1	7
06	1	3	6	2	7
07	1	4	1	1	7
08	1	4	1	2	7
09	1	4	1	3	7
10	1	4	2	1	7
11	1	4	2	2	7
12	1	4	2	3	7
13	1	4	3	1	7
14	1	4	3	2	7
15	1	4	4	1	7
16	1	4	4	2	7
17	1	4	5	1	7
18	1	4	5	2	7
19	1	4	6	1	7
20	1	4	6	2	7
21	2	1	6	1	7
22	2	1	6	2	7
23	2	2	6	1	7
24	2	2	6	2	7

S	GR	I	SR	SS	CLUSTER
25	2	3	6	1	7
26	2	3	6	2	7
27	2	4	1	1	7
28	2	4	1	2	7
29	2	4	1	3	7
30	2	4	2	1	7
31	2	4	2	2	7
32	2	4	2	3	7
33	2	4	3	1	7
34	2	4	3	2	7
35	2	4	4	1	7
36	2	4	4	2	7
37	2	4	5	1	7
38	2	4	5	2	7
39	2	4	6	1	7
40	2	4	6	2	7

Table A.10. Clustar Correlation Factors

Frequency-Duration Correlation Group		Clustar 1	2	3	4	5	6	7	8	9
GR	1	X	X	X	X	X	X	X		
	2	X	X	X	X	X	X	X		
	7								X	X
I	1	X	X	X	X	X	X	X		
	2	X	X	X	X	X	X	X		
	3		X	X	X	X	X	X	X	X
	4				X	X		X		
SR	1	X	X	X	X	X	X	X		
	2	X	X	X	X	X	X	X		
	3		X	X	X	X	X	X		
	4		X	X	X	X	X	X		
	5			X	X	X	X	X	X	X
	6				X	X		X		
SS	1	X	X	X				X		
	2		X	X				X		
	3				X		X	X		
	4				X				X	
	5					X				X

ENCLOSURE 3

Enclosure 3

NUCLEAR UTILITY GROUP
ON STATION BLACKOUT

SUITE 700
1200 SEVENTEENTH STREET, N. W
WASHINGTON, D. C. 20036
TELEPHONE (202) 857-9833

July 17, 1985

Mr. William J. Dircks
Executive Director for Operations
U. S. Nuclear Regulatory Commission
Maryland National Bank Building
7735 Old Georgetown Road
Bethesda, MD 20014

Dear Mr. Dircks:

When we last met on May 28, 1985, we discussed the perspectives of the Nuclear Utility Group on Station Blackout (NUGSBO) concerning the current Staff proposal to the Commission for a rule designed to resolve the station blackout (USI A-44) issue. We find that station blackout does not pose an undue risk to the public health and safety and therefore does not warrant the commitment of resources on the scale and priority normally reserved for rulemaking.

On May 8, 1985, NUGSBO submitted its alternate resolution proposal to the Staff. The objective of the NUGSBO approach is to provide reasonable assurance that the current level of protection that is provided against station blackout events is maintained in the future. Accordingly, our proposal emphasizes prevention of station blackout events by means of assuring the continued high reliability that has been demonstrated in AC power supplies. As discussed in our site-specific station blackout risk assessment (NUGSB-85-002, May 1985), it must be recognized that existing plant designs provide a substantial additional margin of safety beyond that which is already assured by the reliability of AC power supplies. Boiling water reactors and pressurized water reactors are equipped with decay heat removal systems designed to operate in the absence of AC power. In addition, procedures are currently already in place or are under development (as the result of post-TMI regulatory initiatives) which will provide guidance to plant operators for maintaining a plant in a stable configuration until AC power is restored. An important element of the NUGSBO alternate proposal is a review of these procedures for completeness in view of the insights which have become

available under the NRC's programs for addressing USI A-44 and related generic issues. Our proposal would also result in the development of procedures and implementation of training programs for rapid restoration of AC power sources with the objective of minimizing the duration of any postulated station blackout event.

At our May 28, 1985 meeting, we discussed the merits of the NUGSBO approach for resolving USI A-44 along with the pertinent aspects of certain other generic issues which relate to station blackout. As a result of that meeting we understand that three questions remain which members of your Staff believe to be important to your consideration, specifically:

1. To what extent do nuclear utilities support the NUGSBO proposal and the Group's views concerning the importance of an integrated approach to the resolution of outstanding generic issues?

