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SUBJECT: Forwards non-proprietary & proprietary responses to RAI re GL 96-06, "Assurance of Equipment Operability & Containment Integrity During Design Basis Accident Conditions." W/13 oversize drawings.Proprietary encl withheld.

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102-04130–JML/SAB/RMW
June 4, 1998

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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Washington, DC 20555-0001

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2 and 3
Docket Nos. STN 50-528/529/530
Response to Request for Additional Information Regarding Response to Generic Letter (GL) 96-06, "Assurance of Equipment Operability and Containment Integrity during Design Basis Accident Conditions" for the Palo Verde Nuclear Generating Station, Unit Nos. 1, 2 and 3.

Enclosure 1 provides the additional information regarding Arizona Public Service Company's (APS) response to Generic Letter (GL) 96-06, "Assurance of Equipment Operability and Containment Integrity During Design Basis Accident Conditions" for the Palo Verde Nuclear Generating Station, Unit Nos. 1, 2 and 3, that was requested in your letter to APS dated March 31, 1998.

The test plan and the summary of the test results provided as Attachment 1 to the Enclosure are considered by APS to be proprietary information. APS requests that this information be withheld from public disclosure pursuant to 10 CFR 2.790(a)(4). In accordance with 10 CFR 2.790(b)(1), an affidavit requesting that this information be withheld from public disclosure is provided along with this letter.

This letter does not make any commitments to the NRC. Please contact Mr. Scott Bauer at (602) 393-5978 if you have any questions or would like additional information regarding this matter.

Sincerely,

Will [signature] for

Enclosure/Attachments

JML/SAB/RMW/rlh

cc: E. W. Merschoff
K. E. Perkins
M. B. Fields
J. H. Moorman

A072

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AFFIDAVIT OF WILLIAM E. IDE

I, William E. Ide, Vice President, Nuclear Engineering, Arizona Public Service Company (APS), do hereby affirm and state:

1. I am an Officer of APS and duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and referenced in the paragraph immediately below. APS requests that this information be withheld from public disclosure under the provisions of 10 CFR 2.790(a)(4). This affidavit is submitted in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations.

2. The information for which proprietary treatment is sought is contained in the following document and is being submitted in conjunction with the Palo Verde Nuclear Generating Station response to the Nuclear Regulatory Commission Request For Additional Information Regarding Generic Letter (GL) 96-06, "Assurance Of Equipment Operability and Containment Integrity During Design Basis Accident Conditions" for the Palo Verde Nuclear Generating Station, Unit Nos. 1, 2, and 3, Docket Nos. STN 50-528, STN 50-529 and STN 50-530 (TAC Nos. M96845, M96846, and M96847): Letter 102-04130-JML/SAB/RMW, Enclosure 1, Attachment 1, "Attachment 8, "Pressure Leakage Test Plan on a 3"-150# Gate Valve Bonnet to Body Gasketed Joint", and Section 11, "Pressure Leakage Test Results on the 3"-150# Valve, 3" Schedule 40S Stainless Steel Pipe and 3"-300# Blind Flange Tested by PVNGS", of APS Study 13-MS-B06", dated June 4, 1998.

3. This document has been appropriately designated as proprietary and I have personal knowledge of the criteria and procedures utilized by Arizona Public Service Co. in designating information as trade secret, privileged or as confidential commercial or financial information.

4. Pursuant to the provisions of paragraph (b) (4) of Section 2.790 of the Commission's regulations, the following information is furnished in support of this request that this information be withheld from public disclosure:

   i) The information sought to be withheld from public disclosure, is owned and has been held in confidence by APS. This information was formally classified as proprietary on June 5, 1997. It consists of information documenting and evaluating gasket leakage testing performed in conjunction with analytical modeling to predict component response to thermally induced over-pressurization.

   The information consists of test data, evaluations, and graphical analysis concerning a process and method, the application of which results in substantial competitive advantage to APS.

AFFIDAVIT OF WILLIAM E. IDE

ii) The information is of a type customarily held in confidence by APS and not customarily disclosed to the public. PVNGS Procedure 84DP-0RM32, "Handling of Proprietary, Confidential, and Company Confidential Information", defines the requirements for the classification of proprietary information. The requirements of this procedure were applied in classifying the subject document herein as proprietary.

iii) The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.

iv) The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence.

v) Public disclosure of the information is likely to cause substantial harm to the competitive position of APS because:

a. Development of this information by APS required hundreds of thousands of dollars and thousands of man-hours of effort. A competitor would have to undergo similar expense in generating equivalent information.

b. In order to acquire such information, a competitor would also require considerable time and inconvenience to develop and validate analytical methods to predict valve gasket leakage behavior due to thermally induced over-pressurization.

c. The information consists of test data, evaluations, and graphical analysis regarding the leakage behavior of isolated containment penetration systems subjected to thermally induced over-pressurization. The availability of such information to competitors would enable them to modify and market similar research products to better compete with APS, take marketing or other actions to improve their product's position and avoid developing similar data and analyses in support of their processes and methods.

AFFIDAVIT OF WILLIAM E. IDE

William E. Ide
Vice President, Nuclear Engineering
Arizona Public Service Company

Subscribed and sworn to before me

this 5 day of June, 1998

Nora E. Meador
Notary Public

My commission expires: April 6, 1999

OFFICIAL SEAL
NORA E. MEADOR
Notary Public - State of Arizona
MARICOPA COUNTY
My Comm. Expires April 6, 1999

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ENCLOSURE 1

Response to Request for Additional Information Regarding Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design Basis Accident Conditions".

NRC Request

Please provide a copy of the test report for staff review. In addition, please provide the following information for each pipe segment:

1. Describe the applicable design criteria for the piping and valves. Include the required load combinations.

2. Provide a drawing of each valve. Provide the pressure at which each valve was determined to lift off its seat or leak and describe the method used to estimate this pressure. Discuss the applicability of the mock-up test results to the valve sizes or types that were not tested. Discuss any sources of uncertainty associated with the estimated lift off or leakage pressure.

3. Provide the maximum-calculated stress in each piping run based on the estimated leakage pressure.

4. Describe the impact, if any, of changing the bonnet bolt torque values on the seismic qualification or functional capability of each valve.

In the January 28, 1997, submittal, APS indicated that sections of piping directly adjacent to the inside containment isolation valves for three lines were also affected. APS indicated these three sections of piping are not safety-related and a failure of the valves in the non-safety portion of the line would not affect the ability of the adjacent valves and piping to perform their safety-related function. Please clarify whether or not any potential overpressure in the non-safety section of the pipe will impact any safety-related plant system or function.

