Interdepartmental letterhead

Mail Station L- 373

Ext: 4-4688

Revision A
END 92-072

AAN93-100021-0A

High Pressure Systems Group
Nuclear Test Engineering Division

September 8, 1993

TO: Distribution

FROM: Matt Traini, Pressure Inspector

SUBJECT: END92-072, REVISION A, PRESSURE TESTING OF VACUUM "CONFLAT" FLANGES

Please replace your existing copy of END92-072 with the current one enclosed. The only difference is the addition of information regarding the pressure testing of 8 inch diameter flanges with viewports. Tests were conducted by Roger Carnahan, Pressure Inspector, High Pressure Laboratory. This information is summarized on page 14.

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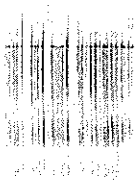
Mechanical Engineering Note

PRESSURE TESTING OF VACUUM "CONFLAT" FLANGES



By

Matthew W. Traini

November 1992
Revision A, September 1993

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The purpose of this Engineering Note is to summarize pressure tests that were performed on a variety of vacuum "conflat" flanges. Since manufacturers offer no pressure ratings on vacuum components, it was necessary to perform tests at the Lawrence Livermore National Lab (LLNL), High Pressure Laboratory (HPL), Bldg. 343. This would assist designers in determining working pressures and establishing safety guidelines when using.

All the test results are presented in memo format as was originally issued.

The first series of tests involved testing a $1^{1}/_{3}$" diameter flange that was welded to a valve and connected to a gas sample cylinder (Refer to memo dated January 27, 1988 to C. Borzileri). Building 343 Test Request (T.R.) #6226 required the testing of both $1\ ^{1}/_{3}$" and $2\ ^{3}/_{4}$" blank flanges.

The second series of tests are referenced to T.R. 6408 (Refer to memo dated March 31, 1988 to J. Stapleton). These tests involved $4\ ^{5}/_{8}$" flanges that were connected to a 2 liter volume.

The final series of test involved pressure testing of $2\ ^{3}/_{4}$" vacuum flanges with viewports (Refer to the 3 memos to Brad Maker dated January 23, February 6 and February 23, 1989) on several Bldg. 343 Test Requests.

The mode of failure for the blank flanges, regardless of size, is the assembly bolts would stretch causing gas to vent through the gasket. On several tests, a linear displacement tranducer was used to detect any growth of the flange at test pressure, which proved minimal.

The flanges with Pyrex viewport of course failed at much lower pressures than the blank leaked. It should be emphasized that the failure pressure was very much dependent on the condition of the glass (i.e. scratches or blemishes). Further recommendation for their use are detailed in Engineering Safety Note ENW 89-901.

Interdepartmental letterhead

Mail Station L- 373

Ext: 2-9596

January 27, 1988

TO: Chuck Borzileri

FROM: Matt Traini

SUBJECT: PRESSURE TESTING OF "CONFLAT" VACUUM FLANGES

The purpose of this memo is to document information on test results pertaining to knife-edge type vacuum ("conflat") flanges when used in positive pressure situations.

These components are known to be used in pressure systems throughout the laboratory and because commercial manufacturers offer no pressure (only vacuum) data, it became necessary to perform a series of tests in order to establish guidelines to be followed when using vacuum flanges for pressure requirements.

The nature of these tests evolved as a result of Building 343 Test Request No. 6196. The customer requested us to pressure test a gas sample bottle that consisted of a 1-1/3" Ø vacuum flange welded to a valve. This assembly was then threaded to the sample bottle. The area of concern was the weld integrity between the flange and valve and the pressure at which the flange would leak or fail. Therefore, test requests were generated internally in order to obtain this information. These results will be explained later in this report.

The results summarized in this document were comprised of three separate Building 343 Test Requests: T.R. #6202 tested the weld integrity between the conflat flange and valve. T.R. #6226 determined at what pressure a conflat flange will begin to leak. The purpose of T.R. #6196 was to proof-test the gas sample bottle assembly. Figures 1, 2 and 3 illustrates each of these arrangements.

