

CERTIFIED BY:

Carlyle Michelson - 11/05/93

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SUMMARY/MINUTES OF THE ACRS SUBCOMMITTEE MEETING
ON MECHANICAL COMPONENTS
OCTOBER 5, 1993
BETHESDA, MARYLAND

INTRODUCTION

The ACRS Subcommittee on Mechanical Components held a meeting on October 5, 1993, in Room P-110, 7920 Norfolk Avenue, Bethesda, Maryland. The purpose of the meeting was to hear a briefing by representatives of the NRC staff and industry on the status of the testing and surveillance programs for motor-operated valves (MOVs), the industry's check valve reliability programs, and other valve-related matters. A copy of the meeting agenda is attached. Handouts of the presentations are attached to the office copy of the minutes. The Subcommittee had received neither written comments nor requests for time to make oral statements from members of the public. Mr. Elpidio Igne was the cognizant ACRS staff member for this meeting. The meeting was begun at 8:30 a.m. and adjourned at 6:30 p.m. and was held entirely in open session.

ATTENDEES: Principal meeting attendees included:

ACRS

- C. Michelson, Chairman
- J. Carroll, ACRS Member
- C. Wylie, ACRS Member
- P. Wohld, ACRS Consultant
- E. Igne, Staff

NRC

- R. Baer
- F. Grubelich
- T. Sullivan
- G. Weidenhamer
- T. Scarbrough

OTHERS

- C. Calloway, NUMARC
- J. Hosler, EPRI
- S. Kalsi, Kalsi Engineering
- K. Hart, Pennsylvania Power and Light
- G. Hunter, Baltimore Gas and Electric
- J. Price, Florida Power and Light
- M. Robinson, EPRI/NIC
- M. Eidson, Southern Nuclear
- P. Damerell, MPR Associates, Inc.

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REVIEW DOCUMENTS

No official review document was discussed at this meeting.

DISCUSSION

Opening Remarks

Mr. Michelson convened the meeting at 8:30 a.m. and mentioned that a great deal of interesting work has been ongoing in the areas of MOV and check valve operability under design loading conditions and that the situation seems to be well in hand. Mr. Carroll said that he does not quite share Mr. Michelson's optimism on this matter, in view of the fact that GE has not resolved the MOV problems for the ABWR design.

Graded Approach to MOV Prioritization - Mr. C. Calloway, NUMARC

Mr. Calloway stated that NUMARC has been working with several utilities to develop a document, reflecting on-going industry efforts to provide a policy-level guidance for structuring a graded approach, based on a blend of probabilistic and deterministic methods, for completing the implementation of the provisions of Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." The underlying principle of this work is to apply resources in a manner that is commensurable with the safety significance of the MOV. He mentioned that:

- High priority MOVs should be dynamically tested, if testing is practicable and meaningful, at the most likely accident conditions

- Medium priority MOVs may be analyzed or dynamically tested to validate the MOVs capability
- Low priority MOVs need only be analyzed to ensure the capability of the MOVs

The draft document entitled "Guidelines for Optimizing Safety Benefits in Assuring the Performance of Motor-Operated Valves," is expected to be available for review by the industry and NRC staff by the end of the week. Mr. Calloway noted that this document will be issued for industry guidance only.

Mr. Michelson noted that the PRA must be performed with the correct values for valve reliability and include pressurization of sub-compartments in order to determine the significance of the assumed accident events. Mr. Calloway mentioned that the PRA methodology is not an exact science, but that the industry will improve the PRA methodology by the use of deterministic methods. Mr. Michelson also questioned NUMARC's philosophy, included in the draft document, of testing MOVs at the most likely accident conditions, but not necessarily at the maximum accident conditions. The Subcommittee did not agree with NUMARC's philosophy of testing only at the most likely accident conditions.

EPRI MOV Performance Prediction Program - Mr. J. Hosler, EPRI

Mr. Hosler presented an overview and status of the EPRI MOV performance program. He noted that the program has been in place for about 3 years and is approaching \$25 million in expenditures. Completion of the program is expected by April 1994. The primary objective of the program is to predict MOV performance based on a combination of analytical prediction and performance-based

information on a specific MOV obtained from testing. The program is applicable to gate, globe, and butterfly valves.