APS Response

The test plan and a summary of the test results (Attachment 8, "Pressure Leakage Test Plan on a 3"-150# Gate Valve Bonnet to Body Gasketed Joint", and Section 11, "Pressure Leakage Test Results on the 3"-150# Valve, 3" Schedule 40S Stainless Steel Pipe and 3"-300# Blind Flange Tested by PVNGS, of APS Study 13-MS-B06) are provided in Attachment 1. APS requests that this information be withheld from public disclosure pursuant to 10 CFR 2.790(a)(4). In accordance with 10 CFR 2.790(b)(1), an affidavit requesting that this information be withheld from disclosure is provided along with this letter.

1. Describe the applicable design criteria for the piping and valves. Include the required load combinations.

The piping and valves are designed to appropriate plant conditions and design loadings. The plant conditions are design, normal, upset, emergency, faulted and thermal conditions. The design loadings are pressure, temperature, dead weight, seismic and dynamic loads. These plant and loading conditions are as defined in the ASME Boiler and Pressure Vessel (B&PV) Code, Section III, for Class 2 & 3 piping and components as delineated in the PVNGS Updated Final Safety Analysis Report (UFSAR), Tables 3.9-4 and 3.9-10.

The self-limiting phenomenon of thermal over-pressurization of containment penetrations as a result of a faulted event (i.e., a LOCA) is not addressed within these UFSAR tables. For PVNGS, the design of the containment penetrations was performed in accordance with Regulatory Guide 1.141, Containment Isolation Provisions for Fluid Systems, Revision 0, April 1978. This regulatory guide endorses ANSI Standard N271-1976/ANS56.2, Containment Isolation Provisions for Fluid Systems. ANSI Standard N271-1976/ANS56.2 does not mandate specific configurations wherein over-pressure protection is required. The language of the standard places responsibility for determining the necessity of over-pressure protection for a given piping/component configuration on the licensee. The justification for not installing over-pressure protection on isolable containment penetrations was reviewed by the NRC under the licensing process and was documented in Section 6.2.4 of the PVNGS Safety Evaluation Report (SER). The PVNGS justification, contained in the Containment System Independent Design Review open items responses, consisted of the following points:

- **The containment penetrations are not assumed to be perfectly rigid.**

  Thus, the piping and components can be expected to plastically deform so as to accommodate some of the effects of the internal pressures.

- **The valves are not assumed to be leak-tight at excessive pressures.**

  Thus, a degree of pressure relief is anticipated to result due to valve leakage.

- **The isolated, trapped fluid will not attain the maximum pressure associated with the peak containment atmosphere due to heat loss from the pipe to the environment.**

  Thus, heat transfer effects are expected to limit the maximum attainable pressures.

The justification further stated that the amount of volume leakage required to preclude system/component over-pressurization was quite small. Therefore, given the specified inherent relief mechanisms, APS concluded that the addition of relief systems to closed, cold penetrations was not required. Thus, a qualitative basis was approved and implemented with regard to thermal over-pressurization of containment penetrations as a result of a faulted event (i.e., a LOCA) and a quantitative design criteria was not established for this condition.

The PVNGS engineering staff considers these qualitative assessments to remain valid with regard to precluding over-pressurization to the point of catastrophic failure and loss of containment integrity. These conclusions have been further substantiated by additional analysis and testing. Additionally, adjustment of bonnet bolt torque values for some containment penetration isolation valves enables PVNGS to expand the current design criteria to encompass quantitative limits regarding thermal over-pressurization of containment penetration isolation piping and valves.

The analysis that was performed utilized the guidance of the ASME B&PV Code, Section III, Division 1-1974 Edition, with Winter 1975 Addenda, Appendix F-1000, to provide a conservative limit on the amount of piping stress and corresponding plastic strain (70% of instability load) that would be credited to accommodate the thermal expansion of the trapped fluid inside the penetration. Similarly, the analysis of the affected valves was performed in accordance with the elastic method provided in Appendix F-1000. This analysis demonstrated that the expected maximum pressures did not result in the corresponding stresses significantly exceeding the elastic limit for the valves.

2. **Provide a drawing of each valve. Provide the pressure at which each valve was determined to lift off its seat or leak and describe the method used to estimate this pressure. Discuss the applicability of the mock-up test results to the valve sizes or types that were not tested. Discuss any sources of uncertainty associated with the estimated lift off or leakage pressure.**

Provide a drawing of each valve.

Drawings are provided for each valve in Attachment 2 (total of 13 drawings). Please note that one drawing may represent more than one valve. The drawings and the valves that they represent are listed below.

Drawing Number (Bechtel Log Number)	Valve Number(s)
13-10407-P403C-68-2	13PDWNV411
13-10407-P221A-61-12	13PSIAV944 13PSIBV941
12-10407-J605-32-6	1JNCAUV0402 (Unit 1 only) 2JNCBUV0403 (Unit 2 only)
03-10407-J605-39-3	3JNCAUV0402 (Unit 3 only) 3JNCBUV0403 (Unit 3 only)
12-10407-J605-24-6	1JNCBUV0403 (Unit 1 only) 2JNCAUV0402 (Unit 2 only)
13-10407-P221B-283-7	13JRDBUV0024
13-10407-P221B-293-7	13JRDAUV0023
13-10407-P221B-139-14	13JWCAUV0062 13JWCBUV0061
13-10407-P242-8-17	13PPCNV072
13-10407-P221B-225-5	13PPCEV070 13PPCEV071 13PPCEV075 13PPCEV076 13PPCEV123 13PPCEV124
13-10407-P222B-98-5	13PRDNV088 13PRDNV091
13-10407-P221A-67-10	13PDWEV061 13PDWEV062
13-10407-P221B-368-3	13PRDNV205

Provide the pressure at which each valve was determined to lift off its seat or leak.

A summary of the predicted leakage pressure through the valve gasketed joint is presented in Table 1. The first pressure value provided is the initial pressure at which the gasket starts leaking. This leakage consists of drops of water emerging from the interface of the flange faces at a very slow rate, on the order of tenths of a pint per hour (or approximately one drop a second). The second pressure value is the final pressure at which the gasket is continuously leaking with small laminar streams of water flowing out from the flange interface at a consistent and continuous rate. Figures 1 and 2 are pictures of the actual valve tests that were performed by APS. Figure 1 is a picture of the actual gasket leakage that occurs when the gasket begins to leak continuously. Figure 2 is a picture of the test mockup that APS utilized to perform the testing described in Attachment 1. The valve gasketed joint fastener torque and number of fasteners are also listed in Table 1 to provide a better understanding of the containment penetration response to thermally induced over-pressurization and the affects of fastener preload in the predicted valve gasket leakage pressures. Additionally, the maximum predicted internal piping pressure for each pipe segment described in Table 2 is provided. The notes provided for each piping segment in the "Penetration Piping Between Isolation Valves" column identify whether or not leakage is required to ensure that the allowable pressures are not exceeded. Root valves that serve the function of drain and vent test points are not identified in the table since they are smaller than the analyzed main branch of piping and are capable of withstanding significantly higher pressures.

