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Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Joint Owners Group Air Operated Valve Program Document

Project Number: 689

Dear Mr. Imbro:

The Air Operated Valve (AOV) Joint Owners Group (JOG) recently completed revision 1 of their AOV Program Document. This letter forwards a copy of that document for your information.

The JOG AOV Program Document contains programmatic elements for utility use to provide assurance that AOVs are capable of performing their intended safety-significant, i.e., risk significant, functions. It is expected that utilities, by implementing the elements of this program, will focus resources on the most significant AOVs in their plant. Revision 1 to this document was developed as a result of comments and questions identified by utilities while using the initial version. A summary of the changes is included in Enclosure 2.

As was the case with revision 0 of the JOG AOV Program, INPO will publish the document in *The Nuclear Exchange,* a vehicle that provides INPO member utilities timely information that may be useful in supporting station activities. INPO will continue to monitor and evaluate AOV performance as part of its plant evaluation and assistance visits.

The JOG employed a "Core Group" of utility members from each NSSS Owners Group in the preparation of its AOV Program document. The Core Group will be disbanded as the JOG AOV objectives have been met. NEI will continue to provide the regulatory interface for the industry relative to any further actions the NRC

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staff might consider. If you have any questions on this matter, please call Jim Riley at 202-739-8137, jhr@nei.org or me.

Sincerely,

Alex Marion

Alex Marion

JHR/maa
Enclosures

c: Mr. David Fischer, U. S. Nuclear Regulatory Commission
Mr. Joe Colaccino, U. S. Nuclear Regulatory Commission
Mr. Jack Rosenthal, U. S. Nuclear Regulatory Commission

Enclosure 1

Joint Owners Group
Air Operated Valve Program Document,
Revision 1

JOINT OWNERS GROUP
AIR OPERATED VALVE PROGRAM

Prepared by
The Joint Owners Group AOV Committee

December 13, 2000
Revision 1

DE&S Doc. 575.0.1.F10-01

FOREWORD

This document provides the basis and guidance associated with the development of a nuclear industry Air Operated Valve (AOV) Program. The intent is to specify industry AOV Program requirements to provide assurance that AOVs are capable of performing their intended safety-significant, i.e., risk-significant, functions. This document recommends the use of risk-informed tools in establishing the AOV categorization criteria. Specific guidance is also provided for the basic elements of an AOV program including design, setup, testing and maintenance. It is expected that utilities, by implementing elements within this document, will focus station resources on the most critical AOVs in the plant.

The terms "requirement", "require", etc. used throughout the JOG AOV Program document refer to requirements of the JOG AOV Program. The JOG AOV Program is not intended to revise a plant's licensing basis. Meeting the JOG AOV Program requirements is one acceptable method to establish an effective plant AOV program. For plants implementing the JOG AOV Program, the program shall be followed as described in this document, or deviations from the JOG AOV Program shall be addressed in the plant's implementing program.

ACKNOWLEDGMENTS

This document was prepared by Duke Engineering & Services for the Joint Owners' Group (JOG) AOV Committee. The JOG AOV Committee consists of representatives from the participating utilities of the four nuclear industry Owners' Groups: Babcock & Wilcox Owners' Group, Boiling Water Reactor Owners' Group, Combustion Engineering Owners' Group, and Westinghouse Owners' Group. The development of the guidance in this document has been directed by a JOG AOV Core Group, which consisted of three elected utility representatives from each Owners' Group.

Some members of the JOG AOV Core Group served on related industry organizations. These individuals have provided input to this document based on their involvement with the following organizations:

- Air Operated Valve Users' Group (AUG)
- ASME O&M Committee
- USA Consortium
- EPRI Technical Advisory Group (TAG) on AOVs
- EPRI Performance Prediction Methodology (PPM) Users Group

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1. INTRODUCTION

1.1 Background

A review of "lessons learned" from nuclear plant Motor Operated Valve (MOV) Programs and pilot Air Operated Valve (AOV) Programs indicates that AOV performance can be enhanced via improvements in valve and actuator sizing, setup, testing, and maintenance. Some lessons learned include:

- Similarities in valve designs between AOVs and MOVs indicate the potential for GL 89-10 issues, such as initial valve setup assumptions being non-conservative.
- Industry concerns with sizing of air actuators.
- Enhancements to AOVs in balance of plant systems show improvement in plant performance.

In an effort to maximize the benefits of industry experience to address AOV issues, utilities have voluntarily formed a Joint Owners' Group (JOG). The JOG includes representatives from the participating utilities of the Babcock & Wilcox Owners' Group (B&WOG), the Boiling Water Reactor Owners' Group (BWROG), the Combustion Engineering Owners' Group (CEOG), and the Westinghouse Owners' Group (WOG) (see Appendix C).

The JOG has determined that there are advantages to working together to develop a common industry AOV Program. These advantages include:

- Provides focused resources to develop consistent, technically sound methods.
- Leverages utility resources in addressing common AOV issues.
- Ensures thoroughness through a uniform approach.
- Minimizes regulatory uncertainty and plant-to-plant regulatory variations through a uniform approach.
- Provides a focal point for communication with the Nuclear Regulatory Commission (NRC) and other industry AOV groups.
- Utilizes benefits of MOV "lessons learned."
- Provides a controlled environment for vendor/contractor interaction.
- Affords every utility the opportunity to participate in the JOG.

The JOG AOV initiative was established in November of 1997, with the goal of developing a common and cost-effective U.S. nuclear plant AOV program to enhance the safety and reliability of AOVs.

1.2 Objective

The objective is to provide an industry document that defines the minimum requirements of an AOV program that provides assurance of AOV capability. The program utilizes risk-informed methods to determine the in-scope AOV population. It is expected that utilities will develop a plant specific AOV program to implement the requirements and methods provided in this document.

1.3 AOV Program Elements

Nine key elements for an AOV Program are identified as follows:

- Scoping and Categorization
- Setpoint Control
- Design Bâsis Reviews
- Testing
- Preventive Maintenance
- Training
- Feedback
- Documentation/Data Management
- Tracking and Trending of AOV Performance

This document provides guidance on the above elements. Section 3.0 provides the program requirements with respect to these elements. Sections 4.0 and 5.0 address program implementation.

1.4 Operability Concerns

If during the implementation of the program, an AOV is determined to be degraded or incapable of performing its design basis function, plant management is responsible to address operability in accordance with plant specific corrective action processes, such as NRC Generic Letter 91-18, "Information to Licensees Regarding NRC Inspection Manual Section on Resolution of Degraded and Nonconforming Conditions" (Ref. 6.15).

1.5 Instrument Air Systems

NRC Generic Letter 88-14, "Instrument Air Supply System Problems Affecting Safety-Related Equipment" (Ref. 6.16), provides guidance on instrument air systems. The Instrument Society of America (ISA) and the Electric Power Research Institute (EPRI) provide additional information on air quality in References 6.6 and 6.7, respectively. The JOG recognizes the importance of maintaining high quality pneumatic supply systems for components to be addressed by this program. It is the responsibility of individual plants to assure that pneumatic supply systems are appropriately maintained and operated consistent with plant commitments. Therefore, it is not the intent of the JOG AOV Program to provide additional requirements on instrument air systems.

1.6 Existing Plant Programs

This document is not intended to supercede the requirements of any existing plant program(s) or commitment(s). Existing programs or commitments potentially affected during implementation of the AOV Program should be addressed.

2. DEFINITIONS

active valve: a valve that must perform a mechanical motion during the course of accomplishing a system safety-significant function.

air operated valve assembly (AOV): valve and actuator combination in which the actuator uses air as a power source to provide a valve stem thrust/torque to open, close or throttle a valve. It also includes those accessories required to allow the AOV to perform its intended safety-significant function. For example, a fail close (spring) AOV that has a safety-significant function to close will require the solenoid valve to change position to exhaust. As a minimum, the solenoid valve is an accessory that is considered part of the AOV assembly. Accessories may include solenoid valves, regulators, positioners, boosters, E/P and I/P transducers, quick exhaust valves, and lock-up systems. Ref. 6.2 provides detailed descriptions of the various accessories and their functions.

damper: a device that regulates the flow of gas in low pressure ducts.

differential pressure (DP) load: force due to differential pressure acting on the valve disc or plug that must be overcome to operate the valve.

high safety-significance: designation referring to the importance to plant safety by a blended process of risk ranking and expert panel evaluations.

passive valve: a valve that does not perform a mechanical motion during the course of accomplishing a system safety-significant function.

probabilistic safety assessment (PSA): a quantitative assessment of the risk associated with plant operation. PRA (probabilistic risk assessment) is another term for PSA.

safety related: the classification of components necessary to assure the integrity of the reactor coolant pressure boundary, the capability to achieve shutdown condition, or the capability to prevent or mitigate the consequences of accidents which could result in offsite exposures comparable to guideline exposures of 10CFR100. (Ref. 6.22)

setpoint: a point or set of points that would be set by a technician so that the valve assembly would meet its design function. Examples are provided in Section 4.2

3. PROGRAM REQUIREMENTS

The first step in establishing an AOV program is to identify and categorize the plant AOVs for evaluation. AOVs are screened for inclusion or exclusion from the JOG AOV Program. Those included in the program are placed in one of two categories (Categories 1 and 2) based on their contribution to safe plant operation (Section 4.1.3) and/or accident mitigation. The requirements of the JOG AOV Program are dependent on the category in which each AOV is assigned. These categories determine the extent of design review and testing activities to be performed.