In response to a question by Mr. Michelson concerning the methodology of predicting valve performance by extrapolation of test results, Mr. Hosler stated that a firm basis now exists to predict MOV performance from test results. Documentation of this extrapolation methodology will be available during April 1994.

In response to several questions from Mr. Michelson, Mr. Hosler stated that there are uncertainties in the results that cannot, at the present time, be quantified, but the results will be reasonably conservative or bounding as to be defensible.

Mr. Hosler stated that separate-effects testing was performed to address areas of known uncertainty in rate of loading of the operator valve design effects, friction, and stem-nut lubrication. Some principal findings of the program are as listed below:

1. Butterfly Valves
 - Butterfly valve torque values are bounded by vendor predictions.

2. Globe Valves
 - Globe valve factors for incompressible flow at 15 fps ranged from 1.0 to 2.1 (standard industry equations recommend globe valve factors of 1.87 for two-phase hot water blowdown conditions).

3. Gate Valves
 - The number of strokes to achieve a plateau in apparent disc coefficient of friction during preconditioning varied from 100 to 900 (initial

coefficient of friction values ranged from 0.1 to 0.3).

- The maximum disc friction during cold-water-pumped flow testing (after preconditioning) was between 0.3 and 0.6 (industry practice assumes a 0.3 coefficient of friction).
- Disc friction tends to decrease with higher differential pressure.
- Hot water blowdown (530°F) apparent disc friction values ranged between 0.35 and 0.80 (significant guide/seat damage was observed).

Mr. Hosler mentioned that valve design guidance will be documented and provided to valve vendors in order to improve the valve performance. In response to questions from Mr. Wohld, ACRS Consultant, Mr. Hosler stated that test results indicate that the handwheel method would satisfactorily simulate the worst case loading under accident conditions.

Mr. Hosler mentioned that the program products delivered to date include:

- Guidelines for in-situ testing of MOVs
- General information data base for MOVs
- MOV design margin improvement guidelines
- Butterfly valve application guidelines
- Stem-nut lubrication report

Mr. Hosler noted that although all the reports contain proprietary information, they will be available for staff review.

In reply to a question by Mr. Michelson on the effects of valve operability when two valves are in series, Mr. Hosler said that flow tests have not been performed with two valves in series, but that engineering judgment indicates that the worst situation is when one valve does all the work. Mr. Michelson mentioned that enough information is not yet available to make a valid engineering judgment. Mr. Hosler, in reply to Mr. Michelson's comment, stated that based on results obtained during the performance program, a reasonably good argument could be made on valve performance when installed in a system in series. With respect to flow orifices and significant constrictions in a piping system and its effects on valve performance, Mr. Hosler stated that the overall methodology of the flow system would be modeled as part of the performance analysis. Mr. Hosler mentioned that this matter will be studied more in detail.

Butterfly Valve Model Status - Dr. M. Kalsi, Kalsi Engineering, Inc.

Dr. Kalsi presented highlights of the work performed by Kalsi Engineering, Inc. for EPRI in the area of butterfly valve performance prediction. The program spanned almost two years of analysis and tests. The objective of the program was to provide validated methodology to predict butterfly valve performance, to cover a wide range of valve sizes, and seat disc designs, bearing configurations, and various flow media (air, steam and water) and inlet flow conditions.

In response to a question by Mr. Michelson, Dr. Kalsi stated that the tests were performed in either fully incompressible or fully compressible flow and that sufficient information has been gathered from the tests to conclude that incompressible flow conditions will be the upper bound condition.

Major conclusions of the model tests performed at Kalsi Engineering, Inc., include the following:

- Torque and flow coefficients have been validated to be nondimensional
- Nondimensional coefficients obtained during the test program have been validated for predicting performance of large valves from small scale model tests
- The butterfly valve model bounds the test results

Dr. Kalsi mentioned that the final design review package will be available by the end of 1993. Dr. Kalsi's presentation on the stresses in the actuator assembly was deferred to a future meeting of the Mechanical Components Subcommittee.

Status of NRC Activities to Improve the Performance of MOVs -

Mr. F. Scarbrough, NRR

Mr. Scarbrough presented a summary of recent MOV problems that have occurred at operating plants. He mentioned that the most significant cause of MOV problems has been the weakness in the original design of MOVs resulting from underestimation of the thrust and torque required to operate the valves under design-basis differential pressure and flow conditions.