2. Is NUGSBO prepared to elaborate on the seven point program?

3. What is the basis for NUGSBO's contention that some capability to cope with a postulated station blackout is already present at operating plants?

We believe that these questions are certainly relevant to your consideration of our proposal. In view of your plans to brief the Commissioners on this issue in the near future, we are confident that the substance of the following comments will be satisfactory.

Utility Support

A key element to the success of the NUGSBO proposal is the widespread support by operating utilities. The proposal has been agreed to by all of the nation's nuclear utilities with the exception of three which are still considering it. To this point not a single company has rejected the idea. Efforts will continue to get unanimous backing.

The Seven Point Program

The Staff has requested additional information concerning the seven suggested industry initiatives, noting the focus of these initiatives on power system reliability in addressing the station blackout issue. The Staff indicated that further details would be needed in order to evaluate the merits of the proposal.

The objective of the seven initiatives outlined in our May 8, 1985 proposal is to ensure that the future risk of station blackout will remain at or below the currently acceptable level. The principal features of the proposal are the timely review of current practices and procedures, the correction of any observed deficiencies in procedures or systems, and the monitoring of future performance. Such a program would be carried out by individual utilities, with industry-wide guidance provided by NUGSBO and other industry organizations such as INPO, NSAC, and the NSSS Owners' Groups.

An important consideration in assessing the merits of our proposal is that it seeks to be effective in a short time frame. However, another expected benefit of this approach is that it can be implemented at a much lower cost than the rule being contemplated by the staff. Of the seven initiatives proposed, we believe that implementing procedures for coping with a station blackout and for prompt restoratin of AC power has the greatest safety significance in view of the already very high reliability demonstrated in AC power supplies. These initiatives will ensure that operators are sufficiently trained to utilize existing plant equipment to maintain the plant in a stable condition without AC power until the event is terminated by restoration of power.

Procedures and training for rapid restoration of power will have the effect of reducing the mean time required for recovery of an emergency diesel generator or an offsite source. This will be accomplished by identifying potential failure mechanisms and providing appropriate guidelines for emergency diagnosis and corrective action. This will effectively reduce the mean duration of postulated station blackout events and thereby reduce the already very low predicted frequency of longer duration station blackout events. (See Table 4 of NUGSB-85-002).

With regard to long duration events, we refer you to the NUREG-1032 finding that postulated weather-related events are predicted to be the primary initiators. We believe that the frequency of these events is sufficiently low that a more appropriate and cost effective way to address them is to emphasize prevention. Our proposed approach is to implement administrative practices or procedures whereby plant operators would be alerted to the approach of severe weather (e.g. via hurricane warning or tornado watch) and would take actions to ensure that emergency power supplies are available.

Other elements of our proposal are aimed at assuring the continued high reliability of emergency diesel generators by

improved surveillance and trending practices and by implementing improved preventative maintenance practices.

Finally, our proposal includes the evaluation of significant events relating to the reliability of AC power sources. The objective of this initiative is to provide early identification of failure mechanisms which might have generic implications. These evaluations could be performed both at the utility level and at the industry level (e.g. by NSAC or INPO).

We believe that the combined effect of the initiatives in the NUGSBO proposal will result in providing a margin of safety in addition to that which already exists.

Blackout Mitigation

An important position in the NUGSBO proposal is that the likelihood of a station blackout event occurring at power is sufficiently remote so as not to pose an undue risk to the public health and safety. This contention is based on the offsite and emergency power supply studies performed to date by NSAC and the NRC staff. We have observed that the remote likelihood of a station blackout is governed by the demonstrated reliability and diversity which is designed and maintained in AC power sources. Improvements in offsite power supplies and the accumulation of operating experience at power plant sites have led to a decreasing frequency of loss of offsite power events and improved capabilities for promptly restoring a source of power.

Despite the observed improvements in AC power system reliability and restoration capabilities, some members of the Staff are apparently of the opinion that it may be appropriate to protect against long duration station blackout events (i.e., several hours). Moreover, there is an apparent concern that even shorter duration station blackout events at some unspecified plants could pose undue risk to the public health and safety. NUGSBO believes that sufficient information exists to demonstrate that this concern is not justified.