Training, Feedback, Tracking and Trending, and Documentation/Data Management are general program requirements. In addition, all program AOVs require setpoint control and shall be included in a maintenance program. Setpoint control ensures that for each AOV, setpoints, (e.g., preload, regulator setting, etc.) are maintained. For AOVs that are active and have high safety-significance (Category 1), additional requirements are stipulated to provide added confidence in the functional capability of these AOVs. These requirements include Design Basis Reviews (DBR), Baseline Testing, Periodic Testing and Post Maintenance Testing. The detailed description of the program elements is provided in Section 4, AOV Program Elements.

Table 3-1 summarizes the program elements associated with each category of valves.

Table 3-1: AOV PROGRAM REQUIREMENTS

Program Element	Section	Category 1 Valves[A]	Category 2 Valves[B]
Setpoint Control	4.2	Yes	Yes
Design Basis Reviews	4.3	Yes	No[1]
Baseline Testing	4.4.1	Yes	No[2]
Periodic Testing	4.4.2	Yes[3]	No[3]
Post Maintenance Testing	4.4.3	Yes	No[4]
Preventive Maintenance	4.5	Yes	Yes
Training	4.6	Yes	Yes
Feedback	4.7	Yes	Yes
Documentation/Data Management	4.8	Yes	Yes
Tracking and Trending	4.9	Yes	Yes

Notes:

1. Although a DBR is not required for Category 2 valves, any generic issues identified through Category 1 DBRs or industry feedback mechanisms listed in Section 4.7 that could affect Category 2 valves shall be considered. For example, if a given vendor's effective diaphragm area is found to be less than stated in the original sizing, similar Category 2 AOV actuators shall be evaluated for impact.
2. Baseline testing is not required on Category 2 AOVs unless a DBR is required due to a generic issue identified through the Category 1 DBR process.
3. Testing may be required by existing plant programs such as inservice testing (ISI), Maintenance Rule, ASME code, local leak rate testing (LLRT), licensing commitments, etc. For Category 2 AOVs, additional testing is not specifically required for the JOG AOV Program.
4. This program does not require additional post maintenance testing for Category 2 AOVs beyond verification of the affected setpoints established in Section 4.2.

[A] AOVs that are safety-related, active, and have high safety-significance, or

AOVs that are non-safety-related, active, and have high safety-significance. (see Section 4.1.3).

[B] AOVs that are safety-related and active but do not have high safety-significance (see Section 4.1.3).

4. AOV PROGRAM ELEMENTS

4.1 AOV Scope and Categorization

4.1.1 General

This section defines the scope and methods for categorizing the AOVs. In general, nuclear power plants have a large population of AOVs with varying degrees of safety-significance. Therefore, to develop an effective AOV Program, it is essential to establish a method to clearly identify those AOVs with the highest contribution to safe plant operation.

A risk informed approach provides a structured, systematic, and defensible method as well as providing a basis for program establishment and allocation of resources. The risk informed method endorsed by this program will allow proper use of resources in the appropriate areas to increase safety focus, achieve appropriate risk reduction, and eliminate unnecessary conservatism and burden for the nuclear power industry.

4.1.2 Scope

All AOVs are considered for categorization, except isolation devices that are in duct work, i.e., dampers. Dampers typically are installed in low differential pressure applications. In these applications, static loads are significant compared to dynamic loads. A search of the Institute of Nuclear Power Operations' (INPO) databases, i.e., Nuclear Plant Reliability Database System (NPRDS) and Equipment Performance and Information Exchange System (EPIX), did not identify any damper failures as a result of design basis issues. Also, NUREG/CR-6654 Table 3 (12/99) lists 21 LERs associated with air operated dampers. Based on a review of the information contained in NUREG/CR-6654, none of these LERs appear to be the result of undersized actuators or setpoint controls. Therefore, dampers are excluded from the scope of this program. This conclusion is consistent with Generic Letter 89-10, "Safety-Related Motor Operated Valve Testing and Surveillance" (Ref. 6.14, Supplement 1, question 3).

4.1.3 Categorization Process

Each plant shall determine the safety-significance of the AOV. Specific methods and screening criteria used to determine safety-significance is the responsibility of each plant. Figure 4-1 illustrates the process for categorizing AOVs. The AOVs within the scope of this program are classified into two categories.

Category 1: AOVs that are safety-related, active, and have high safety-significance,

OR

AOVs that are non-safety-related, active, and have high safety-significance.

Category 2: AOVs that are safety-related and active but do not have high safety- significance

When determining which AOVs are active, each plant should consider passive safety-related AOVs that are moved to their non-safety position during testing or maintenance. If the system or train is not declared inoperable when a passive AOV is in its non-safety position then this AOV may now have an active safety function.

AOVs not in Categories 1 or 2 are considered outside the scope of this program, as they are deemed not to be critical to plant safety. It is recognized that the AOVs outside the scope of this program may currently be included in other plant programs and activities such as: ISI/IST, LLRT, preventive maintenance, equipment qualification inspections, etc. It is expected that the JOG AOV Program will not impact these on-going activities. Additionally, the quality requirements of 10CFR50 Appendix B still apply to passive, safety-related AOVs.

4.1.3.1 Expert Panel

Each plant shall convene an expert panel to verify the scope and categorization of each plant's AOV program. This panel should include representatives from organizations such as operations, maintenance, engineering, safety analysis, licensing, and PSA. The expert panel shall give consideration to PSA, plant specific performance and deterministic considerations. The panel shall review the screening criteria to ensure plant specific AOV concerns are considered (e.g., passive AOVs that are credited to remain closed for which flow tends to open). The expert panel's qualification requirements, screening criteria and decisions shall be documented.

4.1.3.2 Determination of Safety-Significance

The safety-significance classification shall involve a blended process of risk ranking and plant expert panel evaluation. The expert panel should document and validate the results of the risk ranking to justify the process and results. The following documents can be used for guidance for ranking safety-significance and conducting the expert panel:

- ASME Code Case OMN-3, "Requirements for Safety-Significance Categorization of Components Using Risk Insights for Inservice Testing of LWR Power Plants." (Ref. 6.12)
- BWROG Integrated Risk-Informed Regulation Committee Position Paper: 2000-01, "Application of Probabilistic Safety Assessments to Ranking of Air Operated Valves," dated March 2000. (This document is authorized only for use by BWROG utilities participating in the BWR Owner's Group Integrated Risk-Informed Regulation Committee (IRIRC).) (Ref. 6.10)
- Risk Ranking Approach for Air-Operated Valves, V-EC-1776, Revision 0. (For use by participating members of the Westinghouse Owners' Group). (Ref. 6.11)
- Demonstration Project to Apply Risk-Informed Inservice Testing to Air-Operated Valves, BAW-2539, July 2000. (For use by the B&W Owners Group members) (Ref. 6.24)
- Regulatory Guide 1.160, Rev. 2, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." (Ref. 6.13) (Commonly referred to as the "Maintenance Rule")
- Regulatory Guide 1.174, Rev. 0, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis." (Ref. 6.18) and Regulatory Guide 1.175, Rev. 0, "An Approach for Plant-Specific Risk-Informed Decision Making: Inservice Testing." (Ref. 6.19)

Other methods may be used to establish safety-significance as justified by the plant.