Mr. Scarbrough then reviewed the contents of GL 89-10 up to the proposed Supplement 6 which discussed schedule, MOV grouping and other information such as Kalsi's report on overthrust capability, degraded voltage evaluation, and pressure locking and thermal binding. The proposed Supplement 6 to GL 89-10 was issued for public comment on July 11, 1993. The NRC staff has reviewed and

reconciled the public comments and is preparing the proposed final supplement for review by the Committee to Review Generic Requirements (CRGR) before issuance.

Mr. Michelson asked several questions concerning Generic Safety Issue 152, "Design Basis for Valves That Might be Subjected to Significant Blowdown Loads." He asked if there is reason to believe that every plant is considering pipe breaks in the HPCI, RCIC, auxiliary feedwater, steam supply, and reactor water cleanup systems. Mr. Scarbrough stated that of all the inspections performed on operating plants so far, which include all of the program review elements for GL 89-10, reveals that none assumed a very low differential pressure for the aforementioned systems piping. The inspectors have been made aware of this matter, even though it may not be listed as a design-basis condition.

Mr. Scarbrough noted that if a utility had not listed pipe-break conditions as a design basis, the utility is not required to meet this requirement, although in all probability the utility may have designed the piping systems for the pipe-break condition. In summarizing this concern, Mr. Michelson stated that inspectors reviewing the inspection results are led to believe that the utilities are designing important piping systems to pipe-break conditions even though the pipe-break conditions are not listed as a design basis. Mr. Scarbrough agreed.

Mr. Michelson asked about mixed two-phase flow condition and its effect on gate valve performance. The staff mentioned that it is still studying the EPRI and INEL test results. Mr. Michelson added that we have to show that incompressible fluid flow is the upper bounding condition for gate valves as well as butterfly valves. Mr. Scarbrough noted that the staff will study this matter further.

Mr. Scarbrough mentioned that there are no special problems related to DC motor operators on MOVs. Mr. Weidenhamer, RES, stated that they are beginning to look into concerns regarding performance of AC and DC motor operators, e.g., motor behavior under load, thrust characteristics vs. temperature, stall and motor speed, etc. Mr. Weidenhamer mentioned that the operator study program has just begun and some preliminary results will be forthcoming. Mr. Scarbrough stated that the staff has asked IAEA, and they have agreed, to host a meeting on MOVs in the spring of 1994. The MOV experts worldwide will be invited to attend. With respect to new designs, Mr. Scarbrough mentioned that Anchor/Darling has an improved valve design.

Mr. Scarbrough said that for advanced reactors, the staff has been discussing this issue to require advanced reactor designs to qualify the valve before installation and provide design features for periodic verification. With respect to a better valve than a gate valve for use in reactor water cleanup isolation in ABWR designs, Mr. Scarbrough mentioned that the MOV test results were made available to designers of advanced reactors for consideration in their valve design applications. He noted that perhaps a globe valve configuration, whose performance is easier to predict, should be considered for use. Mr. Hosler mentioned that the industry has performed preliminary conceptual redesigns, e.g., globe valves, combination of globe and gate valves, etc. in lieu of gate valve. Other valves such as ball valves and squib valves have been considered but design efforts are focused primarily on gate valves with design modifications.

Mr. Michelson asked about the demonstration of the performance of butterfly valves out in the field. Mr. Scarbrough stated that for the most part, licensees have been slower in getting a program under way mainly because of the lack of advanced diagnostic

equipment. However, MOVATS has developed a system called BART and Liberty is in the process of developing a system. Information on butterfly valve operability should be available within a year.

NUCLEAR INDUSTRY CHECK (NIC) VALVE GROUP PRESENTATION

Introduction and Overview - Mr. K. Hart, Vice President of NIC

Mr. Hart discussed NIC origin, organization, charter and accomplishments. Some accomplishments mentioned are listed as follows:

- Developed check valve monitoring techniques
- Revised EPRI's check valve application guide
- Developed a forum for disseminating check valve information to the nuclear industry via meetings, computer data base, and a reference library

Committee on Check Valve Diagnostics - M. G. Hunter, Baltimore Gas and Electric

Mr. Hunter presented the status of check valve diagnostics. He stated that the Committee on Check Valve Diagnostics was formed to evaluate the non-intrusive test technologies that were available for check valves. The program consisted of three phases: Phase I tests were performed in water environment, Phase II in air environment, and Phase III in steam environment. Phases I and II have been completed and the results have been documented, published and available from the EPRI M&D Center in Eddystone, Pennsylvania (Telephone [215] 595-8876). Phase III is currently in progress.