Staff analyses and the literature, in general, indicate that the safety functions which need to be provided in a station blackout can be provided reliably for several hours without AC power. Even following loss of one or more functions, Staff analyses demonstrate that up to several hours would elapse before the onset of core uncovery. Attachment 1 provides further details concerning our view that station blackout events of a nominal duration pose no undue risk to the public health and safety.

We conclude that, lacking evidence to the contrary, a regulatory requirement to demonstrate a capability to accommodate station blackout events does not provide substantial additional protection of the public health and safety.

This conclusion is supported by our assessment of station blackout risk using the Staff's methodology and data gathered under the USI A-44 program. Consequently, we fail to see the safety benefits to be gained by the substantial expenditure of Staff and industry resources normally associated with a rulemaking effort.

We are confident that our proposal of May 8, 1985 represents a new and unique approach to resolving generic safety issues in a cost-effective manner by the direct and timely involvement or the nation's nuclear utilities. The level of support for this program among nuclear utilities reflects a commitment to focus resources on ensuring that the current level of safety is maintained in the future. We trust that our response addresses your concerns and we look forward to a continuing dialogue on this issue.

Sincerely,

C. H. Poindexter
Vice President - Engineering
and Construction
Baltimore Gas & Electric Company

L. G. Kuncl
Assistant General Manager -
Nuclear
Nebraska Public Power District

EXECUTIVE CO-CHAIRMEN
Nuclear Utility Group on
Station Blackout

Enclosure: As Stated

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July 17, 1985

ATTACHMENT 1

EXISTING BLACKOUT MITIGATION CAPABILITY

In the event of a station blackout, two key safety functions must be satisfied to prevent the onset of core damage: (1) maintenance of reactor coolant system (RCS) inventory; and (2) decay heat removal. Providing for these safety functions constitutes the capability to mitigate a station blackout. Since it appears that a total loss of AC power will not result in a significant loss of RCS inventory, the principal goal of this capability is to successfully remove decay heat. Although station blackout is not a design basis event, nuclear power plants have the capability for cooling the core without AC power. The loss of all normal and emergency sources of AC power would significantly reduce the available means of cooling the core but sufficient AC-independent equipment is available to cope with station blackout for a substantial period of time. In addition, other independent power sources are available at some plants which could provide power to core cooling systems and their support equipment.

In addition to relying on AC-independent capabilities, a second approach involves the prompt restoration of AC power to core cooling systems from sources other than normal or emergency AC. Such sources include standby gas turbines, additional diesel generators, and adjacent non-nuclear electric plants. For plants with these enhanced power recovery capabilities, reliance on AC-independent decay heat removal capabilities is reduced to very short durations.

Both the Staff and the industry have performed extensive reviews of the first approach to station blackout mitigation (see References). These reviews have covered such topics as:

1. NSSS response
2. Primary coolant inventory control
3. Decay heat removal capability
4. DC power availability
5. Equipment operability under loss of HVAC

While reported in separate documents and studies, the Staff's state of knowledge is summarized in NUREG/CR-3226, entitled "Station Blackout Accident Analyses (Part of NRC Task Action Plan A-44)", published in April 1983. This document provides a reasonable basis for confidence in the existing mitigation capability.

Staff analyses indicate that the NSSS response to a station blackout event is similar to that of other mild (i.e., non-accident) transients up until the point when loss

of heat sink occurs. As reported in NUREG/CR-3226, between 30 minutes and two hours must elapse from the time the heat sink is lost until the onset of core uncovery. These results are supported by Cook et al. (1981), Fletcher (1981) and Schultz (1982), (references 1, 2 and 3). These reports confirm that the central station blackout mitigation issue is the operability of AC-independent decay heat removal systems.

In PWRs, condensate storage tank inventory can limit the duration of heat sink availability. This inventory is currently established in technical specifications to be that necessary to achieve residual heat removal system operational conditions. The reserve varies between 30,000 and 200,000 gallons. In many cases, alternate water sources are available to supplement the condensate reserve. With these amounts of cooling water available, AC-independent auxiliary feedwater system operation for 6 to 24 hours is possible. Furthermore, the Bulletins and Orders Task Force recommendations (references 4, 5, and 6) have resulted in the development of procedures for the alignment of alternate sources of water and the verification of the AC-independence of the auxiliary feed water system (AFWS).

