

June 25, 2003

MEMORANDUM TO: John A. Zwolinski, Director, DLPM:NRR
Farouk Eltawila, Director, DSARE:RES
Michael E. Mayfield, Director, DET:RES

FROM: Scott F. Newberry, Director /RA/
Division of Risk Analysis and Applications
Office of Nuclear Regulatory Research

SUBJECT: FINAL REPORTS: COMMON-CAUSE FAILURE EVENT INSIGHTS
REPORTS FOR EMERGENCY DIESEL GENERATORS, MOTOR-
OPERATED VALVES, PUMPS, AND CIRCUIT BREAKERS,
NUREG/CR-6819, VOLS. 1, 2, 3, and 4

Four final reports on common-cause failure (CCF) insights for emergency diesel generators (EDGs), motor-operated valves (MOVs), pumps, and circuit breakers, NUREG/CR-6819, Vols. 1, 2, 3, and 4, are attached for your information and use. These reports document CCF trends, insights, and descriptive information for these risk-important components from 1980 through 2000. The insights in these reports have been obtained from the same event data used to obtain quantitative CCF parameter estimates used in risk analyses. Drafts of these reports were provided earlier for peer review and comment to NRR, the regions, and industry and public interest organizations. These reports have been revised to incorporate the resolutions to the comments. Attachment 1 is a tabulation of the comments and the associated resolutions.

In the future, we intend that updated information similar to that provided in these reports will be made available and broadly disseminated to the NRC staff through an operating experience information website. In addition, the data and results typically presented in our system reliability and component studies, ASP analyses, initiating event studies, and other efforts will be made available through a web page. Therefore, we will not routinely produce hard copy NUREG reports of this nature in the future. The feedback on this work is valuable to us. We have endeavored to consider your comments to make these insights of optimal use in your work. Your continued feedback is welcome.

The insights contained in these studies are meant to provide information to enhance the risk-informed planning of various inspection activities. These reports include engineering insights that may be used to improve the risk perspective of inspection activities associated with failure causes, coupling factors, detection methods, and sub-systems that contribute most to CCF events. To help better identify and relate this detailed information to various risk-important regulatory applications, we have provided a Foreword section in these reports. The Foreword sections provide directions to the relevant quantitative and qualitative information contained in each report. The Foreword also identifies the source database and provides information on

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contacts to access the more detailed data records that were used in these studies. In addition, each section of each report provides information to guide users to specific CCF contributor data records for more detailed applications (e.g., inspection planning). If more information about individual events is desired than what is in the summaries in the Appendices, the full record (LER or NPRDS report) can be identified using the CCF Database. OERAB is ready to assist users of these reports as well as other operating experience reports. RES is working with NRR to define the information that will be useful to support the inspection process.

The studies documented in these reports were intended to look beyond the CCF parameter estimates that can be obtained from the CCF data, to gain further understanding of why CCF events occur and what measures may be taken to prevent, or at least mitigate the effects of, CCF events. The reports present quantitative presentations of the CCF data and discussions of some engineering aspects of the events.

As noted below, these reports and similar studies conducted by the Office of Nuclear Regulatory Research (RES) support the strategic goals of maintaining safety; improving regulatory effectiveness, efficiency, and realism; reducing unnecessary burden; and increasing public confidence. The major findings that support each of these strategic goals follow, with specific cognizant organizations indicated in parentheses.

Maintaining Safety - These reports provide occurrence rate trends in time of CCF events and complete CCF events. These analyses of CCF trends in time could be useful for determining whether safety is improving, deteriorating, or remaining constant in light of both Agency and licensee safety initiatives. (NRR:DIPM:IIPB, NRR:DSSA:SPSB, RES:DSARE:REAHFB)

- *Trends.* The trends in the yearly occurrence rates for all CCF events for the four component types are decreasing and statistically significant. The trends for all CCF events for the four component types split by failure modes are also all decreasing and statistically significant.
- *General Insights.* About 70 percent of the units had zero or one event counts involving the EDGs, MOVs, or breakers. About 50 percent of the units had zero or one event counts involving pumps. Fewer than about 10 percent of the units had four or more CCF events involving the EDGs, MOVs, or breakers. About 23 percent of the units had four or more events involving pumps.