Table 1: Predicted Gasket Leakage Pressures

OARD VALVE **Gasket Leakage Pressures**	PENETRATION PIPING BETWEEN ISOLATION VALVES **Predicted Internal Pressure**	OUTBOARD VALVE **Gasket Leakage Pressures**
Valve 13JRDAUV0023 3"-150# Motor Operated Gate Valve **Gasket Leakage Pressure:** **3943- 5943 psig.** This valve gasketed connection is fastened with 8 studs (5/8-11) at a torque of 88 ft-lbs and will relieve such that the maximum internal pressure of 5943 psig does not exceed the valve allowable pressure of 7378 psig.	Penetration U009 **Internal Pressure:** **5583 psig.** No leakage is required through either of the isolation valves. The maximum predicted pressure of 5583 psig does not exceed the piping allowable pressure of 5749 psig.	Valve 13JRDBUV0024 3"-150# Air Operated Gate Valve **Gasket Leakage Pressure:** **4607 - 6870 psig.** This valve gasketed connection is fastened with 12 studs (5/8-11) at a reduced torque of 60 ft-lbs (initially 88 ft-lbs) and will relieve such that the maximum internal pressure of 6870 psig does not exceed the valve allowable pressure of 7378 psig.
Valve 13JWCBUV0061 10"-150# Motor Operated Gate Valve **Gasket Leakage Pressure:** **1425- 1702 psig.** This valve gasketed connection is fastened with 12 studs (3/4-10) at a reduced torque of 122 ft-lbs (initially 165 ft-lbs) and will relieve such that the maximum internal pressure of 1702 psig does not exceed the valve allowable pressure of 3214 psig.	Penetration U061 **Internal Pressure:** **2851 psig.** Leakage is required through either of the isolation valves. The maximum predicted pressure of 2851 psig does not exceed the piping allowable pressure of 2851 psig.	Valve 13JWCAUV0062 10"-150# Motor Operated Gate Valve **Gasket Leakage Pressure:** **1425- 1702 psig.** This valve gasketed connection is fastened with 12 studs (3/4-10) at a reduced torque of 122 ft-lbs (initially 165 ft-lbs) and will relieve such that the maximum internal pressure of 1702 psig does not exceed the valve allowable pressure of 3214 psig.
Valves 13PPCEV071 and 075 4"-150# Manual Gate Valve **Gasket Leakage Pressure:** **3334- 4922 psig.** The gasketed connection on these valves is fastened with 8 studs (3/4-10) at a torque of 158 ft-lbs and will relieve such that the maximum internal pressure of 4922 psig does not exceed the valve allowable pressure of 6500 psig.	Penetrations U050 and U051 **Internal Pressure:** **4792 psig.** Leakage is required through outboard isolation valve. The maximum predicted pressure of 4792 psig does not exceed the piping allowable pressure of 4792 psig.	Valves 13PPCEV070 and 076 4"-150# Manual Gate Valve **Gasket Leakage Pressure:** **1254- 1860 psig.** The gasketed connection on these valves is fastened with 8 studs (3/4-10) at a reduced torque of 40 ft-lbs (initially 158 ft-lbs) and will relieve such that the maximum internal pressure of 1860 psig does not exceed the valve allowable pressure of 6500 psig.

Table 1: Predicted Gasket Leakage Pressures

INBOARD VALVE **Gasket Leakage Pressures**	**PENETRATION PIPING BETWEEN ISOLATION VALVES** **Predicted Internal Pressure**	**OUTBOARD VALVE** **Gasket Leakage Pressures**
Valve 13PDWEV062 2"-600# Manual Globe Valve **Gasket Leakage Pressure:** **3820 – 5563 psig.** This is a globe valve which is directly connected through the bonnet to the downstream, non-quality related (NQR), pipe inside containment. This gasketed connection is fastened with 4 studs (3/4-10) at a reduced torque of 60 ft-lbs (initially 125 ft-lbs) and will relieve such that the maximum internal pressure of 5563 psig does not exceed the valve allowable pressure of 6500 psig. Valves 13PSIBV941 and 13PSIAV944 are globe valves that are the terminal ends of the in-containment NQR line. They are the same model of valve as valve 13PDWEV062, except that the bonnet gasketed joint is not exposed to the NQR line pressure and as such no relief rate is required. Valve 13PDWNV411 is a 1"-150# globe valve where the bonnet gasketed joint is exposed to pressure from the NQR line. Leakage is expected through the gasketed joint, but not required to maintain acceptable line pressure. This valve has been analyzed up to 6500 psig.	Penetration U006 **Internal Pressure:** **5563 psig.** Leakage is required through outboard isolation valve. The outboard valve is directly connected through the bonnet to the safety related penetration pipe. The maximum predicted pressure of 5563 psig in the piping and valve bonnet does not exceed the piping allowable pressure of 5749 psig.	Valve 13PDWEV061 2"-600# Manual Globe Valve **Gasket Leakage Pressure:** **3820 - 5563 psig.** This is a globe valve which is directly connected through the bonnet to the safety related penetration pipe. This gasketed connection is fastened with 4 studs (3/4-10) at a reduced torque of 60 ft-lbs (initially 125 ft-lbs) and will relieve such that the maximum internal pressure of 5563 psig does not exceed the valve allowable pressure of 6500 psig.

Table 1: Predicted Gasket Leakage Pressures

OARD VALVE **Gasket Leakage Pressures**	**PENETRATION PIPING BETWEEN ISOLATION VALVES** **Predicted Internal Pressure**	**OUTBOARD VALVE** **Gasket Leakage Pressures**
Valves 13PRDNV088 and 091 2.5" - 150# NQR Check Valves **Gasket Leakage Pressure:** **2845 – 3172 psig.** These are check valves which are directly connected to the NQR pipe inside containment upstream of isolation valve 13JRDAUV0023. These gasketed connections are fastened with 4 studs (9/ 16 - 12) at a torque of 64 ft-lbs and will relieve such that the maximum internal pressure of 3172 psig does not exceed the valves allowable pressure of 4400 psig. In addition, the valve's bonnet fasteners will achieve significant plastic deformation at a pressure of 3956 psig. Valve 13PRDNV205 3"-150# NQR Check Valve Leakage is not required from this NQR valve. The valve is analyzed up to 4400 psig.	This is the NQR piping upstream of isolation valve 13JRDAUV0023. **Internal Pressure:** **3172 psig.** Leakage is required through the check valve gasketed joints. The maximum predicted pressure of 3172 psig does not exceed the isolation valve 13JRDAUV0023 allowable pressure of 7378 psig. The maximum predicted pressure of 3172 psig also does not exceed the NQR piping allowable pressure of 8087 psig.	Not Applicable. All of these check valves are interconnected inside containment, upstream from containment penetration valve 13JRDAUV0023.

