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LOFT TECHNICAL REPORT LTR 1144-37

JANUARY 18, 1978

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LOFT PRESSURIZER SAFETY -
RELIEF VALVE RELIABILITY

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950 2158

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DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE UNDER CONTRACT EY-76-C-07-1570

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LOFT TECHNICAL REPORT LOFT PROGRAM

FORM EG&G-229
(Rev. 12-78)

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SUMMARY

The LOFT pressurizer self-actuating safety-relief valves are constructed to the present state-of-the-art and should have reliability equivalent to the valves in use on PWR plants in the U.S. There have been no NRC incident reports on valve failures to lift that would challenge the Technical Specification Safety Limit. Fourteen valves have been reported as lifting a few percentage points outside the $\pm 1\%$ Tech. Spec. surveillance tolerance (9 valves tested over and 5 valves tested under specification). There have been no incident reports on failures to reseal.

The LOFT surveillance program for assuring reliability is equivalent to nuclear industry practice.

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Appendix 5	Crosby Installation, Operating and Maintenance Instruction No. I-1105-2
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1.0 VALVE HISTORY

The LOFT primary coolant system is protected from over-pressure transients by two spring-loaded, self-actuating, safety relief valves located on piping connected to the steam space of the pressurizer. Four valves for this service (two are spares) were purchased from Crosby Valve and Gage Company in 1971 via Subcontract S-7254. Valve designation is as follows:

<u>Crosby Ser. No.</u>	<u>Plant Designation</u>
N56037-00-0001	RV 200
N56037-00-0002	RV 200A
N56037-00-0003	RV 201
N56037-00-0004	RV 201A

These valves are 1-1/2" inlet, 2" outlet, thus smaller than Crosby's normal nuclear class relief valve and were furnished as a one-of-a-kind design. A design deficiency, since corrected, was discovered during LOFT Plant lift tests performed January 1, 1976. The corrective action incorporated the design features found in the normal (larger) nuclear class valves. A description of the test, valve examination results, evaluation and disposition follow.

1.1 Description of the Test

January 1, 1976, RV-201 lift pressure was checked with plant pressure (without the air set device). Test results were erratic; the valve lifted at 2590 psig (specification is 2488 ± 25 psig) and reseated at 2080 psig. While the plant was being raised to normal pressure, the valve lifted again at 2200 psig and reseated at 1700 psig, then lifted at 1900 psig and reseated at 1700 psig. The valve was gagged but would not hold.

The valve was removed and replaced with a spare valve. During the attempt to check and set the spare valve, using the air set device, the following was observed:

Initial lift was equivalent to 2550 psig with plant pressure at 2000 psig. The valve was adjusted by backing the adjusting bolt (part 29, Figure 1) off two (2) flats which should have reduced the pressure about 60 psi. The valve then lifted at a plant pressure of 2030 psig with 1.5 psig on the air set (equivalent plant pressure of approximately 2070 psig). Then while the plant pressure was building up again, the valve vented at 1920 psig.

1.2 Valve Examination Results

The original RV-201 was damaged internally, not repairable in the field. The moving parts were galled and the spindle bearing end was brinelled, allowing the spring to relax, which explained why the set point kept moving down--see Figure 1. The spare valve was field repairable, but it was evident damage had begun in the same fashion.

1.3 Evaluation

These safety-relief valves are smaller than Crosby's normal nuclear class valve and are a one-of-a-kind design. The normal nuclear class Crosby valve incorporates a hard ball between the spindle and disc holder and stellite on the stem where it goes through the guide. These features were not incorporated on these valves and these were the problem areas; however, these features have since been incorporated, so that the LOFT valves are now current to the state of the art.

These valves were qualification tested (5 lifts) at the vendor's plant using 400 psig steam and a de-rated spring which provides an explanation of why the brinelling/galling problem did not surface until the LOFT plant tests were performed in January of 1976. The softer 400 psi spring would not make bearing pressures on the spindle end sufficiently high to cause the brinelling later observed. There would also be less tendency to chatter and the rubbing velocities would be lower, reducing the galling tendencies. All in all, it would seem that while testing the valve with the 400 psi spring was satisfactory in determining the set point and blow-down of the valve, it was not satisfactory as a qualification test method.

REV	DESCRIPTION	BY	CHK	DATE	APP'L
A	REVISED INLET FACING ADDED PC NO. 44 ADDED DIMENSIONS TO OUTLET CHANGED MAT. PC. 54 AND MISC. CHANGES	JHA	OK	1-25-72	OK 1-25-72
B	WAS 2-1/4 MIN.	JHA	OK	10-17-72	OK 10-17-72
C	ADDED PC NOS. 148, 55, 8, 56	KJM	OK	3-22-76	OK 3-22-76

REV	DESCRIPTION	DATE	APPROVED
-----	-------------	------	----------

THIS DOCUMENT IS RELEASED 1-9-78 AND
SUBSEQUENTLY CONTROLLED IN ACCORDANCE
WITH EG&G STANDARD PRACTICES.

OUTLET
2"
600# ANSI STD.

W.D. Green 5/8/72
DIRECTOR ENG.

On Human 5/10/72
QUALITY ASSURANCE
MGR.

NOTES:

1. RECOMMENDED SPARE PIECE
2. PRESSURE RETAINING PIECE
3. CERTIFICATION OF MATERIAL AND NON-DESTRUCTIVE TESTING
IN ACCORDANCE WITH CROSBY QAI 3226

PC NO.	DESCRIPTION	NO REQD	MATERIAL	MAT'L SPEC.	SEE NOTES	REMARKS
1	BODY	1	SST	ASME SA182 F316 & RDT-M2-2	2,3	
2	NOZZLE	1	" (STELLITE SEAT)	"	2,3	BODY THREADS CHROME PLATED
3	NOZZLE RING	1	"	ASTM A582 TYPE 416 COND. T		
4	" " SET SCREW	1	"	"		
5	A DISC HOLDER	1	INCONEL	INCONEL 718	1,2,3	HEAT TREATED
6	C DISC RING	1	SST	ASTMA479 TYPE 304		
7	D BELLOWS	1	INCONEL	INCONEL		
8	DISC INSERT	1	HAYNES ALLOY	HAYNES STELLITE NO. 6B	1,2,3	
9	" " PIN	1	"	HAYNES ALLOY NO. 25		
10	EDUCTOR	1	"	HAYNES ALLOY NO. 6 OR 6B		
11	ADJUSTING RING	1	SST	ASTMA479 TYPE 304		
12	" " SET SCREW	1	"	ASTM A582 TYPE 416 COND. T		
13	A SPINDLE	1	"	ASTM A193 GR. B6	2,3	
14	B " BALL	1	"	ASTM A276 TYPE 440C	2,3	HEAT TREATED
15	PISTON	1	HAYNES ALLOY	HAYNES STELLITE NO. 6B		
16	" RETAINING RING	1	SST	COMMERCIAL		
17	BONNET ADAPTER	1	INCONEL	INCONEL 718		HEAT TREATED
18	SPINDLE NUT	1	SST	ASTM A582 TYPE 416 COND. T		
19	" " COTTER	1	"	COMMERCIAL		
20	BONNET	1	"	ASME SA 182 F316 & RDT-M2-2	2,3	
21	A SPRING	1	INCONEL ALLOY	INCONEL X750	2,3	
22	B " WASHER	2	SST	ASTM A193 GR. B6	2,3	
23	CAP	1	"	ASTM A351 CF8M		
24	DOG	1	ALLOY STEEL	ASTM A148 CL 150-125		
25	" " SHAFT	1	SST	ASTM A582 TYPE 416 COND. A		HEAT TREATED
26	" " BEARING	1	STEEL	AISI B113-1120		
27	" " O-RING	1	RUBBER	VITON A		
28	" " LEVER NUT	1	STEEL	ASTM A194 CL. 2H		
29	" " LOCKWASHER	1	"	COMMERCIAL		
30	LEVER	1	SST	"		
31	ADJUSTING BOLT	1	"	ASTM A193 GR. B6	2,3	
32	" " NUT	1	"	ASTM A582 TYPE 416 COND. T		
33	CAP PLUG	1	STEEL	COMMERCIAL		
34	" " GASKET	1	"	"		
35	BONNET ADAPTER GASKET	1	"	"		
36	EDUCTOR GASKET	1	"	"		
37	SETScrew GASKET	2	"	"		
38	DOG SHAFT BRNG. GASKET	1	"	"		
39	CAP GASKET	1	"	"		
40	BONNET STUD	6	SST	ASME SA453 GR660 & RDT-M6-6T	2,3	CHROME PLATED
41	" " NUT	6	"	ASME SA453 GR660 & RDT-M6-6T	2,3	
42	NAMEPLATE	1	"	COMMERCIAL		
43	DATA PLATE	1	"	"		
44	GAG SCREW & TAG	1	"	ASTM A582 TYPE 416 COND. T		
45	INLET GASKET	1	COMMERCIAL	COMMERCIAL (FLUOROPOLYMER SPIRAL WOUND GASKET OR EQUIVALENT)		
46	CAP STUD	4	ALLOY STEEL	ASTM A193 GR. B7		
47	" " NUT	4	STEEL	ASTM A194 CL. 2H		
48	NAME PLATE (SECT. III)	1	SST	COMMERCIAL		
49	CAUTION PLATE	1	"	"		
50	DRIVE SCREWS	8	STEEL	"		
51	INLET STUDS	4	SST	ASME SA453 GR660 & RDT-M6-6T	2,3	CHROME PLATED
52	OUTLET STUDS	8	"	"		CHROME PLATED
53	SEAL & WIRE	2	LEAD - SST.	COMMERCIAL		
54	SEAL WIRE	3	SST	"		

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CROSBY CUST. AEROJET NUCLEAR
ORDER NO. S7254
CROSBY F.O. N203956

PREPARED BY JHA DATE 5-10-72
CHECKED BY JHA DATE 5/10/72
CERTIFIED BY JHA DATE 5/10/72

RV-201

ASME SECT. III CLASS I

WEIGHT 110 LBS. APPROX.

SIZE 1-1/2 F2 STYLE HB-BP 86

TYPE E ASSEMBLY NO N56037

CROSBY CROSBY VALVE & GAGE CO.
WRENTHAM, MASS 02093

DRAWING TITLE NOZZLE TYPE RELIEF VALVE

DRAWING NO. DS-C-56037 REV. C

Figure 2 Nozzle Type Relief Valve, Dwg. DS-C-56037, Rev. C

1.4 Disposition

The original RV-201 was sent back to Crosby for evaluation and rebuilding and the spare valve was field repaired and bench set for temporary use on the system. An additional spare was available if required.

At this time, December 1977, all valves have been modified to the normal Crosby nuclear valve design by the addition of part 14B (spindle ball, type 440C heat treated SST); part 55 (piston, Haynes Stellite No. 6B) and part 56 (piston retaining ring, SST)--see Figure 2.

1.5 Valve Lift Testing History (Rebuilt Valves)

Valve lift tests on the plant using the air set device have been performed on two separate dates on valves rebuilt to the Figure 2 design (hard ball between spindle and disc holder and stellite stem).

APRIL 16, 1977 LIFT TESTS (APPENDIX 1)

<u>Crosby Ser. No.</u>	<u>Plant Designation</u>	<u>Calculated Lift Pressure</u> ⁽¹⁾
N56037-00-0002	RV 200A	2445 psig ⁽²⁾
N56037-00-0004	RV 201A	2510 psig

AUGUST 25, 1977 LIFT TESTS (APPENDIX 2)

<u>Crosby Ser. No.</u>	<u>Plant Designation</u>	<u>Calculated Lift Pressure</u> ⁽¹⁾
N56037-00-0002	RV 200A	2535 psig ⁽³⁾
N56037-00-0003	RV 201	2535 psig ⁽⁴⁾
		(Adjusted and retested to 2475 psig)

- (1) Calculated from step 3.6 of Crosby Test Procedure No. T-1652-2 (see Appendix 3) using Drawing No. SK-3625-V, air motor pressure vs. differential pressure. Air motor pressure is read when the

valve opens, begins to simmer or leak audibly. Corresponding differential pressure from SK-3625-V is then added to system pressure to obtain calculated lift pressure.

- (2) Valve removed from plant June 2, 1977, and was returned to Crosby for inspection and re-test.
- (3) Steam was observed escaping from the bonnet vent hole indicating a broken bellows. No attempt was made to alter the set point to specification, 2488 ± 25 psig. Negotiations were in process with Crosby as of December 2, 1977, as to the choice of field or factory repair. (See Appendix 4)
- (4) The valve set point was adjusted and retested through three iterations. The last iteration showed the valve to be within specification 2488 ± 25 psig.

1.6 Potential Errors in Lift Pressure Data

The test pressure gages used to measure lift pressure as specified by DOP 20-018 are a 0-3000 psig $\pm 0.5\%$ of full scale, installed on the pressurizer and a 0-200 to 300 psig $\pm 0.5\%$ of full scale, installed on the air set device. A 0-200 psig gage graduated in 2 psi increments was used for the first three lifts during the 8-25-77 tests. Thus, gage accuracy alone could account for a maximum error in the reported lift pressure of 15 psig plus 25 psig = 40 psig (SK-3625-V of Appendix 3 shows 1 psi on the air set is equivalent to 25 psi differential in plant pressure). Maximum root mean square error would be ~ 29 psi which is approximately equal to one-half the permissible variation in valve set pressure, 2488 ± 25 psig.

A change to a 0-50 psig gage was made for the subsequent 8-25-77 lifts. Assuming 0.5% full scale accuracy, this would reduce reported maximum lift pressure error (assuming reading errors are zero) to 15 psig + 6.25 psig ~ 21 psig. Maximum root mean square error would be ~ 16 psig.

Reading errors are not in fact zero since pressurizer test gage pressure is recorded to the nearest 5 psi and the air set test pressure gage is recorded to the nearest 0.5 psi. Thus, there could be maximum reading/recording errors of 2.5 psi in pressurizer pressure and 6.25 psi in plant differential pressure equal ~ 9 psi, or a maximum root mean square error of ~ 7 psi.

The combined maximum error due to gage accuracy and reading error is then $21 + 9 = 30$ psig, or $16 + 7 = 23$ psig, maximum root mean square.

Obviously, gage accuracy is the major contributor to the total error between true lift pressure and reported lift pressure. This also applies on repeatability between LOFT tests performed several years apart and also between Crosby tests and LOFT tests. Therefore, it is not surprising that the LOFT plant lift test data does not duplicate the Crosby factory data and sometimes the LOFT data falls outside the $\pm 1\%$ lift tolerance, ± 25 psi, following installation of a factory tested valve on the plant.

2.0 LIFT AND RESEAT PRESSURE ADJUSTMENT

Figure 2 shows the pressurizer relief valves as presently configured. Those parts involved in adjusting lift and reseal pressure are listed below (Ref. Figure 2). Detailed instructions for lift pressure and set pressure testing and adjustment are contained in Appendix 5.