BWRs with HPCI-HPCS/RCIC systems also have several hours of cooling capability available from either the condensate storage tank or the suppression pool. According to the Staff, isolation condenser BWRs (without HPCI/RCIC) have

approximately one hour to replenish shell-side cooling water using a dedicated diesel fire pump or similar source of high pressure injection. Once restored, decay heat removal may proceed unhindered for several hours as in a PWR. Thus, BWRs have several hours of AC-independent decay heat removal capability available during a station blackout event.

According to Staff analysis and data, DC power availability does not appear to be of concern for moderate duration station blackout events. Licensee responses to NRC Generic Letter 81-04 indicated battery capacities are at least two hours in duration, assuming design basis accident loads. Under the postulated conditions of station blackout (i.e., no concurrent LOCA), many non-essential loads can be shed. With prudent load shedding, the batteries are estimated by the Staff to be capable of lasting from four to seven hours or more (references 3 and 7). Thus, DC power availability does not appear to be a concern for limited duration station blackout events.

The Staff's analysis in NUREG/CR-3226 (reference 7) indicates that the loss of AC-dependent support systems does not significantly affect station blackout coping capability. The necessary instrumentation and control systems can be operated with DC power or, if required, AC power supplied by the batteries via inverters. The valves important to AFWS operability are designed to have the proper configuration upon loss of AC power or are AC-independent.

The Staff even addressed two concerns regarding the indirect impacts of losing support capabilities in their analyses. The first is the potential overheating of the room containing the turbine-driven AFWS/RCIC pump, resulting in the loss of feedwater or coolant injection flow. In NUREG/CR-3226 the staff dismisses this as a concern noting that approximately eight hours of operation would need to occur before equipment operability would be threatened. Furthermore, natural air circulation facilitated by opening the pump room doors may provide the necessary cooling to prevent loss of the pumps. The second concern is the potential failure of station batteries as a result of overheating. Again, the remedy discussed is to simply open the battery room doors to facilitate the natural circulation of air (reference 7).

The traditional evaluation of station blackout events focuses on reliance on AC-independent systems for mitigation. However, in practice, other power sources are often available which may be used to restore AC-independent systems. These sources include nearby or adjacent power sources external to the plant as well as onsite power sources that can be used to power needed systems. Analyses of station blackout risks often overlook the value of these power sources, treating plant sites as "islands" with minimal outside power connections. Yet, in fact, the diversity and number of power sources provides an additional

level of protection. Sites which have this protection include Oconee (nearby hydroelectric dam), Indian Point (gas turbines) and H.B. Robinson (fossil units and diesel generators). The presence of these alternate power sources can provide the same degree of protection from station blackout events as is afforded by the AC-independent mitigation capability.

This brief review of the station blackout mitigation issue indicates that sufficient knowledge exists as a result of the Staff's analyses to support the Group's contention that limited duration station blackout events pose no undue risk to the public health and safety.

REFERENCES

1. Cook, D.H., et al., "Station Blackout at Browns Ferry Unit One - Accident Sequence Analysis," NUREG/CR-2182, November 1981.

2. Fletcher, C.D., "A Revised Summary of PWR Loss of Offsite Power Calculations," EGG-CAAD-5553, September 1981.

3. Schultz, R.R., "The Station Blackout at The Browns Ferry Unit 1 Plant, A Severe Accident Sequence Analysis (SASA) Program Study," NRC Tenth Water Reactor Safety Information Meeting, Gaithersburg, MD, October 12-15, 1982.

4. U.S. Nuclear Regulatory Commission, "Staff Report on Generic Assessment of Feedwater Transients Designed by the Babcock & Wilcox Company," NUREG-0560, May 1979.

5. U.S. Nuclear Regulatory Commission, "Generic Evaluation of Feedwater Transients and Small Break Loss-of-Coolant Accidents in Westinghouse-Designed Operating Plants," NUREG-0611, January 1980.

6. U.S. Nuclear Regulatory Commission, "Generic Evaluation of Feedwater Transients and Small Break Loss-of-Coolant Accidents in Combustion Engineering-Designed Operating Plants," NUREG-0635, January 1980.