Table 1: Predicted Gasket Leakage Pressures

INBOARD VALVE Gasket Leakage Pressures	PENETRATION PIPING BETWEEN ISOLATION VALVES Predicted Internal Pressure	OUTBOARD VALVE Gasket Leakage Pressures
Valves 13PPCEV123 and 124 4"-150# Manual Gate Valve **Gasket Leakage Pressure:** **3334 – 4922 psig.** These gate valves are connected to the NQR piping inside containment upstream of isolation valve 13PPCEV071. The gasketed connection of these valves is fastened with 8 studs (3/4-10) at a torque of 158 ft-lbs and will relieve such that the maximum internal pressure of 4922 psig does not exceed the valve allowable pressure of 6500 psig. Valve 13PPCNV072 2" Plug Valve Leakage is not required from this NQR valve. The valve is analyzed up to 5765 psig.	This is the NQR piping upstream of isolation valve 13PPCEV071. **Internal Pressure:** **5765 psig.** No leakage is required through any of the gate valves. The maximum predicted pressure of 5765 psig does not exceed the allowable pressure of 6500 psig for valves 13PPCEV071, 13PPCEV123 and 124. The maximum predicted pressure of 5765 psig also does not exceed the NQR piping allowable pressure of 6901 psig.	Not Applicable. All of these gate valves are interconnected to the upstream NQR piping of valve 13PPCEV071 inside containment.

Table 1: Predicted Gasket Leakage Pressures

BOARD VALVE Gasket Leakage Pressures	PENETRATION PIPING BETWEEN ISOLATION VALVES Predicted Internal Pressure	OUTBOARD VALVE Gasket Leakage Pressures
Valve 13JNCAUV0402 10" – 150# Motor Operated Butterfly Valve **Gasket Leakage Pressure:** **Not Applicable.** Previous testing in conjunction with leakage and deflection behavior of the EPT epoxy filled seats for these valves was utilized to develop the operability assessment of this penetration. Further testing of these butterfly valves would be required to extend the operability assessment to an acceptable long-term design solution. PVNGS has determined to install a single relief valve on the NC penetration in each unit in lieu of pursuing further testing.	Penetration U034 A relief valve will be installed in this penetration.	Valve 13JNCBUV0403 10" - 150# Motor Operated Butterfly Valve **Gasket Leakage Pressure:** **Not Applicable.** Previous testing in conjunction with leakage and deflection behavior of the EPT epoxy filled seats for these valves was utilized to develop the operability assessment of this penetration. Further testing of these butterfly valves would be required to extend the operability assessment to an acceptable long-term design solution. PVNGS has determined to install a single relief valve on the NC penetration in each unit in lieu of pursuing further testing.

Figure 1: Close View of Leakage Through The Valve Gasketed Joint

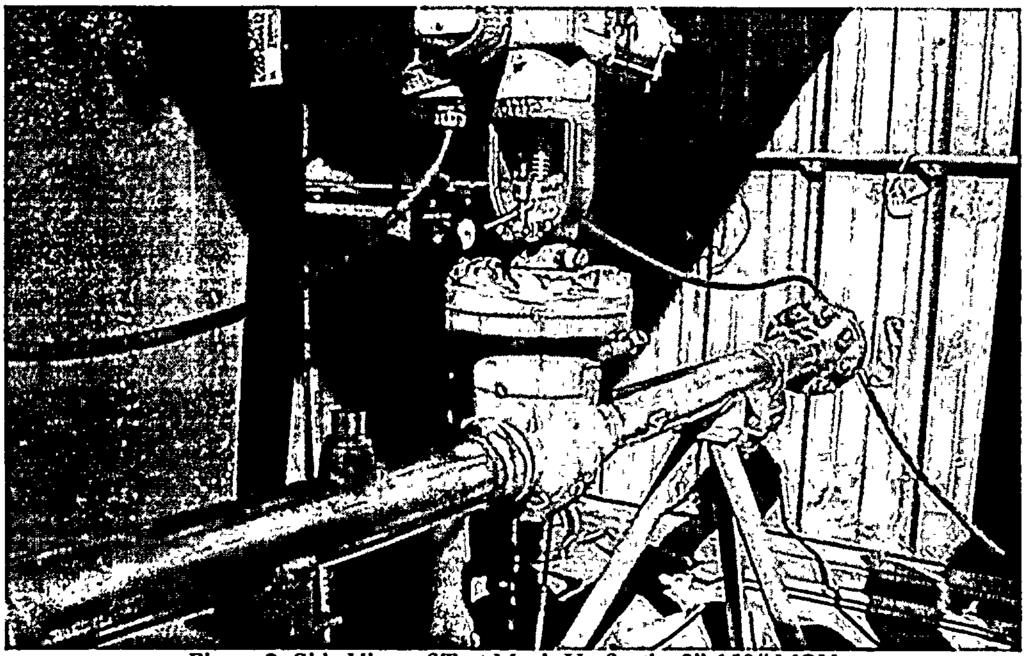


Figure 2: Side View of Test Mock-Up for the 3"-150# MOV

Describe the method used to estimate this pressure.

In order to determine the valve gasketed joint leakage pressure, a thorough examination of the response of each containment penetration to thermally induced over-pressurization due to a LOCA was required. This process included evaluation of the thermal expansion of water trapped in the penetration piping and valve bonnet, the plastic deformation of piping, the differential opening pressure of the flex wedge disk in the gate valve and determination of the valve gasketed joint relief pressure. All of these steps were interrelated with the primary goal of establishing conservative pressure limits for the piping and valves such that structural integrity was assured. A summary of the evaluations that were performed and the order in which they took place is presented below.

a) **Pressure and Temperature Time History Profiles Determined**

The internal pressure and temperature time history profiles for each of the affected piping/valves was determined, during and after a LOCA condition inside of containment, assuming that the valves and piping were water solid and no relief mechanisms exist.

b) **Maximum Allowable Pressure Determined for Valves**

The maximum pressure the valves are allowed to withstand was determined based on the elastic faulted stress method of ASME B&PV Code, Section III, Division 1-1974 Edition, with Winter 1975 Addenda, paragraphs NB-3221, NB-3545.2 and Appendix F-1000, Subsection F1323.1(b). Critical parts of the valve such as the crotch, body neck, bonnet neck and flanges were evaluated under the postulated pressures in combination with seismic loads.

