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March 6, 1991

Mr. David A. Ward, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subj: AEOD Study on Solenoid Operated Valves

Dear Chairman Ward:

INTRODUCTION AND SUMMARY

On behalf of the Nuclear Utility Group on Equipment Qualification ("Group")[1/] we provide the following observations and comments concerning the draft study prepared by the Office for Analysis and Evaluation of Operational Data ("AEOD") concerning solenoid operated valves ("SOVs").[2/] We understand that this study is to be the subject of a presentation by the NRC Staff to the Advisory Committee on Reactor Safeguards on March 8, 1991. Accordingly, we provide these comments for consideration in connection with ACRS deliberations on this topic.

To summarize the comments below, we believe there exist fundamental differences of opinion regarding the interpretation and actual significance of the historical conditions described in the report, as well as differences of opinion as to the nature and degree of response appropriate for such conditions. The Group believes that careful review of the Study, taking into account the matters discussed below, including ongoing programs and improvements in place or under way, will lead to the conclusion

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1/ The Nuclear Utility Group on Equipment Qualification was formed in 1980 and presently consists of 40 utilities owning or operating 105 nuclear power reactors licensed by the NRC. Since its formation, the Group has addressed numerous equipment qualification issues before the NRC.

2/ AEOD Case Study C-90-01, "Operating Experience Feedback Report, Solenoid-Operated Valve Problems At U.S. Light Water Reactors," December 1990 ("Study").

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that imposition of new generic requirements regarding SOVs as recommended by AEOD is not justified.[3/]

DISCUSSION

OVERVIEW

The Group would first note that it supports properly focused efforts to address valid concerns regarding the performance of safety-related equipment. Where justified, new generic requirements may be appropriate to address such concerns. (Those requirements would, of course, need to be developed consistent with applicable administrative processes.) In this case, the Group does not believe that existing data and experience regarding SOVs, considering efforts previously undertaken by licensees as well as ongoing efforts, support the AEOD recommendation to impose new generic requirements for all SOVs. The Group believes those industry efforts represent appropriate licensee measures that have or will appropriately enhance SOV performance, consistent with current experience.

GENERAL COMMENTS

The SOV Study identifies various historical conditions (i.e., occurring over several years) potentially impacting SOV operation. Fundamental to the conclusions drawn by the Study is its determination that these conditions collectively represent a "significant safety concern" which is not being adequately addressed (Study at p. 54). Accordingly, the Study recommends imposing a number of generic and plant-specific initiatives for all safety-related SOVs that would "require significant industry resources" to implement (Study at p. 53). In the Group's view, a closer analysis of the various conditions observed suggests that new comprehensive measures may be unnecessary. Rather, previous and ongoing activities already appear to have had, or are having,

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3/ The draft Study was distributed to interested individuals and organizations, including the Group, for limited review (i.e., only with respect to the accuracy of factual information). The Group subsequently pursued the opportunity to provide more substantive comments, and did so by letter dated December 7, 1990, to T. M. Novak. (The Group notes that it has kept NUMARC apprised of its efforts in this area.) Whereas some of the Group's comments were apparently considered by the Staff, the principal concerns of the Group were not resolved in the version of the Study recently released.

a favorable impact in this area. In particular, the industry has already initiated various efforts and programs which will favorably impact the reliability of SOVs. In addition, individual utilities would have undertaken specific activities to address concerns related to SOV operability that were identified in NRC generic communications (e.g., Information Notices). In the Group's view, the AEOD recommendation for new generic SOV requirements without first assessing the impact of implementing those efforts would, at best, be premature. Accordingly, the Group recommends careful scrutiny of data, underlying analyses and conclusions of the Study, as well as consideration of alternative measures to achieve improvements in SOV operability, if necessary, rather than directing further specific actions on behalf of licensees for all SOVs.