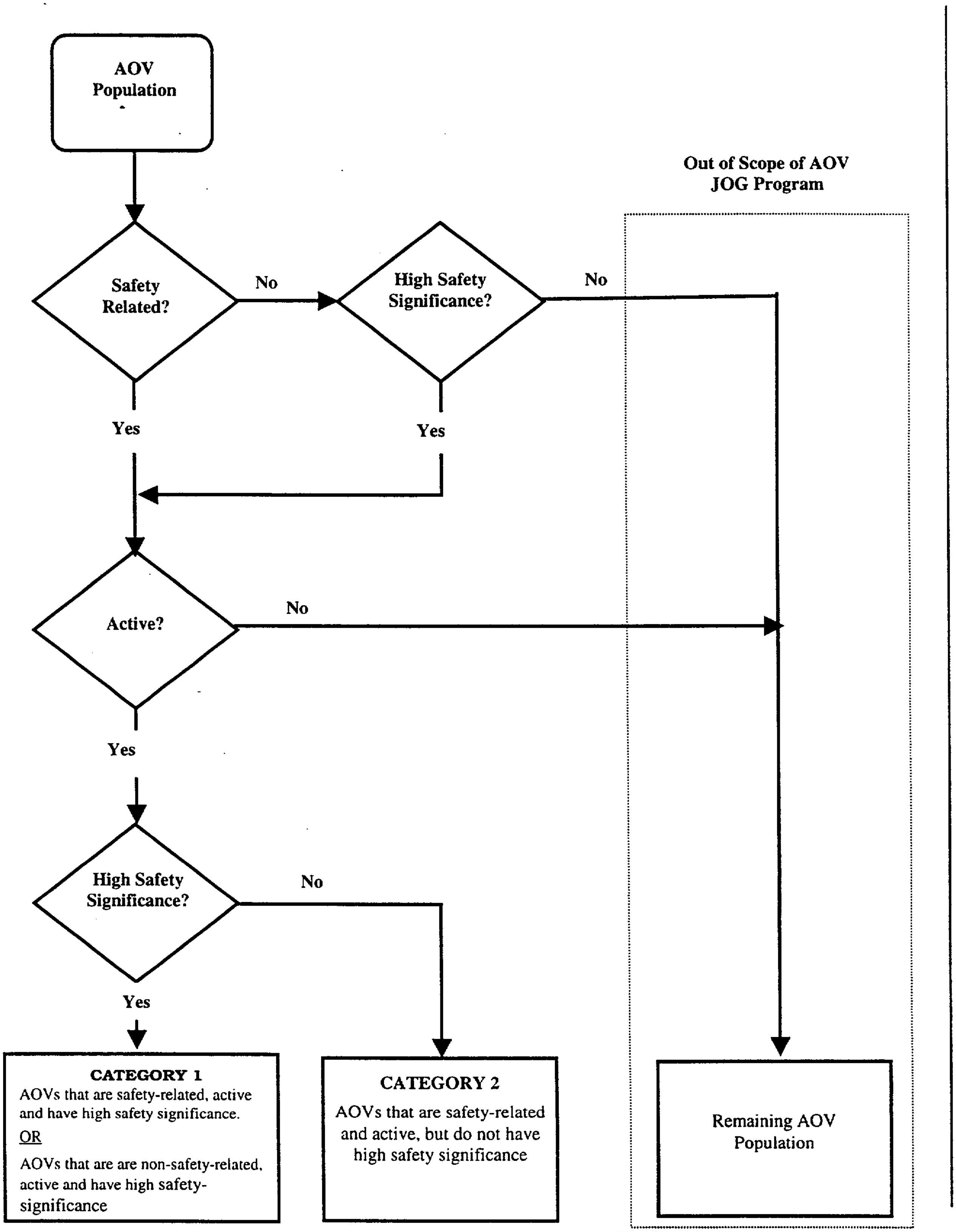
The plant IST program basis document, Updated Final Safety Analysis Report (UFSAR)/Final Safety Analysis Report (FSAR), Technical Specifications, design basis documents, and system operating procedures are acceptable sources for determining AOV function.

If improved safety-significance or risk ranking models are developed, or if plant configuration changes alter the safety-significance ranking, AOV categories may be affected resulting in an increase or decrease in category level or a complete removal from the program. Plant AOV programs should be updated to reflect these changes as appropriate.

4.1.4 Mispositioning

Mispositioning or inadvertent operation of an AOV is not considered in this program on the basis of Generic Letter 89-10, Supplements 4 and 7 (Ref. 6.14).

Figure 4-1: CATEGORIZATION FLOW CHART



4.2 Setpoint Control

Setpoint control is required for those setpoints affecting the active safety functions of the AOV. As a minimum, parameters to be maintained and documented as part of the plant specific setpoint control program, as applicable, are:

- Actuator air supply setting(s)
- Preload (bench set)
- Stroke length

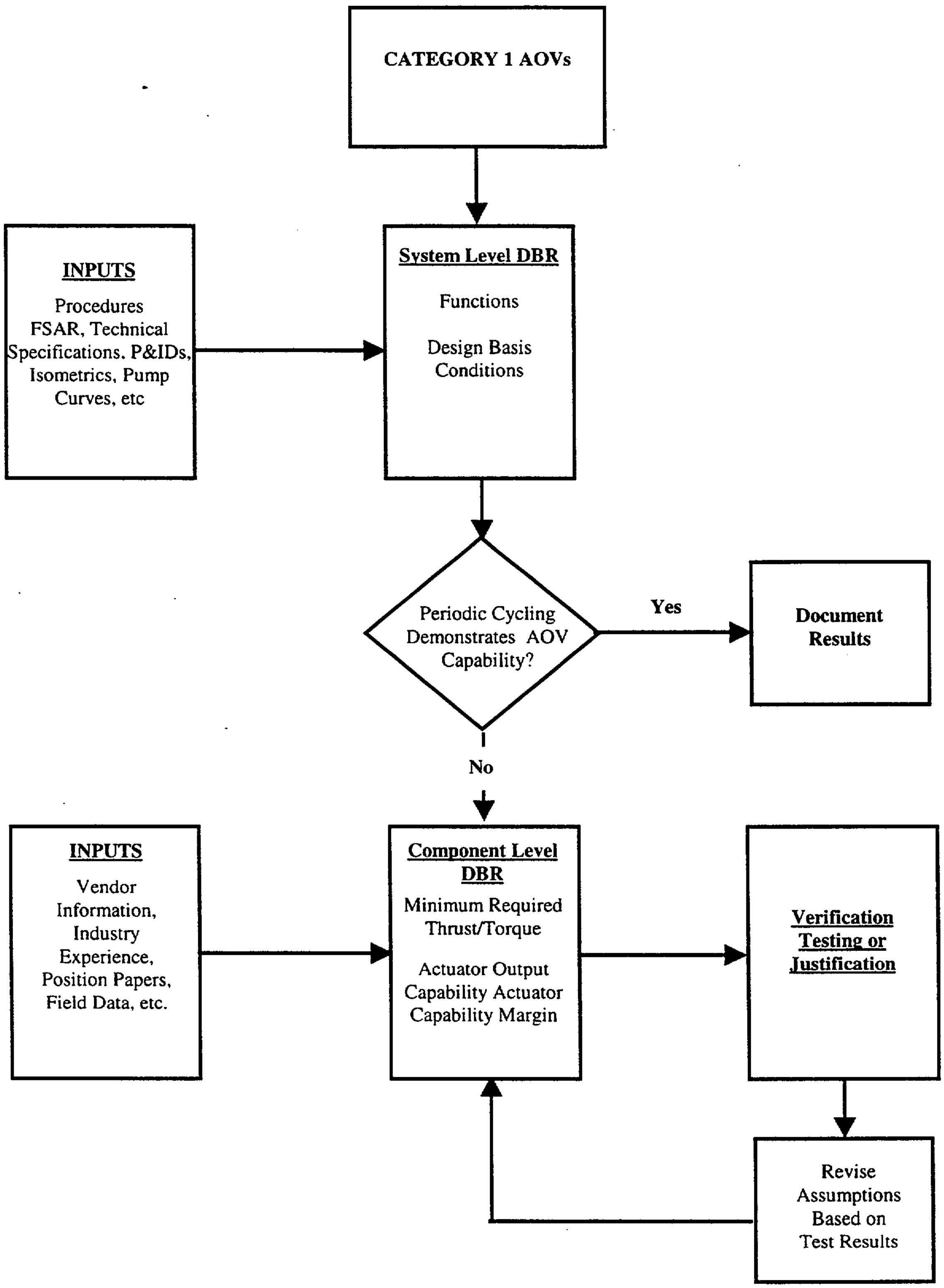
For Category 1 valves, the above information is established as part of the design basis review (Section 4.3). For Category 2 valves, the required information is typically obtained from the current specification.

4.3 Design Basis Reviews

The design basis review (DBR) is used to verify and document the adequacy of AOV sizing and setpoints, and in establishing conditions for verification testing. Specifically, the DBR consists of both a system level review and a component level review. The system level review determines the AOV's system (worst case) operating conditions within the licensing basis of the plant. The component level review, if required, establishes the AOV's required operating thrust/torque, actuator output capability, and available actuator capability margin. Figure 4-2 provides an overview of the DBR process.

Plants should consider the impact of NRC Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power Operated Gate Valves" (Ref. 6.20) and NRC Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity during Design-Basis Accident Conditions" (Ref. 6.21) on AOVs.