All tests were performed using knife-edge "conflat" flanges and copper gaskets. Tests performed on 1-1/3" Ø flanges used #8-32 bolts and were torqued to 70 in-lbs. (5.8 ft-lbs.). The 2-3/4" Ø flanges used 1/4-28 bolts and were torqued to 192 in-lbs. (16 ft-lbs.). An anti-seize lubricant ("Silver Goop") was used on all threads.

Each test was performed using helium. New gaskets and bolts were used for each run. Results are summarized below.

T.R. #6202

The purpose of T.R. #6202 was to test the weld joint between the valve and flange and to determine the weakest point in the assembly. The flange tested was an MDC Model No. F133000 (1-1/3" Ø blank flange). The valve that was threaded and then welded to the flange was a Whitey "DK" series shut-off valve, Model No. SS-14DKM4 rated for 3,000 psi.

Testing procedure included pressurizing flange/valve assembly and then isolating the flange from the valve and checking leak pressure across the valve stem.

Five assemblies were tested. In all cases except one, the vacuum flange was the first to fail. The average pressure where leakage occurs for the tests performed was at 10,970 psi, with a range of 10,150 to 12,700 psi. With the flange isolated from pressure, leakage at the valve stem occurred at an average of 12,200 psi, with a range of 9,700 to 13,400 psi. This valve confirmed an industry standard of a 4 to 1 safety factor on valves.

It should be noted that failure in all cases were not catastrophic, but took the form of small leaks. No failure concerning the welds were noted. The stainless steel bolts used to assemble the flanges stretched 0.010 - 0.020 inches in length under pressure allowing the flanges to separate from each other resulting in leakage at the gasket.

T.R. #6226

The purpose of T.R. #6226 was somewhat similar to T.R. #6202. However, both 1-1/3" Ø and 2-3/4" Ø flanges were tested. Also, tests were made for flanges with stainless steel and Grade 8 alloy bolts in order to make comparisons. In addition, a linear variable differential transformer (LVDT) was used to measure flange movement when subjected to a pressure load. Three tests were performed for each size flange and bolt material in order to obtain an average value.

The 1-1/3" Ø flanges assembled with stainless steel bolts leaked at an average of 15,170 psi. The same size flange assembled with alloy bolts leaked at an average of 14,170 psi.

The 2-3/4" Ø flanges (MDC Model No. F 275000) assembled with stainless steel bolts leaked at an average of 5,050 psi; at 4,860 psi with those assembled with alloy bolts.

The LVDT measured movement in the center of the test flange and ranged from 0.0005 to 0.001 inch at full pressure. It should be noted that a new flange was used for each test to eliminate any cumulative fatigue that may have occurred.

T.R. #6196

The final portion in this series involved proof-testing the gas sample bottles with the valves and flanges in position. The cylinders were a Whitey Part No. 304L-HDF4-500. Their volume was 0.5 liter and a 1800 psi maximum operating pressure. Testing pressure was 2,700 psi. A total of 9 vessels and 5 valve/flange assemblies were tested. An Engineering Safety Note should have accompanied this test request in order to certify these vessels. An identifying T.R. number was etched on each vessel and released to the customer. However, it was made clear that an Engineering Safety Note needed to be provided in order to use the valve/flange assembly with the Whitey vessel for their intended purpose.

Conclusion:

It should be noted that the intention of these tests were to provide guidelines for usage of "conflat" flanges. Any modifications to hardware may alter test results and would require additional engineering and testing. Therefore, it is necessary to understand under what conditions results were derived from and decisions can be made accordingly. It should be further emphasized that failure was not catostraphic, but rather took the form of a small leak resulting from flange bolts stretching and allowing gas to pass between the gasket and "knife-edge" seal.

If there are any questions regarding these tests, please contact me at (415) 422-9596.

Matt Traini

Matt Traini
High Pressure Laboratory
Building 343

0264mt

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SUBJECT

SKETCH

LAWRENCE LIVERMORE LABORATORY
UNIVERSITY OF CALIFORNIA

JOB ORDER INFORMATION

JOB NO.

TAG NO. Revision A

SERIAL NO.

