HIGH PRESSURE

BACK UP AIR PIPING

PRESSURE TEST

D-ZERO ENGINEERING NOTE # 3823.115-EN-563

March 12, 2002

Author: Russell A. Rucinski

Project Engineer

PPD/MSD/D0 Operations

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Fermilab

2/12/2002

HP Air Compressor connection tubing
Pressure Testing Permit (Page 1 of 2)*

Type of Test: [√] Pnuematic
Test Pressure: 110%(2200 psi) = 2420 psig

Maximum Allowable Working Pressure: 2200 psig (Set by the rating of several ball valves)

Items to be Tested: Short length (12") of flex hose, Approx. 50 feet of 1/2" OD x 0.049 " wall tubing run from gas shed to existing piping. Will includes some compression fittings. Will also test about 300 feet of existing ½" piping and components from tube trailer isolation valve to final regulator PRV-745-I in utility room. Ref. P&I Drg. 3740.000-ME-273995.

Location of Test: South side DAB tank farm _____ Date: ~~February~~ March 2002

Hazards Involved: Sudden mechanical release of high pressure gas could cause flying debris, whipping hoses, loud noise. Equivalent stored energy is 620,000 Joules = 460,000 ft-lbs or the equivalent of 134 grams of TNT.

Safety Precautions Taken: Test personnel will be excluded from the gas shed and pump room during the pressurization portion of the test ~~unless behind a barrier~~. Ear plugs will be required for personnel within vicinity of gas shed in case 2500 psig relief goes off. Flex hoses greater than 24" long are safety chained.

Shed door locked
/ Technician posted

Special Conditions or Requirements: We will control perimeter during the test. We will use the HP air compressor to achieve test pressure. Pumping rate will be about 100 psi/min. The 2500 psig relief on the discharge of the HP compressor will limit overpressure during the test. A 2200 psig relief will be installed on the piping after the test.

* Must be signed by division/section safety officer and division/section head prior to conducting test. It is the responsibility of the test coordinator to obtain signatures.

Fermilab

2/12/2002

HP Air Compressor connection tubing

Pressure Testing Permit (page 2 of 2)

Test Coordinator: Russ Rucinski Dept/Date PPD/MD/D0 OPs 2/11/2002

Division/Section Safety Officer Martha Heflin #8971 Dept/Date PPD/ESH 3-7-02

Division/Section Head John Cooper Dept/Date 3/8/02

Results SUCCESSFUL TEST. FIXED A COUPLE OF SMALL LEAKS AT COMPRESSION FITTINGS. LEAKS DETECTED BY SNOOP (SOAP WATER), PRESSURE REDUCED DURING TIGHTENING OF FITTINGS. NO FAILURES OR SURPRISES. TEXT OF TEST ACTIVITY AND PRESSURE TREND OF PT-744-I IS ATTACHED. DOCUMENTATION STORED LOCALLY AS DØ ENGINEERING NOTE 3823.115-EN-563.

Witness Russell A. Rucinski ID# 8351 Dept/Date PPD/MD/DØ OPS 3/12/02
(Safety Officer or Designee)

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
	PPD / MD DØ OPERATIONS	DØ UTILITIES	3823.115	1

SUBJECT: HIGH PRESSURE AIR LINE PRESSURE TEST. (LOG)

NAME: RUSS RUCINSKI

DATE: MAR. 12, 2002 | REVISION DATE:

MARCH 12, 2002. RECORDING TEST ACTIVITY BY RUSS RUCINSKI ID#8351

DID VALVE LINE UP.

"OLD" SECTION OF PIPING @ 1500 PSI. WILL MODIFY PROCEDURE TO CONTROLLABLY BACK FEED NEW SECTION TO TEST PRESSURES.

PERSONNEL: RUSS RUCINSKI - TEST COORDINATOR
BOB BARGER - CONTROLLING COMPRESSOR & FELLOW GAGE WATCHER
JIM FAGAN @ TUBE TRAILER END
BRYAN JOHNSON - GUARD @ CRYO ROOM
BILL FRANK - OPS TECH IN CRYO CTRL RM.

10:00 PRESSURIZED TO 75 PSIG. SNOOPED ✓ OKAY.
BLED PRESSURE DOWN, CHANGE OUT 1/4" OD Cu TUBING TO TEST GAGE TO 1/4" OD STN. STL., RATING ON Cu SUSPECT, INITIALLY THOUGHT IT WAS 1/8" OD.

10:15 NEW 1/4" OD STN. STL LINE FOR TEST GAGE BACKFILLED TO 100 PSIG HELD

10:18 BACKFILLING COMPLETELY.