Figure 4-2: DESIGN BASIS REVIEW METHOD OVERVIEW



4.3.1 System Review

The system review identifies the worst case operating condition(s) under which an AOV must operate and maintain position within the licensing basis of the plant.

The system review identifies the following parameters:

- Upstream and downstream line pressures
- Process fluid
- Fluid temperature
- Flow direction (flow-to-open, flow-to-close)
- Fluid flow (as required to determine differential pressure or valve factor)
- Allowable seat leakage

The results of this step will be input for the component level review, if required, in order to establish the valve thrust/torque requirements.

4.3.2 Periodic Cycling

Existing site programs and normal plant operation could provide adequate demonstration of AOV capability via periodic cycling. Credit can be taken for this demonstration provided that the periodic cycling conditions meet or exceed the worst case operating conditions within the licensing basis of the plant. Conditions that should be considered are those items listed in 4.3.1 and the following:

- Actuating air pressure and source
- Air controlling devices
- Actuator exhaust paths

In these cases, component level DBRs are not required; however, assurance should be provided that the component and accessories are operating within allowable limits. The basis for satisfying the component level DBR requirement shall be documented.

4.3.3 Component Level Review

A component level review evaluates the actuator's ability to stroke the valve at the conditions determined in Section 4.3.1. This is accomplished by:

1. Determining the valve's minimum required thrust/torque,
2. Assessing the actuator output capability,
3. Comparing the required thrust/torque with the actuator output capability to establish the resultant actuator capability margin, and
4. Evaluating allowable limits of the valve, actuator and its accessories.

Appendix A lists the critical inputs that may be required for the component level review and provides acceptable methods for their determination.

4.3.3.1 Minimum Required Thrust/torque

Thrust and torque methods from approved Generic Letter 89-10 programs can be used for AOVs subject to confirming the methods' applicability to the specific AOVs to which they are applied. This confirmation of applicability should cover the technical basis of the methods used and the range of conditions (valve parameters, system parameters, etc.) associated with the data used to justify the methods.

The EPRI Performance Prediction Methodology (PPM) can be used for gate, globe and butterfly valves, subject to the adjustments specified by EPRI for applying the PPM to AOVs.

For several valve types such as caged balanced disk globe valves, pilot globe valves, double seat globe valves, 3-way valves, ball valves, plug valves, diaphragm valves, etc., vendor or first-principles methods should be used.

For details on these methods see Appendix A.

4.3.3.2 Actuator Output Capability

First principle methods for determining actuator capability should be used. The EPRI evaluation guide for evaluation of actuator output capability for AOVs (Ref. 6.25) provides acceptable first principle equations. Vendor methods may also be used if determined to be appropriate by the plant.

4.3.3.3 Actuator Capability Margin and Allowable Limits

Actuator Capability Margin

Actuator capability margin is the difference between the available actuator output thrust (torque) and the required thrust (torque) expressed as a percentage of the required thrust (torque). Actuator capability margin is defined so that all contributors that affect margin are considered. These contributions are considered by the use of adjusted thrust (torque) values as follows:

$$\text{Actuator Capability Margin} = \frac{\text{Adjusted Actuator Output Thrust (Torque)} - \text{Adjusted Required Thrust (Torque)} \times 100}{\text{Adjusted Required Thrust (Torque)}}$$

Adjusted Actuator Output Thrust (Torque) = Nominal Output – Uncertainties – Degradation

Adjusted Required Thrust (Torque) = Nominal Required + Uncertainties + Degradation

Each plant is responsible for appropriately applying the adjustments to the actuator output thrust (torque) or required thrust (torque) using either bounding or justifiable values. The square root sum of the squares (SRSS) method may be used to combine adjustments where appropriate.

The actuator capability margin calculation shall include allowances for uncertainties and known degradation. For degradation to be addressed by periodic testing, actuator capability margin should include the potential degradation anticipated during the interval between

tests. For elements not addressed by periodic testing, actuator capability margin should address potential degradation anticipated during remaining AOV life.

Appendix B provides a comprehensive list of uncertainties and degradations to be considered in the actuator capability margin calculation. It also provides acceptable methods for combining these factors.

Actuator capability margin shall be calculated in the stroke direction(s) related to the AOV's safety-significant function. In some cases, the actuator force may change throughout the stroke; therefore, it may be necessary to determine actuator capability margin at more than one stroke position.

An actuator capability margin greater than 0% is acceptable.

Allowable Limits

Allowable limits[1] are determined to evaluate component design limitations versus their actual operating conditions. Two types of limits are considered: pressure limits and thrust/torque limits, including spring compression.

Table 4-1 lists the rating types for typical AOV components along with the appropriate operating conditions to be used in the allowable limit comparisons. The nominal operating conditions should be adjusted for applicable uncertainties or degradations (see Appendix B). Plants should verify that each component's operating condition is within allowable design limits. For example, an actuator may have a minimum supply pressure of 20 psig and a maximum casing pressure rating of 60 psig. Therefore, a regulator setpoint of 40 psi is within the allowable range.

Note: Valve and actuator limits need not be evaluated if the current setpoints are within the original equipment manufacturer's (OEM) specified setpoints. The normal design process is expected to ensure the OEM established setpoints are within the design ratings of the valve and actuator assembly.

[1] Allowable limits, as discussed in this section, are used as acceptance criteria for setpoints and do not apply to environmental qualification issues.

Table 4-1: AOV COMPONENT RATINGS

Component	Applicable Limit(s), (units)	Operating Condition
Accessories (Accumulator, Regulator, SOV, etc.)	Rated pressure, differential pressure or pressure range, as applicable, (psig)	Maximum or minimum input pressure, as applicable
Actuator Spring	Maximum safe spring force, e.g., safe load, (lbf) and/or Maximum spring compression, (inches)	Maximum spring force output at full travel Spring compression length at full travel
Actuator	Rated pressure, (psig) Thrust/torque rating, (lbf/ft-lbf)	Maximum AOV input pressure Maximum actuator output thrust/torque
Valve	Valve thrust/torque rating, (lbf/ft-lbf)	Maximum actuator output thrust/torque

4.4 Testing

Testing is performed to verify component functional capabilities and, where appropriate, validate design assumptions. All testing shall be performed utilizing plant approved test procedures and acceptance criteria for each type of testing performed. Current plant maintenance activities may satisfy the requirements for testing. Equipment and instruments used to measure and record test data within the scope of the JOG AOV Program shall be calibrated in accordance with the plant's quality assurance requirements.

4.4.1 Baseline Testing

Baseline testing shall be performed on all Category 1 AOVs, unless existing site programs and normal plant operation provide adequate demonstration of AOV capability via periodic cycling (see Section 4.3.2). Baseline testing is performed with the intent to:

- Verify the functional capability
- Validate DBR design inputs in accordance with Appendix A
- Confirm required operating setpoints
- Establish a reference for periodic testing

Each plant should determine the type of baseline testing, which can range from stroke time testing to dynamic testing with diagnostics, needed to satisfy the above requirements. See Table 4-2 and Appendix A for guidance in selecting the appropriate baseline test.

Baseline testing is not required on Category 2 AOVs unless a DBR is required due to a generic issue identified through the Category 1 DBR process (see Section 3).

4.4.2 Periodic Testing

Periodic testing shall be performed on Category 1 AOVs to identify potential degradation except for those AOVs periodically cycled in accordance with Section 4.3.2. The initial frequency of testing shall be at least once every 3 refueling outages or 6 years, whichever is longer, until sufficient data exists to determine a more appropriate test frequency.

Grouping of valve assemblies is encouraged. The number of valve assemblies tested from each group within the periodic test interval shall be a minimum of 30% however, no less than two shall be selected from each group. The following shall be considered when grouping valve assemblies:

- AOV assemblies with identical or similar designs and with similar plant service conditions may be grouped.
- Individual AOVs in a group should be tested at consecutive intervals to monitor degradation rather than testing a different valve when the next test is due for the group.
- Generic issues that are identified during the performance of testing shall be reviewed for their impact on similar AOV assemblies within the scope of the JOG AOV Program.

Each plant should determine the method of periodic testing (See Table 4-2). Degradation parameters are addressed in Appendix B. This program does not add any periodic testing requirement for Category 2 AOVs beyond current plant requirements.

4.4.3 Post Maintenance Testing

Post maintenance testing shall be performed on Category 1 AOVs to re-baseline the DBR inputs and functional capability following replacement, repair, or maintenance that could affect valve performance. The post maintenance testing requirements are established by the individual plants and need not exceed the initial (baseline) testing requirements. This program does not require additional post maintenance testing for Category 2 AOVs beyond verification of the affected setpoints established in Section 4.2.