Moreover, the imposition of new generic requirements would seem to run counter to the concerns and recommendations identified in the recent Regulatory Impact Survey.[4/] The survey identified several consistent themes being voiced by the industry including the concern that the large number of new generic requirements being imposed by the NRC Staff is, in effect, dominating the industry's resources rather than providing regulatory oversight.[5/] In recognition of this concern, the Staff concluded that future regulatory oversight should be improved by giving proper consideration to "the cumulative effect of the NRC's generic requirements and generic communications."[6/] In light of the generic industry initiatives and efforts already under way to improve maintenance, procurement and design control programs, and licensees' individual efforts to address specific concerns, the Staff should afford individual licensees the opportunity to implement such measures in a manner best suited for their individual situation. The Group urges that for the Staff's conclusion to be meaningful, the effectiveness of these efforts should be considered before imposing new and burdensome generic requirements.

4/ NUREG-1395, "Industry Perceptions of the Impact of the U.S. Nuclear Regulatory Commission on Nuclear Power Plant Activities," Draft Report, March 1990.

5/ SECY-90-347, Regulatory Impact Survey Report, dated October 9, 1990 at 3.

6/ Id.

In addition, the Group disagrees with the assertion in the AEOD letter to NRR that this matter is a "compliance" issue.[1] The generic requirements proposed by AEOD appear similar to those originally set forth in Generic Letter 89-10, "Safety-Related Motor Operated Valve Testing And Surveillance." In that case the Staff requested actions more stringent (e.g., testing and inspection) than were previously required, ostensibly to demonstrate compliance with an underlying regulatory requirement. However, the Staff reconsidered this view upon consideration of comments demonstrating that under 10 C.F.R. § 50.109 the proposed measures constituted a modification to "the procedures ... required to design, construct or operate a facility" resulting from "the imposition of a regulatory staff position interpreting the Commission rules that is either new or different from a previously acceptable staff position." (10 C.F.R. § 50.109(a)(1).) The Staff acknowledged in Supplement 1 to the Generic Letter that the backfitting rule did in fact apply. As in the MOV situation, the Group believes that any new generic requirements associated with SOV reliability would be appropriately characterized as a backfit, necessitating a backfitting analysis and justification.

TECHNICAL COMMENTS

The Group addresses below a number of technical concerns with the Study's conclusions and recommendations. We focus our discussion on the principal topics we believe indicate that either different conclusions or different actions in response to the findings in the Study are warranted.

The first set of comments address the Study's conclusion that margins of safety for LWRs do not meet the levels perceived at the time of licensing (Study at p. 56). The second set of comments focuses on several specific concerns expressed by the Study. As to this latter set of comments, the Group maintains that previous and ongoing industry initiatives already address the bulk of the concerns expressed in the Study.

Margins of Safety

SOV Availability: Based on its analysis of the LER and NPRDS databases for the period 1/85 to 12/89, the Study calculates a SOV average unavailability of approximately 7E-03 to 9E-03/demand and a constant failure rate of approximately 6.5E-06 to 8E-06/hr. It

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[1] NRC Memorandum from E.L. Jordan, AEOD, to T.E. Murley, NRR, dated January 25, 1991 at 2.

concludes that operating experience demonstrates that SOV average unavailability is 7 to 9 times larger than assumed in WASH-1400 (Reference 1 (See attached list)) and in NUREG/CR-1150 (Reference 2) (i.e., 1E-03/demand). Contrary to the Study results, other operating data reviews, including some cited by the Study, support the SOV failure rate data presently used in PRAs rather than the values proposed by the Study. For example, NUREG/CR-4819 (Reference 4) estimates an SOV individual failure rate of 7E-08/hr.[8/] The EPRI Advanced LWR Requirements Document(Reference 5), based on detailed evaluations of plant-specific failure data, recommends the use of an AOV failure rate per demand of 2.0E-03, while NUREG/CR-2770 (Reference 6) estimates AOV individual failure rates of 1.5E-06/hr or 1.6E-03/demand assuming quarterly testing.[9/] Our brief review of the Study's Appendix A LER data for the 72 month period from 1984 to 1989 (assuming a total of 320 SOV failures, an average of 63 plants, 500 SOVs per plant and quarterly testing) suggests a SOV individual average unavailability of approximately 3E-04/demand, instead of the 7 to 9E-03/demand reported in the Study. Unfortunately, since the Study did not publish its LER and NPRDS[10/] analysis assumptions and failure rate calculation methodology, it is not possible to verify the validity of the failure rate calculations or determine the basis for the differences in the Study values and those published elsewhere.[11/]

Safety Significance of Certain SOV Failures: The Study fails to recognize that many of the reported SOV failures are not safety

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8/ Contrary to the Study's conclusions, NUREG/CR-4819 concludes that the frequency of SOV failures in safety-related applications is relatively low and only makes recommendations for refinements of existing aging and degradation monitoring techniques.