<u>Part No.</u>	<u>Description</u>
29	Adjusting Bolt
30	Adjusting Bolt Nut
3	Nozzle Ring (Adjusts pop action and also effects blowdown)
12	Adjusting Ring (the principal blowdown control ring)

Both the nozzle ring and adjusting ring settings are carefully determined by test at the Crosby Factory. The set screws (parts 4 and 13) are installed, engaging notches in the rings, then are lock wired and sealed by part no. 52.

Adjustments in lift pressure have been done at LOFT utilizing part nos. 29 and 30. Access to these parts is also lock wired and sealed.

2.1 Crosby Test Data Example

Appendix 6 is Valve Test Data from testing N56037-00-0001, RV-200, at the Crosby Plant, and illustrates the industry typical bench test for lift and reseal.

Blowdown/reseat is tested by a steam system at approximately 400 psig. This is done by replacing the regular 2500 psig spring (part no. 19A) with a 400 psig test spring. The nozzle ring and guide ring (adjustment ring) are adjusted for pop action and blowdown of 20 psi (5% of the 400 psig opening pressure). This approach is possible since blowdown as a proportion of set pressure stays fairly constant over a wide range of set pressures. Final ring settings (no. of notches from zero) recorded at the bottom of the data sheet are obtained from an imperial Crosby correlation that relates ring settings with the test spring at test pressure vs. the regular spring at the specified lift pressure, 2488 $\pm$ 25 psig. Zero position for both the nozzle ring and guide ring (adjustment ring) is contact with the disc ring (part no. 5-C, Figure 2).

The final setting test for lift pressure is done with the regular spring installed using air as the test medium. The recorded set pressure is 2490 psig.

Seat leakage tests were performed also, once with steam and once with air.

Thus, the valve as received at LOFT from Crosby has been blowdown adjusted, lift tested, and leak tested with all adjustments locked and sealed.

3.0 METHODS OF ASSURING LIFT-RESEAT PRESSURE

The ASME Code, Section XI, 1977, Inservice Inspection of Nuclear Power Plant Components, IWV-3512, deals with testing of Category C, Safety and Relief Valves. IWV-3512 is quoted for ready reference:

IWV-3512 Test Procedure

Safety valve and relief valve set points shall be tested in accordance with ASME PTC 25.2-1966. Bench testing, with suitable hydraulic or pneumatic equipment, or testing in place with hydraulic or pneumatic assist equipment, is an acceptable method under PTC 25.2-1966.

The most recent PTC is ANSI/ASME PTC 25.3-1976 "Safety and Relief Valves" which supersedes PTC 25.2-1966. A new section (4.09) has been added for Valve Operational-Readiness Tests. This section enumerates methods for determining certain valve characteristics "---to assure service readiness---". Briefly the methods are:

- (1) System testing for set and reseal pressure by increasing system pressure to the lift point.
- (2) System testing with an "Airset" device to determine set pressure. Reseat pressure cannot be determined with this method.
- (3) Simulated system testing off plant for set and reseal pressure provided compensation is made for any difference in service fluid and operating temperatures.
- (4) Testing with a spring of lower set pressure rating to determine control ring adjustments (for blowdown characteristics). This must be followed by testing with the design spring for final setting.
- (5) Bench testing for set pressure.

3.1 LOFT Methods

Testing performed at Crosby, see Appendix 6, meets methods (4) and (5) which tests for both lift and reseal pressures.

Testing at LOFT using DOP 20-018, see Appendix 2, meets method (2) for lift pressure only. DOP 20-018 data sheet records plant pressure when the valve closes (for information). Determination of valve reseal pressure is not possible with the air set device installed on the valve. The air set device introduces a non-linearity in the valve spring rate during the lift transient as well as friction and inertia effects. Reseat testing on the LOFT plant without the air set device is not desirable since cycling the plant to 2488 ± 25 psig would use some of the plant fatigue life. Further, attainment of 2488 ± 25 psig is difficult with present pressurizer heater capacity, as demonstrated during IP-01.03-HF-II.

3.2 Nuclear Industry Methods

LTR 10-34, Reference 2, documents telephone conversations with persons at five PWR nuclear power plants in the U.S. concerning pressurizer relief valve testing.

All the plants contacted test their valves for lift pressure only as required by their Technical Specifications. Testing is done on the plant, on a test stand, or by a testing laboratory. Reseat pressure testing was not practiced by any of the plants contacted.

4.0 PROBABILITY OF A VALVE FAILING TO RESEAT

WASH-1400 (Reference 3) estimates "the failure probability for PWR safety and relief valves to reclose, based on PWR operating experience to be about 10^{-2} with an error spread of 10, i.e., 10^{-1} to 10^{-3} with a mean of 10^{-2} ." So, the occurrence of a transient which causes safety valve actuation (an incident of moderate frequency) coupled with the failure of a safety valve to close (10^{-2} probability) results in a coupled accident that is at least an infrequent incident.

5.0 NRC INCIDENT REPORT EXPERIENCE

Appendix 7 documents a telecon with R. A. Hartfield, NRC Office of Management Information and Program Control, Division of Operations Evaluation. Mr. Hartfield stated that the NRC Incident Report computer printout on PWR Pressurizers, 1969 to the present, shows no incident reports wherein pressurizer spring operated (safety) valves failed to reseal.

There were 6 incident reports of valves failing to lift within Technical Specifications as determined by a later examination of the computer printout furnished by Mr. Hartfield. Fourteen valve tests were reported as outside the Technical Specification limit, nine valves tested over specification, and five valves tested under specification. Results are as shown on the table on the following page.

6.0 PROBABILITY OF RADIATION RELEASE INVOLVING FAILURE OF A SAFETY VALVE TO CLOSE - WASH 1400

The WASH-1400 study says that additional failures are required for core damage to result, such as scram or a secondary coolant heat removal failure. The combined failure sequence with the highest probability for core damage had a probability of only 3×10^{-6} , a limiting fault. This failure sequence was a transient failure to scram, then a resulting safety valve lift followed by a failure to reclose. This sequence had only a release category 7 (a release of only $\sim 2 \times 10^{-5}$ of the core iodine inventory). Other LOCA sequences were shown to have approximately the same probability for the same consequence level.

The highest release involving failure of a safety valve to reseal was a release category 3 (20% of the core iodine inventory) for a failure sequence of a transient, failure to scram, the safety valve failure, and containment failure. This sequence had a 3×10^{-8} mean probability, a probability of the same order of magnitude as for other LOCAs.

Therefore, WASH-1400 shows that a small LOCA resulting in core damage and radioactive release involving failure of a safety valve to reseal is no more probable than core damaging accidents involving other LOCA sequences. (WASH-1400, Chapter 5)

<u>Event</u> <u>Date</u>	<u>Plant</u>	<u>Valve No.</u>	<u>Nameplate</u>	<u>Lift</u> <u>Pressure</u>	<u>%</u>	<u>Over</u> <u>Spec</u>	<u>Under</u> <u>Spec</u>
11-10-76	-Ft. Calhoun - 1	RC-141	2530 psig	2580	-	X	
		RC-142	2485 psig	2315	-		X
10-17-73	Indian Point - 2	-	-	-	+2	X	
		-	-	-	+2	X	
		-	-	-	+2	X	
5-13-77	Indian Point - 2	PCV-468	-	-	+1.6	X	
		PCV-466	Seat leakage prevented testing as found				
11-13-76	Surrey - 1	SV1551A	-	2325	-		X
		SV1551B	-	2575	-	X	
9-20-77	Surrey - 2	SV2551A	-	2430	-2.2		X
		SV2551B	-	2400	-3.4		X
		SV2551C	-	2400	-3.4		X
6-27-77	Yankee Rowe	PR-SV-181	-	2511	-	X	
		PR-SV-182	-	2621	-	X	
		Note: PR-SV-181	also exceeded acceptance limit in 1975				X

7.0 CONCLUSIONS

The LOFT pressurizer self-actuating safety-relief valves, presently built to Crosby's normal nuclear design, represent the present state-of-the-art, and should have reliability equivalent to the valves in use throughout the U.S. on PWR plants.

Two sets of LOFT plant lift pressure data, since the valves were modified to nuclear design, do not indicate any problems when gage accuracy and reading errors are included in judging reported results. Reseat pressure testing on the plant cannot be performed with the air-set device; however, the reseat pressures observed indicate the valves are not sticking, and since ring adjustments are locked and sealed, there is no reason to question the reseat pressure test results reported by Crosby.

The nuclear industry practice, in accordance with Section XI of the ASME Code, utilizes testing on the plant, at a vendor's facility, or at an independent test laboratory. Industry Technical Specifications require lift pressure tests only. Reseat pressure testing is done but is not a Technical Specification requirement. The absence of any NRC incident reports on failures to reseat indicates this is not a problem area. There have been no NRC incident reports on failures to lift that would challenge the Technical Specification Safety Limit.

8.0 REFERENCES

- (1) ASME Code Section XI (1977), Inservice Inspection of Nuclear Power Plant Components
- (2) LTR 10-34, Relief Valves Testing
- (3) WASH-1400, "Reactor Safety Study, An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," United States Nuclear Regulatory Commission (October 1975), Appendix V, P. V-38.

APPENDIX 1

PRESSURIZER SAFETY-RELIEF VALVE

LIFT TESTS 4-16-77

CERTIFICATION OF TEST COMPLETION

Test No. IP-01.03-HF-2 Attachment 5 Revision No. 0Title HOT FUNCTIONAL TESTING PRIOR TO L1-4Changes in effect 68-98Partial or final X certificationTest completed 4/19/77 (Ch. 68-96); 5/12/77 (Ch. 97-98)

Date

Operating Procedures Confirmed: POM II - 9.4.8, ECC Accumulator Heating

Enclosures:

Test Summary See page 2 of 35Test Deficiencies See page 16 of 35Conclusions and recommendations See page 18 of 35Data sheets included Yes X No QDR(s) issued Yes X No If yes list nos.

TM-1603 Item 2

TM-1606 Item 10

TM-1852

TM-1924

TM-1925

TM-1926

Prepared by: WMD5-26-77

Date

Reviewed by: AB. Lochant6/8/77

Date

Reliability and Quality
Engineering North BranchWMSchitt
LOFT Technical Support Div.
Joint Test Group Member6-8-77

Date

Approved by: WMD4/3/77

Date

Manager, LOFT Test and
Data Branch (Chairman,
Joint Test Group)RC Stiens - PER TELECOM UNIT
ERDA Joint Test Group Member6-7-77

Date

Issued by LOFT CDCS

Date 6-10-77

TEST COMPLETION REPORT
IP-01.03-HF-2, Attachment 5

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TEST DATA SHEETS

acting over the area of the QOBV closing side, was sufficient force to cause the valve to reseat following the dissipation of the energy in the cavity of 2250 psig.

The mini-blowdown procedure was repeated on 4/15/77 using the method which shuts CV-P138-42 and -43 10 seconds after actuating the LOCE initiate switch. The QOBV closing chambers were initially cooled to $< 140^{\circ}\text{F}$ by cycling each QOBV with the cooler actuating system water to displace the heated liquid already in the closing chambers. With CV-P138-42 and -43 open and 2250 psig at each QOBV the closing chamber temperatures were closely monitored to ensure that neither chamber exceeded 200°F before blowdown. At the time of blowdown, both closing chambers were less than 150°F . The blowdown was successfully completed with both QOBVs opening and remaining open. The cold leg QOBV closing chamber heated up at a rate of $23^{\circ}\text{F/minute}$ prior to blowdown, while the hot leg QOBV closing chamber heated up at less than 5°F/minute . This indicates that the cold leg QOBV piston rings are leaking by at a greater rate, which supports the leakage data obtained during QOBV testing at Consolidated Corporation.

The 17% trip on the hot leg QOBV was not received in DAVDS during either mini-blowdown. This deficiency is documented in QDR TM-1924.

19. Pressurizer Relief Valve Test (Section 6.18)

4/15/77
The pressurizer safety relief valves RV-200 and RV-201 were tested using the CROSBY Air Set Device to assist in lifting the relief valve stem while maintaining primary plant pressure at 2000 psig. RV-201 lifted within the specified pressure band of 2488 ± 25 psig at 2510 psig. RV-200 lifted at 2445 psig, 18 psig below the minimum specified lift pressure. This is acceptable to LOFT Technical Support Division since the LOFT Technical Specification document now states a maximum acceptable lift pressure of 2513 psig but does not state a minimum pressure limit. The valve vendor states that blowdown and reseat pressure cannot be meaningfully determined when using an air assist device to test the relief valves. RV-201 resealed at a plant pressure of 1900 psig (with 525 psig air assist pressure) and RV-200 resealed at 1450 psig (with pressure bled off the air assist chamber). The low reseat pressure of RV-200 has been documented in QDR TM-1925.