Technologies being evaluated are acoustics, ultrasonics, and magnetics as well as eddycurrent. Phases I and II testing were performed at the Utah State University under the direction of Dr. Tullis. Phase III testing in steam environment is being performed at Calvert Cliffs. The long-term goals of Phase III testing are to determine check valve wear-trending characteristics and to provide a data analysis guide primarily as a training tool and for maintenance personnel.

Support to ASME OM-22 Work and Technical Information Committee

Mr. M. Robinson, Past President, NIC

Mr. Robinson discussed briefly NIC's support to the ASME OM-22 work and the NIC Database and library. He mentioned that the NIC meeting schedule coincided with the OM-22 summer and winter meetings. The NIC is represented at all OM-22 meetings. Presently, NIC is pursuing at OM-22 meetings the matter of performing condition monitoring on check valves. He suggested that a representative from OM-22 brief the Subcommittee on its charter and current activities. Mr. F. Grubelich, NRR, noted that a check valve standard and update of the existing code on check valves are ongoing with OM-22, with a completion date sometime in late 1994 or early 1995.

Mr. Robinson next discussed the work performed by the Technical Information Committee. Presently, the NIC library consists of about 600 documents related to check valves. The NIC database contains about 6,500 entries on check valves. The database also includes names of people in the field of check valves, for example, Mr. C. Michelson was listed in the database.

Check Valve Maintenance Guide - Mr. J. Price, Florida Power and Light Company

Mr. Price discussed briefly the Check Valve Maintenance Guide. He stated that the guide is similar to recent guides on air-operated valves, solenoid-operated valves, and motor-operated valves, in that the guide captures general consensus on maintenance practices.

The purpose of the guide is to provide a good technical foundation for maintenance personnel. Some basic topics of the guide are technical description of valves, failure analysis, criteria for preventive and corrective maintenance. It was mentioned that EPRI will eventually publish the guide as a non-proprietary document. Mr. Price noted that some plants are using check valves for main steam isolation and reverse flow applications. In response to a question by Mr. Michelson, Mr. Price stated that experience to date indicates no check valve failures. Further, Mr. Grubelich, NRR, stated that if the check valve is a pressure-retaining boundary valve, code requirements require a structural integrity analysis. Mr. Price stated that a check valve under pipe break load program would be too exotic for NIC to pursue.

NRC Presentation on Check Valves - Mr. F. Grubelich, NRR

Mr. Grubelich discussed briefly the NRC check valve activities. He said that the NRC staff has performed trial audits and regional inspections. The audit (1991) covered five plants and the regional inspection covered 21 plants. Results of the audits revealed lack of specific guidance and consistency in the preventive maintenance or reliability programs, although all licensees are in various stages of evaluating, planning, or implementing applications of non-intrusive methods. General observations from regional inspections indicate that the licensees are now more knowledgeable

in check valve program needs, and a number of programs were deemed satisfactory.

Mr. Grubelich reviewed the check valve historical failure report development. This study was performed by ORNL for NRR and the results reported during the Second NRC/ASME symposium on Pump and Valves in July 1992, and documented in NUREG/CR-5944, "A Characterization of Check Valve Degradation and Failure Experience in the Nuclear Power Industry." The report characterizes failures by system, valve size, manufacturer, component age, plant age, failure mode, extent of degradation, detection method, failure area, and system operating status.

Mr. Grubelich discussed the staff's future plans in the check valve area. These include:

- 1) Review and evaluation of the ORNL failure report updates
- 2) Review of NIC Maintenance Manual
- 3) Continue the participation in the development of the OM-22 codes and standards

FUTURE SUBCOMMITTEE ACTION

The Subcommittee Chairman plans to brief the full ACRS on this matter during the November/December 1993 ACRS meeting.