c) **Maximum Allowable Pressure Determined for Piping**

For the safety related piping, the maximum allowable pressure was determined by utilizing the ASME B&PV Code, Section III, Division 1-1974 Edition, with Winter 1975 Addenda, Appendix F-1000, Subsections F1321.1(e) and F1324.4, which provide a maximum allowable value of 70% of the Plastic Instability Load. For the non-quality related (NQR) piping, the same method described above was utilized except that the allowable pressure was assumed to be equal to the plastic instability load or bursting pressure. The NQR piping and valves inside containment, upstream of the inboard containment isolation valve, were also evaluated and it was determined that the over-pressurization of the NQR piping will not cause structural failure of these components and will not exceed the allowable pressure limit of the adjoining safety related valves. Thus, there is no impact to any safety related plant system or function.

d) **Excess Penetration Water Volume Determined**

The amount of trapped water that can not be accommodated within the established pressure limits for the piping and valves was determined. This evaluation also utilized the temperature time history profiles to develop the required leakage rate for each penetration to preclude a further increase in pressure.

e) **Valve Disk Behavior Evaluated**

The behavior of the gate valve flex wedge disk assemblies were evaluated using maximum valve operator thrust and under various differential pressures. This was done to establish the required piping pressure to deflect the disk away from the seat and allow leakage/pressure transfer from the piping into the valve bonnet.

f) **Gasket Stress and Fastener Preload Requirements Determined**

The maximum seating and residual gasket stresses and corresponding joint fastener preload required to satisfy the pressure limit and leakage constraints of the piping and valves were determined. This evaluation utilized the Pressure Vessel Research Council (PVRC) Tightness Parameter (*Tp*) concept, with gasket constants *Gb, a* and *Gs*. These constants define gasket mechanical and leak behavior.

g) **Fastener Preload Analysis Values Adjusted**

The valve gasketed joint fastener torque (preload analysis value) was adjusted for some of the valves (see response to question 4) to meet the maximum seating and residual gasket stresses that were previously established to satisfy the pressure limit and leakage constraints of the piping and valves. In addition, verification was made that this new lower fastener torque, under normal operating conditions, with all loads and a concurrent seismic event, was adequate to maintain the integrity of the joint.

h) **Verification Testing Performed**

Leakage testing was performed to validate the analytical leakage model for the gasketed joint, as well as to verify the structural adequacy of the penetration components and deflection behavior of the flexible wedge disk of the gate valve. This testing was performed on a 3"-150# motor-operated gate valve (identical to valve 13JRDAUV0023 in penetration U009) and associated 3"-schedule 40S stainless steel piping.

Discuss the applicability of the mock-up test results to the valve sizes or types that were not tested.

The valve gasketed joint leakage characteristics are dependent upon the internal valve bonnet pressure and the gasket type and flange configuration. The purpose of the test was to validate and provide any required adjustments to the analytical model which predicts flange gasket leakage rates for corresponding valve bonnet pressures. The mock-up test results are applicable to the other valve sizes and types that were not tested because the gasketed joint for all of these valves is of the same gasket type and flange configuration. The disks of these valves are proportionally identical, specifically in terms of thickness and hub diameter, such that extrapolation of the test results is applicable. Additional tests were conducted to ensure that displacement of the flex-wedge gate valve disk would allow pressure transfer from the isolated piping to the gate valve bonnet.

Comparisons were made between the leakage pressure predicted by the analytical model to the PVNGS leakage test results, as well as to the test results for various size flanges in Rodabaugh's Report ORNL/SUB/2913-3,NRC-5 (8"-150# of various flange thicknesses and yield strengths, 12"-300#, 4"-900# and 3"-150#). The comparisons showed favorable correlation between the pressures predicted by the analytical model and the PVNGS and Rodabaugh test results. These comparisions provide additional confidence that the verification testing performed and the analytical techniques utilized by the model are appropriate and apply to the configurations of concern which were not tested. In addition, a review of the analysis conclusions and methodology was performed by an industry expert on the subject of bolted connections. This industry expert is a member of the PVRC and ASME Committees involved in the testing and development of the proposed new rules for the design of bolted flange joints. The PVRC test gasket constants, *Gb*, *a* and *Gs*, (additional discussion regarding these constants is provided in the following section), which are based on standardized test data, in conjunction with the Tightness Parameter (*Tp*) concept, provide the ability to express gasketed joint leak performance in terms of any combination of pressure and mass leak rate. These new gasket constants will eventually replace the traditional *m* and *y* factors in the ASME Code.

Discuss any sources of uncertainty associated with the estimated leak off or leakage pressure.

The uncertainties associated with the estimated leakage pressures are related to the mechanical and leakage behavior of the gasketed joint. It is recognized that the stiffness of bolted flanged joints has a strong effect on the creep relaxation behavior of gaskets and, therefore, on the relaxation of the bolt and gasket loads. Consequently, apart from the gasket itself, the tightness of bolted flange joints depends greatly on the actual design of flanges and bolts. A gasket can be considered as a spring in series with the bolts, nuts and flanges. Since the gasket is part of the joint, its spring constant can be combined with that of the joint members to construct a joint diagram and perform joint calculations. Within this model, gaskets have the following characteristics which introduce uncertainty into the analysis, usually leading to a loss of preload and a leaky gasketed joint:

- The gasket stiffness is usually less than that of the other joint members and thereby dominates the elastic behavior of the joint.

- Gasket stiffness is variable. At ambient temperature, it is usually non-linear during its initial compression but becomes more linear for subsequent unloading-reloading cycles. Most gaskets exhibit hysteresis and some will take a progressive permanent set with load cycles. Gasket stiffness also changes with thermal degradation.

- The gasket has a tendency to creep under load. This reduces the tension in the bolts, even before the joint has been pressurized. Gasket creep may substantially increase with elevated temperature exposure.

Recent work on the mechanical and leak behavior of gaskets by the PVRC, namely the PVRC test gasket constants *Gb*, *a* and *Gs*, and the Tightness Parameter (*Tp*) concept, provide the ability to express gasketed joint leak performance in terms of any combination of pressure and mass leak rate. Gasket constants *Gb* and *a*, together, represent the capacity of the gasket to develop tightness upon initial seating. They express the relationship between the gasket initial seating stress and the gasket tightness as a line on a log-log plot. Because they determine the gasket seating stress, *Gb* and *a*, together, give stresses that are similar to the *y* stress of the present ASME code. Gasket constant *Gs* is an independent constant which represents operation. It characterizes the gasket tightness sensitivity to operating bolt load reductions which occur during pressurization or gasket creep or thermal disturbances that cause load loss. Constant *Gs* idealizes the relationship between gasket stress and gasket tightness during stress excursions by assuming that this relationship is linear on a log-log plot. However, *Gs* does not represent a unique relationship - it is dependent of the initial seating stress level. For a specified tightness (minimum leak rate), *Gs* indicates the minimum stress needed on the gasket. A high value of *Gs* may indicate that the gasket is sensitive to unloading excursions or susceptible to blow out at low loads.

Factor *m* in the present ASME code is similar because it also provides a minimum gasket stress. However, *m* does not describe anything about leakage.