Improving Regulatory Effectiveness, Efficiency and Realism - The results, findings, conclusions, and information contained in these and similar studies conducted by RES support a variety of risk-informed regulatory activities. These regulatory activities include plant inspections, technical reviews of proposed license amendments, regulatory effectiveness analyses, and development of enhanced performance indicators.

- *Plant inspections.* The reports provide information for risk-informed inspection activities to enhance the use of inspection resources. The reports indicate the most important causes of failures, detection methods, sub-systems and/or sub-components. (NRR:DIPM:IIPB)

- *Technical reviews of proposed license amendments.* The results of these studies can be used in the review of plant-specific licensing applications, probabilistic risk assessments (PRAs) and design modifications and issues. (NRR:DSSA:SPSB)
- *Regulatory effectiveness analyses.* The trending information on CCF events in these reports provides information for determining the degree of change the regulatory activities may have accomplished. (REAHFB:DSARE:RES)

The technical insights that can be used to support this strategic goal include the following:

- *Failure mode:* The dominant failure mode was fail to run for EDGs (57 percent) and pumps (54 percent). Fail to open was the dominant failure mode for MOVs (60 percent) and circuit breakers (55 percent).
- *Detection method:* For EDGs, 65 percent of the events were detected through testing, while inspection and maintenance detected 26 percent of the events. Only 9 percent were discovered during an actual demand. This is as expected considering the extensive and frequent surveillance test requirements for EDGs contained in Technical Specifications. Similarly, 60 percent of the circuit breaker CCF events were detected by testing. More than 20 percent were discovered during an actual demand. Inspection and maintenance accounted for the other 21 percent of the events.
- *Detection method:* In contrast, only 35 percent of the pump CCF events and 41 percent of the MOV CCF events were detected by testing. About 31 of the pump CCF events and 38 percent of the MOV CCF events were detected by an actual demand. Inspection and maintenance accounted for 35 percent for pumps and 21 percent for MOVs.
- *Detection method:* A review of the MOV CCF events by dates shows that, prior to 1990, 35 percent of the events were discovered by Testing and 45 percent by Demands. Since 1990, 52 percent have been discovered by Testing and 24 percent by Demands. This tends to confirm the effectiveness of the impact of Generic Letter 89-10 and its follow-on activities.
- *Sub-system:* The largest number of events (30 percent of the EDG CCF events) affected the instrumentation and control (I&C) sub-system. The cooling, engine, fuel oil, and generator were other significant contributors. Together, these five sub-systems were involved in more than 80 percent of the EDG CCF events. The battery, exhaust, and lubricating oil sub-systems were minor contributors. For the MOVs, the highest number of events (85 percent) occurred in the actuator sub-component.
- *Failure trends:* The trends in the yearly occurrence rates for all CCF events for the four component types are decreasing and are statistically significant. The trends for all CCF events for the four component types split by failure modes are also all decreasing and are statistically significant.

Reducing Unnecessary Burden - These reports include engineering insights, descriptions of CCF events, and associated information that may be used to focus inspection activities on more important areas identified by the CCF experience and, consequently, reduce unnecessary inspection burden. (Regional offices, NRR:DIPM:IIPB)

The technical insights summarized under the “Improving Regulatory Effectiveness, Efficiency and Realism” strategic goal can also be used to reduce unnecessary burden by limiting activities in areas that are not important contributors to reliability or by adjusting intervals for inspection consistent with observed trends in performance.