Table 4-2: TESTING METHODS

Testing Method	Verification Parameters	Description
Stroke Time Test, Static or Dynamic	Stroke Time	This method is used as a general indication of valve performance for AOVs. This test could be performed under static or dynamic conditions. Stroke time can sometimes be trended to provide indication of degradation. For example, increased stroke time for an air operated valve may be an indication of increasing loads or issues related to air supply or exhaust.
Pressure Measurement, Bench (Uncoupled)	Spring preload, spring rate, spring load at full travel	Actuator bench-set is the pressure range at which the actuator begins to move (lower bench-set / spring preload) and the pressure at which the actuator reaches full-rated travel (upper bench-set). The measured pressures can be converted to force using the piston/diaphragm area. The force values can be used to estimate the spring preload and spring rate.
Direct Stem Diagnostics, Bench (Uncoupled)	Spring preload, effective diaphragm area, spring rate, spring load at full travel	Stem diagnostics (load cell and distance measurements) can be used to accurately measure spring preload and spring rate on a bench. This method requires additional setup but produces highly accurate results.
Pressure Measurements, In-Situ (Coupled)	Spring preload, friction loads, spring rate, spring load at full travel, seat load, gate valve unwedging load, butterfly valve unseating load	This test is identical to the bench test, except the actuator is coupled to the valve. In addition to estimating spring preload and spring rate, this test method can be used to estimate the friction loads.

Table 4-2: TESTING METHODS (Continued)

Testing Method	Verification Parameters	Description
AOV Air Diagnostics, In-Situ Static	Spring preload, spring rate, spring load at full travel, friction load, gate valve unwedging load, butterfly valve unseating load	In-situ static air diagnostics typically involve measuring actuator pressure and position throughout the valve stroke. Diagnostics can be used to identify anomalies such as plug/stem misalignment, seat wear, excessive friction loads, etc. This testing does not allow separation of actuator forces from valve forces unless a separate test is performed on the uncoupled actuator. This test method can also be used to estimate static seat load, friction loads, spring preload, and spring rate. Each of the above loads is estimated by multiplying the actuator air pressure by the effective applied area at various points along the valve stroke.
Direct Stem Diagnostics, In-Situ Static	Spring preload, spring rate, spring load at full travel, friction load, effective diaphragm area, gate valve unwedging load, butterfly valve unseating load	Static in-situ stem diagnostics can be used to measure static seat load and friction loads. Spring preload, spring rate, and effective diaphragm area can be determined if actuator pressure is also measured. This testing can also be used to clearly identify valve anomalies such as condition loads or improper friction loads. Space limitations may prevent use of this method.
Direct Stem Diagnostics, In-Situ Dynamic	Valve factor, bearing coefficients, gate valve unwedging load, butterfly valve unseating load	Dynamic in-situ stem diagnostics can be used to quantify dynamic loads. If combined with an accurate differential pressure measurement, stem load measurements can be used to determine dynamic friction coefficients. This includes gate valve friction factors and butterfly valve bearing coefficient of friction.

Table 4-2: TESTING METHODS (Continued)

Testing Method	Verification Parameters	Description
AOV Air Diagnostics, In-Situ Dynamic	Valve factor, bearing coefficients, gate valve unwedging load, butterfly valve unseating load	Dynamic in-situ stem diagnostics can be used to quantify dynamic loads. If combined with an accurate differential pressure measurement, stem load measurements can be used to determine dynamic friction coefficients. This includes gate valve friction factors and butterfly valve bearing coefficient of friction. Each of the above loads is estimated by multiplying the actuator air pressure by the effective applied area at various points along the valve stroke.

4.5 Preventive Maintenance

Preventive Maintenance (PM) shall be performed for all program AOVs to provide a high level of confidence that AOVs will perform their intended design function. Safety-significance, duty cycle and environment should be considered when determining PM activities and frequency. It is the responsibility of the plant to establish and maintain a PM program.

Considerations for the PM program include:

- Vendor recommendations
- Licensing commitments
- Environmental qualification
- Equipment history
- Maintenance Rule

The AOV PM template in the EPRI Preventive Maintenance Basis Document (Ref. 6.17) provides an acceptable method for determining PM activities and frequencies.

4.6 Training

Training is critical to a successful AOV program. Industry feedback has shown that cross training of disciplines involved with AOVs is extremely effective. Individual plants shall be responsible for identifying and performing the appropriate plant specific training and documenting individual qualifications for specific tasks.

Recommended training areas include:

- Actuator, valve, and accessory design and function
- Setpoint control
- Test equipment use and evaluation

- Calculation processes
- Maintenance practices
- Lessons learned, including other valve programs

4.7 Feedback

There are two types of feedback: plant specific feedback and industry feedback. Plant specific feedback is critical to ensure that plant operating, testing and maintenance experiences are appropriately incorporated into plant programs. Industry feedback is important to ensure that generic issues can be evaluated for inclusion into plant specific programs.

4.7.1 Plant Specific Feedback

Plant specific feedback shall ensure AOV test results and failures are incorporated into the appropriate plant programs. As a minimum, this feedback mechanism shall ensure that design basis calculations remain valid and lessons learned pertaining to design, maintenance and operations are evaluated for inclusion into the AOV program and plant PSA models. Credit should be taken for activities performed under other plant programs, such as the Maintenance Rule Program or root cause evaluation of failures.

4.7.2 Industry Feedback

There are several industry feedback mechanisms that currently exist, such as the 10CFR Part 21 process, NRC formal communications, NRC Notices and Bulletins, INPO Equipment Performance and Information Exchange System (EPIX) and the INPO Nuclear Network. Additionally, industry forums such as the Air Operated Valve Users' Group (AUG) meetings provide an opportunity for sharing information. These should be incorporated as the current feedback mechanisms for the plant's AOV program. Information that affects the content of this document should be communicated to the participating Owners' Groups.

4.8 Documentation/Data Management

Each plant shall develop a method for configuration control in accordance with their individual plant practices. Use of electronic formats (e.g., database) may facilitate data control and retrieval. Documents and information to be controlled, as applicable, are:

- Plant program document (Section 1.2)
- AOV scoping and categorization, criteria, bases and results (Section 4.1)
- System design basis reviews (Section 4.3.1)
- Actuator/Valve capability calculations (Section 4.3.2)
- Setpoints (Section 4.2)
- Test results (Section 4.4)
- Training records (Section 4.6)
- Tracking and trending reports (Section 4.9)

4.9 Tracking and Trending

Each plant shall track and trend AOV failures for all program AOVs. Additionally, critical AOV performance parameters obtained during periodic testing of Category 1 AOVs shall be tracked and trended (Section 4.4.2). Examples of information that may be trended are:

- Stroke time
- Packing/running loads
- Setpoint pressure
- Preload or bench set range
- Seating/unseating loads
- Valve friction factors (if dynamically tested).

Credit may be taken for existing plant programs that provide this information.

5. FULL PROGRAM IMPLEMENTATION

Individual plant AOV programs are considered fully implemented when the program elements presented in Sections 3 and 4 are completed or established. An effective program is one that is updated, assessed, and periodically enhanced with new information and incorporates lessons learned even after full program implementation.

6. REFERENCES

6.1 Electric Power Research Institute, *Application Guide for Evaluation of Actuator Output Capability for Air-Operated Valves in Nuclear Power Plants*, EPRI TR-107321, June 1997.

6.2 Electric Power Research Institute, *Guidelines for the Selection and Application of Power Plant Control Valves: Revision 1*, EPRI TR-102051-R1, March 1994.

6.3 Electric Power Research Institute's Nuclear Maintenance Applications Center, *Air Operated Valve Maintenance Guide*, NMAC NP-7412-R1, November 1996.

6.4 Electric Power Research Institute, *Application Guide for Motor-Operated Valves in Nuclear Power Plants: Volume 2: Butterfly Valves*, EPRI TR-106563-V2, October 1998.

6.5 Electric Power Research Institute, *EPRI MOV Performance Prediction Program Topical Report – Revision 2*, EPRI TR-103237-R2, April 1997.

6.6 Instrument Society of America, *Quality Standard for Instrument Air*, ISA S7.0.01.

6.7 Electric Power Research Institute's Nuclear Maintenance Applications Center, *Instrument Air Systems: A Guide for Power Plant Maintenance Personnel*, NMAC NP-7079, December 1990.

6.8 Electric Power Research Institute's Nuclear Maintenance Applications Center, *Application Guide for Motor-Operated Valves in Nuclear Power Plants*, NMAC NP-6660-D, March 1990.