In a gasketed bolted joint, tightness is a measure of the joint's ability to control the gasket leak rate. Thus, with all other variables equal, a tighter joint requires higher internal pressure to push the same rate of fluid through the gasket. Therefore, based on the previous discussions, the calculation of seating gasket stress and operating gasket stress levels have the most significant amount of uncertainty in regards to estimation of leakage pressure and leakage rate. Both of these factors are a result of the initial preload and residual bolt preload present at the time of over-pressurization. In order to consider the potential for under predicting leakage pressures and leakage rates, the analytical model utilizes a probabilistic criterion to determine the range of actual preloads at various confidence levels. The factors utilized in the probabilistic criterion are conservative and are based on industry experience. The method outlined in EPRI Report NP-5769, Vol 2, Section 4, was used, with a minor modification, in the preload bias term to account for elastic interaction and gasket creep. For instance, utilizing standard torque wrench procedures in the initial assembly of the joint, and assuming a 99.99% confidence level (i.e., 3.72 standards of deviation), results in a probability lower than 1×10^{-4} that the highest bolt load for that joint is at 118.1% of the target load for that joint. The present analytical model conservatively assumes that every bolt in the joint is at this load level and is present at the time the design basis accident and resulting over-pressurization occurs. In addition, the analytical model calculates the stiffness of the joint members and utilizes gasket constants that have been minimized to account for manufacturing variations in the gaskets. This analytical model approach results in leakage pressures that are in the order of 1.5 to 2 times larger than if one were to utilize a typical total load across the gasketed joint equivalent to 60 to 80% of the target preload (design). This range of 60 to 80% of target preload is representative of a well assembled joint by mechanics trained in the use of calibrated torque wrenches and is directly applicable to the PVNGS gasketed joint assemblies.

Various industry bolting studies have investigated the loss of preload due to short and long term effects and the effects of bolt elastic interaction in flanges. These studies report wide variability in preload across the joint and support the referenced range of 60 to 80% of design joint load. Considerable improvement in flange loading can be achieved by gauging the joint studs and estimating a variable preload for the 4th torque pass. This gives a realistic estimate of the friction and bolt elastic interaction and results in joint loads of 70 to 90% of the total design loading. However, this latter method is not representative of the method used to assemble valve gasketed joints at PVNGS.

The results of the tests performed by PVNGS (i.e., total of 18 tests) on a 3"-150# valve and a 3" blind flange, at various levels of bolt preload, reveals good correlation between test results and the analytical model predictions of leakage pressure and associated joint leakage. This comparision demonstrates that under the current assumptions regarding level of preload across the gasketed joint, the estimation of leakage pressure and leakage rates are conservative and will envelope any source of uncertainty in the behavior of the gasketed joint.

3. Provide the maximum-calculated stress in each piping run based on the estimated leakage pressure.

The maximum hoop stress (S_H) and longitudinal stress (S_L), and the corresponding hoop strain (%) as a result of the maximum postulated internal piping pressure are provided in Table 2.

Table 2: Piping Maximum Stresses Based on Piping Estimated Pressure

Penetration Number	Line Number	Total length of Pipe (inches)	Material	Calculated Stress, S_H and S_L (psi), And Estimated Piping Pressure (psig)	Calculated Hoop Strain (%)
U009	RD-259-HCBA-3" between containment isolation valves 13JRDAUV0023 and 13JRDBUV0024	3" - Schedule 40, Ametek Mechanical Penetration Piping = 69.5 3" - Schedule 40, Connecting Penetration Piping = 90 Drains & Vents 1/2" pipe = 76 (0.012ft³) 1" pipe = 27 (0.012ft³)	SA-376 TP304 SA-376 TP304	S_H = 41,255 S_L = 20,627 S_H = 40,112 S_L = 20,056 P = 5,583	3.96 1.16
U061	WC-042-HLBB-10" between containment isolation valves 13JWCBUV0061 and 13JWCAUV0062	10" – Schedule 40, Ametek Mechanical Penetration Piping = 74 10" – Schedule 40, Connecting Penetration Piping = 69.9 Drains & Vents 1" pipe = 5.2 (0.002ft³)	SA-333 GR 6 SA-106 GR B	S_H = 39,430 S_L = 19,715 S_H = 39,520 S_L = 19,760 P = 2,851	0.8 0.98
U050	PC-073-HCBA-4" between containment isolation valves 13PPCEV070 and 13PPCEV071	4" - Schedule 40, Ametek Mechanical Penetration Piping = 69.5 4" - Schedule 40, Connecting Penetration Piping = 47.7 Drains & Vents 1" pipe = 12.5 (.0063ft³)	SA-376 TP304 SA-376 TP304	S_H = 41,776 S_L = 20,888 S_H = 41,220 S_L = 20,610 P = 4,792	2.6 1.27
U051	PC-072-HCBA-4" between containment isolation valves 13PPCEV075 and 13PPCEV076	4" – Schedule 40, Ametek Mechanical Penetration Piping = 69.5 4" - Schedule 40, Connecting Penetration Piping = 77.3 Drains & Vents 1" pipe = 15.1 (0.007ft³)	SA-376 TP304 SA-376 TP304	S_H = 41,776 S_L = 20,888 S_H = 41,220 S_L = 20,610 P = 4,792	2.6 1.27

Table 2: Piping Maximum Stresses Based on Piping Estimated Pressure

Penetration Number	Line Number	Total length of Pipe (inches)	Material	Calculated Stress, S_H and S_L (psi), And Estimated Piping Pressure (psig)	Calculated Hoop Strain (%)
U006	DW-055-HCBA-2" between containment isolation valves 13PDWEV061 and 13PDWEV062	2" - Schedule 40, Ametek Mechanical Penetration Piping = 115.8 2" - Schedule 40, Connecting Penetration Piping = 53.6 Drains & Vents 1" pipe = 7.7 (0.003ft^3)	SA-376 TP304 SA-376 TP304	S_H = 37,847 S_L = 18,923 S_H = 37,691 S_L = 18,845 P = 5,563	1.4 0.95
U034	NC-137-HLBB-10" between containment isolation butterfly valves 13JNCAUV0402 and 13JNCBUV0403	10" – Schedule 40, Ametek Mechanical Penetration Piping = 74 10" – Schedule 40, Connecting Penetration Piping = 246.4	SA-333 GR 6 SA-106 GR B	Not Applicable Will Install Relief Valves	Not Applicable Will Install Relief Valves
NQR Piping Upstream Of containment isolation valve 13JRDAUV0023	RD-258-HCDA-3" and RD-258-HCDA-2.5" RD-260-HCDA-2.5"	3" - Schedule 40, NQR piping = 222.4 2.5" – Schedule 40, NQR piping = 953.9 Drains & Vents 1" pipe = 19.3 (.0107ft^3)	A312 TP 316L or A312 TP 304 same as above	S_H = 22,571 S_L = 11,286 S_H = 19,313 S_L = 9,656 P = 3,172	0.2 0.12
NQR Piping Upstream Of containment isolation valve 13PPCEV071	PC-077-HCDA-4"	4" - Schedule 40, NQR piping = 2,196 Drains, Vents, Branch 2" NQR pipe = 68.04 (0.132 ft^3)	A312 TP 316L or A312 TP 304	S_H = 50,198 S_L = 25,099 P = 5,765	2.48
NQR Piping Downstream of Containment isolation valve 13PDWEV062	DW-59-HCDA-2", DW-96-HCDA-2", and DW-95-HCDA-1" DW-96-HCDA-1" DW-184-HCDA-1" DW-195-HCDA-1"	2" - Schedule 40, NQR pipe = 1235.5 1" – Schedule 40, NQR pipe = 2684.3	A312 TP 316L or A312 TP 304 same as above	S_H = 37,709 S_L = 18,855 S_H = 21,978 S_L = 10,989 P = 5,563	1.0 0.2