20. Pressurizer Sample Valve Leak Check (Section 6.23)

While the primary plant was at 540°F and 2250 psig primary sample recirculation flow was established from the pressurizer sample cooler to qualitatively identify seat leakage through pressurizer sample isolation valves at normal operating conditions. Primary sample recirculation flow indicated by FI-P136-29 was recorded when each of the following valves were sequentially shut to provide a boundary:

CV-P136-19	Pressurizer Liquid Sample Isolation
CV-P136-20	Pressurizer Sample Cooler Inlet
CV-P136-21	Pressurizer Sample Containment Isolation A
CV-P136-22	Pressurizer Sample Containment Isolation B
CV-P136-30	Pressurizer Spray Line Sample Isolation
CV-P139-10	Pressurizer Vent and Sampling Stop

Sheet 1 of 1

DATA SHEET 23

Date 4-18-77Test No. IP-01.03-III-2 Cog. Test Eng. PIP Test Eng. ArmideiTest Title Plant Hot Functional Test - Part 2

Section 6.18 Pressurizer Relief Valve Lift Test

Step No.	Parameter	RV-200	RV-201
6.18.6,14	Pressurizer Pressure, FI-P139-5	<u>1990</u>	<u>2000</u>
	Pressurizer Pressure, test gage psig	<u>2000</u>	<u>1985</u>
6.18.8,	Air test gage lifting pressure psig	<u>19</u>	<u>21</u>
6.18.16	RV discharge high temp. alarm?	<u>No *</u>	<u>YES</u>
6.18.10,	Differential pressure from Rev. 8.9, psid	<u>445</u>	<u>525</u>
6.18.18	Relief valve lift pressure, psig { Pzr. pressure (test gage) plus differential pressure (Rev. 8.9) }	<u>2445</u>	<u>2510</u>
	Required lift pressure, psig	<u>2488 ± 25</u>	<u>2488 ± 25</u>

Serial#:

L-6465NONE

* setpoint set @ 800°F - discharge temp did go up to > 275°F
 Step 6.19.3 QOBV Isolation Valve Operation

QOBV Isolation Valve Remote, Indication, %	CV-P138-2 local Stem position, %	CV-P138-16 local Stem Position, %
20	<u>20</u>	<u>20</u>
40	<u>40</u>	<u>40</u>
60	<u>60</u>	<u>60</u>
80	<u>80</u>	<u>81</u>
100	<u>100</u>	<u>100</u>
50	<u>49</u>	<u>50</u>
0	<u>0</u>	<u>0</u>

Step 6.19.4 PCP-3 Flow Rate @ 2250 psig

PCP-3 flow to PCP-1 (FI-P139-42) (75%) 2 1/4 gpm (2 ± 1 gpm)PCP-3 flow to PCP-2 (FI-P139-43) (39%) 1.8 gpm (2 ± 1 gpm)

FI-P139-42 zeroes @ 14% } no flow 1.83 gpm w/offset
 FI-P139-43 zeroes @ 8% } 1.53 gpm w/offset

← should read
 525 psig per
 correct accept-
 ance per 7.3 in test
 procedure -
 Mott

APPENDIX 2

PRESSURIZER SAFETY-RELIEF VALVE

LIFT TESTS 8-25-77

LOFT DOP - 20-018

PRESSURIZER RELIEF VALVES
(REQUALIFICATION TEST VI-2.2.4)

Prepared by

P. O. O. O. O.5/12/77
Date

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J. P. Kester
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DateJ. C. Haire
PRAC5-23-77
Date

Issued by LOFT CDCS

6-16-77 SA

ISSUED: _____

PAGE

i

TITLE: LOFT DOP-20-018SUBJECT: PRESSURIZER RELIEF VALVES (Requalification Test VI-2.2.4)

Date	Change No.	DRR No.	Effective Pages
6-16-77	Original		i, 1-7
8-25-77	1		2, 3, 4, 6, 7

Original Issue
Date: 6-16-77

ISSUED: _____ PAGE 1TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

1.0 REFERENCES

- 1.1 LOFT Requalification Manual, Volume VI
- 1.2 LOFT Plant Operating Manual, Volume II, Chapter 4 - Primary Coolant System
- 1.3 Crosby Valve and Gage Company "Installation, Operating and Maintenance Instruction No. I - 1105 - 2 for Crosby Style HB and HB-BP Self-Actuated Nozzle Type Safety - Relief Valves."
- 1.4 LMP-001 - Cleaning and Cleanliness Requirements for Nuclear Construction

2.0 GENERAL

This procedure provides instructions for the set pressure testing of the pressurizer relief valves, RV-200 and RV-201. An air set pressure device will be attached to each valve to allow testing the valves on the system at a pressure below the normal system operating pressure.

The signoff spaces in the margins shall be initialled by the individual performing that step in the procedure. Steps identified by a "Q" require Quality Division coverage. The inspector providing the coverage shall so certify by placing his stamp marking in the margin near the signoff space.

3.0 MATERIAL

- 3.1 A test pressure gage with a range of 0 to 3000 psig and an accuracy of $\pm 0.5\%$ of full scale.
- 3.2 A Crosby Valve and Gage Co. Air-set Pressure Device with the following installed:
 - 3.2.1 A test pressure gage with a range of 0 - 200 to 300 psig and an accuracy of $\pm 0.5\%$ of full scale.
 - 3.2.2 An air regulator supplied by Crosby Valve and Gage Co. for use with the device.
- 3.3 A contact or optical pyrometer capable of reading up to 500° F.
- 3.4 Approximately fifteen (15) feet of stainless steel tubing and fittings.

4.0 SPECIFIC PRECAUTIONS

- 4.1 LOFT Facility Division Standard Practice LFSP - 6.3.2, Non-Nuclear Hot Operations Containment Test Chamber Access Requirements, will be observed for all entry and work in the test chamber.

5.0 PREREQUISITES

Original Issue
Date: 6-16-77

ISSUED: _____ PAGE 2

TITLE: LOFT DOP - 20-018 (Qualification Test VI-2.2.4)

SUBJECT: Pressurizer Relief Valves

- Q 5.1 The test pressure gage, serial no. L-5686, of step 3.1 is in current calibration and has been installed to the instrument tap for pressurizer transmitter, PT-P139-5.

Verified: Quality Division 8-25-77
Date

- Q 5.2 The test pressure gage, serial no. A-200, for use with the air-set device is in current calibration.

Verified: Quality Division 8-25-77
Date

- 5.3 The length of stainless steel tubing and fittings have been connected between the pressurizer loop seal drain line, 1" PCD-19 downstream of V-6337 and routed to the condensate sump below the water level.

Ch. 1

- 5.4 The primary coolant system is at 1950 ± 50 psig and in the operating region with a bubble in the pressurizer as indicated on figure 4.8.1 of Reference 1.2.

6.0 PROCEDURE

Procedure started: Time 15:05 Date 8/25/77

- 6.1 The Shift Supervisor verifies that the Prerequisites have been met.

- 6.2 Install the air set pressure device on either RV-200 or RV-201 in accordance with steps 3.1 and 3.2 of Crosby Test Procedure No. T-1652 of Reference 1.3.

- 6.3 Attach a 150 psig, or greater, plant or instrument air supply with a pressure regulator and test pressure gage to the air motor of the air-set pressure device.

- 6.4 Manually cycle the pressurizer heaters as necessary to establish and maintain a steady state pressurizer pressure of 2000 ± 25 psig as indicated by PI-P139-5.

- 6.5 Blowdown the pressurizer loop seal to establish a steam environment at the relief valve inlet as follows:

- 6.5.1 Shut or check shut CV-P139-10, Pressurizer Vent and Sampling Stop, and CV-P139-20, Pressurizer Sample Cooler Inlet. ~~unpetone splash *~~

- 6.5.2 Deleted.

Ch. 1

ISSUED: _____ PAGE 3

TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)

SUBJECT: Pressurizer Relief Valves

6.5.3 Open loop seal drain valves V-4024 and V-6337.

6.5.4 While the loop seal is venting, take pyrometer readings of the loop surface temperature close to the pressurizer thermal sleeve (Location No. 1 on Figure 1), of the loop just below the relief valve inlet flange (Location No. 2 on Figure 1), and of the relief valve body just above the inlet flange (Location No. 3 on Figure 1). When locations 1 and 2 are over 500° F and location 3 is above 250° F, shut LV-4024 and V-6337. Ch.1

6.5.5 If there is any delay in the testing, the loop seal should be reopened to prevent condensation. Pyrometer readings should again be taken to verify the temperatures of step 6.5.4 before testing is resumed.

6.6 Record on Data Sheet 1 the pressurizer pressure from PI-P139-5.

6.7 Stop the primary coolant pumps.

6.8 Increase the air pressure to the air motor slowly by operating the pressure regulator. When the relief valve opens, begins to simmer, or leaks audibly, record the air test gage pressure and the pressurizer test gage pressure on Data Sheet 1. Verify that the relief discharge high temperature alarm actuates.

6.9 Release all air pressure on the air motor. If the relief valve opened instead of simmering, record the pressurizer test gage pressure and air set test gage pressure when the valve reseats.

6.10 Restart the primary coolant pumps per section 4.4.1 of Reference 1.2.

6.11 Using the air test pressure recorded in step 6.8, determine the differential pressure from curve F of drawing SK - 5015 - V of Reference 1.3. Then add this differential pressure to the initial pressurizer pressure of step 6.8 and record the sum as the relief valve set pressure on Data Sheet 1.

6.12 If the relief valve opened, repeat step 6.11 using the air test gage and pressurizer test gage pressures of step 6.9 to determine the reseal pressure for the relief valve.

6.13 Remove the air test pressure device and reinstall the hand lifting lever assembly on the relief valve.

If the other relief valve will not be tested, proceed to step 6.23.

ISSUED: _____ PAGE 4TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

- 6.14 Install the air set pressure device on the other relief valve in accordance with steps 3.1 and 3.2 of Crosby Test Procedure No. T-1652 of Reference 1.3.
- 6.15 Manually cycle the pressurizer heaters as necessary to establish and maintain a steady state pressurizer pressure of 2000 ± 25 psig. Record on Data Sheet 2 the pressurizer pressure from PI-P139-5.
- 6.16 Stop the primary coolant pumps.
- 6.17 Increase the air pressure to the air motor slowly by operating the pressure regulator. When the relief valve opens, begins to simmer, or leaks audibly, record the air test gage pressure and the pressurizer test gage pressure on Data Sheet 2. Verify that the relief discharge high temperature alarm actuates.
- 6.18 Release all air pressure on the air motor. If the relief valve opened instead of simmering, record the pressurizer test gage pressure and air set test gage pressure when the valve reseats on Data Sheet 2.
- 6.19 Restart the primary coolant pumps per section 4.4.1 of Reference 1.2.
- 6.20 Using the air test pressure recorded in step 6.17, determine the differential pressure from curve F of drawing SK - 5015 - V of Reference 1.3. Then add this differential pressure to the initial pressurizer pressure of step 6.17 and record the sum as the relief valve set pressure in Data Sheet 2.
- 6.21 If the relief valve opened, repeat step 6.20 using the air test gage and pressurizer test gage pressures of step 6.18 to determine the reseal pressure for the relief valve.
- 6.22 Remove the air set pressure device and reinstall the hand lifting lever assembly on the relief valve.
- 6.23 Deleted
- 6.24 Return the primary coolant system to normal or as required for further plant testing.

Ch. 1

Procedure completed: Signature _____ Shift Supervisor

Time _____ Date _____

ISSUED: _____ PAGE 5

TITLE: LOFT DOP 20-018 (Requalification Test VII-2.2.4)

SUBJECT: Blowdown Suppression Tank Check Valves

FIGURE 1

ISSUED: _____ PAGE 6TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

Data Sheet 1

Rev. No. 1 of 1
RV 200

Step No.	Parameter	<u>RV-200/201</u> (Circle one)
6.6	Pressurizer Pressure from PI-P139-5	<u>2020</u> psig
6.8	Air Test Gage Pressure	<u>22</u> psig
	Pressurizer Test Gage Pressure	<u>2015</u> psig
	Relief Discharge High Temp Alarm Activated	Yes <u>(No)</u> (Cross one out)
6.9	Air Test Gage Pressure upon reseat if valve opens	<u>0</u> psig
	Pressurizer Test Gage Pressure upon reseal if valve opens	<u>1750</u> psig
6.11	Relief Valve Set Pressure	<u>2535</u> psig
6.12	Relief Valve Reseat Pressure if valve opens	<u>1750</u> psig (1)

Acceptance Limit for set Pressure = 2408 ± 25 psig

Ch. 1

(1) For information only

ISSUED: _____ PAGE 6TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

Data Sheet 1

Run No 2 on RV 200

Step No.	Parameter	RV (200) 201 (Circle one)
6.6	Pressurizer Pressure from PI-P139-5	<u>2000</u> psig
6.8	Air Test Gage Pressure	<u>20</u> psig
	Pressurizer Test Gage Pressure	<u>1990</u> psig
	Relief Discharge High Temp Alarm Activated	☒ Yes / ☐ No (Cross one out)
6.9	Air Test Gage Pressure upon reseal if valve opens	<u>0</u> psig
	Pressurizer Test Gage Pressure upon reseal if valve opens	<u>1800</u> psig
6.11	Relief Valve Set Pressure	<u>2450</u> psig
6.12	Relief Valve Reseat Pressure if valve opens	<u>1800</u> psig (1)

Acceptance Limit for set Pressure = 2408 ± 25 psig

(1) For information only

/ch.1

ISSUED: _____ PAGE 7TITLE: LOFT DOP - 20-018 (Regualification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

Data Sheet 2

TIME 182 2030 Run No 1
RV-200/001 (Circle one) on RV 201

Step No.	Parameter	
6.15	Pressurizer Pressure from PI-P139-5	<u>2000</u> psig
6.17	Air Test Gage Pressure	<u>23</u> psig
	Pressurizer Test Gage Pressure	<u>1995</u> psig
	Relief Discharge High Temp Alarm Activated	Yes/No (Cross one out)
6.18	Air Test Gage Pressure upon reseat if valve opens	<u>0</u> psig
	Pressurizer Test Gage Pressure upon reseal if valve opens	<u>1950</u> psig
6.20	Relief Valve Set Pressure	<u>2535</u> psig
6.21	Relief Valve Reseat Pressure if valve opens	_____ psig (1)

Acceptance Limit for set pressure = 2480 ± 25 psig

(1) For information only

Ch. 1

RV-201
2005
2050ISSUED: _____ PAGE 6TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

Data Sheet 1

Step No.	Parameter	RV-200/ <u>(201)</u> (Circle one)
6.6	Pressurizer Pressure from PI-P139-5	<u>2015</u> psig
6.8	Air Test Gage Pressure	<u>23</u> psig
	Pressurizer Test Gage Pressure	<u>2005</u> psig
	Relief Discharge High Temp Alarm Activated	EX NO (Cross one out)
6.9	Air Test Gage Pressure upon reseal if valve opens	<u>0</u> psig
	Pressurizer Test Gage Pressure upon reseal if valve opens	<u>1975</u> psig
6.11	Relief Valve Set Pressure	<u>2345</u> psig
6.12	Relief Valve Reseat Pressure if valve opens	<u>1975</u> psig (1)

Acceptance Limit for set Pressure = 2408 ± 25 psig

(1) For information only

/ch.1

ISSUED: _____ PAGE 7TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

Data Sheet 2

RV 201
Run #3

RV-200/201 (Circle one)

Step No.	Parameter	
6.15	Pressurizer Pressure from PI-P139-5	<u>2020</u> psig
6.17	Air Test Gage Pressure	<u>19</u> psig
	Pressurizer Test Gage Pressure	<u>2015</u> psig
	Relief Discharge High Temp Alarm Activated	Yes/No (Cross one out)
6.18	Air Test Gage Pressure upon reseat if valve opens	<u>0</u> psig
	Pressurizer Test Gage Pressure upon reseal if valve opens	<u>1975</u> psig
6.20	Relief Valve Set Pressure	<u>2465</u> psig
6.21	Relief Valve Reseat Pressure if valve opens	<u>1975</u> psig (1)

Acceptance Limit for set pressure = 2480 ± 25 psig

Ch. 1

(1) For information only

RV 201 adjusted 1/2 flat "back"

ISSUED: _____ PAGE 6

TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

Data Sheet 1

Run #1

Step No.	Parameter	RV-200/201 (Circle one)
6.6	Pressurizer Pressure from PI-P139-5	<u>2000</u> psig
6.8	Air Test Gage Pressure	<u>17.5</u> psig
	Pressurizer Test Gage Pressure	<u>2000</u> psig
	Relief Discharge High Temp Alarm Activated	Yes/No (Cross one out)
6.9	Air Test Gage Pressure upon reseat if valve opens	<u>0</u> psig
	Pressurizer Test Gage Pressure upon reseal if valve opens	<u>1935</u> psig
6.11	Relief Valve Set Pressure	<u>2405</u> <u>2425</u> psig
6.12	Relief Valve Reseat Pressure if valve opens	<u>1935</u> psig (1)