NO. END 92-072

DATE ISSUED

Page 6

DELIVER TO

DRAWN BY M. TRAINI

DATE 23 DEC 87 | BUILDING NO. 343 | ROOM NO.

APPROVED BY

DATE

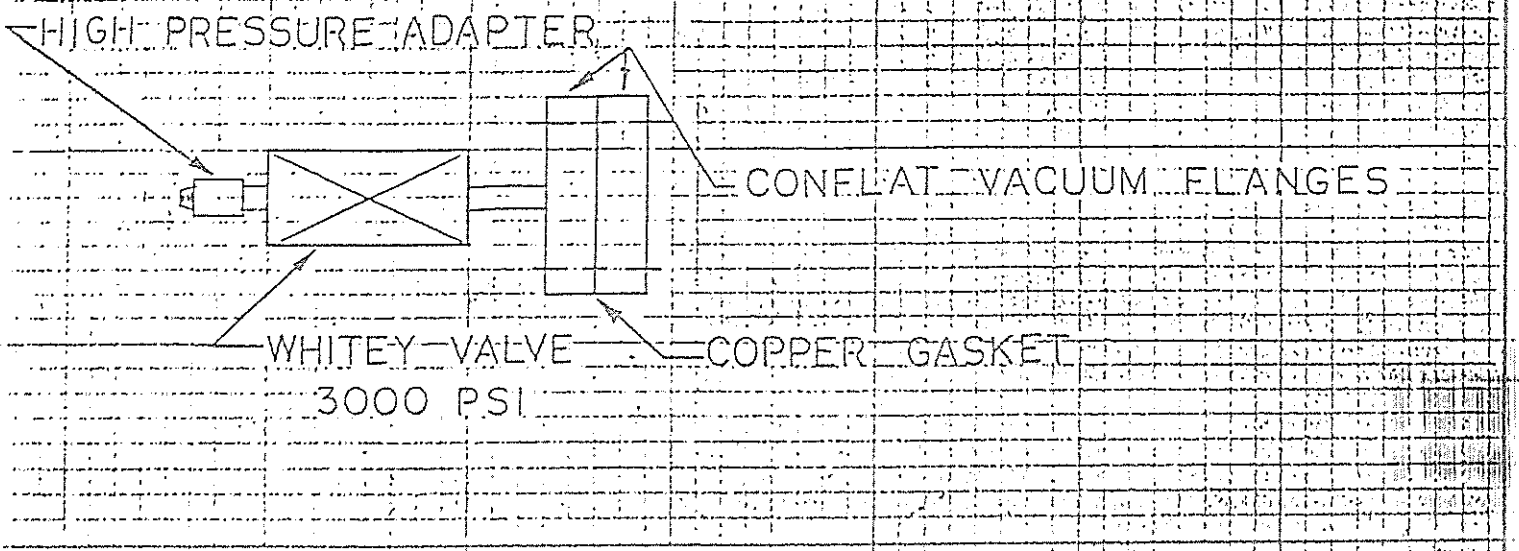


FIGURE 1: VALVE - FLANGE ASSEMBLY
(T.R. 6202)

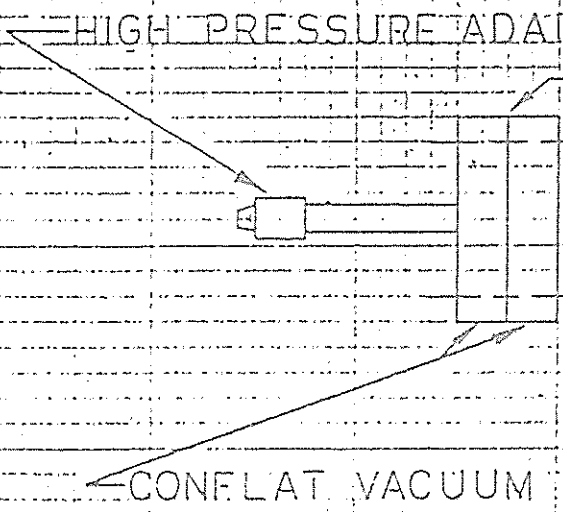


FIGURE 2: FLANGE - BLANK ASSEMBLY
(T.R. 6226)