9/ SOV failure rates are bounded by AOV failure data.

10/ Also, the Group reviewed the LER data from the draft version of the Study. Given the recent availability of the later version, we have not had an opportunity to review any later data.

11/ As discussed later, ongoing industry programs will be evaluating industry SOV operational experience data. This information will be available at a later date.

significant (e.g., coil failure of SOVs with de-energized safety position). SOV failure rate calculations typically include all failure events but many are not safety significant. As noted in NUREG/CR-4819, coil failures were responsible for approximately half of the safety-related SOV failures reported in the 1978-1984 time period. A large number of coil and other electrical failures are also reported in the LERs listed in the Study's Appendix A. A large portion of the SOV's in nuclear power service are de-energized to accomplish their safety functions. Since no credible coil electrical failure modes can prevent these valves from going to their de-energized position, coil failures are not a safety concern for these valves. Because of the inclusion of coil failures, published SOV failure rates generally overestimate safety-significant failures for de-energized to function valves.

Consideration of CCFs in PRAs: The Study fails to properly recognize the significant industry and NRC efforts to identify, model, and qualify common cause failures ("CCFs") in PRAs. In fact, PRAs typically assume SOV CCF failure probability of 10%, which is consistent with the results of other NRC and EPRI research studies of CCF events. For example, NUREG/CR-1150 documents the performance of level 1 PRAs for five domestic nuclear power plants utilizing a beta factor of 0.1 for two or more SOVs failing from a common cause.[12/] NUREG/CR-2770, based on a review of LERs for the time period 1976-1980, estimates failure rates of 1.3E-07 for simultaneous common cause failure of 2, 3, or 4 AOVs and individual AOV failure rates of 1.5E-06. This indicates that approximately 10% of the failures were classified as CCF. Similarly, EPRI NP-3967 (Reference 8), identifies dependent events based on 2,654 events at domestic plants. Of the 2,654 events, an average component beta factor of 0.1 was calculated.

Frequency and Significance of SOV CCFs: Our cursory review of the Study's Appendix A LER failure data does not support the Study's finding of widespread concurrent failures of SOVs in redundant trains or systems. Our review of the LER data suggests that SOV CCFs are less than 10 percent of the total number of SOV failures and are, therefore, consistent with PRAs' CCF assumptions.

In accordance with available NRC core damage frequency and CCF research studies, common cause failure events are those in which two or more component fault states occur at the same time or in a short time interval (i.e., concurrent) and are the direct result

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12/ NUREG/CR-1150 implements the CCF methodology described in NUREG/CR-4780 (Reference 7).

of a shared root cause (e.g., hardware, human, environmental, or external). Concurrence is essential because the importance of CCFs stems from the seriousness of having several valves failing simultaneously. It appears to the Group that the Study may have improperly selected several LER events as examples of significant SOV CCFs that may share a common root cause but are not concurrent. It would appear the Study assumed that most SOV failures are related to some shared root cause that could escalate into concurrent failures and should be classified into the CCF category regardless of other analysis factors (such as the actual occurrence of multiple concurrent failures or the identification of realistic CCF coupling mechanisms). It should be noted that over 70% of the Study's examples of SOV CCF failures are related to design, construction, or manufacturing errors. However, both NUREG/CR-2770 and NUREG/CR-4780 indicate these type of errors normally contribute to high individual failure rates, often leading to recurrent failures, but are not classified as CCFs because there usually is no coupling mechanism to synchronize the faults causing redundant component failures.