Acceptance Limit for set Pressure = 2408 ± 25 psig

(1) For information only

/ch.1

ISSUED: _____ PAGE 6

TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

Data Sheet 1

Run #5

Step No.	Parameter	RV-200/201 (Circle one)
6.6	Pressurizer Pressure from PI-P139-5	<u>1995</u> psig
6.8	Air Test Gage Pressure	<u>18.5</u> psig
	Pressurizer Test Gage Pressure	<u>1995</u> psig
	Relief Discharge High Temp Alarm Activated	Yes/No (Cross one out)
6.9	Air Test Gage Pressure upon reseat if valve opens	<u>0</u> psig
	Pressurizer Test Gage Pressure upon reseat if valve opens	<u>1975</u> psig
6.11	Relief Valve Set Pressure	<u>2422</u> psig
6.12	Relief Valve Reseat Pressure if valve opens	<u>1975</u> psig (1)

Acceptance Limit for set Pressure = 2408 ± 25 psig

(1) For information only

/ch.1

APPENDIX 4

LETTER FROM EG&G TO CROSBY;
SUBJECT: RELIEF VALVE REPAIR AND TEST OF CROSBY VALVE,
SERIAL NUMBERS N56037-00-0002 AND N56037-00-0003,
LMC-132-77, DECEMBER 2, 1977

ISSUED: _____ PAGE 7TITLE: LOFT DOP - 20-018 (Requalification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

Data Sheet 2

Run 8

Step No.	Parameter	RV-200/ <u>201</u> (Circle one)
6.15	Pressurizer Pressure from PI-P139-5	<u>198.5</u> psig
6.17	Air Test Gage Pressure	<u>20.5</u> psig
	Pressurizer Test Gage Pressure	<u>1990</u> psig
	Relief Discharge High Temp Alarm Activated	Yes/no (Cross one out) <i>485</i> <i>1980</i> <i>2475</i>
6.18	Air Test Gage Pressure upon reseal if valve opens	_____ psig
	Pressurizer Test Gage Pressure upon reseal if valve opens	<u>1975</u> psig
6.20	Relief Valve Set Pressure	<u>2475</u> psig ✓
6.21	Relief Valve Reseat Pressure if valve opens	_____ psig (1)

Acceptance Limit for set pressure = $2480 \pm .25$ psig

(1) For information only

| Ch. 1

Adjusted 1/8 Flat "forward"

ISSUED: _____ PAGE 7TITLE: LOFT DOP - 20-018 (Regualification Test VI-2.2.4)SUBJECT: Pressurizer Relief Valves

Data Sheet 2

Step No.	Parameter	RV-200/201 (Circle one)
6.15	Pressurizer Pressure from PI-P139-5	_____ psig
6.17	Air Test Gage Pressure	_____ psig
	Pressurizer Test Gage Pressure	_____ psig
	Relief Discharge High Temp Alarm Activated	Yes/No (Cross one out)
6.18	Air Test Gage Pressure upon reseat if valve opens	_____ psig
	Pressurizer Test Gage Pressure upon reseat if valve opens	_____ psig
6.20	Relief Valve Set Pressure	_____ psig
6.21	Relief Valve Reseat Pressure if valve opens	_____ psig (1)

Acceptance Limit for set pressure = 2480 ± 25 psig

Ch. 1

(1) For information only

APPENDIX 3

CROSBY TEST PROCEDURE NO. T-1652-2,
DETERMINING SAFETY VALVE SET PRESSURE
WITH AIR SET PRESSURE DEVICE

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASSACHUSETTS

TEST PROCEDURE NO. T-1652-2
DETERMINING SAFETY VALVE SET PRESSURE
WITH AIR SET PRESSURE DEVICE

1. Principle of Operation

- 1.1 The apparatus basically consists of a safety valve lifting device which is mounted on the bonnet of the safety valve (hand lifting gear assembly removed), an air operated lifting motor (diaphragm sealed air cylinder having a known effective area) and a pressure gage. The principle of operation is to apply and measure the differential force required to lift the safety valve when the actual system (steam) pressure force acting on the area of the valve seat is below the spring setting of the valve, and evaluate this force in terms of valve spring force to determine valve set pressure.

2. Description of Device and Operation

The device operates as follows:

- 2.1 Air pressure is applied by means of the air pressure regulator or manual control valve to the air inlet of the air motor. The resultant force is transmitted by the lower plate, through the spindle adapter, to the spindle of the valve, imposing a lifting force on the spindle and thereby in effect adding to the lifting effort of the steam pressure below the valve seat. When the total lifting force is equal to the spring load holding the valve closed, the valve will partially open, simmer or leak audibly. The air pressure to the air motor at that point can be converted into Valve Differential Set Pressure from the chart of Air Motor Pressure Vs. Differential Set Pressure (SK-3626-V for 12 Sq. In. Air Motor or SK-3627-V for 50 Sq. In. Air Motor). This data has been plotted from factory tests for each orifice size.
- 2.2 The air set pressure device used is as shown on Drawing SK-2737-V, this drawing shows the device in place on the bonnet of a safety valve.

The items used to make up the apparatus are as follows:

- 2.2.1 Subassembly consisting of air motor assembly, upper plate, lower plate, studs and nuts.
- 2.2.2 Base plate.
- 2.2.3 Bonnet adapter.
- 2.2.4 Spindle adapter.
- 2.2.5 Manifold assembly consisting of pressure regulator, pressure gage and the necessary fitting.

3. Test Procedure

- 3.1 Remove hand lifting lever assembly and mount bonnet adapter selected from chart on Drawing SK-2980-V and air set pressure device on top of valve (see Drawings SK-2737-V and SK-3066-V).
- 3.2 Assemble spindle adapter selected from chart on Drawing SK-2980-V to valve spindle until the top of the adapter is flush with the top of the valve spindle.
- 3.3 Attach manifold assembly to air motor.
- 3.4 Read system (steam) pressure beneath valve seat. (Note:- The established system (steam) pressure for set pressure testing should be in the range of 15-25% below the set pressure of the valve. System (steam) pressures in the blowdown range of the valve (4-10%) and pressures below 25% of set pressure should be avoided.)
- 3.5 Increase air pressure to air motor slowly by operating the pressure regulator. Raising pressure will exert an upward force on the valve spindle.
- 3.6 When valve opens, begins to simmer, or leak audibly, record the air pressure on gage on manifold assembly, and the system (steam) pressure.
- 3.7 Release all air pressure on air motor.
- 3.8 With the air motor pressure recorded in Paragraph 3.6 read the differential pressure from the graph on the following drawings:

<u>Air Motor Size</u>	<u>Drawing No.</u>
12 Sq. In.	SK-3626-V
50 Sq. In.	SK-3627-V

This value of differential pressure when added to the system pressure, recorded in Paragraph 3.6, is the safety valve set pressure.

- 3.9 The operation may be repeated a number of times to average out data readings and to establish more accurately the opening pressure of the valve.

Application

- 4.1 This set pressure device requires only a source of air pressure for actuation of the air motor, and sufficient head room and space as shown on Drawing SK-3066-V for mounting the device on top of the valve.
- 4.2 With air pressure of 150 p.s.i. available, this apparatus can be used for determining the set pressure of valves with a maximum recommended pressure differential beneath the valve as indicated below.

4. Application (Continued)

4.2 (Continued)

<u>Air Motor Size and Part No.</u>	<u>Orifice</u>	<u>Differential Pressure</u>
12 Sq. In. (SA-50601)	F	2500
	G	2500
	H	1500
	J	875
	K	650
50 Sq. In. (SA-50529)	K	2200
	K2	1800
	M1, M, M2	1350
	P	825
	Q	475
	R	325
	T	200

CROSBY VALVE & GAGE CO.
WRENTHAM, MASS.

DRAWING NO. SK-2737-V

TABULATION OF CROSBY PART NUMBERS FOR SET PRESSURE DEVICE
FOR CROSBY HC AND HCA VALVES, ORIFICE F THRU T
CROSBY TEST PROCEDURE T-1652
DRAWING NO. SK-2980-V

12 Sq. In. Air Set Pressure Device
Device Assembly Consists of the following:
Subassembly SA-50601, Base Plate 83547, Air
Pressure Manifold SA-50804, Bonnet and
Spindle Adapters from Table Below

VALVE STYLE	NAME	F	G	H	J	K
HC-2()	BONNET ADAPTER					
HCA-2()	SPINDLE ADAPTER					
HC-3()	BONNET ADAPTER	85433	83549	83549	83549	83549
HCA-3()	SPINDLE ADAPTER	83551	83551	83551	83550	82893
HC-4()	BONNET ADAPTER					
HCA-4()	SPINDLE ADAPTER					
HC-5()	BONNET ADAPTER	85433	83549	83549	83549	83549
HCA-5()	SPINDLE ADAPTER	83551	83551	83551	83550	82893
HC-6()	BONNET ADAPTER	85433	83549	83549	83549	83549
HCA-6()	SPINDLE ADAPTER	83551	83551	83551	83550	82893
HC-7()	BONNET ADAPTER	85433	83549	83549	83549	83549
HCA-7()	SPINDLE ADAPTER	83551	83551	83551	82893	82893
HC-8()	BONNET ADAPTER	85433	83549	83549	83549	83549
HCA-8()	SPINDLE ADAPTER	83551	83551	83551	82893	82893
HC-9()	BONNET ADAPTER	85433	83549	83549	83549	83549
HCA-9()	SPINDLE ADAPTER	83551	83551	83551	82893	82893
HCA-10()	BONNET ADAPTER		83549	83549	---	
HCA-11()	SPINDLE ADAPTER		83551	82893	83507	

50 Sq. In. Air Set Pressure Device
Device Assembly Consists of the following: Subassembly
SA-50529, Base Plate 83506, Air Pressure Manifold
SA-50804, Bonnet and Spindle Adapters from Table Below

VALVE STYLE	NAME	K	K2	M	M2	P	Q	R	T
HC-2()	BONNET ADAPTER					---	---	---	---
HCA-2()	SPINDLE ADAPTER					83508	83507	83509	83509
HC-3()	BONNET ADAPTER	83436	83436	---	---	---	---	---	---
HCA-3()	SPINDLE ADAPTER	82893	82893	83508	83508	83508	83507	83509	83509
HC-4()	BONNET ADAPTER					---	---	---	
HCA-4()	SPINDLE ADAPTER					83508	83509	83509	
HC-5()	BONNET ADAPTER	83436	83436	---	---	---	---	---	
HCA-5()	SPINDLE ADAPTER	82893	82893	83508	83508	83508	83509	83509	
HC-6()	BONNET ADAPTER	83436	83436	---	---	---	---	---	
HCA-6()	SPINDLE ADAPTER	82893	82893	83508	83508	83509	83509	83509	
HC-7()	BONNET ADAPTER	83436	---	---	---				
HCA-7()	SPINDLE ADAPTER	82893	83508	83508	83508				
HC-8()	BONNET ADAPTER	83436	---	---	---				
HCA-8()	SPINDLE ADAPTER	82893	83508	83508	83508				
HC-9()	BONNET ADAPTER	83436	---	---	---				
HCA-9()	SPINDLE ADAPTER	82893	83508	83508	83508				
HCA-10()	BONNET ADAPTER	---	---	---	---				
HCA-11()	SPINDLE ADAPTER	83509	83509	83509	83509				

CROSBY VALVE & GAGE CO.
WRENTHAM, MASS.
DRAWING NO SK-3066-V

AIR MOTOR	"A"	
12 SQ. IN.	15"	
50 SQ. IN.	20"

VALVE-TYPE C
WITH
HAND LIFTING LEVER ASSEMBLY
INSTALLED

SEE VALVE SPEC.
SHEET FOR THE
OVERALL AND
DISMANTLING HTS.

"A"
INCL. CONN.
FOR AIR
PRESSURE
SOURCE

VALVE-TYPE C
WITH
HAND LIFTING LEVER ASSEMBLY REMOVED
AND AIR SET PRESSURE DEVICE
INSTALLED

AIR SET PRESSURE DEVICE MOUNTING DIMENSIONS

CROSBY VALVE & GAGE CO.
WRENTHAM, MASS.
DRAWING NO. SK-3626-V

F A G-

H-

J-

K-

DIFFERENTIAL PRESSURE (PSIG)

HC VALVES
CHART FOR DETERMINING
DIFFERENTIAL SET PRESSURE
USING AIR SET PRESSURE
DEVICE PER SK-2737-V
TEST PROCEDURE NO. T-1652
12 SQ. IN. AIR MOTOR
ORIFICES "F" THROUGH "K"

AIR MOTOR PRESSURE (PSIG)

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

CROSBY VALVE & GAGE CO.
WRENTHAM, MASS.
DRAWING NO SK-3627-V

DIFFERENTIAL PRESSURE (PSIG)

DIFFERENTIAL PRESSURE (PSIG)

AIR MOTOR PRESSURE (PSIG)

HC VALVES

CHART FOR DETERMINING

DIFFERENTIAL SET PRESSURE

USING AIR SET PRESSURE DEVICE PER

SK-2737-V TEST PROCEDURE NO T-1652

50 50 IN AIR MOTOR ORIFICES "K" THROUGH "T"

Cronby Valve & Gage Company
Wrentham, Massachusetts

SUPPLEMENT NO. 1 TO TEST PROCEDURE NO. T-1652
TEST APPARATUS FOR DETERMINING SAFETY VALVE SET PRESSURE

1. This supplement covers the necessary instructions to allow the use of the air set pressure device described in Test Procedure No. T-1652 on Style HB Safety Valves.
2. Modifications In Equipment
 - 2.1 Paragraphs 2 and 3 of Test Procedure T-1652 outlines the equipment and how it shall be used. These paragraphs should be followed when installing the air set pressure device and testing HB Valves except that the equipment selection and installation should be to the following drawings.
 - 2.1.1 Drawing SK-3624-V - "Tabulation Of Air Set Pressure Device Part Numbers Used On Style HB Safety Valves".
 - 2.1.2 Drawing SK-3619-V - "Head Room Necessary For Mounting The Air Set Pressure Device On Style HB Safety Valves".
 - 2.1.3 Drawing SK-3620-V - "Air Set Pressure Device Mounted On A Style HB Safety Valve".
 - 2.1.4 Drawing SK-3625-V - "Chart For Air Motor Pressure Versus Differential Set Pressure".

REVISED - JUNE 1970

CROSBY VALVE & GAGE CO.
WRENTHAM, MASS.

