CRYOSTAT RELIEF VALVE FLOW TEST

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16-MAR-89

D0 ENGINEERING NOTE
3740.000-EN-156

Approved: _____

Introduction

This engineering note presents the results of a flow test conducted by the National Board of Boiler and Pressure Vessel Inspectors on an Anderson Greenwood type 93T pilot operated pressure relief valve. This valve is to be used as the primary relief device on each d0 liquid argon calorimeter cryostat (SEC, NEC, CC). The valve has a 2" inlet, a 3" exhaust, a set pressure of 13 psig, and a stamped flow capacity of 1018 SCFM. This test was conducted to verify both the set pressure and the flow capacity (although the 93T is built to ASME code specifications and worthy of certification, our particular valves will not carry code stamps due to the fact that such stamps are not placed on devices rated below 15 psig). Details concerning required valve size and the choice of the A&G 93T may be found in EN#100.

Discussion

The following documents include a copy of the letter from the National Board and a detailed list of their test results, a diagram of the 93T valve, and a summary sheet regarding capacity. Five operational tests yielded an average set pressure of 13.2 psig (compared to the manufacturer's 13 psig claim) and a blowdown of 2.6 psig. A valve capacity of 1252 SCFM air (1129 SCFM Ar) was measured in a flow test conducted at 16.14 psig upstream of the valve. Using this inlet condition, valve data, and Anderson Greenwood's equation for valve capacity, a value of 1139 SCFM air (1027 SCFM Ar) was calculated. The valve itself is stamped with a capacity of 1018 SCFM air (918 SCFM Ar). The National Board tested the valve at 16 psig because subsonic, non-choked conditions occur in their test apparatus at inlet pressures below 15 psig, causing inaccuracies in the flow equations (see 12/3/87 file memo from R.W. Fast, attached). Presumably, the stamped valve capacity represents the flow at the valve's set pressure.

Conclusions

Under test conditions the A&G 93T valve intended for use on the LAr cryostats performed according to specifications. Although the valve carries no ASME code stamp, it is felt that this independent test provides the necessary peace of mind to allow its use.

The National Board of Boiler and Pressure Vessel Inspectors

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Fermi National Accelerator Laboratory
Mr. Ernie Ramierez
P. O. Box 500
Batavia IL 60510

SUBJECT: Experimental Testing of a Pilot Operated Pressure Relief Valve

Dear Mr. Ramierez:

On February 4, 1988, a test was conducted at the National Board Testing Laboratory for the purpose of obtaining experimental functional and flow test data for a pilot operated pressure relief valve supplied by Fermilab. This test was conducted in accordance with the provisions of the National Board Testing Laboratory quality control manual with air as the test medium. Enclosed is a copy of the test results, reported as test number 13,112A.

The valve was cycled through five operational tests. Each test included measuring the set pressure (defined as initial flow through the main valve), an increase of pressure to approximately three psi overpressure and then allowing the valve to reclose. Using the last three tests, an average set pressure of 13.2 psig and blowdown of 2.6 psi were determined. No adverse performance characteristics were noted.

A flow test was then conducted at approximately 3 psi above the measured set pressure and a flow of 1252 scfm was determined. Using the nominal area of this valve type as listed in Pressure Relief Device Certifications a coefficient of discharge of .976 was calculated.

It should be noted that these results were obtained with a smoothly tapered inlet adaptor and no discharge piping and valve performance under installed conditions could vary from those reported. In addition, although we attempt to maintain a clean air system, there may be traces of dirt or oil present in the valve following the flow test.

We hope this information will be of value to you in your work.

Yours truly,

Joseph F. Ball

Joseph F. Ball, P. E.
Manager, Pressure Relief Department

JFB/cjh

Enclosure

NATIONAL BOARD TESTING LABORATORY
Air Test Report
Sonic Flow Method

	Test Sponsor	Fermi Nat. Acc. Lab.
2	Sponsor Type	Experimental
3	Test Number	13112A
4	Test Date	2-4-88
5	Valve Type	93T0203RA
6	Manufactured By	Anderson Greenwood
7	Inlet Size IN	2 F1
8	Outlet Size IN	3 F1
9	Set Pressure PSIG	13
10	Stamped Capacity SCFM	1018
11	Code Section	
12	Serial Number	87/09186
13	Date Code	

Observed Operation Data and Measured Dimensions

14	Warn Pressure PSIG	
15	Set Pressure PSIG	13.2
16	Reset Set Pressure PSIG	
17	Blowdown PSI	2.6
18	Reset Blowdown PSI	
19	Bore Diameter IN	2.152 Inlet
20	Lift IN	

Flow Data

	Valve Flow Area SQ IN (AV)	2.29
22	Barometric Pressure PSIA (Pb)	14.42
23	Vessel Pressure PSIG (P)	16.14
24	Nozzle Pressure PSIG	1571
25	Vessel Temperature Deg. F	22.8
26	Nozzle Temperature Deg. F	30.0
27	Nozzle Area SQ IN (A)	.04137