The Group also believes the Study does not appear to have a consistent analysis methodology to assess and classify operating events into the CCF category. Consequently, the existence of CCFs and the safety significance of SOV failures are supported by a subjective analysis of LER events considered "significant" by the Study. Because of the unstructured nature of the Study's analysis of CCF events, its classification of some SOV failure events into the CCF category do not appear to be supported.

SOV Failures as Accident Precursors: Of the 22 LERs identified by the Study as examples of "significant" accident precursors for the time period 1985-1990, only three are classified as precursors by the NRC's severe core damage status report (NUREG/CR-4674) (Reference 9).[13/] No other events related to multiple SOV failures (actual or potential) are deemed significant precursors by the status report. NUREG/CR-4674 screens all LERs and selects events as precursors if they meet one of the following requirements:

- Involved the failure of at least one system required to mitigate the consequences of a LOFW, LOCA or SLB;

13/ These LERs are 324/85-008, 440/87-009, and 458/89-022.

- Involved the degradation of more than one system required to mitigate the effects of one of the above initiating events; or

- Involved an actual initiating event that required safety system response.

Activities Related to Specific Technical Concerns

Temperature: A significant number of the events described by the Study relate to thermal degradation due to prolonged exposure to high ambient temperatures or self-heating effects. The NRC and the industry have issued several informational documents, also indicated in the Study, discussing both these degradation causes.

Equipment Qualification: A significant number of the Study's Appendix A LERs relate to increased licensee awareness in the context of equipment qualification efforts of potential qualification issues. In fact, these EQ-based LERs account for virtually all of the "incipient" failures in the LER data. However, most relate to situations in which the qualification of the equipment may be unverified only for the most severe of postulated accidents. These concerns, as is evidenced by the LERs, are being addressed by licensees. The Group would not anticipate significant additional findings such as these to be identified in the future.

Maximum Operating Pressure Differential ("MOPD"): Regarding SRV SOVs, the Study indicates the NRC first issued IN 80-40 (followed by Bulletin 80-25) requiring measures to insure these SOVs operate within their MOPD ratings. The NRC issued more generic guidance regarding MOPD in 1988 (IN 88-24). The Study notes that, subsequently, several licensees informed the NRC of similar discoveries. This again indicates that utilities are responsive to NRC information issuances related to SOVs and that a portion of the LER data simply reflects licensee corrective actions to resolve potential problems rather than reporting actual failures.[14/]

14/ The Group notes that most of the reported MOPD problems require the failure of air pressure regulators typically installed upstream of each SOV operating pneumatically actuated valves (i.e., AOVs). These failures, particularly simultaneous failures, are unlikely unless the regulators experience harsh service conditions beyond their design capability.

BWR Scram System SOVs: As noted by the Study, BWR owners have made design improvements in the SOV vent and drain systems, including the installation of redundant vent and drain valves at all U.S. BWRs. Similarly, the BWR Owners Group is involved in the design and qualification of BWR scram SOVs with improved thermally resistant elastomers.

Replacement vs Rebuilding: During 1990, ASCO notified the industry that rebuild kits would no longer be available for the ASCO NP series valves. This action minimizes the potential for such problems with these valves. Also, several SOV manufacturers are in the process of qualifying new SOV designs for safety-related applications. The use of higher temperature-rated and petroleum resistant elastomers, coupled with reductions in SOV self-heating (using power reduction modules located remotely from the SOVs) will significantly extend the rebuild interval and consequently reduce the potential for errors associated with rebuilding.

Locktite: The Study cites three examples of excessive locktite causing valve sticking problems. Two were related to one valve manufacturer's fabrication and field service personnel errors. Regarding these, the NRC issued IN 87-48. Additional industry failures with this root cause have apparently not occurred. The final example related to the use of excessive locktite on BWR scram SOVs. GE in a supplemental SIL recommended that BWR owners discontinue using the locktite or other chemical adhesives in the SCRAM SOVs. Subsequent failures have not been reported.[15/]

Instrument Air System Contamination: The Study data indicates a significant number of the reported failures are related to air system contamination. However, several generic industry activities have been initiated to address this issue. Many of these generic and plant specific activities are in response to NRC issuances IN 88-24 (Reference 10) and Generic Letter 88-14 (Reference 11), and include the issuance of an EPRI Nuclear Maintenance Analysis Center ("NMAC") guideline on instrument air systems and an associated seminar on air systems. Although premature to assess the effectiveness of these ongoing activities, their existence is another indication that ongoing industry efforts are addressing SOV concerns.