10:20 EQUALIZED COMPLETELY @ ~~800~~ 830 PSI

VERIFIED CRYO PUMP ROOM GAURDED

10:20 STARTED COMPRESSOR
10:21 900 PSI
10:24 1200 PSI
10:26 1610 PSIG — SHUT OFF POWER @ 1500 PSIG, PRESSURE WENT UP AFTER SHUTTING OFF POWER.
10:33 1595 PSIG — HELD FOR 10 MINUTES
10:36 1595 PSIG.
PRESSURIZING TO 1900 psig

FERMILAB ENGINEERING NOTE	SECTION PPD / MD DØ OPERATIONS	PROJECT DØ UTILITIES	SERIAL-CATEGORY 3823.115	PAGE 2

SUBJECT: PRESSURE TEST OF HIGH PRESSURE COMPRESSOR PIPING. (LOG)

NAME: RUSS RUCINSKI

DATE: 3-12-02 REVISION DATE:

10:39 1940 PSIG SHUT OFF COMPRESSOR
1975 PSIG ON GAGE IN CR40 PUMP ROOM PI-743-1
1911 PSIG ON PT OF COMPUTER PT-744-1

10:47 1930 PSIG ON PRESSURE TEST GAGE

10:49 1930 PSIG. - HELD GOOD FOR 10 MINUTES.

10:50 ISOLATED NEW SECTION BY CLOSING MV-1406 ~~SUPPLY~~
OPENED MV1728I & BLED PRESSURE DOWN TO 700 PSIG.
TIGHTENED SWAGELOK @ MV-1729-I, LEAK FIXED

10:55 1700 PSIG STARTING TO PUMP BACK UP..

10:58 2000 PSIG

11:00 2200 PSIG HOLDING, SHUT OFF COMPRESSOR

11:08 2200 PSIG

11:10 2190 PSIG HELD FOR 10 MINUTES OKAY.
SUCCESSFUL. TURNING PUMP ON GOING TO 2420 PSIG

11:12 2430 PSIG, PUMP SHUT OFF
2425 PSIG @ PT GAGE
2339 PSIG @ PRESSURE TRANSMITTER ON IFIX; PT-744-1
≈ 2400 PSIG ON PI-743-I IN PUMP ROOM