SKETCH NUMBER 1

SUBJECT

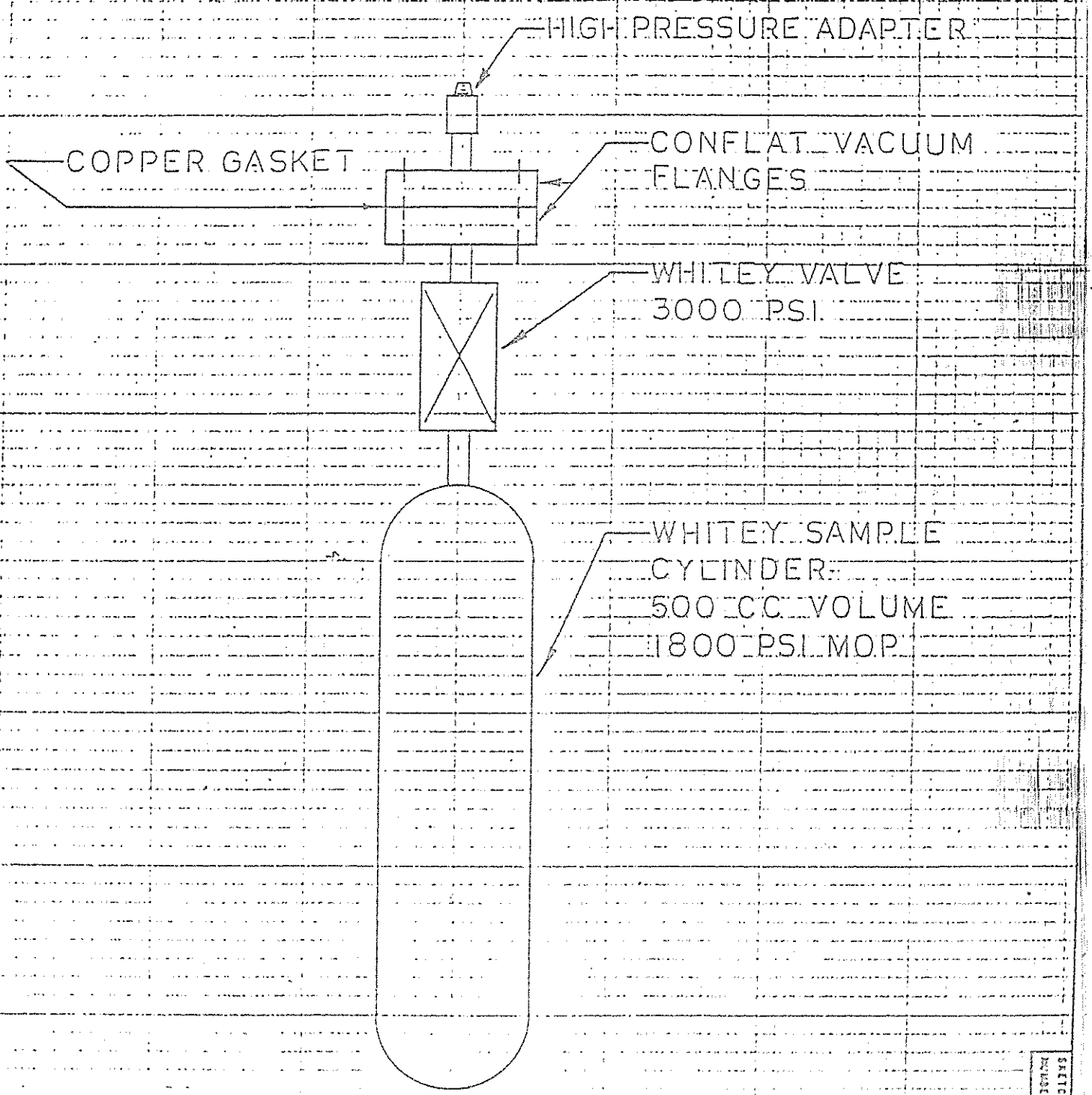
SKETCH

LAWRENCE LIVERMORE LABORATORY
UNIVERSITY OF CALIFORNIA