ACTION, AGREEMENTS, SUGGESTIONS, AND COMMITMENTS

- Mr. Michelson deferred Dr. Kalsi's presentation on stresses in valve actuator assembly to a future meeting of the Mechanical Components Subcommittee
- Mr. Sorenthal, EPRI, agreed to provide the Subcommittee NIC's reports on the maintenance and application guidelines, when available
- Mr. Robinson, past president of the Nuclear Industry Check Valve Group, suggested that the Subcommittee invite a representative of the ASME OM-22 Committee to provide a briefing on its Charter and activities associated with valves.

NOTE: Additional meeting details can be obtained from a transcript of this meeting available in the NRC Public Document Room, 2120 L Street, NW, Washington, DC 20006, (202) 634-3273 or can be purchased from Ann Riley and Associates, LTD., 1612 K Street, N.W, Suite 300, Washington, DC 20006, (202) 292-3950.

MEETING OF THE ACRS SUBCOMMITTEE ON
MECHANICAL COMPONENTS ON THE STATUS
OF MOV AND CHECK VALVES
7920 NORFOLK AVENUE, ROOM P-110
BETHESDA, MARYLAND
OCTOBER 5, 1993

- TENTATIVE SCHEDULE -

	<u>Time</u>
I. Chairman's Opening Statements and Introductory Remarks, C. Michelson	8:30-8:40 a.m.
II. Motor Operated Valves (MOVs)	
• Status of MOV Operability/Reliability Programs	
- Industry Presentation	8:40-9:10 a.m.
1. Graded Approach to MOV Priori- tization, C. Calloway, NUMARC	
2. MOV Research Program at EPRI, J. Hosler, EPRI	9:10-10:40 a.m.
* * * * *	[15 Minute Break ≈ 10 a.m.]
3. Testing of Butterfly Valves, and Other MOV Valve and Actua- tor Activities, Dr. Kalsi, Kalsi Engineering	10:50-11:50 a.m.
- NRC Presentation	11:50-12:50 p.m.
1. Status of GL 89-10, including Supplement 6. Also, discuss the technical basis of valve qualification by grouping and the staff's position on MOV priori- tization using PRAs, T. Scarbrough, NRR	
2. Results, Conclusions, Recommenda- tions, Lessons Learned from GL-89-10 Inspections, T. Scarbrough, et al., NRC	
* * * * * LUNCH * * * * *	12:50-1:50 p.m.

- TENTATIVE SCHEDULE - (Cont'd.)

	<u>Time</u>
- Roundtable Discussions on Other MOV Issues	1:50-2:50 p.m.
1. Clarification of Staff's Response to GI-152, R. Baer, RES	
2. Torque Reduction Due to High Motor Temperature (NRC/Industry)	
3. Concerns with Direct Current MOVs (NRC/Industry)	
4. Status of Valve Operability/Relia- bility Programs in Foreign Countries (NRC/Industry)	
5. Application of MOVs in Advanced Reac- tor Designs, Questions by the Subcom- mittee (NRC/Industry)	
6. Check Valves (Quad Cities) Failing to Open at Low Pressure (NRC/Industry)	
7. Other Valve Designs--for Gate Valves (Industry)	

III. Check Valves

- Status of Check Valve Operability/Reli-
ability Programs

- Industry Presentation	2:50-4:15 p.m.
1. Introduction, Ken Hart	
2. Test Results, Greg Hunter	
3. Maintenance guide, Joe Price	
4. Failure Analysis, Ken Hart	

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[15 Minute Break
≈ 3 p.m.]

- NRC Comments, F. Grubelich, NRR	4:15-4:45 p.m.
- Roundtable Discussions on Other Check Valve Issues	4:45-5:15 p.m.

- TENTATIVE SCHEDULE - (Cont'd.)

Time

1. Integrity of Check Valve Disk
Assembly Subject to Reverse Flow
Due to Pipe Break Conditions
(Industry/NRC)
 2. Application of Check Valves for
Advanced Reactor Designs, Questions
by the Subcommittee (NRC/Industry)
- Penn State Univ. Study on Check
Valves for Advanced Reactor Design
(Industry/NRC)

IV. Subcommittee Discussion

5:15-5:30 p.m.

V. Adjournment

5:30 p.m.

Subcommittee Chairman: C. Michelson

Cognizant Subcommittee Staff Engineer: E. Igne (301) 492-8142