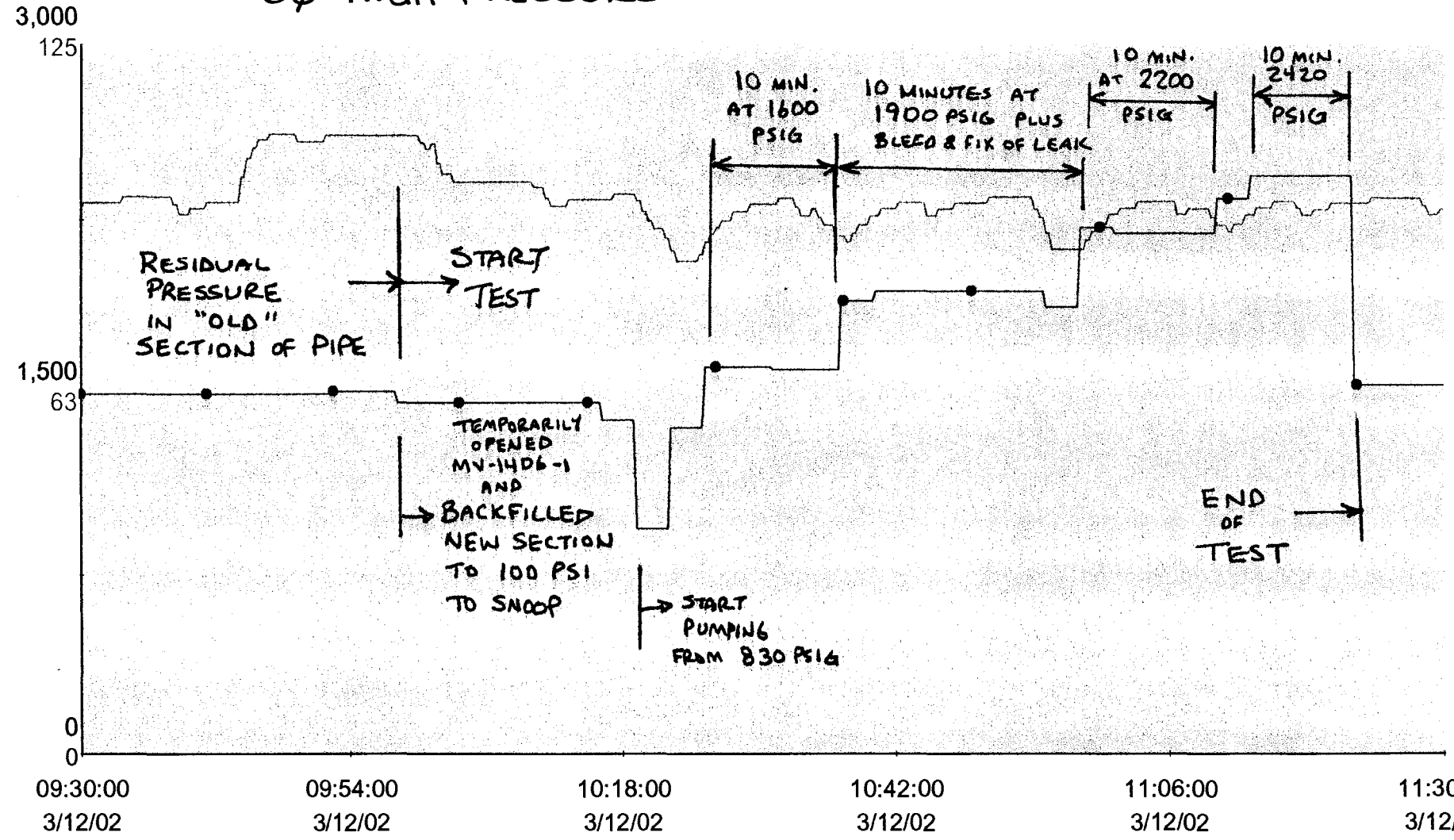
11:19 2420 PSIG

11:22 2410 - HELD GOOD FOR 10 MINUTES

11:23 OPENED MV-1, PUT PRESSURE ~~IN~~ INTO TRAILER, WENT TO 1550 PSI.
CLOSED MV-1406-I
OPENED MV-1728-I BLEEDING "NEW" SECTION.

11:25 "NEW" SECTION @ ATM, LEFT MV-1728-I OPEN.
B. BARGER REMOVING JUMPER ON HIGH PRESS. CUT-OUT SWITCH OF COMPRESSOR.
TEST GAGE WILL BE REMOVED, SV-1791-I INSTALLED.

DØ HIGH PRESSURE PIPING - PRESSURE TEST



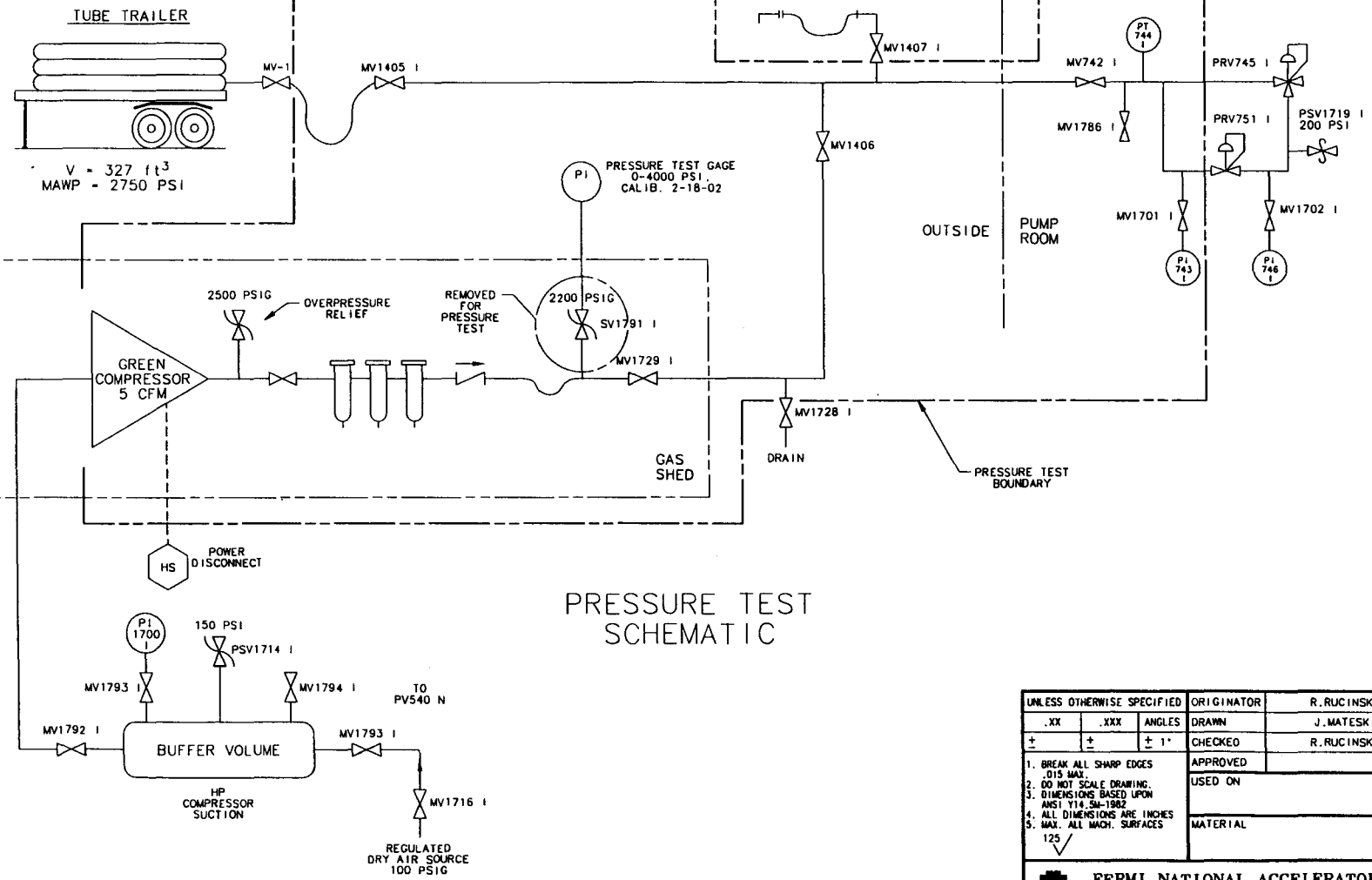
D0_CCRS1::D0_CCRS1:PT744I.F_CV I/A HIGH PRESSURE BACKUP 2,436