JOB ORDER INFORMATION
JOB NO.
SERIAL NO.
DATE ISSUED
DELIVER TO

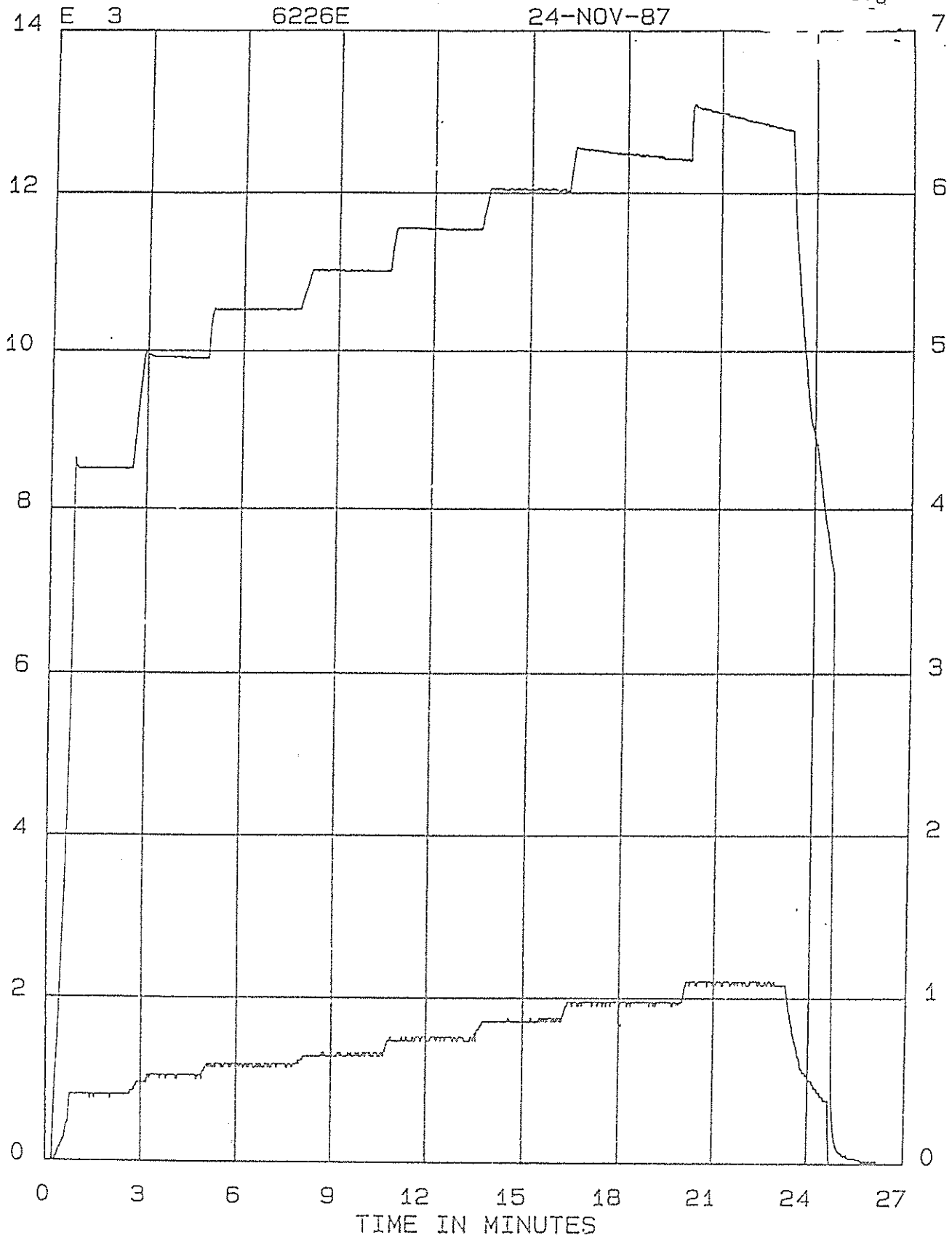
TAG NO. END 92-072
REQD.
DATE REQD.