DRAWING NO. SK-3619-V

AIR MOTOR	"A"	
12 SQ. IN.	13"	
50 SQ. IN.	15 1/2"	

"A"
INCL. CONN.
FOR AIR PRES-
SURE SOURCE

SEE VALVE SPEC.
SHEET FOR THE
OVERALL AND
DISMANTLING HGTS

VALVE-TYPE D OR E
WITH
HAND LIFTING LEVER ASSEMBLY
INSTALLED

VALVE-TYPE D OR E
WITH
HAND LIFTING LEVER ASSEMBLY REMOVED
AND AIR SET PRESSURE DEVICE
INSTALLED

AIR SET PRESSURE DEVICE MOUNTING DIMENSIONS

CROSBY VALVE & GAGE CO.
WRENTHAM, MASS.

DRAWING NO. SK-3620-V

AIR SET PRESSURE DEVICE
FOR DETERMINING VALVE SET PRESSURE
WITH TYPE D OR E HANDLIFTING
LEVER ASSEMBLY REMOVED

Crosby Valve & Gage Company
Wrentham, Massachusetts

**TABULATION OF CROSBY PART NUMBERS FOR SET PRESSURE
DEVICE FOR CROSBY HB SAFETY VALVES, ORIFICE F THRU M
CROSBY TEST PROCEDURE NO. T-1652 SUPPLEMENT NO. 1
DRAWING NO. SK-3624-V**

	12 Sq. In. Air Motor Device Assembly Consists of the fol- lowing: Subassembly SA-50601, Air Pressure Manifold SA- 50804, Base Plate, Bonnet and Spindle Adapters, Box and Saddle from Table Below.	50 Sq. In. Air Motor Device Assem- bly consists of the following: Sub- assembly SA-50529, Air Pressure Manifold SA-50804, Base Plate, Bonnet and Spindle Adapters, Box and Saddle from Table Below.
Valve Size	F	K K2 M1 & M
Base Plate	85510	83512 83512 83512
Spindle Adapter	85511	83508 83508 83508
Box and Saddle	SA-52068	SA-50477 SA-50477 SA-50477

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

1. Valve studs and nuts shall be clean and visually inspected to insure freedom from any objectionable foreign matter, rust, burrs or physical damage.
2. With the valve in place, lubricate the flange bolt threads as well as the nut spot-faces with NEVER-SEEZ Compound (which conforms to Government Specification MIL-A-907B, Federal Stock No. 8030-286-5453) or equivalent.
3. Install nuts on the bolts finger-tight.
4. Tighten the nuts in the sequence shown in diagram below to approximately one-half the torque value shown in table below. Repeat the same sequence of tightening to the torque value shown in table below. Then starting with the No. 1 Nut, tighten each nut in order in a clockwise or counterclockwise direction to the value shown in table below.
5. Wipe off excess lubricant.

4 Studs

6 Studs

8 Studs

12 Studs

Stud Thread	Torque (Ft. Lbs.) to Produce Stress in Stud Bolts		
	30,000 p.s.i. Stress	45,000 p.s.i. Stress	60,000 p.s.i. Stress
7/16-14	20	30	40
1/2-13	30	45	60
5/8-11	60	90	120
3/4-10	100	150	200
7/8-9	160	240	320
1-8	240	370	500
1-1/8 - 8	350	525	700
1-1/4 - 8	500	750	1000

A-1519	1
PROCEDURE NO.	REV.

APPENDIX 4

LETTER FROM EG&G TO CROSBY;
SUBJECT: RELIEF VALVE REPAIR AND TEST OF CROSBY VALVE,
SERIAL NUMBERS N56037-00-0002 AND N56037-00-0003,
LMC-132-77, DECEMBER 2, 1977

bcc: E. Brown
E. B. Forrest
J. H. Hunter
J. P. Kester
D. Kirkham
M. Morgan
H. L. Spilker
G. E. Tanguay
D. G. Vest
L. M. Collins
File
Central File

December 2, 1977

Mr. Bob O'Neill
Crosby Valve & Gage Company
43 Kendrick Street
Wrentham, MA 02093

SUBJECT: RELIEF VALVE REPAIR AND TEST OF CROSBY VALVE SERIAL NUMBERS
N56037-00-0002 AND N56037-00-003 - LMC-132-77

Dear Mr. O'Neill:

EG&G currently has four 2500 PSI 1½ Relief Valves installed at the LOFT Facility that provide protection to the Primary Reactor System. These valves were purchased from Crosby in 1971. During the past six years, EG&G has experienced several problems that have manifested themselves during Lift Testing of the subject valves. Because of the problems, EG&G is under considerable pressure from the Department of Energy to verify performance characteristics and the acceptability of the Crosby Valves for continued use.

Lift Testing of two Relief Valves, Serial Numbers N56037-00-0002 and 0003 was conducted at the LOFT Facility on August 25, 1977. Crosby's Field Representative, Mr. Walter Conrad, was present and witnessed these tests at our request and expense. During the Lift Test of Relief Valve N56037-00-0002, steam blew through the vent port indicating a broken bellows. It seems improbable that this valve would fail on its first lift in view of the fact that it had recently been returned to us from the Crosby manufacturing facility where it was inspected and tested for both lift and blowdown characteristics.

EG&G has just completed a program of returning each of these valves to you for retesting to establish both lift and blowdown characteristics as a means of verifying performance in response to inquiries and concerns expressed by the Department of Energy. The Department of Energy's concern was generated by the Lift Test that was conducted on April 16, 1977 in which a Relief Valve blew down excessively causing a plant pressure drop of 25 percent. The Relief Valve that caused the excessive blowdown was Serial No. 0002, the same valve which vented steam on the August 25, 1977 test. In fact, this excessive blowdown was the reason that Relief Valve S/N 0002 was selected as the first to be sent back to Crosby for inspection and testing and the first to be re-tested at the LOFT Facility.

EG&G recognizes Crosby as a leader in the Relief Valve industry and therefore requests your assistance in the following two areas:

1. EG&G currently has Relief Valve S/N 0002 with a potentially broken bellows. We also have a spare bellows assembly.

Crosby Valve & Gage Company
December 2, 1977
LMC-132-77
Page 2

EG&G could crate up both the valve and spare bellows and return to Crosby for repair or EG&G could repair the Relief Valve at the Idaho National Testing Laboratory with the assistance of your Field Representative. We would like your advice on the best course of action. EG&G is willing to assist Crosby in any way to help determine the cause of failure and to make the appropriate repairs. EG&G could also provide a Metallurgist and the use of the site Metallurgical Laboratory.

- 2. EG&G further has a problem in justifying the acceptability and continued use of the Crosby Relief Valves to the Department of Energy. To help resolve this and upon Crosby's firm determination that the testing procedures were sufficient, a report from your Field Representative, Mr. Conrad, verifying the Lift Testing Procedures as used at LOFT are sufficient for determining lift set points would be beneficial. EG&G expected such a report as part of Crosby's representative visit. EG&G also needs vendor originated information and recommendations on blowdown set point testing. Specifically, EG&G needs documentation that we can use with the Department of Energy to show that vendor determination of the blowdown characteristic is sufficient to prevent extended plant blowdown during valve lift and is consistent with standard industry practice.

EG&G believes once the bellows has been repaired in Relief Valve S/N 0002 inspected and tested, the major mechanical concerns for the balance of the Crosby Relief Valves will be resolved. EG&G still has the specific need to convince the Department of Energy that the Crosby Valves are satisfactory for continued use. Crosby's efforts to aid EG&G resolve the Department of Energy's concern would be greatly appreciated.

Very truly yours,

Original Signed By

L. M. Collins

L. M. Collins

Subcontract Administrator

db

APPENDIX 5

CROSBY INSTALLATION, OPERATING
AND MAINTENANCE INSTRUCTION NO. I-1105-2

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASSACHUSETTS

INSTALLATION, OPERATING AND MAINTENANCE
INSTRUCTION NO. I-1105-2

FOR
CROSBY STYLE HB AND HB-BP SELF-ACTUATED
NOZZLE TYPE SAFETY-RELIEF VALVES

RECEIVED JUL 27 1972

AEROJET NUCLEAR COMPANY

A. E. C. CONTRACT NO. AT (10-1)-1375

P. O. NO. S. 7254

SPEC. NO.

EQUIP. ITEM NO.

C. S. NO. 02 10 01

AEROJET NUCLEAR COMPANY	
☒ APPROVED ☐ NOT APPROVED ☐ APPROVED W/COMMENTS ☐ NO ACTION TAKEN	Approval shall not relieve the contractor from responsibility for deviations from the contract drawings and specifications nor shall it relieve him from responsibility for any errors in the vendors information submitted herein. KKC-259-72
By <i>K. K. Carpenter</i>	DATE AUG 3 1972

W.D. Greenlaw
 Dick Zaherisky
 Julian Klein

Director Eng.

8-617-384-3121

CROSBY

WRENTHAM, MASSACHUSETTS

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FIGURES

<u>Figure No.</u>	<u>Description</u>
1 (2 Sheets)	Section of Valve
2	Valve Jacking Devices
3	Disassembly of Valve Jacked and Hydrostatic Test Plug
4	Seat Leakage Measuring Device
5	Gagging Load (Ft. Lbs. of Torque)

ATTACHMENTS

<u>Number</u>	<u>Description</u>
T-1652	Determining Safety Valve Set Pressure With Air Set Pressure Device
A-1519	Assembly and Bolting Procedure for Valve Flanges

The design of the Crosby Self-Actuated Safety Valves with Balancing Bellows and a Balancing Piston is shown on Figure 1 as Style HB-BP. For some applications a balancing piston is not specified. This construction is shown on Figure 1a as Style HB.

The valve inlet may be flanged or welded with either seal welded or full nozzle construction. Flanged inlet with full nozzle construction is illustrated in Figure 1c. The welded inlet with a seal welded nozzle is shown in Figure 1b.

Figure 1 shows a typical Style HB. The approved drawing number of the valves supplied with unit is indicated in the cover page of this instruction.

1. Description of Valve

- 1.1 Figure 1 shows the valve assembly in cross-section and the following covers the essential elements of the valve. Inside the Body (1) is housed the upper portion of the Nozzle (2), Nozzle Ring (3), Disc Ring (7), Adjusting Ring (12), Eductor (11), and the Bellows Assembly consisting of the Bellows (8) to which is welded the Disc Holder (5). The Disc Insert (9) is held in place in the Disc Holder (5) by Insert Pin (10).
- 1.2 The Eductor (11), Bellows Assembly and the Bonnet Adapter (15) are retained between the valve Body (1) and the Bonnet (18) by Bonnet Studs (38) and Bonnet Stud Nuts (39).
- 1.3 Housed in the Bonnet (18) is the Spring (19) and Spring Washers (20) carried by the Spindle Assembly (14), the lower end of which is positioned on the Bushing (6) in the Disc Holder (5).
- 1.4 Adjusting Bolt (29) is locked in place by the Adjusting Bolt Nut (30) at the top of the Bonnet (18), within the Cap (21).
- 1.5 Manual lifting means is provided by Lever (28), Dog Shaft (23), Dog (22), and Spindle Nut (16) and Spindle Nut Cotter (17).
- 1.6 Cap Plug (31) is screwed into the top of Cap (21) or Cap Top (43) when gagging screw is not in use.

2. Installation Instructions

- 2.1 Safety valves should be mounted in a vertical position directly on the pressure vessel on a nozzle having a well-rounded approach that provides smooth, unobstructed flow between the vessel and the valve. A safety valve should NEVER be installed on a fitting having an inside diameter SMALLER than the inlet connection of the valve, as restricted flow can cause faulty valve operation.
- 2.2 The discharge piping should be designed for minimum load on the outlet flange of the valve and anchored sufficiently to prevent any adverse movement or vibration while the valve is discharging. The inside diameter of the discharge pipe must never be less than that of the valve outlet, and should be drained so that no fluid can collect in the body bowl.

2. Installation Instructions (Continued)

2.3 Inlet and outlet flanges should be bolted using good bolting practice and in accordance with Crosby Procedure No. A-1519 with torque values applicable to the flange bolt size and stress level desired.

3. Hydrostatic Testing

3.1 Valves With Flanged Inlets: Shipped Assembled

3.1.1 When valves are equipped with flanged inlets it is recommended that blank flanges be used in preference to using a hydrostatic test plug or gagging, since excessive tightening of gag screw may damage valve seats.

3.1.2 If the valve is to be gagged the following steps should be taken.

3.1.2.1 Remove gag screw from cap top and lubricate threads and pointed end of gag screw with Never-Seez or any other acceptable lubricant.

3.1.2.2 Remove Cap Plug (31) and install gag screw as shown on Figure 1c. Tighten gag screw finger tight only at this point.

3.1.2.3 Raise system pressure to approximately 100 p.s.i. below set pressure of valve.

CAUTION

VALVES SHOULD NEVER BE GAGGED FOR HYDROSTATIC TEST PRESSURES GREATER THAN ONE AND ONE-QUARTER (1-1/4) TIMES THEIR SET PRESSURE.

3.1.2.4 Apply necessary torque to the gag screw in the valve in accordance with the value shown on Figure 5 for the valve orifice size. This torque value is determined as follows:

3.1.2.4.1 Determine ΔP by subtracting the valve set pressure from the hydrostatic test pressure.

3.1.2.4.2 Read the value of ΔP on the vertical scale, proceed horizontally to the appropriate orifice curve and then down to read the torque on the horizontal scale.

3.1.2.4.3 The torque values (foot-pounds) obtained should be increased by a factor of approximately 25% to take into account normal variations in friction, valves, and test conditions.

3. Hydrostatic Testing (Continued)

3.1 Valves With Flanged Inlets: Shipped Assembled (Continued)

3.1.2.4 (Continued)

- 3.1.2.4.4 After applying the necessary torque to the gag screw, increase the hydrostatic test pressure to the required amount. Observations should be made during the rising pressure cycle to determine whether or not any of the valves show leakage.

CAUTION

SHOULD ANY VALVE SHOW LEAKAGE, IT IS NECESSARY TO DROP THE HYDROSTATIC TEST PRESSURE UNTIL THE LEAKAGE STOPS.

The torque should then be increased on the valve about 10% above the initial torque value.

NEVER ATTEMPT TO INCREASE THE GAGGING LOAD TO SHUT OFF VALVE LEAKAGE. THIS CAN RESULT IN DAMAGE TO THE SEATS AND BENDING OF THE SPINDLE ROD.

At the conclusion of the hydrostatic test, the pressure on the system should be dropped to approximately 100 to 200 p.s.i. below the set pressure of the valve. THE GAG SCREW SHOULD BE LOOSENED AT THIS POINT AND REMOVED FROM THE VALVES.

NOTE:- Valve gag screw should not be left on the valves in a gagged or loaded position for an extended period of time or under conditions where large thermal variations are expected.

- 3.1.2.5 At conclusion of hydrostatic test, the gag screw should be removed and cap plug reinstalled.