6.9 Electric Power Research Institute, *Valve Stem Packing Improvements*, EPRI NP-5697, May 1988.

6.10 BWROG Integrated Risk-Informed Regulation Committee Position Paper: 2000-01, "Application of Probabilistic Safety Assessments to Ranking of Air Operated Valves," dated March 2000.

6.11 Westinghouse Document, *Risk Ranking Approach for Air-Operated Valves, V-EC-1776, Revision 0*

6.12 American Society of Mechanical Engineers (ASME), *Requirements for Safety Significance Categorization of Components Using Risk Insights for Inservice Testing of LWR Power Plants*, Code Case OMN-3.

6.13 U.S. Nuclear Regulatory Commission Regulatory Guide, *Monitoring the Effectiveness of Maintenance at Nuclear Power Plants*, Regulatory Guide 1.160, Rev. 2, March 1997.

6.14 U.S. Nuclear Regulatory Commission Generic Letter 89-10, *Safety-Related Motor-Operated Valve Testing and Surveillance*, GL 89-10 Rev. 0, June 28, 1989 and Supplements.

6.15 U.S. Nuclear Regulatory Commission Generic Letter 91-18, *Information to Licensees Regarding NRC Inspection Manual Section on Resolution of Degraded and Nonconforming Conditions*, GL 91-18 Rev.1, October 8, 1997.

6.16 U.S. Nuclear Regulatory Commission Generic Letter 88-14, *Instrument Air Supply System Problems Affecting Safety-Related Equipment*, GL 88-14 Rev. 0, August 8, 1988.

6.17 Electric Power Research Institute, *Preventive Maintenance Basis: Volume 1: Air Operated Valves*, EPRI TR-106857-V1, July 1997.

6.18 U.S. Nuclear Regulatory Commission Regulatory Guide, *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis*, Regulatory Guide 1.174, Rev. 0, July 1998.

6.19 U.S. Nuclear Regulatory Commission Regulatory Guide, *An Approach for Plant-Specific, Risk-Informed Decision Making: Inservice Testing*, Regulatory Guide 1.175, Rev 0, August 1998.

6.20 U.S. Nuclear Regulatory Commission Generic Letter 95-07, *Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves*, GL 95-07 Rev.0, August 17, 1995.

6.21 U.S. Nuclear Regulatory Commission Generic Letter 96-06, *Assurance of Equipment Operability and Containment Integrity during Design-Basis Accident Conditions*, GL 96-06 Rev.0, September 30, 1996 and Supplement.

6.22 1989 ASME Boiler & Pressure Vessel Code, Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, Article IWA-9000 Glossary.

6.23 Electric Power Research Institute, *EPRI MOV Performance Prediction Program Globe Valve Model Report*, EPRI TR-103227, April 1994.

6.24 B&W Owner;s Group, *Demonstration Project to Apply Risk-Informed Inservice Testing to Air-Operated Valves, BAW-2539, July 2000.*

6.25 Electric Power Research Institute, *EPRI Air-Operated Valve Evaluation Guide,* TR-107322, May 1999

Appendix A: Design Parameter Selection, Verification, and Testing

The following tables identify and describe the key design parameters for each type of valve[1]. Verification shall be performed in cases where there is insufficient confidence in a specific design assumption/parameter affecting the safety-significant function.

Table A-1: RISING STEM VALVES

Parameter	Valve Type	Parameter is Dependent On	Available Method(s) for Determining Value	Verification Testing[2]
Packing Load	Gate and Globe	Packing configuration, material, preload, coefficient of friction	EPRI method (Ref. 6.9, Sectio n 5) for calculating packing using a bounding packing to stem coefficient of friction, or plant test data.	Yes
			Nominal packing load	Yes
			Vendor recommendations	Yes
			Plant specific analysis, which provides a bounding method, based on existing plant or industry data.	No
Valve factor	Gate	Valve design, fluid media, temperature, material, orientation, valve DP	Plant specific GL 89-10 MOV dynamic test results as applicable	No
			EPRI PPM (Ref. 6.5, Section 5), where applicable	No
			Documented engineering judgment	Yes
			Independent flow loop testing	No

[1] Ball valves, plug valves, pilot globe, double seat, 3-way valves, and diaphragm valves are not addressed by these tables as there is limited industry testing of these designs. Vendor provided information is considered "best available information".

[2] Refer to Table 4-2

Appendix A: Design Parameter Selection, Verification, and Testing
(Continued)

Table A-1: RISING STEM VALVES

Parameter	Valve Type	Parameter is Dependent On	Available Method(s) for Determining Value	Verification Testing[2]
Valve Factor, Side Load	Globe – All Types		Plant specific GL 89-10 MOV Dynamic test results as applicable.	No
	Globe – Unbalanced	Guide area, media	Set to 1.0 for non-compressible fluid consistent with EPRI PPM (Ref. 6.5, Section 6). Note: There are applicability criteria in Ref. 6.5, Table 6-4 that should be reviewed. Set to 1.5[3] for Y-pattern globe valves with underseat, tow-phase flow, consistent with EPRI test data (Ref. 6.5, Appendix E, pg. E-23). For other valve in compressible fluids, set to 1.0[3].	No
	Globe -balanced caged		Set valve factor to 1.0[3].	No
	Globe – balanced uncaged		EPRI PPM method (Ref. 6.5, Section 6). Note: There are applicability criteria in Ref. 6.5, Table 6-4 that should be reviewed.	No
Unbalanced area	Gate	Body Style	Mean seat area	No
	Globe – balanced	Body Style	Vendor data	No
	Globe – unbalanced	Body Style	Dimensional information from the vendor using the guidance in EPRI PPM (Ref. 6.23, Appendix A)	No
Leakage Class Contact Load	Globe	Seat leak test requirements, leak class, valve design	Test data or vendor. Note: only required for valves that must be leak tight.	No

2 Refer to Table 4-2

3 There is limited industry testing on unbalanced globe valves in compressible fluid applications and balanced globe valves. The 1.5 value for the Y-pattern is from a single test (#48) from EPRI MOV testing program. These values provided here are considered "best available information."

Appendix A: Design Parameter Selection, Verification, and Testing
(Continued)

Table A-1: RISING STEM VALVES

Parameter	Valve Type	Parameter is Dependent On	Available Method(s) for Determining Value	Verification Testing[2]
Piston Ring friction	Globe – Balanced	Piston ring material and design	Vendor information	Yes
			Test Data	No
Weak Link	Gate & Globe	Valve design	Vendor input	No

[2] Refer to Table 4-2

Appendix A: Design Parameter Selection, Verification, and Testing
(Continued)

Table A-2: BUTTERFLY VALVES

Parameter	Parameter is Dependent On	Recommended Value / Suggested Method(s) for Determining Value	Verification Testing[4]
Packing Load	Packing configuration, material, preload, friction	EPRI method (Ref. 6.4, Section 5.2.3) for calculating packing using a bounding packing to stem coefficient of friction, or plant test data.	Yes
		Nominal packing load	Yes
		Vendor recommendations	Yes
		Plant specific analysis, which provides a bounding method, based on existing plant or industry data.	No
Bearing friction coefficient	Material, fluid media	EPRI PPM (Ref. 6.4, Section 5.2.1 or Ref. 6.5, Section 7), provides bounding values for metallic type bearings	No
		Utilize applicable MOV test data (plant specific or JOG-PV data).	No
		Utilize vendor methods	Yes
Seating / Unseating load	Seat type, system conditions	EPRI PPM methods (Ref. 6.5, Section 7)	No[5]
		Plant Specific Data	No
		Vendor provided coefficient/values	Yes

[4] Refer to Table 4-2

[5] For normally closed valves, age-hardening of the seat material can potentially increase the torque required to unseat the valve. Accordingly, for normally closed valves, this parameter should be verified with in-situ testing (Ref. 6.5, Section 7).