DRAWN BY M. TRAINI
DATE 23 DEC 87
BUILDING NO. 343
ROOM NO.
APPROVED BY
DATE



SKETCH NUMBER

FIGURE 3: GAS SAMPLE BOTTLE ASSEMBLY (T.R. 6196)



NAME OF EXPERIMENTER MATT TRAINI
NAME OF OPERATOR MATT TRAINI
1 PSIG 30K TD REL MAX= 0.1310E+05
2 MILS LVDT MAX= 7.000 MIN= 0.0000

Interdepartmental letterhead

Mail Station L-373

Ext: 2-9595

March 31, 1988

TO: Jerry Stapleton

FROM: Matt Traini - High Pressure Laboratory

SUBJECT: PRESSURE TESTING OF 4 5/8" Ø "CONFLAT" VACUUM FLANGES

The following is an explanation of pressure tests performed on 4 5/8" Ø "Conflat" vacuum flanges. These tests are referenced to Bldg. 343 Test Request No. 6408.

Two test assemblies were provided and the flanges were bolted together using 12 point stainless steel capscrews. Each of the vessels were initially hydro tested to 1200 psi and no leaks were present. The purpose for the initial hydro testing was to minimize any catastrophic failure that may have occurred due to the relatively large volume (approximately 2 liter) of the assemblies. In addition, 300 psi NPT fittings were welded into the assemblies (for testing purposes only) and this was also an area of concern. Each assembly was tested separately and initially pressurized to approximately 500 psi. Pressure increased in 50 to 100 psi increments to a maximum test pressure of 1200 psi. These tests are referenced to T.R. 6408B and 6408C.

Following hydro testing the vessels were disassembled and cleaned. They were reassembled using new stainless steel hardware and gaskets and tightened to a specified torque of 9 ft-lbs. Next, they were pressurized with helium in 100 psi increments until a helium mass spectrometer could detect any leaks. Following the series of tests using stainless steel hardware, the vessels were reassembled using grade 8 alloy steel cap screws. They were tightened to a specified torque of 30 ft-lbs. These results are referenced to T.R. 6408D thru 6408H and are detailed at the end of this memo.

It should be noted that no significant conclusions could be drawn when comparing alloy bolts to stainless steel hardware. Past similar tests indicate there is no pressure advantage using one over the other.

New hardware was used for each test and the bolt lengths were measured before and after testing. No increase in bolt length occurred. In addition, the portion of the adapter where the cap was welded on was measured before and after testing. No growth was evident. Refer to the attached data for the pressure/time plots for each test.

Test No.	Assembly No.	Fluid	Hardware	Leakage / Range
6408B	#1	Water	SST	No leaks @ 1200 psi
6408C	#2	Water	SST	No leaks @ 1200 psi
6408D	#1	Helium	SST	930 psi / 10^{-6} Torr
6408E	#2	Helium	SST	500 psi / 10^{-6} Torr
6408F	#2	Helium	SST	525 psi / 10^{-6} Torr
6408G	#1	Helium	Alloy	550 psi / 10^{-6} Torr
6408H	#2	Helium	Alloy	900 psi / 10^{-6} Torr

If there are any questions regarding these tests, please contact me at Ext. 2-9596.

Matt Traini

Matt Traini
High Pressure Laboratory

0281mt

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Interdepartmental letterhead

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Ext: 2-9596

January 23, 1989

TO: Brad Maker

FROM: Matt Traini
High Pressure Laboratory

SUBJECT: PRESSURE TESTING OF CONFLAT FLANGES WITH PYREX VIEWPORTS

The purpose of this memo is to summarize work performed under Bldg. 343 Test Request No. 6709.

Five VARIAN conflat flanges, 2 3/4" diameter, with Pyrex windows were to be pressurized with helium gas to failure. Pressure was increased in 10 psi increments with a one minute hold at each pressure. The flanges were assembled using copper gaskets. Following manufacturer's specifications, the bolts were tightened to 16 ft-lbs. New bolts and gaskets were used for each flange.