D0_CCRS1::D0_CCRS1:PT797I.F_CV INSTRUMENT AIR PRESSURE 95

} VALUES @ 11:15 FULL TEST PRESSURE

ANNOTATIONS BY RUSS RUCINSKI

REV	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE



PRESSURE TEST SCHEMATIC

UNLESS OTHERWISE SPECIFIED			ORIGINATOR	R.RUCINSKI	05-MAR-2002
.XX	.XXX	ANGLES	DRAWN	J.MATESKI	05-MAR-2002
±	±	± 1°	CHECKED	R.RUCINSKI	
1. BREAK ALL SHARP EDGES .015 MAX. 2. DO NOT SCALE DRAWING. 3. DIMENSIONS BASED UPON ANSI Y14.5M-1982 4. ALL DIMENSIONS ARE INCHES 5. MAX. ALL MACH. SURFACES 125			APPROVED		
			USED ON		
			MATERIAL		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

D-ZERO DETECTOR EXPERIMENT PRESSURE TEST SCHEMATIC

SCALE	DRAWING NUMBER	SHEET	REV
NONE	3740.510-MC-295633	1 OF 1	
CREATED WITH : IdeasBm4		GROUP: PPD/MECHANICAL DEPARTMENT	

Russ Rucinski
3/5/2002

High Pressure Air compressor connection tubing

Pressure test procedure:

Pre-requisites:
A signed and approved copy of the Pressure testing permit is on-hand. The Safety officer or designee listed on the Pressure testing permit is present.

SV-1791-I is removed from the system and the pressure test gage is connected there. The pressure test gage is remotely located outside of the gas shed next to the power disconnect for the compressor.

The compressor high pressure cut off switch is jumpered out to allow manual over-ride of pressure to 2420 psig. Compressor is off.

Procedure:

1.) Place barriers around compressor in the gas shed.
2.) Close MV-1, the tube trailer main block valve.
3.) Open MV-1405-I.
4.) Open MV-1406-I.
5.) Close MV-1728-I.
6.) Open MV-1729-I.
7.) Close MV-1407-I.
8.) Open MV-742-I.
9.) Close MV-1786-I.
10.) Open MV-1701-I.
11.) Open MV-1792-I.
12.) Open MV-1793-I.

13.) Station a technician with walkie talkie at the end of the catwalk OUTSIDE the cryo pump room as a guard to keep personnel out of the room.

14.) Evacuate personnel from the gas shed then lock the back doors to the gas shed.

15.) One spotter with walkie talkie is stationed in the vicinity of the tube trailer but away from the piping and flex hose.

16.) Test personnel with walkie talkie are stationed outside of the gas shed at the compressor's power disconnect switch and watching test gage.

17.) Test coordinator records test activities, and makes a written record of pressure versus time log of events.

18.) Test personnel apply power to compressor and watch pressure in piping increase. Power is shut off when pressure is between 25 psi and 100 psi.

19.) Perform a Snoop leak check connections on the new section of piping.