Appendix A: Design Parameter Selection, Verification, and Testing
(Continued)

Table A-2: BUTTERFLY VALVES

Parameter	Parameter is Dependent On	Recommended Value / Suggested Method(s) for Determining Value	Verification Testing[4]
Dynamic flow coefficients	Disc design (e.g., single offset, symmetric, etc.), media, fluid velocity	Guidance provided in EPRI Application Guide (Ref. 6.4, Section 5.3). Dynamic torque can be neglected (incompressible fluid only) for valve sizes <20" and fluid velocities <16 ft/sec in accordance with the Guide.	No
		EPRI PPM (Ref. Ref. 6.5, Section 7), where applicable.	No
		Vendor methods (incompressible fluids)	Yes
		Plant specific GL 89-10 MOV dynamic results as applicable.	No
Weak Link	Valve Design	Vendor Input	No

[4] Refer to Table 4-2

Appendix A: Design Parameter Selection, Verification, and Testing (Continued)

Table A-3: ACTUATOR

Parameter	Parameter is Dependent On	Recommended Value / Suggested Method(s) for Determining Value	Verification Testing[6]
Actuator supply pressure, minimum	System supplied air, capacity of actuator, capacity of accessories	Field measurement of regulator setting (calibrated gauge)	No
		If there is no regulator, use the minimum capability of the air system supply.	No
Actuator supply pressure, maximum	System supplied air, capacity of actuator, capacity of accessories	Field measurement of regulator setting (calibrated gauge)	No
		If there is no regulator, use the maximum capability of the air system supply.	No
Effective diaphragm or piston area	Actuator design	Vendor input	No[7]
		Independent testing	No
Spring preload	Actuator/Spring design	Field measurement of bench set	No
		Vendor supplied recommended setting	Yes
Actual travel	Valve and actuator design, field setup	Field measurement	No
		Vendor input	Yes
Spring rate	Spring design	Vendor input	Yes
		Diagnostic testing or spring test	No

[6] Refer to Table 4-2

[7] There is limited industry testing on effective diaphragm areas. Anchor/Darling has performed testing on the BS&B/WKM product line. Currently, the vendor provided values are considered "best available information."

Appendix A: Design Parameter Selection, Verification, and Testing (Continued)

Table A-3: ACTUATOR

Parameter	Parameter is Dependent On	Recommended Value / Suggested Method(s) for Determining Value	Verification Testing[6]
Internal actuator friction (breakaway or running)	Actuator design	Vendor input – typically this is negligible; however, not in all cases	Yes
		Field measurement – typically will be included with the total running load if coupled to the valve.	No
Efficiency for rotary actuators	Actuator design	Vendor input	No
		Bench or field testing of actuator	No

[6] Refer to Table 4-2

Appendix B: Uncertainties and Potential Degradations

Accounting for Uncertainties

When evaluating AOV margins, there are many parameters to consider. Some of these parameters have associated uncertainties that may include the following:

Measurement uncertainty
- Actuator spring preload
- Actuator spring displacement and force used to derive spring rate
- Actuator supply air
- Stem thrust/torque

Engineering input uncertainty
- Effective diaphragm area
- Seating/Unseating load (quarter turn)
- Gate valve pullout
- Cage seal friction
- Spring rate
- Valve packing friction load
- Valve factor
- Bearing coefficient of friction

Using bounding inputs can eliminate uncertainties. However, use of a nominal value with a random uncertainty may demonstrate additional margin. Refining engineering analyses or employing more accurate measurement systems may reduce uncertainties.

Accounting for Potential DegradationP

Items to be considered for evaluation of AOV actuator capability margin to address potential degradation mechanisms include:
- Actuator preload (spring) relaxation
- Internal valve friction coefficient degradation (gate valves)
- Bearing degradation (quarter turn valves)
- Regulator or positioner drift

Applying Uncertainties and Potential Degradation

Uncertainties and potential degradation are determined by the plant and applied to margin calculations to ensure conservative results. These can be combined and applied to the overall actuator capability margin calculation (e.g., to the required thrust/torque or the actuator capability). Alternatively, uncertainties and potential degradation affecting the

Appendix B: Uncertainties and Potential Degradations
(Continued)

required operating load or actuator output capability (e.g., spring rate uncertainty) could be applied to individual terms within the equations. Although applying uncertainties and potential degradation in this way can sometimes simplify the analysis, it may result in unnecessary conservatism.

The most common method used to combine uncertainties and degradation is the square root sum of the squares (SRSS) method, as shown in the equation below. The individual adjustment terms are percent deviations of the expected parameter of interest. For example, if the minimum required thrust is estimated nominally to be 500 lbf. and a 10% uncertainty is associated with the nominal packing load of 100 lbf., then the error associated with packing is 2% (10/500), not 10%.

$$\text{TotalAdj} = b_1 + \ldots + b_n + \sqrt{r_1^2 + r_2^2 + \ldots + r_n^2}$$

Where:

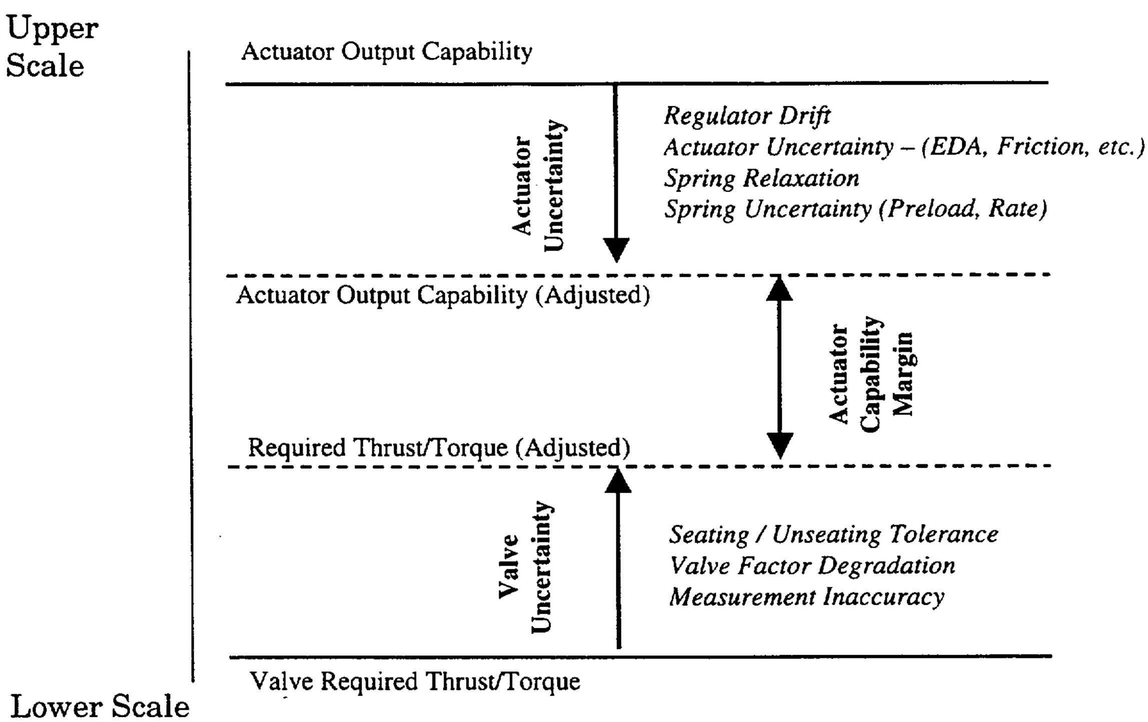
TotalAdj	=	The total combined adjustment
R	=	Random uncertainties, (%)
B	=	Bias adjustments, (%)

Note that the equation makes a distinction between bias and random adjustments. Random uncertainties are adjustments that have an equal probability of increasing or decreasing the value of a parameter, e.g., design tolerances. Bias adjustments tend to either increase or decrease the value of a parameter, e.g., degradation. There are a number of statistical texts that outline tests that can be performed in order to determine whether a given uncertainty should be treated as random or bias.

Figure B-1 illustrates an example of AOV margin uncertainties to consider. This example does not cover every possible uncertainty. Some uncertainties may not apply depending upon the valve and actuator configuration and the set-up method. For example, if actuator output is measured at the valve stem, uncertainties associated with spring and effective areas are irrelevant.

Appendix B: Uncertainties and Potential Degradations (Continued)

Figure B-1: AOV Margin Example



Appendix B: Uncertainties and Potential Degradations
(Continued)

Example Margin Calculations: The following examples illustrate how margin may be calculated; however, they do not include all of the uncertainties that may be considered.

Example 1 – Combining Uncertainties
Nominal Valve Required Thrust = 2000 lbf (1750 dp load + 250 lbf packing)
Valve Factor Degradation (bias) = 5% = 0.05 x 1750 = 87.50 lbf
Measurement Inaccuracy on static running load (random) = 11% = 0.11 x 250 = 27.50 lbf

Nominal Actuator Output Thrust at the fully closed position (preload) = 5000 lbf
Spring preload measured uncertainty (random) = 11%
Spring relaxation (bias) = 2%

Total Adjustments; 87.5 + 100 + sqrt[550^2 + 27.5^2] = 738 lbf
Margin: (5000 – 2000 – 738)/(2000 + 87.5 + 27.5) = 107% margin above all uncertainties

Example 2 – Applying Uncertainties to Individuals Terms
Nominal Valve Required Thrust = 2000 lbf (1750 dp load + 250 lbf packing)
Valve Factor Degradation (bias) = 5% = 0.05 x 1750 = 87.50 lbf
Measurement Inaccuracy on static running load (random) = 11% = 0.11 x 250 = 27.50 lbf
Total Uncertainty = 87.5/2000 + sqrt[$(27.50/2000)^2$] = 5.75%
Required Thrust Adjustment = 2000 x 1.06 = 2115 lbf

Nominal Actuator Output Thrust at the fully closed position (preload) = 5000 lbf
Spring preload measured uncertainty (Random) = 11%

Spring relaxation (bias) = 2%
Total Uncertainty = 0.02 = sqrt[$(0.11)^2$] = 13%
Actuator Output Thrust Adjusted = (1 – 0.13)x 5000 = 4350 lbf

Margin: (4350 – 2115)/2115 = 106% margin above all uncertainties.

