MARK II PRIMARY CONTAINMENT VACUUM RELIEF VALVE TEST PROGRAM PHASE IV INTERIM

Revision 1

Prepared by

Guy G. Williamson
Milton E. Teske

CONTINUUM DYNAMICS, INC.
PRINCETON, NEW JERSEY 08540

J. Alan West

ANDERSON, GREENWOOD & COMPANY
BELLAIRE, TEXAS 77401

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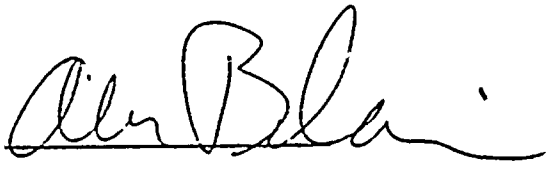
BECHTEL POWER CORPORATION
SAN FRANCISCO, CALIFORNIA 94119

Approved by



Alan J. Bilanin

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ERRATA SHEET NO. 1

Page	Section	Subsection	Line	
i	1	1.4	1	"1.4 Description of Report Sections 1.4"
				the above should read:
				"1.4 Description of Report Sections 1.2"
iii	Illustrations	4.12	1	"4.12 Test Nos. [illegible] and [illegible] strain No. 8 versus [illegible]"
				the above should read
				"4.12 Cyclic strain in vertical arm, strain gage No. 8"
iii	Illustrations	8.1	1	"8.1 Test performance flow diagram 8.2"
				the above should read
				"8.1 Q.A. test performance flow diagram 8.2"
3.1	3	3.2	3	".. code which is documented in Ref. 1."
				the above should read
				".. code which is documented in Ref. 2."
3.1	3	3.3	6	".. where selected for determining the desired.."
				the above should read
				".. were selected for determining the desired.."
5.1	5	5.3	2	".. actuator to a preselected angle and then.."
				the above should read
				".. actuator set to a preselected angle and then.."
5.1	5	5.5	4	".. the valve desired with the regulator adjusted.."
				the above should read
				".. the value desired with the regulator adjusted.."

Revision 1

ERRATA SHEET NO. 2

Page	Section	Figure	
5.7	5	5.5	"Fig. 5.5 Visual procedure and operability checklist"
			the above should read
			"Fig. 5.5 Visual inspection and operability checklist"
6.2	6	6.1	"Fig. 6.1 24" Vacuum breaker valve .25 to .50 psid set pressure"
			the above should read
			"Fig. 6.1 24" Vacuum breaker valve .25 to .50 psid set pressure (front)"
6.3	6	6.2	"Fig. 6.2 24" Vacuum breaker valve .25 to .50 psid set pressure"
			the above should read
			"Fig. 6.2 24" Vacuum breaker valve .25 to .50 psid set pressure (back)"
6.6	6	6.3 legend	The following should be added: "(3) Relubricate with Dow Corning DC 33 and replace seals with replacement seal kit 05-1116-029"
8.2	8	8.1	"Test performance flow diagram"
			the above should read
			"Fig. 8.1 Q.A. Test performance flow diagram"

valve (Table 3.1), the anticipated nominal closing impact velocities are lower (Table 3.2) as well; therefore, no apparent justification exists for running an additional test at a lower velocity than already investigated.

Since the test components were still functional, though no longer designated for operational use, and since all test equipment was still in place, additional tests were executed to investigate valve operability at a higher closing velocity than predicted for pool swell. These tests would either identify failure modes of the valve or show that it could sustain higher than necessary nominal closing impacts. Valve operability was still acceptable after the highest nominal closing impact test (Fig 4.5, -20 rad/sec).

4.4 Summary of Strain Gage Data

Material strains were recorded continuously during all of the tests listed in Table 4.1 at the locations specified in Section 7.3. These strain measurements are used to determine if permanent deformation occurs and not to demonstrate valve operability.

It should be noted that the highly transitory nature of the impact tests which imply a highly complex stress state makes it difficult to accurately compare the inferred stress levels with ASME static yield stress levels.

The maximum values of strain and the stress inferred by multiplying the strain values by Young's Modulus are listed in Table 4.2. The ASME static yield stress limit for 300 series stainless steel, as given in ASME Boiler and Pressure Vessel Code, Appendix I, Table I-2.2, was exceded on the disc and arm in several tests with no permanent deformation either visually observed or measured by the strain gages. There are two factors which could produce this result.