- 3.1.3 Flanged valves may be shipped jacked as discussed in Paragraph 3.2 when specified by the customer, they will be dismantled with a jacking device as discussed in Paragraph 6.2.3 and hydrostatic test plugs as shown in Figure 3 installed.

3.2 Valves With Flanged or Welded Inlets: Shipped Jacked

- 3.2.1 Valves with flanged or welded inlets can be shipped in the following condition to facilitate installation and hydrostatic testing with hydrostatic test plugs. (Note:- Flanged valves will be shipped in this fashion only upon customer request.)

3. Hydrostatic Testing (Continued)

3.2 Valves With Flanged or Welded Inlets: Shipped Jacked (Continued)

3.2.1 (Continued)

- 3.2.1.1 Springs jacked using a Thrust Bearing, Collar and Nut above Adjusting Bolt (29) (see Figure 2b) for valves "J" Orifice and smaller to maintain spring tension or using jacking device (see Figure 2a) for valves "K" Orifice and larger.
 - 3.2.1.2 The valve Body Assembly (1) is disassembled from Bonnet (18) Assembly. See Figure 3.
 - 3.2.1.3 Set Screws (4 and 13) and Nozzle Ring (3) removed from Nozzle (2) and attached to valve Bonnet (18).
 - 3.2.1.4 Hydrostatic Plug, "O" Ring, Back-Up Ring and Hydrostatic Plug Cap are installed on Nozzle (2). See Figure 3.
- 3.2.2 When the valve body and nozzle assembly is installed on the system, hydrostatic tests can be performed with the hydrostatic test plug cap, "O" ring and back-up ring installed in the valve as shown in Figure 3b.

CAUTION

SHOULD LEAKAGE PASS THE "O" RING OCCUR DURING HYDROSTATIC TEST, DO NOT TIGHTEN PLUG CAP. REPLACE "O" RING AND BACK-UP RING.

- 3.2.3 When hydrostatic test is completed and system pressure is zero the following procedure should be used to assemble the valve.
- 3.2.3.1 Remove Hydrostatic Test Plug Assembly from Nozzle (2). To facilitate removal of the Plug, place Hydrostatic Test Plug Pin in hole in Plug Extension. Unscrew the Cap, which will engage the Plug Pin and exert an upward force as the Cap is turned, thus lifting the Plug and Rings from the valve Nozzle (2).
 - 3.2.3.2 Clean nozzle bore and seat and inspect seating surface. (If nozzle seat is damaged, lap per Section 7.)
 - 3.2.3.3 Install Nozzle Ring (3), locating it approximately 1/32 above the seat level of the Nozzle (2).

CAUTION

EACH BONNET ASSEMBLY, NOZZLE RING AND SET SCREW IS IDENTIFIED AND IS MATCHED WITH A SPECIFIC VALVE BODY BY TAG NUMBER AND SHOULD BE ASSEMBLED ACCORDINGLY.

Crosby Valve & Gage Company
Wrentham, Massachusetts

3. Hydrostatic Testing (Continued)

3.2 Valves With Flanged or Welded Inlets: Shipped Jacked (Continued)

3.2.3 (Continued)

3.2.3.4 Remove protective covering from Bonnet (18) Assembly and make sure that all parts are clean and that insert seat is in good condition. If damaged, relap as per Section 7. Clean joints and gasket surfaces, and install bonnet assembly.

3.2.3.5 Place Bonnet Nuts (39) in place and tighten uniformly.

3.2.3.6 Lower Nozzle Ring (3) by turning to the left (clockwise when facing the set screw hole) until it is in the lowest position.

3.2.3.7 Remove Nut, Collar and Thrust Bearing from the Spindle (14), making sure that the Spindle (14) does not turn during this operation. If the jacking device shown in Figure 2 is used proceed as follows:

Rotate the Bearing Nut (4) counterclockwise until the load is removed then rotate the Spindle Lifter (2) until it can be lifted from the spindle. The jacking device can then be removed from the valve as an assembly.

3.2.3.8 Install the Cap (21) reversing the procedure described in Paragraph 6.2.1.

3.2.4 After valve is assembled adjust Nozzle Ring (3), by inserting screw driver or similar tool and engage notch on Nozzle (3) turning to right (counterclockwise) until it makes contact with Disc Ring (7). This position is called the zero location. Then turn to the left counting the notches. The Nozzle Ring (3) location is stamped on top of Bonnet (18) (i.e., N.R. Minus-). Install the Nozzle Ring Set Screw (4) and Gasket (35) making sure that the point engages a notch.

3.2.5 Turn Adjusting Ring (12) to right (upward - counterclockwise) until it contacts Disc Ring (7). This position is called the zero location. Then turn to left (clockwise) lowering the ring the number of notches indicated by stamping on top of Bonnet (18) (i.e., Guide Ring Minus-). Then install the Guide Ring Set Screw (13) and Gasket (35) as above.

CAUTION

THE NOZZLE RING AND GUIDE RING SET SCREWS ARE DIFFERENT LENGTHS AND ARE FACTORY FITTED FOR EACH VALVE AND ARE NOT INTERCHANGEABLE.

4. Description of Operation

4.1 When pressure reaches the set point, the valve will open with a sharp pop with very little simmer or warn. Full relieving capacity is reached within

4. Description of Operation (Continued)

4.1 (Continued)

rated accumulation above set pressure. After the valve has popped the valve will remain open until the pressure under the valve has decreased to the reseal pressure. The valve will then close sharply.

5. Set Pressure Testing and Adjustment

The popping pressure of a safety valve may be checked by three (3) methods. Two of these methods are with the valve on the system and one through bench testing.

5.1 Set Pressure Testing on System

5.1.1 The first method is through the use of an air set pressure device which allows setting of the safety valves on the system at pressures below normal system operating pressures. This method is described in Crosby Test Procedure No. T-1652, a copy of which is attached to this instruction manual.

5.1.2 The second method of set pressure testing is by raising the system pressure and popping the valve. Prior to pressure testing, a pressure gage which has a known accuracy should be located on the vessel being tested. The test procedure to be followed when checking the valve set pressure by raising the system pressure is as follows:

CAUTION

ALL SAFETY VALVES ON THE SYSTEM EXCEPT THE VALVE WHICH IS TO BE POPPED SHOULD BE GAGGED.

Raise the system pressure until the valve pops.

Record the popping and reseating pressure (pressure at which the valve closes sharply).

5.1.2.1 Set Pressure Adjustments

If it is necessary to adjust the valve set pressure, proceed as follows. Remove the Cap (21) and lifting gear as described in Paragraph 6.2.1. With the cap removed, the Adjusting Bolt (29) and Locknut (30) are exposed. Loosen the Adjusting Bolt Locknut (30). The opening pressure may now be adjusted as follows:

To increase the set pressure turn the Adjusting Bolt (29) to the right (clockwise) and to decrease the set pressure turn the Adjusting Bolt (29) to the left (counterclockwise). After each adjustment the Locknut (30) should be securely tightened to prevent loosening of the Bolt (29).

5. Set Pressure Testing and Adjustment (Continued)

5.1 Set Pressure Testing on System (Continued)

5.1.2 (Continued)

CAUTION

THE ADJUSTING BOLT (29) SHOULD NEVER BE TURNED WHEN THE VESSEL PRESSURE IS NEAR THE SET PRESSURE OF THE VALVE. ADJUSTMENTS SHOULD BE MADE WHEN THE PRESSURE IS AT LEAST 10 PERCENT BELOW THE ACTUAL POPPING PRESSURE OF THE VALVE. THIS PRECAUTION SHOULD BE TAKEN TO AVOID POSSIBLE DAMAGE OF INTERNAL PARTS.

5.1.2.2 Ring Adjustments (When Testing on System Per Paragraph 5.1.2 Only)

CAUTION

BEFORE MAKING ANY RING ADJUSTMENTS THE FOLLOWING OBSERVATIONS SHOULD BE MADE:

1. IF THE OUTLET IS CONNECTED TO A CLOSED SYSTEM, PRESSURE ON THE VALVE DISCHARGE SHOULD BE DECAYED TO ZERO BEFORE REMOVING SET SCREWS (4 OR 13).
2. NEVER MAKE ANY RING ADJUSTMENTS WHEN THE VESSEL IS UNDER PRESSURE WITHOUT GAGGING THE VALVE PROPERLY. CARE SHOULD BE TAKEN TO USE ONLY SUFFICIENT TORQUE ON THE GAG SCREW TO HOLD THE VALVE CLOSED. OVERGAGGING MAY DAMAGE THE VALVE INTERNALS.

- 5.1.2.2.1 If the blowdown is not as desired after the pressure has been set, it will be necessary to adjust the rings. The Adjusting Ring (12) is the principal blowdown control ring in this valve.

To change the adjusting ring position, remove the Adjusting Ring Set Screw (13) from the valve Body (1). Insert a screw driver or similar tool and engage one of the notches (these can be seen through the set screw hole). The Adjusting Ring (12) can then be turned to the right or left as desired. NOTE:- Turning the Adjusting Ring (12) to the right (counterclockwise) raises it and decreases the blowdown. Turning the Adjusting Ring (12) to the left (clockwise) lowers it and increases the blowdown. The Adjusting Ring (12) should never be turned more than five (5) to ten (10) notches either way without retesting the valve. After each adjustment always replace and tighten the Set Screw (13), being careful that its point engages a notch.

5. Set Pressure Testing and Adjustment (Continued)

5.1 Set Pressure Testing on System (Continued)

5.1.2.2 Ring Adjustments (When Testing on System Per Paragraph 5.1.2 Only) (Continued)

5.1.2.2.2 Nozzle Ring Adjustment

The safety valve is fitted with a Nozzle Ring (3) which is essential in obtaining pop action of the valve. This ring setting is carefully determined by test before the valve is installed and rarely needs any further adjustment. However, in case the Adjusting Ring (12) adjustment does not give the desired operating characteristics under all conditions of operation, the Nozzle Ring (3) may be used to control the valve operation for very fine adjustment.

The Nozzle Ring (3) is adjusted by removing the Nozzle Ring Set Screw (4) from the valve Body (1). Moving the ring to the right (counterclockwise) raises it and results in a stronger "pop" action and will increase blowdown. Moving the ring to the left (clockwise) lowers the ring and decreases the blowdown and may result in a warn or simmer if lowered too far. The range of adjustment of this ring is limited and it should not be moved more than one (1) notch at a time from its set position. The valve performance should be checked after each adjustment.

5.1.2.3 Whenever ring adjustments are changed a record should be kept of the number of notches and the direction in which the ring is moved. This will make it possible to return to the original setting in case of error.

5.1.3 Bench Testing

The third method of testing is with the valve removed from the system and installed on a test bench or air test stand. Testing should be performed as follows.

5.1.3.1 Setting and Testing the Valve With Air

5.1.3.1.1 Remove the Cap, Spindle Nut and Lifting Gear as described in Paragraph 6.2.1.

5.1.3.1.2 Bolt the valve on the air test stand.

5. Set Pressure Testing and Adjustment (Continued)

5.1 Set Pressure Testing on System (Continued)

5.1.3 Bench Testing (Continued)

5.1.3.1 Setting and Testing the Valve With Air (Continued)

- 5.1.3.1.3 It is essential that the air be clean and free of any impurities. Solids or other foreign material in the test medium can severely damage the seating surfaces and negate all the care exercised in preparation for testing or used in reconditioning the valve. The valve should be set to open at the desired pressure. This is done by tightening the Adjusting Bolt (29) (clockwise) to increase, - or loosening (counterclockwise) to decrease, - the spring compression. After each adjustment the Adjusting Bolt Locknut (30) should be tightened.

CAUTION

THE ADJUSTING BOLT SHOULD NEVER BE TURNED UNTIL INLET PRESSURE IS AT LEAST 10 PERCENT BELOW OPENING POINT OF VALVE.

- 5.1.3.1.4 Since the capacity of a test stand is considerably less than the actual valve capacity, it is essential that a "strong" Nozzle Ring (3) setting be used for good bench test operation. Strong ring settings are obtained by raising the Nozzle Ring (3) thereby obtaining maximum lifting force from a small amount of flowing medium. A suggested Nozzle Ring setting for this test is minus (-) 8. (See Paragraph 3.2.4 to establish setting.)
- 5.1.3.1.5 Seat tightness should be checked with air or nitrogen on the inlet side at the specified percentage below set pressure. The rate of seat leakage may be observed by blanking off the outlet flange by means of a cover plate or other blind flange with a soft gasket between it and the valve. This plate should be equipped with an outlet consisting of a piece of tubing of known inside diameter, the end of which is submerged 1/2" in a suitable container of water. Leakage will show in the form of bubbles. This method is in accordance with API Standard RP-527 (see Figure 4).
- 5.1.3.1.6 After bench testing, the Cap, Spindle Nut, Lifting Gear, etc., should be replaced, see Paragraph 8.2.12. The Nozzle and Adjusting Rings should be reset to their original positions if they have been disturbed, see Paragraphs 8.2.10 and 8.2.11.

5. Sat Pressure Testing and Adjustment (Continued)

5.2 Assembly of Lifting Gear After Testing

5.2.1 After the valve has been adjusted to open at the desired pressure, make certain that the Adjusting Bolt Locknut (30) and the Ring Set Screws (4 and 13) and Gaskets (35) are installed properly and tightened. Restamp the valve bonnet with the new tested ring locations. See Paragraph 3.2.4. Reinstall the lifting gear reversing the steps in Paragraph 6.2.1, making certain the Dog (22) is free, and engages the Spindle Nut (16) when the Lever (28) is rotated. If a pull cable or easing gear mechanism is used, it should be adjusted or counterbalanced so as to maintain clearance between Dog (22) and Spindle Nut (16) under normal operating conditions.

6. Valve Maintenance

The functioning and life of a safety valve depends primarily upon the methods used in its maintenance. For this reason, the following recommended steps for maintenance should be followed.

6.1 General Information

- 6.1.1 When possible remove the valve from the system before dismantling. In any case, there should be no system pressure when a valve is either dismantled in place or removed for shop repair.
- 6.1.2 Several flat metal gaskets are employed for sealing joints. Care must be exercised when dismantling not to damage or lose these gaskets as they can be reused. Gasket locations can be determined by referring to Figure 1.
- 6.1.3 Nozzle and guide ring set screws are custom fitted to each valve and are not to be interchanged.
- 6.1.4 Spring washers are fitted to each end of the spring. The spring and its washers are to be kept intact as a unit.

6.2 Disassembly

The proper procedure for dismantling a safety valve is as follows:

6.2.1 Removal of the Cap

- 6.2.1.1 If the valve is the type shown in Figure 1b, which does not have a Cap Top, remove the Lifting Lever (28). Remove Cap Nuts (39A) and remove the Cap (21) and Lifting Gear, now remove the Spindle Nut Cotter (17) and Spindle Nut (16).
- 6.2.1.2 If the valve is the type shown in Figure 1, which has a Cap Top (43), remove the Lifting Lever (28), now remove the Cap Top (43) and the Spindle Nut Cotter (17), unscrew Spindle Nut (16) from the Spindle and remove Cap Nuts (39A) and Cap (21).