APPENDIX C: PARTICIPATING UTILITIES

BABCOCK & WILCOX OWNERS' GROUP:

• Duke Energy Corporation*	*Oconee-1* *Oconee-2* *Oconee-3*
• Entergy Operations, Inc.	*Arkansas Nuclear One-1*
• Florida Power Corporation*	*Crystal River-3*
• GPU Nuclear, Inc.*	*Three Mile Island-1*
• Toledo Edison Company*	*Davis Besse-1*

BOILING WATER REACTOR OWNERS' GROUP:

• Alliant Utilities	*Duane Arnold*
• Boston Edison	*Pilgrim*
• Carolina Power & Light	*Brunswick-1* *Brunswick-2*
• Commonwealth Edison*	*Dresden-2* *Dresden-3* *La Salle-1* *La Salle-2* *Quad Cities-1* *Quad Cities-2*
• Detroit Edison	*Enrico Fermi-2*
• Entergy Operations, Inc.	*Grand Gulf* *River Bend*
• First Energy Corp.	*Perry-1*
• GPU Nuclear, Inc.	*Oyster Creek*
• Illinois Power	*Clinton*
• Nebraska Public Power District*	*Cooper*
• New York Power Authority	*Fitzpatrick*
• Niagara Mohawk Power	*Nine Mile Point-1* *Nine Mile Point-2*
• Northeast Nuclear Energy Co.	*Millstone-1*
• Northern States Power Company	*Monticello*
• PP& L Inc	*Susquehanna-1* *Susquehanna-2*
• PECo Energy*	*Peach Bottom-2* *Peach Bottom-3* *Limerick-1* *Limerick-2*
• Public Service Electric & Gas*	*Hope Creek*
• Southern Nuclear Operating*	*Hatch-1* *Hatch-2*
• Tennessee Valley Authority	*Browns Ferry-2* *Browns Ferry-3*
• Vermont Yankee Nuclear Power Corporation	*Vermont Yankee*
• Washington Public Power Supply System	*WNP-2*

*Denotes JOG AOV Core Group member or alternate

APPENDIX C: PARTICIPATING UTILITIES (CONTINUED)

COMBUSTION ENGINEERING OWNERS' GROUP:

• Arizona Public Service Company	*Palo Verde-1* *Palo Verde-2* *Palo Verde-3*
• Baltimore Gas and Electric*	*Calvert Cliffs-1* *Calvert Cliffs-2*
• Consumers Energy	*Palisades*
• Entergy Operations, Inc.*	*Arkansas Nuclear One-2* *Waterford-3*
• Florida Power And Light Company	*St. Lucie-1* *St. Lucie-2*
• Northeast Nuclear Energy Co.*	*Millstone-2*
• Omaha Public Power District*	*Ft. Calhoun*
• Southern California Edison*	*San Onofre-2* *San Onofre-3*

WESTINGHOUSE OWNERS' GROUP:

• Ameren UE	*Calloway*
• American Electric Power	*D. C. Cook-1* *D. C. Cook-2*
• Carolina Power & Light Company	*H. B. Robinson-2* *Shearon Harris*
• Commonwealth Edison	*Braidwood-1* *Braidwood-2* *Byron-1* *Byron-2*
• Consolidated Edison of N.Y.	*Indian Point-2*
• Duke Energy Corporation	*Catawba-1* *Catawba-2* *Mcguire-1* *Mcguire-2*
• Florida Power & Light Company	*Turkey Point-3* *Turkey Point-4*
• New York Power Authority	*Indian Point-3*
• Duquesne Light Company	*Beaver Valey-1* *Beaver Valey-2*
• Northeast Nuclear Energy Co.	*Millstone-3*
• North Atlantic Energy Service Co.	*Seabrook*
• Northern States Power Company	*Prairie Island-1* *Prairie Island-2*
• Pacific Gas & Electric Company*	*Diablo Canyon-1* *Diablo Canyon-2*
• Public Service Electric & Gas	*Salem-1* *Salem-2*

*Denotes JOG AOV Core Group member or alternate

APPENDIX C: PARTICIPATING UTILITIES (CONTINUED)

WESTINGHOUSE OWNERS' GROUP (Continued):

• Rochester Gas & Electric Corp.	*R. E. Ginna*
• South Carolina Electric & Gas	*V. C. Summer*
• Southern Nuclear Operating*	*Farley-1* *Farley-2* *Vogtle-1* *Vogtle-2*
• STP Nuclear Operating Company*	*STP-1* *STP-2*
• Tennessee Valley Authority*	*Sequoyah-1* *Sequoyah-2* *Watts Bar-1*
• TU Electric*	*Comanche Peak-1* *Comanche Peak-2*
• Virginia Power	*North Anna-1* *North Anna-2* *Surry-1* *Surry-2*
• Wisconsin Electric Power Corp.	*Point Beach-1* *Point Beach-2*
• Wisconsin Public Service Corp.	*Kewaunee*
• Wolf Creek Nuclear Operating Corp.	*Wolf Creek*

*Denotes JOG AOV Core Group member or alternate

Enclosure 2

Joint Owners Group
Air Operated Valve Program Document,
Summary of Changes

Summary of AOV Program Document Changes

Changes:

1. Deleted "Current Document Status" (was on page ii).

2. Added definition of "setpoint" to Section 2.0 (page 3).

3. Revised paragraph 4.1.2 (page 6) to clarify and add reference to NUREG/CR-6654 for emphasis. Intent of paragraph did not change (i.e. dampers are not considered within the scope of the program).

4. Definition of Category 1 and 2 AOVs revised in Section 4.1.3 (page 6). Category 1 expanded to include all active, high safety-significant valves, both safety related and non-safety-related. Category 2 now only includes safety-related, active AOVs that do not have a high safety-significance.

   Paragraph 2 of Section 3 (page 4), Footnotes to Table 3-1 (page 5), and Figure 4-1 (page 9) changed consistent with the new definitions.

5. Added new paragraph to Section 4.1.3 (page 7) to clarify that passive AOVs which are moved to their non-safety position may have to be considered to have an active safety function at that time.

6. Section 4.1.3.2 (page 7) was revised to clarify that the listed documents are for "guidance." Also updated the titles of the Westinghouse Owners Group and the BWROG documents and added the B&W Owners Group Document.

   Revised the Section 6 References (page 23 & 24) accordingly.

7. Revised Figure 4-2 (page 11) to delete an extraneous reference to an attachment.

8. Revised Paragraph 4.3.3.2 (page 13) to refer to the EPRI "evaluation" guide in lieu of the "application" guide.

   Updated Section 6.0 References (page 24) to include reference to the evaluation guide (ref. 6.25).

9. Revised the Note at the end of Section 4.3.3.3 (page 14) to delete reference to information associated with equipment procured as safety-related for consistency with new Category 1 definitions which include both safety-related and non-safety-related, active, high safety-significant AOVs.

10. Added a clarification to the last bullet under Section 4.6 (page 20) to specifically include "other valve programs" in the lessons learned.

Summary of AOV Program Document Changes

11. Updated the footnotes to Table A-1 on page A-2. Added text for footnote 2 and revised footnote 3 to remove reference to potential future EPRI activities.

12. Updated footnote 7 to Table A-3 on page A-6 to remove reference to potential future evaluations by the JOG AOV for the EDA parameter.

13. Changed the definition of Category 1 in footnote A for Table 3-1 on page 5 to read like definition Category 1 at the bottom of page 6.

14. Changed the font size and type for Figures 4-1 and 4-2 on page 9 and page 11.

15. Changed the font size and type on page c2 and c3 for Appendix C to be consistent with the rest of the page.

Notes:

1. The revision bar at the top of Table A-1 (page A-1) is a result of retyping appendices to remove an imbedded corruption and does not represent a change to text or content.

2. The Revision bar on Section 5 (page 22) is a result of a hidden format change – no text or content was changed.

3. The 1st page of the Table of Contents contains formatting errors as a result of converting the document to a PDF file and will be corrected on the final issued document.

4. A portion of the Header for page C-3 was inadvertently rolled back to page C-2 and will be corrected in the final issued document.