First, the actual yield stress of these materials could be higher than the ASME values for yield stress. According to the traceable manufacturer's material test report and certification for the 347 stainless steel (SS) used in the disc, the measured value of the yield stress is 47.4 ksi (158% of the ASME value for yield stress). In addition, the 347 SS used in Susquehanna's vacuum breaker disc originated from the same heat number as the disc material used in the valve tested and, therefore, also has a measured yield stress of 47.4 ksi. Since the arm is not part of the pressure boundary, it does not have a similar traceable material report. However, the 304 SS specified in the engineering drawing and used in the arms of all of the valves at Susquehanna and Limerick as well as the test valve (assured by the AGCo implementation of the ASME Section 8 quality assurance requirements) has nominally the same strength as the 347 SS material (see Table 4.2).

Second the implusive application and relief of the impact load does not allow enough time for the material to deform permanently. The characteristic duration of the opening impact load is typically several milliseconds.

Finally, to reiterate, the primary purpose of these tests is to evaluate vacuum breaker operability after pool swell and is not to provide ASME qualification of this valve and, as such, the strain gage measurements are only of secondary importance.

4.5 Functional Test Results

4.5.1 Leakage -

a) Limerick/Susquehanna Test Series

Leakage was measured, as described in Section 5, before Test 4L4-1 and after Test 4L5-2. High (30 psi) and low (1 psi) test pressures were checked as required by the Susquehanna Vacuum Breaker Specification. Pre-test results indicated a small amount of leakage (12.5 cc/min) at the lower pressure and zero leakage at the higher pressure. Post-test results indicated zero leakage at both pressures. The allowable leak rate specified for Susquehanna is 100 cc/hr/in or 34.37 cc/min. Visual inspection of the sealing surfaces confirmed that the impacts did no damage that would compromise valve sealability.

b) Shoreham Test Series

Since there were no changes in the sealing components and the post-test results from the Limerick/Susquehanna test series indicated no leakage, pre-test leakage inspection was not performed for Shoreham. Post-test results showed some degradation of sealability. A leakage rate of 1220 cc/min was measured at 4 psi (Shoreham Specification test pressure). Although the leakage was significant, it fell well under the allowable leak rate of 1 SCFM or 28317 cc/min specified for Shoreham. Visual inspection indicated that the increased rate of leakage was probably due to local bending of the disc ring flange at the point of contact with the valve body ID.

TABLE 4.2

Maximum Strains and Stresses in Phase IV Tests

	Material on Which Strain Gage is Mounted	Susquehanna Opening Impact Test 16 rps		Shoreham Opening Impact Test 18 rps		Susquehanna and Shoreham Closing Impact Test -16 rps	
		Strain μin/in	Stress* ksi	Strain μin/in	Stress* ksi	Strain μin/in	Stress* ksi
Strain Gages on Main Shaft							
#11	17-4PH	-2180	-63.7	-2260	-66.0	-1760	-51.4
# 9	"	2180	63.7	2540	74.2	-1220	-35.6
#12	"	1220	35.6	1840	53.7	680	19.9
Strain Gages on Arm and Disc							
#8	304SS	-1730	-49.0	-1720	-48.7	690	19.5
#5	347SS	1600	45.3	1490	42.2	1050	29.7
#2	"	-250	-7.1	-110	-3.1	-950	-26.9
#3	"	700	19.8	120	3.4	350	9.9
Strain Gages on Single Bar Linkage							
#10	Carbon Steel (516-7)	400	11.2	380	10.6	-420	-11.7
#13	"	-210	-5.9	-290	-8.1	-190	-5.3

ASME Valves of Young's Modulus and specified minimum yield stress for the materials used in the test valve are (from ASME P&BVC, Section 3, Appendix I, Tables I-2.1, I-2.2, I-6.0, I-6.1)

Material	$E \times 10^{-6}$ (at 70°F)	Yield Stress, ksi
17-4PH	29.2	115
304SS	28.3	30
347SS	28.3	30
Carbon Steel	27.9	38

* Stress is estimated by the product of strain and E for the particular material.

Revision 1