Calculated Test Data

28	Nozzle Total Pres. PSIA (PO)	1585.42
29	Nozzle Total Temp. Deg R (TO)	490
30	Sonic Flow Function Φi^*	.53175
31	Sonic Flow Function Ratio $\Phi^*/\Phi i^*$	1.060561
32	Measured Capacity lbm/sec	
	$WH=.99x\Phi i^*xA(\Phi^*/\Phi i^*)\ (PO)/\sqrt{TO}$	1.654283
33	Vessel Total Temp. Deg. R (T)	482.8
34	Reference Temp. Deg. R (Tr)	520
35	Density lbm/cu ft (rho)	.0764
36	Valve Capacity SCFM (Q)	
	$Q=(60xWH/rho)x\sqrt{(T/Tr)}$	1251.843
37	Rated Capacity for Measured Flowing Pressure SCFM	N/A
38	Coefficient=WH/WT	
	$WT=.5323xAVx(P+Pb)/\sqrt{T}$	.9757716
	Slope=Q/(P+Pb)	N/A

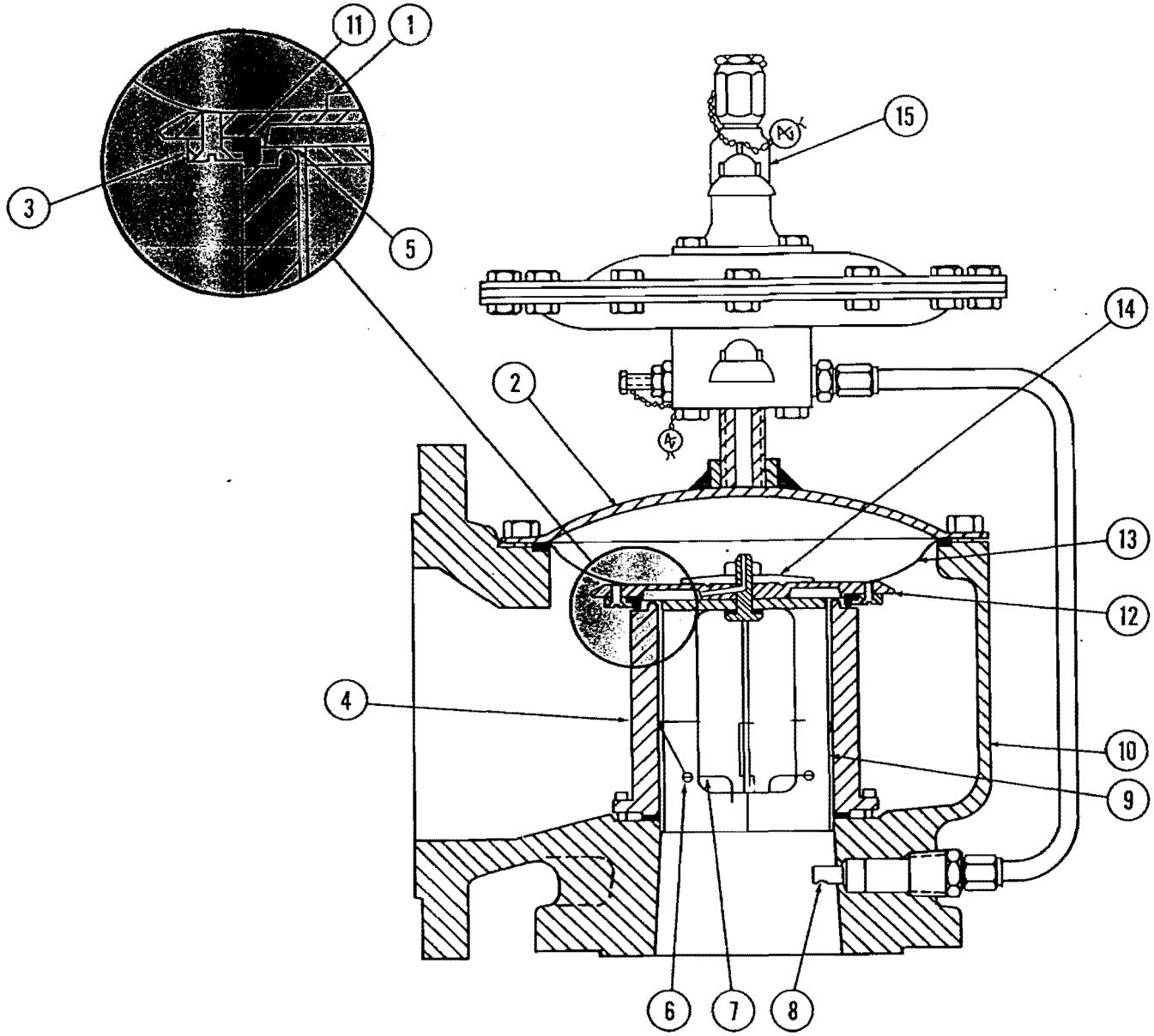
type 93T

main valve construction

- TEFLON DIAPHRAGM, SEAT AND SEALS
- REPLACEABLE NOZZLE
- FILM TYPE MAIN VALVE SEAT
- PRESSURE RANGE 29″ Hg VACUUM to 13 PSIG
- SIZES 2″ to 12″
- ORIFICES 2.29 in.² to 84.0 in.²

TEMPERATURE RANGE = -320 F TO 140 F

ALUMINUM BODY



Relief Valve Flow Test – AGCO 93T

Valve Capacity @ 16.2 psi Vessel Pressure

Measured Flow.....1252 SCFM air (1129 SCFM Ar)

Stamped Flow.....1018 SCFM air (918 SCFM Ar)

Calculated Flow.....1139 SCFM air (1027 SCFM Ar)