Increasing Public Confidence - The final analyses provide rigorous and peer-reviewed evaluations of operating experience. Specifically, they demonstrate the agency’s ability to analyze operating experience independently of licensee-sponsored activities. These independent assessments allow the agency to determine whether licensee assessments of risk and risk-informed activities are reasonable.

These documents are available in ADAMS: Vol. 1 is ML031710318; Vol.2 is ML031710328; Vol. 3 is ML031710336; and Vol. 4 is ML031710861. In addition, the reports are available on the NRC website at <http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6819/>.

Attachment: As stated

cc w/att:

J. Strosnider/A. Thadani, RES

C. Paperiello, DEDO

MEMORANDUM DATED: 9/5/03

SUBJECT: FINAL REPORTS: COMMON-CAUSE FAILURE EVENT INSIGHTS REPORTS FOR EMERGENCY DIESEL GENERATORS, MOTOR-OPERATED VALVES, PUMPS, AND CIRCUIT BREAKERS

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**Resolutions of Comments Received on Draft Reports:
Common-Cause Failure Event Insights Reports for
Emergency Diesel Generators, Motor-Operated Valves, Pumps, and Circuit Breakers**

Copies of the draft reports titled “Common-Cause Failure Event Insights” for Emergency Diesel Generators, Motor-Operated Valves, Pumps, and Circuit Breakers were provided to both internal and external stakeholders for review. The following stakeholders indicated that they had no comments on the reports: the Division of Systems Analysis and Regulatory Effectiveness (DSARE) in the NRC Office of Nuclear Regulatory Research, NRC Region IV (RGN-IV), the Nuclear Energy Institute (NEI), the Westinghouse Combined Owners Group (Westinghouse and Combustion Engineering), the Babcock & Wilcox Owners Group (BWOG), the BWR Owners Group, and the Union of Concerned Scientists (UCS). The stakeholders that provided comments on the reports were: the NRC Office of Nuclear Security and Incident Response (NSIR), the Division of Engineering Technology in the NRC Office of Nuclear Regulatory Research (DET:RES), the Probabilistic Safety Assessment Branch of the Division of Systems Safety and Analysis in the NRC Office of Nuclear Reactor Regulation (SPSB:DSSA:NRR), NRC Region II (RGN-II), NRC Region III (RGN-III), which incorporated comments from Region I and Region II (RGN-I and RGN-II), the Institute of Nuclear Power Operation (INPO), and the Electric Power Research Institute (EPRI).

As stated above, the NRC Office of Nuclear Security and Incident Response (NSIR) reviewed the reports. NSIR concluded that they did not see any sensitive information in these reports that needs to be withheld from the public.

One notable issue raised by several commenters concerned the presentation of the material and the usefulness of the reports to inspectors. This issue was resolved partly by expanding definitions, comparisons, physical meaning, and usage of terms and by expanding the discussions as needed to make the reports more understandable. In addition, all events in the appendices were numbered, new appendices were added that sort the data in various ways, and “pointers” were added throughout the text in each report to indicate which of the data in the appendices apply to the particular figure or insight being discussed. The addition of appendices and “pointers” to the data also aids the commenters who requested more detail by providing a link to the raw data. Also, a foreword was added to each report, with a table to indicate where in the report (section, figure, table, and page) items of interest are located. Finally, the executive summaries were expanded to include a discussion of piece parts of the components or sub-components. Responses to each of the individual comments dealing with this issue are presented below.

Resolutions of the remaining comments that were within the scope of the study resulted primarily in discussion expansions and clarifications. The specific comments and the associated resolutions are detailed in the following table. The table includes a comment tracking identification number, the commenting organization, the specific comment, and the resolution details.

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REMARKS

FINAL REPORTS: COMMON-CAUSE FAILURE EVENT INSIGHTS REPORTS FOR EMERGENCY DIESEL GENERATORS, MOTOR-OPERATED VALVES, PUMPS, AND CIRCUIT BREAKERS, NUREG/CR-6819, VOLs. 1, 2, 3, and 4

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