15/ Apparently only two SCRAM SOVs in one plant ever exhibited this problem.

MSIV SOVs: The Study cites a number of MSIV SOV problems including those associated with ASCO NP8323 SOVs. Several analyses have failed to definitely identify the root cause of many failures, but ASCO has conservatively discontinued supplying this valve to the nuclear industry. Cooperative efforts between R.A. Hiller and the Group are in progress to identify, using specialized tests, acceptable replacement valve designs. Subsequent efforts, if needed, will qualify the preferred replacement valve design. One objective of these efforts is to extend the replacement interval.

Commercial Grade Valves: Industry and NRC initiatives have placed increased emphasis on the dedication of commercial grade items in safety related applications. These generic and plant-specific activities will include the use of commercial grade SOVs. In fact, the EPRI Joint Utility Task Group is presently developing a Technical Evaluation Package addressing the use of such SOVs. As indicated in the context of industry procurement efforts, utilities are expected to take appropriate action when future dedication activities suggest deficiencies may exist with presently installed commercial items.

Additional Industry Initiative: The Group also understands that NMAC and a Solenoid Valve Technical Advisory Group has also initiated a study to provide guidance on the maintenance of SOVs. The activities supporting the guide will include a detailed review and classification of existing SOV failure data, identification of significant SOV design/application considerations, and SOV maintenance recommendations.

RECOMMENDATIONS

In view of the above, the Group would propose, first, that more specific scrutiny of the implications and use of the data cited in the Study be given before considering new generic NRC requirements. Second, the effectiveness of previous, ongoing and proposed efforts in this area should be assessed before considering new requirements. In the Group's view, current evidence does not support the imposition of new NRC generic requirements regarding SOVs. Indeed, many of the conditions underlying the data relied upon in the Study have been previously identified and have been or are being addressed by the industry. The Group believes such efforts demonstrate an ongoing, effective process that licensees should be allowed to implement without imposing an additional layer of specific new requirements. In any event, should such new requirements be considered, appropriate processes should be employed, including the application of backfitting procedures.

The Group appreciates the opportunity to provide these comments for your consideration.

Sincerely,

William A. Horin (by JHP)

Malcolm H. Philips, Jr.
William A. Horin

Counsel to the Nuclear Utility
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cc: Thomas M. Novak (NRC)
Warren Hall (NUMARC)

REFERENCES

1. WASH-1400 (NUREG 75/014), "Reactor Safety Study: Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," October 1975.

2. NUREG/CR-1150, "Severe Accident Risks: An Assessment For Five U.S. Nuclear Power Plants," vols. 1 and 2, June 1989.

3. AEOD Case Study C-90-01, "Operating Experience Feedback Report, Solenoid-Operated Valve Problems at U.S. Light Water Reactors," December 1990.

4. NUREG/CR-4819, "Aging And Service Wear of Solenoid-Operated Valves Used In Safety-Systems of Nuclear Power Plants," vol. 1, Operating Experience And Failure Identification, March 1987.

5. EPRI Advanced LWR Requirements Document, Rev. 0, June 1989.

6. NUREG/CR-2770, 'Common Cause Fault Rates for Valves," February 1983.

7. NUREG/CR-4780, "Procedures For Treating Common Cause Failures In Safety And Reliability Studies," vol. 1, January 1988.

8. EPRI NP-3967, "Classification and Analysis of Reactor Operating Experience Involving Dependent Events," June 1985.

9. NUREG/CR-4674, "Precursors to Potential Severe Core Damage Accidents: A Status Report," vols. 1 through 11 (various dates).

10. Information Notice 88-24, "Failures of Air-Operated Valves Affecting Safety-Related Systems," May 13, 1988.

11. Generic Letter 88-14, "Instrument Air Supply System Problems Affecting Safety-Related Equipment," August 8, 1988.