Table 2: Piping Maximum Stresses Based on Piping Estimated Pressure

Notes:

For the plastic analysis of the Ametek mechanical penetration piping the mechanical properties from the Certified Material Test Reports (CMTR) were utilized, i.e., Tensile Strength (Su), Yield Strength (Sy) and % elongation (eu). For the connecting penetration piping, the minimum mechanical properties for the specific piping material were utilized. For example, for penetration U009, the following room temperature properties were utilized for the 3" - Schedule 40, SA 376, TP 304 pipe:

Ametek Mechechanical Penetration piping: Sy (58,000 psi), Su (89,400), eu = 74%
Connecting Penetration Piping: Sy (30,000 psi), Su (75,000), eu = 32%

4. **Describe the impact, if any, of changing the bonnet bolt torque values on the seismic qualification or functional capability of each valve.**

A thorough analysis was performed for each of the valves where the fastener torque was reduced to ensure that the new torque value was acceptable. The analysis accounts for the joint and assembly restraints listed below:

- The external and operating loads such as actuator maximum thrust and torque, maximum system operating pressure, seismic inertia (SSE).
- The stiffness of the fasteners and joint.
- The maximum and minimum allowed bolt tension based on the strength of the fasteners and joint members.
- The assembly method and the estimated accuracy with which the fastener and the residual preload after relaxation of the joint has occurred.
- The operating environment, importance of the joint and the safety factor required for joint separation or leakage acceptance criteria.

The joint analysis considered the operating pressures in conjunction with all loads plus seismic inertia. In addition, conservatism is added by evaluating the adequacy of the proposed torque assuming that the residual preload is equivalent to 34.57% of target preload. The results of the analysis demonstrate that under all loads, the margin of safety against joint separation and against transverse joint slip is greater than 1. Furthermore, the residual gasket stress was found to be adequate such that no leakage is expected to occur in the joint at the operating pressures which are in a range of 20 to 150 psig. Therefore, there is no impact to the seismic qualification or functional capability of the valves. In addition, none of the valves have a design basis safety function to actuate open post accident.

In the January 28, 1997, submittal, APS indicated that sections of piping directly adjacent to the inside containment isolation valves for three lines were also affected. APS indicated these three sections of piping are not safety-related and a failure of the valves in the non-safety portion of the line would not affect the ability of the adjacent valves and piping to perform their safety-related function. Please clarify whether or not any potential overpressure in the non-safety section of the pipe will impact any safety-related plant system or function.

As stated on page eleven, the NQR piping and valves inside containment, upstream of the inboard containment isolation valve, were also evaluated and it was determined that the over-pressurization of the NQR piping will not cause structural failure of these components and will not exceed the allowable pressure limit of the adjoining safety related valves. Thus, there is no impact to any safety related plant system or function.

ATTACHMENT 1

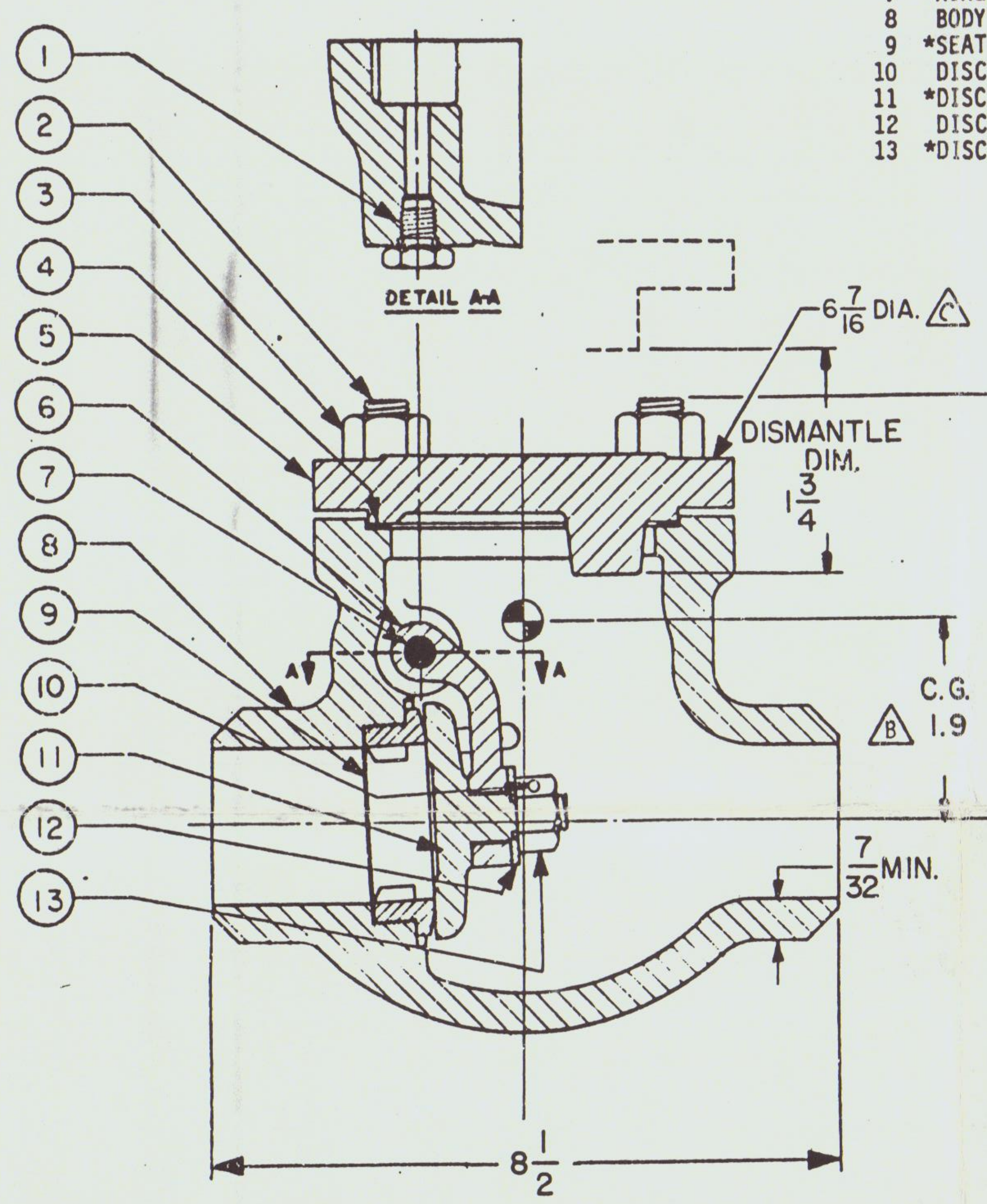
Attachment 8, "Pressure Leakage Test Plan on a 3"-150# Gate Valve Bonnet to Body Gasketed Joint", and Section 11, "Pressure Leakage Test Results on the 3"-150# Valve, 3" Schedule 40S Stainless Steel Pipe and 3"-300# Blind Flange Tested by PVNGS", of APS Study 13-MS-B06