7. U.S. Nuclear Regulatory Commission, "Station Blackout Accident Analyses (Part of NRC Task Action Plan A-44)," NUREG/CR-3226, April 1983.

ENCLOSURE 4

Enclosure 4

North American
Electric
Reliability
Council

July 1, 1985

Mr. Themis P. Speis
Director, Division of Safety Technology
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Speis:

This is a reply to your June 17, 1985 letter to Mr. Michehl R. Gent, President of the North American Electric Reliability Council, regarding the loss of off-site power to nuclear generating plants.

The information NERC maintains on bulk power supply (grid) failures is from copies of the system disturbance reports the electric utilities file with the Department of Energy. Generally, disturbance reports are filed only when a significant amount of customer load has been interrupted, or during system voltage reductions or public appeals for reductions in electricity use. I have enclosed a copy of the DOE criteria for reporting these incidents. We do not have specific information on grid failures that might have caused the loss of off-site power to a nuclear plant per se.

We began collecting bulk power system disturbance data in 1971. Since that time, the number of disturbances reported to us is as follows:

1971 — 15	1975 — 39	1979 — 24	1983 — 13
1972 — 13	1976 — 52	1980 — 42	1984 — 24
1973 — 14	1977 — 31	1981 — 43	
1974 — 12	1978 — 27	1982 — 44	

We do not see a trend in these numbers and we cannot predict the number of disturbances that will occur in the future. By and large, such disturbances are random; however, they may be exaggerated by the particular operating situations, such as heavy electric interchange, that exist in a particular utility area or region. Many of the disturbances from 1975 through 1981 occurred in Florida because the state was importing a large amount of economy interchange over the limited transmission lines connecting it to the Southeast. Recently, two 500 kV lines have been installed from Georgia through the length of Florida, which have drastically reduced the number of disturbances in that state. Similarly, we are seeing more disturbances in the Western Systems Coordinating Council region because of heavy economy energy transfers between the Pacific northwest and southern California.

Research Park, Terhune Road, Princeton, New Jersey 08540-3573 • 609-924-6050

The planning and operating reliability criteria electric utilities follow are aimed at maintaining the integrity of the electric grid during routine single and double equipment (e.g., generator, transformer, transmission line) failures. That is, the grid is designed and operated so that single and double contingencies do not "cascade," domino-like, causing all generators on the grid to shut down. Should a portion of the grid become isolated with insufficient generating capacity (the situation you are concerned about), customers served by that part of the grid are automatically disconnected. Next, the isolated grid section is quickly reconnected to the bulk power system, often in minutes, and rarely more than the two-hour limit you cited. Customers are then returned to service as back-up generating capacity is brought on line. These criteria were adopted after the 1965 Northeast Blackout, and, with few exceptions, have worked well. There are no plans to change these criteria.

I will be glad to discuss these issues with you in further detail if you care to give me a call.

Sincerely,

Donald M Benjamin

Donald M. Benjamin
Director-Operations

DMB:tgf
Enclosure

REPORTS ON MAJOR ELECTRIC UTILITY SYSTEM

REPORTING REQUIREMENTS

Every electric utility or other subject entity engaged in the generation, transmission or distribution of electric energy shall report promptly to the DOE's Alert Coordination Officer (ACO) any of the events described in subparagraphs (a) through (f) below. (A report or a part of a report required by DOE may be made jointly by two or more entities.)

(a) The issuance of any public or private request to any customer or the general public to reduce the use of electricity for reasons of maintaining the continuity of service of the reporting entity's bulk electric power supply system. Requests to a customer(s) served under provisions of an interruptible contract are not a reportable action unless the request is made for reasons of maintaining the continuity of service of the reporting entity's bulk electric power supply. (The DOE ACO shall be notified as soon as practicable, but no later than 24 hours after the issuance of such a request.)

(b) Any intentional reduction of system voltage by 3 percent or greater for reasons of maintaining the continuity of service of the reporting entity's bulk electric power supply system. (The DOE ACO shall be notified as soon as practicable, but no later than 24 hours after the initiation of the action.)

(c) Any load shedding action that results in the reduction of over 100 megawatts (MW) of firm customer load for reasons of maintaining the continuity of service of the reporting entity's bulk electric power supply system. The routine use of load control equipment that reduces firm customer load is not considered to be a reportable action. (The DOE ACO shall be notified within three hours after such action is taken, or as soon thereafter as practicable.)