6. Valve Maintenance (Continued)

6.2 Disassembly (Continued)

6.2.2 Recording of Ring Settings

6.2.2.1 Remove the Adjusting and Nozzle Ring Set Screws (4 and 13). Check the setting of the Nozzle Ring (3) by turning it to the right, counting the number of notches turned, until it makes contact with the Disc Ring (7). Record the number of notches. Check the setting of the Adjusting Ring (12) by turning it to the right, counting the number of notches turned, until it makes contact with the Disc Ring (7). Record the number of notches.

6.2.3 Disassembly: Retaining Spring Compression

6.2.3.1 If the valve is to be reconditioned without retesting, the original set pressure can be retained by use of a Jacking Device shown in Figure 2a, or by use of the Nut, Collar and Thrust Bearing shown in Figure 2b and as described in Paragraph 3.2.1.1.

6.2.3.2 When using the Nut, Collar and Thrust Bearing, the unit should be installed as shown in Figure 2b. The spring load can be taken up by rotating the Jacking Nut (13). Care should be used in lifting the spring load with the Jacking Nut to insure no rotation of the Spindle (14) occurs.

6.2.3.3 If the jacking device is to be used, it shall be installed on the valve in the following manner (see Figure 2a):

6.2.3.3.1 Lubricate the valve spindle threads with "Never-Seez", "Molykote-G" or equivalent and install the Spindle Lifter (2) (Figure 2) on the valve Spindle (14).

6.2.3.3.2 Lubricate the Thrust Bearing Part (5, 6 and 7) with a suitable bearing grease and install each part into the housing as follows.

6.2.3.3.3 The Bottom Thrust Washer (7) guides into position on its outside diameter.

6.2.3.3.4 Install the Cage (6) to rest on the Bottom Thrust Washer (7). The Cage (6) has no top or bottom distinction.

6.2.3.3.5 Place the Top Thrust Washer (5) on top of the Cage (6).

6.2.3.3.6 Install the Housing (1) and Bonnet Spacer (1A) on top of the valve Bonnet (18) taking care to insure that the Key (8) locates in the keyway slot in the Spindle Lifter (2).

6. Valve Maintenance (Continued)

6.2 Disassembly (Continued)

6.2.3 Disassembly: Retaining Spring Compression (Continued)

- 6.2.3.3.7 If the jacking device has been properly installed, approximately one-half (1/2) inch of the keyway should be visible. The Spindle Lifter (2) must be screwed (clockwise) onto the valve Spindle (14) until the proper length of keyway is visible.

CAUTION

IF THE VALVE IS JACKED WITHOUT THE PROPER AMOUNT OF KEYWAY VISIBLE, THE JACKING DEVICE CAN BE SERIOUSLY DAMAGED.

- 6.2.3.3.8 Lubricate the Spindle Lifter (2) external threads with "Never-Seez" or an equivalent lubricant and screw the Operating Nut (4) onto the Spindle Lifter (2) until it contacts the thrust bearing.
- 6.2.3.3.9 Rotating the Operating Nut (4) clockwise raises the valve Spindle (14), thereby raising the Lower Spring Washer (20) and compressing the Spring (19).
- 6.2.3.3.10 For removing the jacking device this procedure is reversed.
- 6.2.3.4 After the valve has been jacked approximately one-eighth (1/8) inch and the spring load has been taken up by means of the Nut, Collar and Thrust Bearing, or the jacking device, remove Bonnet Stud Nuts (39) and lift complete Bonnet (18) Assembly from valve Body (1).
- 6.2.3.5 The valve may now be further disassembled for maintenance as follows:
- 6.2.3.5.1 Remove the adjusting ring from the eductor. Remove the Disc Insert Pin (10). See Paragraph 6.2.4.5 and Caution Note before removing Disc Insert Pin (10), Disc Insert (9) and Disc Ring (7). Slide the Eductor (11) off the Disc Holder (5). The Disc Holder (5) and Bellows Assembly (5, 6 and 8) may now be screwed off the Spindle (14) and the Bonnet Adapter (15) can be lifted over the Spindle (14).

6. Valve Maintenance (Continued)

6.2 Disassembly (Continued)

6.2.3 Disassembly: Retaining Spring Compression (Continued)

6.2.3.5 (Continued)

CAUTION

IN REMOVING THE DISC HOLDER AND BELLOWS ASSEMBLY FROM THE SPINDLE, CARE SHOULD BE EXERCISED NOT TO DAMAGE THE BELLOWS.

THE SPINDLE SHOULD ALSO BE PROTECTED TO PREVENT ANY DAMAGE (BENDING) WHILE HANDLING.

6.2.4 Disassembly: Without Retaining Spring Compression

If it is desired to completely disassemble the valve and not retain the spring compression, the following procedure should be used.

6.2.4.1 Measure the length of the Spindle (14) above the Adjusting Bolt (29). Record this dimension so the same distance can be re-established when reassembling the valve.

6.2.4.2 Release the spring tension by loosening the Adjusting Bolt Locknut (30) and then the Adjusting Bolt (29).

WARNING:- NEVER LOOSEN BONNET NUTS BEFORE RELEASING SPRING TENSION WITH THE ADJUSTING BOLT.

6.2.4.3 Loosen the Bonnet Nuts (39) holding the Bonnet (18) to the Body (1) of the valve. Lift the Bonnet (18) up to clear the Spindle (14) and Spring (19). Remove the Spring (19) and Washers (20).

6.2.4.4 The Spindle (14), Bellows (8) and Disc Holder Assembly, and Eductor (11) should be lifted out of the valve as a complete unit. Place this assembly on a clean soft material to insure no damage occurs to the Disc Insert (9) seating surface.

6.2.4.5 Remove the Spindle (14) from the Disc Holder Assembly and the Adjusting Ring (12) from the Eductor (11). Next, remove the Disc Insert Pin (10).

CAUTION

THE DISC INSERT PIN (10) IS FLARED AT ONE END AND SHOULD BE REMOVED BY DRIVING A DRIFT PIN INTO THE HOLE FROM THE NON-FLARED END, WHILE RESTING THE OPPOSITE END ON A SOFT WOODEN BLOCK TO INSURE THAT NO DAMAGE OCCURS TO THE DISC RING.

6. Valve Maintenance (Continued)

6.2 Disassembly (Continued)

6.2.4 Disassembly: Without Retaining Spring Compression (Continued)

6.2.4.5 (Continued)

After the removal of the Disc Insert Pin (10), the Disc Insert (9) can be removed from the Disc Holder (5) and the Disc Ring (7) can be screwed off of the Disc Holder (5). The disc holder and bellows assembly can now be removed from the Eductor (11).

6.2.5 Remove Nozzle Ring (3) from Nozzle (2).

6.2.6 When the valve is completely dismantled, examine all parts for signs of wear, damage or corrosion to determine whether any replacement parts are required. Particular care should be used to examine the inside of the Eductor (11), the outside of the Disc Holder (5), the inside of the Bonnet Adapter (15) and the Piston (40) for wear or scoring.

7. Repair Procedure

7.1 Lapping of Valve Seats

Good seating surfaces on the Nozzle (2) and Disc Insert (9) are of the greatest importance when reconditioning safety valves. The seats should be perfectly flat and free from surface scratches.

7.1.1 Laps

The laps specified for lapping all seating surfaces are made of a special grade of annealed cast iron and lapped optically flat. It is essential that it remain flat to produce a truly flat seating surface. In checking the lapping block and for restoring flatness after use, a lapping block reconditioner should be used.

7.1.2 Lapping Block Reconditioner

This is also made of a special grade of annealed cast iron, machined and lapped flat on the side which has small squares. This side is the surface on which the lapping blocks are reconditioned.

7.1.3 Lapping Compounds

The following lapping compounds, or their commercial equivalent, are suggested:

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7. Repair Procedure (Continued)

7.1 Lapping of Valve Seats (Continued)

7.1.3 Lapping Compounds (Continued)

<u>Abrasive</u>	<u>Grit Size</u>	<u>Average Micron Size</u>	<u>Description</u>	<u>Mfg. Trade Name or Equivalent</u>
Silicon Carbide	320	31	Medium Coarse	U.S. Products No. 2F Crystolon
Silicon Carbide	400	22	Medium	U.S. Products No. 3F Crystolon
Silicon Carbide	600	16	Fine	U.S. Products No. A-600 Crystolon
Hard Alumina or Aluminum Oxide	900	9	Polish	U.S. Products No. 38-900-A

Experience has proven that three grades of compound - medium, fine and polish - will properly condition almost any damaged valve seat, unless of course, remachining is necessary. A medium coarse compound may be used for fast cutting as a first operation if desired.

7.1.4 Lapping Procedure

Different individuals have different methods of lapping valve seats, but certain essential steps must be taken to get satisfactory results. The following procedure is suggested for lapping of valve seats:

- 7.1.4.1 Never lap the disc insert against the nozzle. Lap each part separately against a cast iron lapping block of the proper size. These blocks hold the lapping compound in their surface pores but must be recharged and reconditioned frequently.
- 7.1.4.2 Check the lapping block frequently on a good lapping block reconditioner to make certain it is perfectly flat.
- 7.1.4.3 If considerable lapping is required, spread a thin coat of medium lapping compound on the block. After lapping with this compound, lap again with a fine compound. Unless much lapping is called for, the first step can be omitted. Next, lap again using a polish compound.
- 7.1.4.4 Lap the block against the seat. Never rotate the block continuously, but use an oscillating movement, as in grinding automobile valves.
- 7.1.4.5 When all nicks and marks have disappeared, remove all the compound from the block and seat. Apply polish compound to another block and lap the seat with this. As the lapping nears completion, only the compound left in the pores of the block should be present. This should give a very smooth finish. If scratches appear, the cause is probably dirty lapping compound. These scratches should be removed by using compound free from foreign material.

7. Repair Procedure (Continued)

7.1 Lapping of Valve Seats (Continued)

7.1.4 Lapping Procedure (Continued)

7.1.4.6 Extreme care should be taken throughout to make certain that the seats are kept perfectly flat.

7.1.5 Micro-Finishing of Valve Seats

HB Type Safety-Relief Valve seats should be lapped to a micro-inch finish using special compounds and the lapping procedure as herein outlined. Prior to micro-finishing, the valve seats should be lapped flat and to a fine surface finish in accordance with Paragraph 7.1.3.

The Lapping Compound PDH-6 is used in conjunction with a lapping and cleaning Thinner PDH-27 and should be used as described in the following procedure. (Both PDH-6 and PDH-27 are available from Crosby.)

7.1.5.1 Clean lapping block using Acetone or apply Cleaning Thinner PDH-27, then wipe with a clean dry soft cloth or Kimwipe (by Kimberly-Clark or equivalent) prior to applying lapping compound.

7.1.5.2 Apply dots of PDH-6 on the lapping block approximately one-half (1/2) to one (1) inch apart (not less than four per block), circumferentially on the face of the lapping block and then apply a drop of lapping Thinner PDH-27 to each dot of compound.

7.1.5.3 Lap the valve seat, keeping the lapping block against the seat and applying slight downward pressure. During the operation the lapping compound may begin to get stiff and movement of the lapping block more difficult; remove lap from lapped surface and add a few drops of lapping Thinner PDH-27 to the lapping block, replace on surface being lapped and continue to rotate exerting no downward pressure.

CAUTION

THE LAPPING COMPOUND CUTS VERY QUICKLY AND THEREFORE THE LAPPING BLOCK MUST BE CHECKED PERIODICALLY TO BE SURE THAT THE BLOCK IS FLAT AND THAT A GROOVE IS NOT WORN IN THE LAPPING BLOCK DUE TO THE LAPPING OPERATION. WHILE LAPPING, THE LAPPING BLOCK SHOULD GLIDE SMOOTHLY OVER THE SURFACE BEING LAPPED. INDICATIONS OF ROUGHNESS IN LAPPING ARE INDICATIVE OF CONTAMINATED COMPOUND, THE LAPPING BLOCK AND SEATING SURFACE SHOULD BE THOROUGHLY RECLEANED WITH THINNER (PDH-27) AND THE LAPPING OPERATION REPEATED.

7 Repair Procedure (Continued)

7.1 Lapping of Valve Seats (Continued)

7.1.5 Micro-Finishing of Valve Seats (Continued)

7.1.5.4 Continue this for approximately one (1) minute then remove the lapping block and clean lapped surface and the block with Thinner PDH-27 and wipe with a clean dry soft cloth or Kimwipe (by Kimberly-Clark or equivalent).

7.1.5.5 If the surface is still in an unsatisfactory condition, change lapping block and repeat the above process until a satisfactory surface is obtained.

7.1.5.6 After final lapping, clean the seating area with PDH-27 and then with Acetone and wipe clean with cotton.

7.2 Reconditioning Parts

7.2.1 All other valve parts should require a minimum amount of maintenance to be put in working order.

7.2.2 These parts should be thoroughly cleaned. Fine emery cloth or crocus cloth may be used to polish guiding surfaces and surfaces in intimate rubbing contact. Care must be used to insure critical dimensions are not affected.

7.2.3 Examine all gasket sealing surfaces and gaskets and if they are damaged, the surfaces should be polished and the gaskets replaced.

7.2.4 Final clean parts with Acetone or any other acceptable cleaner prior to assembly.

8. Valve Assembly

8.1 Lubrication

The following areas should be lubricated before and during assembly with a suitable sealant or lubricant.

8.1.1 All gaskets and gasket surfaces - sealant.

8.1.2 Nozzle to body threads - lubricant.

8.1.3 Adjusting bolt threads - lubricant.

8.1.4 Spindle point threads - lubricant.

8.1.5 Spring washer bevels - lubricant.

8.1.6 Cap top threads - lubricant.

8.1.7 Cap plug threads - lubricant.

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8. Valve Assembly (Continued)

8.1 Lubrication (Continued)

- 8.1.8 Set screw threads - lubricant.
- 8.1.9 Dog shaft bearing threads at I.D. - lubricant.
- 8.1.10 All studs and nuts - Never-Seez.
- 8.1.11 Eductor and guide ring threads - lubricant.
- 8.1.12 Disc ring and disc holder threads - lubricant.
- 8.1.13 Nozzle ring to nozzle threads - lubricant.
- 8.1.14 Piston O.D. and bonnet adapter I.D. - Powdered Graphite or Neolube.

8.2 Assembly of Valve With Spring Compression Retained (See Section 6.2.3)

The bonnet and jacking device assembly, with spring, spring washers, and spindle, should be placed on a work bench with the spindle horizontal.