14.5X

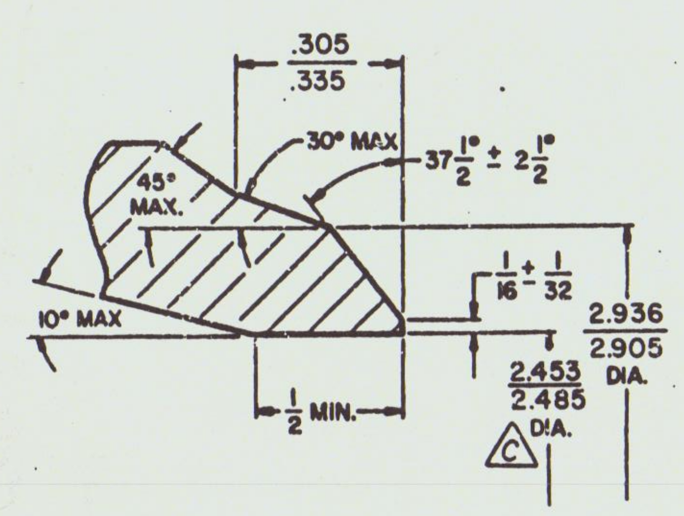
LIST OF PARTS

NO.	PART NAME	MATERIAL SPECIFICATION
1	PIPE PLUG	ASTM A276 GR. 316
2	*BONNET STUD	ASTM A193 GR. B8M
3	BONNET STUD NUT	ASTM A194 GR. 8M
4	BONNET GASKET	316 CORRUGATED
5	*BONNET	ASTM A351 GR. CF8M
6	*HINGE	ASTM A351 GR. CF8M OR A240 GR. 316 (D)
7	*HINGE PIN	ASTM A276 GR. 316
8	BODY	ASTM A351 GR. CF8M
9	*SEAT RING	ASTM A351 GR. CF3M w/CoCrA
10	DISC NUT PIN	ASTM A276 GR. 316
11	*DISC	ASTM A351 GR. CF3M w/CoCrA
12	DISC NUT WASHER	ASTM A276 GR. 316
13	*DISC NUT	ASTM A194 GR. 8M

EQIDs: 13PRDNVD88, 13PRDNVD91



APPROXIMATE VALVE WEIGHT = 43 LBS.



WELD END DETAIL

NOTES:

1. *RECOMMENDED SPARE PARTS.
2. END TO END DIMENSION PER ANSI B16.10.
3. WELD END DIMENSIONS PER BECHTEL SPEC 13-PM-222B, APP 4Q
4. HYDROSTATIC TEST PER P-1736, REV. 4.
5. SEAT RING TO BE SEAL WELDED.
6. P.V. ITEM / CUST. ITEM / TAG NO. / PROJ. CLASS

	P.V. ITEM	CUST. ITEM	TAG NO.	PROJ. CLASS
	112	178	MVN:673	R2D
(B)	194	178	MVN:673	R2D
(C)	323	178	MVN:673	R2D

MICROFILM QUALITY ACCEPTABLE

REVISIONS	BY	CHKD	APPD	DATE	SYM
ADDED ASTM A240 GR. 316 TO MAT'L. SPEC. FOR HINGE (ITEM 6)	KO	KO	KO	10/23/86	D
ADDED ITEM 323 AND REVISED WELD END DETAIL DIM.	JK	RAJ	[illegible]	12/11/79	C
ADDED PV ITEM 194, P.O. ITEM 178 FROM DWG. 7-751. ADDED CG.	DWG	H.A.L.	H.A.L.	6/8/78	B
ADDED APPROXIMATE VALVE WEIGHT AND REVISED OVERALL HEIGHT & BNT. STUD & NUT MAT'L.	SD	H.A.L.	[illegible]	11/28/77	A

CUSTOMER'S NAME	BECHTEL/ARIZONA PUBLIC SERVICE COMPANY
SHOP JOB NUMBER	7-L-0002Z
SIZE & FIGURE NUMBER	2 1/2" S-180-7-HE (40S)
	150 lb. STAINLESS STEEL SWING CHECK VALVE
BY	[illegible]
CHKD. BY	H.A.L.
APPD.	[illegible]
DWG. NO	7-418-D
P.O. NO.	10407-13PM-222B
DATE	9/8/77

PACIFIC VALVES
3201 Walnut Avenue
Long Beach, California 90807

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  - BALANCE OF PLANT
  - BOILER/NSSS
  - PLANT UTILITIES
- PLANT DESIGN
- CONTROL SYSTEMS
- ELECTRICAL
  - WIRING
  - CONDUIT
- MOS
- PAINTING & COATINGS
- CIVIL/STRUCTURAL
- NUCLEAR
- STRESS
- ARCHITECTURAL
- STARTUP
- CONSTRUCTION
- NOT REQ'D BY ENGRG
- CLIENT

IDENTIFYING TITLE OF THIS DOCUMENT: SAME

DATA CODE 1.3
ACTIVITY PKG NO. —
ENGR SYSTEM NO. —
QUAL. CLASS 5

Bechtel Log No. 13-10407

P222B-98-5

IMPORTANT
Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligations.

DATE RECEIVED 11-3-86 — SIGNED AB — DATE 11/6/86

DOCUMENT STATUS
1. ☒ WORK MAY PROCEED.
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3. ☐ REVISE AND RESUBMIT. WORK MAY NOT PROCEED.
4. ☐ INFORMATION ONLY.

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