The test results are summarized in the table below.

Flange Number	Failure Pressure, psig	Nature of Glass
6709 A	108 psig	Normal
6709 B	39	2 Scratches
6709 C	140	Normal
6709 D	116	Normal
6709 E	54	1 Scratch

If there are any questions regarding these tests, please contact me at Ext. 2-9596.

Matt Traini

Matt Traini
High Pressure Laboratory

0358mt

Distribution:
D. Holton
O. Parker

Interdepartmental letterhead

Mail Station L- 373

Ext: 2-9596

February 6, 1989

TO: Brad Maker, L-125

FROM: Matt Traini

SUBJECT: Testing of MDC flanges with Pyrex viewports

The purpose of this memo is to summarize work performed under Bldg. 343 Test Request No. 6726.

Three MDC "conflat" flanges, part number VP-150 (2 3/4" diameter), were pressurized with helium gas to failure. Pressure was increased in 10 psi increments with a 30 second hold at each pressure. The flanges were assembled using copper gaskets and bolts were tightened to 16 ft-lbs. New hardware was used on each of the flanges and threads were lubricated with "Silver Goop". Tests were similar to those performed previously under Test Request No. 6709 where VARIAN flanges were used.

Mention should be made regarding the types of failure. With the VARIAN flanges (TR 6709), the viewports fractured into small pieces. With the MDC flanges (TR 6726), the viewport actually separated intact from the seam of the flange.

Test results for the MDC flanges are summarized in the table below:

FLANGE NUMBER	FAILURE PRESSURE
6726A	190 psig
6726B	110 psig
6726C	141 psig

If there are any questions regarding these tests, please contact me at ext.2-9596.

Matt Traini

Matt Traini
High Pressure Laboratory

Distribution:
D. Holten L-122
O. Parker L-373

University of California
Lawrence Livermore
National Laboratory

Interdepartmental letterhead

Mail Station L- 373

Ext: 2-9596

February 23, 1989

TO: Brad Maker

FROM: Matt Traini

SUBJECT: PRESSURE TESTING OF CONFLAT FLANGES WITH PYREX VIEWPORTS

The purpose of this memo is to summarize work performed under Bldg. 343 Test Request No. 6741.

It was requested that three VARIAN flanges were pressurized with helium gas to failure. The flanges were 2-3/4" diameter. These tests were similar to those previously performed under Test Requests 6709 and 6726. The purpose for testing this set of flanges was to determine if there had been any degradation caused by cleaning the flanges in a caustic solution. The flanges were assembled using copper gaskets and the hardware used for assembly were lubricated with "Silver Goop". The bolts were tightened to 16 ft-lbs. All three viewports fractured into small pieces upon failure.

Results for this series of tests as well as previous ones are summarized in the table below.

FLANGE NUMBER		NATURE OF GLASS	FAILURE PRESSURE, PSIG
6741	A	Normal	180 psig
	B	Normal	250
	C	Normal	150
6726	A	Normal	190 psig
	B	Normal	110
	C	Normal	114
6709	A	Normal	108 psig
	B	2 Scratches	39
	C	Normal	140
	D	Normal	116
	E	1 Scratch	54

Matt Traini

Matt Traini
High Pressure Facility

0359mt
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This additional information regarding the proof and burst testing of new 8" O.D. vacuum "conflat" flanges with viewports is being added to the existing engineering note. These series of tests were performed under Bldg. 343 Test Request number 1489 by Roger Carnahan.

Viewports from 2 manufacturers' were supplied for the tests and results are summarized below:

Flange Mfg.	Proof Pressure/Hold Time	Burst Pressure
MDC	15 psig/15 minutes	
Varian	15 psig/15 minutes	
MDC		54 psig

Two of the flanges were taken to proof test pressure with no leaks and the third to burst. Upon burst, the entire viewport remained intact and separated from the seam of the flange. This is the same type of failure that had occurred on the smaller 2 $^{3}/_{4}$" diameter flanges (MDC) with viewports (see pg. 12).

It should also be stated that as an added safety precaution, a lexan shield should be installed over the viewport in the event of a failure.