- 8.2.1 Place gasket on Bonnet Adapter (15) and place adapter over the spindle.
- 8.2.2 Place the Bellows Assembly (5, 6 and 8) onto the Spindle (14) and turn on spindle until it drops off the spindle thread and spins freely. (Note:- If a new bellows is installed, the bellows flange surfaces should be lapped with medium compound against the bonnet adapter and eductor surfaces until a satin dull finish is obtained on the bellows flange across the sealing face. This operation is performed to preclude the possibility of a leak across this gasket surface.)
- 8.2.3 The Eductor (11) should be installed over the Bellows Assembly (5, 6 and 8).
- 8.2.4 Assemble the Disc Ring (7) with the threads lubricated onto the Disc Holder (5). The through holes in the Disc Ring (7) and Disc Holder (5) must be in alignment, assemble the Disc Insert (9) using the Disc Insert Pin (10). Note:- See Caution in Paragraph 6.2.4.4. If a new pin is installed, one end should be flared prior to assembly.
- 8.2.5 The Adjusting Ring (12) can then be screwed onto the Eductor (11).
- 8.2.6 Install Nozzle Ring (3) on the Nozzle (2) locating it approximately one-thirty second (1/32) above the seat level of the nozzle.

CAUTION

FINAL INSPECT AND CLEAN NOZZLE AND DISC INSERT SEATING SURFACE.

8. Valve Assembly (Continued)

8.2 Assembly of Valve With Spring Compression Retained (See Section 6.2.3) (Continued)

8.2.7 The entire jacked assembly, complete with Eductor, Bellows, Disc Insert and all the other parts described above may now be lowered carefully into the valve body, and the Bonnet Stud Nuts (39) tightened as follows:

8.2.7.1 Valve studs and nuts shall be clean and visually inspected to insure freedom from any objectionable foreign matter, rust, burrs or physical damage.

8.2.7.2 With the bonnet in place, lubricate the bonnet stud threads, the nut threads and nut face with Never-Seez Compound (which conforms to Government Specification MIL-A-907B, Federal Stock No. 803-286-5453) or equivalent.

8.2.7.3 Install nuts on the studs finger-tight.

8.2.7.4 Tighten the nuts in the sequence shown in diagram below to approximately one-half the torque value shown in table below. Repeat the same sequence of tightening to the torque value shown in table below. Then starting with the No. 1 Nut, tighten each nut in order in a clockwise or counterclockwise direction to the value shown in table below.

8.2.7.5 Wipe off excess lubricant.

Stud Thread	Torque (Ft. Lbs.) to Produce Stress in Stud Bolts		
	30,000 p.s.i. Stress	45,000 p.s.i. Stress	60,000 p.s.i. Stress
7/16-14	20	30	40
1/2-13	30	45	60
5/8-11	60	90	120
3/4-10	100	150	200
7/8-9	160	240	320
1-8	240	370	500
1-1/8 - 8	350	525	700
1-1/4 - 8	500	750	1000

8. Valve Assembly (Continued)

8.2 Assembly of Valve With Spring Compression Retained (Continued)

- 8.2.8 Lower Nozzle Ring (3) by turning to the left (clockwise when facing the set screw hole) until it is in the lowest free position and lower the adjusting ring until the lower edge is below the level of the nozzle seat.
- 8.2.9 The jacking device may now be removed by reversing the procedure described in Paragraph 6.2.3.1, 6.2.3.2 and 6.2.3.3.
- 8.2.10 Adjust the Nozzle Ring (3) by turning it to the right until it makes contact with the Disc Ring (7). Then turn the Nozzle Ring to the left the same number of notches recorded in Paragraph 6.2.2. Adjust the Adjusting Ring (12) which should also be reset to original location recorded in Paragraph 6.2.2 by turning it to the right until contact is made with the Disc Ring. Then turn to the left counting the notches until the same number of notches recorded is reached.
- 8.2.11 Replace the Adjusting Ring and Nozzle Ring Set Screws (4 and 13) and Gasket (35) being sure the point engages the notch.
- 8.2.12 The Cap (21), Spindle Nut (16) and Lifting Gear Assembly are assembled by reversing the procedure used in Paragraph 6.2.1. Make sure the Lifting Gear Dog (22) has the curved side up so the curve will contact the Spindle Nut (16) when the lever is lifted. The Spindle Nut should be adjusted, and the Lever (28) put on so the Dog (22) is not bearing on the Spindle Nut (16) until the lever is lifted to about the position shown in Figure 1. Replace the Spindle Nut Cotter Pin (17).

8.3 Assembly of Valve Which Was Completely Disassembled

- 8.3.1 Place the Bellows Assembly (8) on a clean flat surface, such as a work bench, with the Disc Holder (5) up. (See Paragraph 8.2.2 if new bellows is installed.)
- 8.3.2 Place the Eductor (11) over the Bellows Assembly (8).
- 8.3.3 Assemble the Disc Ring (7) with the threads lubricated on the Disc Holder (5). The through holes in the Disc Holder (5) and the Disc Ring (7) must be in alignment. Assemble the Disc Insert (9) using the Disc Insert Pin (10). Note:- See Caution in Paragraph 6.2.4.5. If a new pin is installed one end should be flared and prior to assembly.
- 8.3.4 The Adjusting Ring (12) may then be screwed onto the Eductor (11).
- 8.3.5 The assembly may now be turned over so the Disc Insert is down and the flange on the bellows assembly is up.

8. Valve Assembly (Continued)

8.3 Assembly of Valve Which Was Completely Disassembled (Continued)

CAUTION

WHEN PLACING THIS UNIT ON BENCH CAUTION SHOULD BE USED TO MAKE CERTAIN THE DISC INSERT SEAT IS PROTECTED FROM DAMAGE.

- 8.3.6 Place the Bonnet Adapter (15) on top of the bellows flange.
- 8.3.7 Lubricate and assemble the Spindle (14) into the Disc Holder (5) until the threads drop into the undercut in the disc holder and the spindle rotates freely.
- 8.3.8 Install the Nozzle Ring (3) on the Nozzle (2) locating it approximately one-thirty second (1/32) inch above the seating surface of the Nozzle (2). Final inspect and clean nozzle and disc insert seating surface.
- 8.3.9 Lift the Bellows, Eductor, Adjusting Ring and Bonnet Adapter Assembly straight up with the Spindle (14) and lower it straight down into the Body (1) until the Disc Ring (7) rests on the Nozzle Ring (3).
- 8.3.10 Install the Lower Spring Washer (20), the Spring (19) and the Upper Spring Washer (20).
- 8.3.11 Install the Bonnet (18) and assemble and tighten Nut (39) as per Paragraph 8.2.7.
- 8.3.12 Lower the Nozzle Ring (3) by turning to the left (clockwise when facing set screw hole) until it is in the lowest free position and lower the Adjusting Ring (12) until the lower edge is below the level of the nozzle seat. Note:- If difficulty is encountered in lowering the nozzle ring lift upon the Spindle (14) while lowering nozzle ring.
- 8.3.13 Replace the Adjusting Bolt (29), turning it down until the length of the Spindle (14) above the Adjusting Bolt (29) measurement is the same as before disassembly (see Paragraph 6.2.4.1). Tighten the Adjusting Bolt Nut (30) to lock the Adjusting Bolt (29).

Note:- At this point the valve can be bench tested if desired in accordance with Paragraph 5.1.3.
- 8.3.14 Adjust the Nozzle and Adjusting Ring by following the procedure in Paragraphs 8.2.10 and 8.2.11.
- 8.3.15 Replace the Cap (21), Spindle Nut (16) and Lifting Gear, etc., by following the procedure in Paragraph 8.2.12.

9. Spare Parts

- 9.1 When ordering spare parts the Valve Assembly Number should be given together with the part number and valve size and style. On the valve nameplate, the Valve Assembly Number is shown as "Shop Number". Any Crosby Branch Office or Representative can expedite your spare part requirements.

ALTERNATE CONSTRUCTION
WITHOUT CAP TOP
FIG. 1d

STYLE HB
(WITHOUT PISTON)
FIG. 1a

WELDED INLET
CONSTRUCTION
FIG. 1b

FIG. 1c

STYLE HB-BP
(WITH PISTON)
FIG. 1c

FIG. 1

Crosby Valve & Gate Company
Wrentham, Massachusetts

<u>Part No.</u>	<u>Part Name</u>
1	Body
2	Nozzle
3	Nozzle Ring
4	Nozzle Ring Set Screw
*5	Disc Holder
*6	Disc Bushing
*7	Disc Ring
*8	Bellows
*9	Disc Insert
*10	Disc Insert Pin
11	Eductor
12	Adjusting Ring
13	Adjusting Ring Set Screw
14	Spindle Assembly
14A	Spindle Point
14B	Spindle Rod
15	Bonnet Adapter
16	Spindle Nut
17	Spindle Nut Cotter
18	Bonnet
19	Spring
20	Spring Washer
21	Cap
22	Dog
23	Dog Shaft
24	Dog Shaft Bearing
*25	Dog Shaft "O" Ring
26	Dog Lever Nut
27	Dog Lever Lockwasher
28	Lever
29	Adjusting Bolt
30	Adjusting Bolt Nut
31	Cap Plug
*32	Cap Plug Gasket
*33	Bonnet Adapter Gasket
*34	Eductor Gasket
*35	Nozzle Ring and Adjusting Ring Set Screw Gasket
*36	Dog Shaft Bearing Gasket
*37	Cap Gasket
38	Bonnet Stud

<u>Piece No.</u>	<u>Part Name</u>
38A	Cap Stud
39	Bonnet Stud Nut
39A	Cap Stud Nut
40	Piston
41	Piston Lockclip
42	Gag Screw
43	Gag Top
*44	Cap Top Gasket
45	Canopy Ring
46	Gasket (Special)
47	Nameplate and Identification Plate
48	Caution Plate
49	Drive Screws

Parts noted with an asterisk () are manufacturer's recommended spare parts. Note Pieces No. 5, 6, 7 and 8 are purchased as an assembly.

JACKING DEVICE FOR
VALVE SIZES "K" OR IF AND LARGER

FIG. 2a

FIG. 2b

JACKING DEVICE PARTS IDENT.

- (1) — HOUSING
- (2) — SPINDLE LIFTER
- (3) — THREAD ADAPTER
- (4) — OPERATING NUT
- (5) — TOP THRUST WASHER
- (6) — CAGE
- (7) — BOTTOM THRUST WASHER
- (8) — KEY
- (9) — SCREW
- (10) — BONNET ADAPTER
- (11) — SPACER
- (12) — BEARING
- (13) — JACKING NUT

SEAT LEAKAGE MEASURING DEVICE

FIG. 4

FIG. 5

APPENDIX 6

CROSBY VALVE TEST DATA SHEET, DATED 9-77,
ON VALVE NO. N56037-00-0001

10/11/77

RICK

CROSBY VALVE & CASE COMPANY
Wrentham, Massachusetts

LTR 1144-37

R&D Form 177

10/14/77
8/10/3/77

VALVE TEST DATA

Quality Assurance Instructions: 3226-4 Date: 9/77
Test No.: _____ Test Procedure No.: T-16034-3
Size and Style Valve: 1 1/2 F2 HB BP 86 Set Pressure: 2488 ± 25
Crosby Component Serial No. N56037-00-0001 Assembly No.: N56037
Crosby Factory Order No.: R75128 Item No.: _____ Drawing No. DS-C-56037 Rev. C
Customer's Mark or Tag No.: R1-200 Customer's Order No.: K-5475

1. Hydrostatic Tests

A. Inlet	B. Inlet, Body Bellows & Outlet	C. Complete Valve	D. Tag Test (Water) Set Pressure _____ Valve Tapped _____
Pressure: <u>N/A</u>	<u>750 psi</u>	<u>N/A</u>	<u>N/A</u>
Time: <u>N/A</u>	<u>5 min</u>	<u>N/A</u>	<u>N/A</u>
Results: <u>X</u>	<u>SAT</u>	<u>X</u>	<u>X</u>
Tested By: <u>X</u>	<u>Joe Downing</u>	<u>X</u>	<u>X</u>
Inspected By: <u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
Gage No.: <u>1A</u>	<u>364</u>	<u>N/A</u>	<u>N/A</u>
Date Calibrated: <u>N/A</u>	<u>9/28/77</u>	<u>N/A</u>	<u>N/A</u>
Water Check: <u>N/A</u>	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>

2. Steam Tests

A. Operational
Test Spring No. 361
Ring Setting: N.R. -4
G.R. -84
Guide Ring Level At -18

B. Valve Data

Run No.	Open	Max. Act. in.	Close	Blow-down	Back Pressure		Valve Lift
					Static Valve Closed	Valve Open At Max. Act. in.	
1	400	412	380	20	N/A	N/A	
2	400	412	381	19			
3	400	412	380	20			
4	400	412	381	19			
5	400	412	381	19	N/A	N/A	

C. Seat Leakage
Pressure: 360
Time: 3 MIN
Results: Satisfactory
Gage No.: 1 135
Date Calibrated: 9/30/77

Tested By: ME. Brice 9/30/77
Inspected By: 9/30/77

Final Setting Tests - Final Spring No. NX2691-0003 S/N K55485-31-0003

A. Set Pressure (Air)	B. Seat Leak (Air)	C. Seat Leak (Steam)
1. <u>2490</u>	Time: <u>10 MIN</u>	<u>N/A</u>
2. <u>2490</u>	Leakage: <u>4 bubbles/min</u>	
3. <u>2490</u>	Results: <u>Satisfactory</u>	
Gage No.: <u>201</u>		
Date Calibrated: <u>9/30/77</u>		
<u>RINSE FLUSH w/ DEMINERALIZED H₂O</u>		
<u>CD Downing 10/1/77 TEST NO. 461</u>		
Final Ring Setting: <u>N.R. -8</u>		

Tested by: CD Downing 10/1/77
Inspected by: 10/1/77
Ser. No. 10/1/77

APPENDIX 7

MEMO OF CONVERSATION WITH
R. A. HARTFIELD, NRC, DATED 11-29-77

FORM INEL-601
(Rev. 1-76)IDAHO NATIONAL ENGINEERING LABORATORY
MEMO OF CONVERSATIONDate 11/29/77 Time 3 p.m. Commitment Made _____ Yes _____ No XPerson Calling R. A. Hartfield Person Called E. S. BrownRepresenting NRC, Wash. Representing EG&G, IdahoPurpose of Conversation NRC Incident Report - Failure of Pressurizer Relief Valves
to Reseat.Text of Conversation Mr. Hartfield is under the NRC Office of Management Information and
Program Control and heads the Division of Operations Evaluation, FTS 492-7834.He called me by request through Pete Strom of our local NRC office to give in-
formation on NRC incident reports of failures of pressurizer safety valves to
reseat. The NRC computer printout, 1969 through the present date, indicates no
incident reports from PWR's wherein pressurizer spring operated (safety) valves
failed to reseat.There have been incident reports wherein BWR safety valves failed to reseat but
these were valves of the pilot operated type.Signed Edward J. Brown Date 11-29-77