(d) Any electric power supply equipment or facility failure or other event that, in the judgment of the reporting entity, constitutes a hazard to the current or prospective adequacy and/or reliability of the reporting entity's bulk electric power supply system. (The DOE ACO shall be notified as soon as practicable; however, reports are expected within one business day after such determination.)

Examples of situations which may be reportable under this provision could be ones which:

1. Cause the operating area to be dependent upon neighboring utilities for large quantities of unscheduled electricity deliveries to supply the operating area's loads for longer than three consecutive hours;

2. Cause a significant increase in the use of fuel for generating equipment, such that the supply of this fuel may be a problem;

3. Are caused by a suspected act of physical sabotage.

(e) Any loss in service for greater than 15 minutes by an electric utility of firm loads totaling over 100 MW, or more than 50 percent of the total load being supplied immediately prior to the incident, whichever is less. However, utilities with a peak load in the prior year of over 3000 MW are only to report these losses of service to firm loads totaling over 200 MW for greater than 15 minutes. (The DOE ACO shall be notified as soon as practicable without unduly interfering with service restoration and, in any event, within three hours after the beginning of the interruption.)

(f) Any significant incident on an electric utility system which results in a continuous outage of three hours or longer to over 50,000 customers (meters, delivery points) or more than one half of the reporting entity's total customers, whichever is less. (The DOE ACO shall be notified within 24 hours of the occurrence if practicable, or as soon thereafter as practicable.)

FUEL EMERGENCIES

Utilities shall notify the DOE ACO by telephone whenever a subject entity determines that a fuel supply emergency exists or is projected to occur. A fuel supply emergency exists when supplies of fuels or hydroelectric storage for generation are at a level or projected to be at a level which would threaten the reliability or adequacy of electric service. The following factors should be taken into account to determine that a fuel emergency exists:
(1) Fuel stock or hydro project water storage levels are 50 percent or less of normal for that particular time of the year;

ENCLOSURE 5

Enclosure 5

Proposed Addition to Notice of Proposed Rulemaking on Station Blackout

The following text would be added to the end of the Supplementary Information section of the Notice of Proposed Rulemaking (Enclosure 1, SECY-85-163):

During the development of the proposed resolution of USI A-44, the NRC staff had substantial interactions with various nuclear industry organizations to discuss the evolving technical studies and findings that are now published in NUREG-1032. Subsequent to a staff briefing of the Commission's Advisory Committee on Reactor Safeguards on the status of USI A-44 in February 1985 at which the staff indicated that it was preparing a proposed station blackout rule for consideration by the Commission, one industry group, the Nuclear Utilities Group on Station Blackout (NUGSBO) indicated to the staff its opinion that rulemaking on station blackout is unnecessary and that it was developing an alternative for staff consideration. On May 8, 1985, NUGSBO, representing 25 member utilities, submitted a "Proposal for Resolution of USI A-44 Station Blackout" (4). After discussions with the staff, NUGSBO, on June 5, 1985, submitted a report entitled "Estimation of Site-Specific Station Blackout Core Damage Frequency Using NRC Staff Methodology", (4) which provided information in support of the proposal.

NUGSBO has proposed, as an alternative to the proposed rulemaking, that each licensee voluntarily implement a plant-specific program designed to enhance AC power reliability and ensure the adequacy of procedures and training to cope with plant response to a station blackout event. It appears that the voluntary program conceptually outlined by the Nuclear Utility Group would include many of the elements contained in the proposed regulatory guide on station blackout noted above, regarding reliability programs, and procedures and training for operators to cope with plant response to a station blackout event. The Commission recognizes the importance of such voluntary industry initiatives and wishes to encourage their further development.

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(4) Copies of these documents are available for public inspection and copying for a fee at the NRC Public Document Room at 1717 H Street, N.W., Washington, D.C. 20555. Copies may also be requested from the Nuclear Utility Group on Station Blackout, Suite 700, 1200 Seventeenth Street, N.W., Washington, D.C. 20036.

During the public comment period on the proposed rule and regulatory guide, the Commission would like to receive additional more specific information regarding possible voluntary programs, and comments regarding their effect on the proposed rule and regulatory guide.