20.) Spotter outside cryo pump room enters pump room and verifies pressure on PI-743-I.

21.) When test coordinator feels piping is tight and holding pressure, continue.

22.) Cryo pump room and gas shed are once again evacuated and guarded.

23.) Turn power on to compressor and pressurize to 1500 psig. Stop and hold for 10 minutes.

24.) If leaks are suspected, reduce pressure to 500 psig by opening MV-1728-I. Then investigate and find the leak.

25.) Turn power on to compressor and pressurize to 1900 psig. Stop and hold for 10 minutes.

26.) Turn power on to compressor and pressurize to 2200 psig. Stop and hold for 10 minutes.

27.) Turn power on to compressor and pressurize to 2420 psig. Stop and hold for 10 minutes.

28.) Gradually relieve pressure by opening drain valve, MV-1728-I. Close MV-1728-I when pressure is reduced to atmospheric pressure.

29.) Return system back to normal configuration.

Remove test gage and install system relief valve, SV-1791-I.
Remove barriers.
Remove jumper on compressor high pressure cut-out switch.
Open MV-1, main tube trailer isolation valve.

30.) Test coordinator sends completed documentation to the division safety officer and the independent reviewer.

31.) Test coordinator documents test and documentation in a D-Zero engineering note.

R. Rucinski
3/5/2002
⚠1 REV. 3/12/02

Pressure ratings for components not listed on Piping components list:

1.) Flexible metal hose section: Working pressure = 3200 psig at 70 F. Burst pressure = 13,000 psig. Manufactured by Scott Specialty gases, Model number 58-2M1F-4A24. Supplied as part of Scott Multi-Purpose Automatic change-over manifold, model 8501.

2.) 0.500" OD x 0.049" wall, 304 stainless steel tubing: Working pressure = 3060 psi as listed in Brookhaven National Laboratory Piping guide.

3.) Swagelok compression fittings rated at 4900 psig

4.) Commercial threaded fittings rated at 4500 psig

5.) High pressure compressor, Ingersoll-Rand type 30 model 223 with a capacity of 5.0 cfm at a rated pressure up to 3000 psi. Pressure switch set to shut off unit at 2200 psi. (Pressure switch will be jumpered out for pressure test)

6.) High pressure compressor discharge relief: Anderson Greenwood model 81MS66-3 set at 2500 psig, flow capacity =1137 scfm

7.) Pressure test gage (used for pressure test): 4000 psig minimum. Acco Helicoid Gage, 0 to 4000 psi, 25 psi subdivisions, calibrated 2-18-2002 by Jerry Domoleczney. (Will be removed after test)

⚠1 8.) 1/8" OD Copper tubing from SV-1791-I port to pressure test gage. Working pressure = 5330 psi as listed in Brookhaven National Laboratory Piping guide. (Will be removed after test) FOUND TO BE 1/4" O.D. CU AT TEST. CHANGED TO 1/4" O.D. x .035" WALL STN. STL. BEFORE TEST.

9.) Tube trailer: MAWP = 2750 psi from DOT certification plate. Certification recently done by FIBA technology.

Pressure ratings for components that ARE listed on Piping components list
(Listed for convenience)

MV-742-I	2500 psi	Whitey 60 series, ½" ball valve
PI-743-I	3000 psi	Solrunt, 0 to 3000 psig pressure gage, panel mount.
PT-744-I	3000 psi	Rosemount, model 1151 0 to 3000 psi pressure transmitter
PRV-745-I	6000 psi	Grove model 302G, regulator
PRV-751-I	3000 psi	Grove model 15L, 0 to 150 psig outlet range
MV-1405-I	2500 psi	Whitey 60 series, ½" ball valve
MV-1406-I	2500 psi	Whitey 60 series, ½" ball valve
MV-1407-I	2500 psi	Whitey 60 series, ½" ball valve
MV-1701-I	3000 psi	Parker, model CPI, ¼" valve
MV-1728-I	3000 psi	Whitey model 4VF4 screwed bonnet needle valve
MV-1729-I	6000 psi	Dragon, model 816033KR
MV-1786-I	2200 psi	Whitey model SS6372-12T
SV-1791-I	2200 psi	Anderson Greenwood 81S24-2 (set pressure)

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
PPD / MD DØ OPS			1

SUBJECT: BACKUP AIR SYSTEM, HP PRESSURE TEST.

NAME: RUSS RUCINSKI

DATE: 2-14-02 REVISION DATE:

- ESTIMATE STORED ENERGY DURING PT

$$V = \frac{\pi d_{TUBE}^2}{4} L_{TUBE} + \frac{\pi d_{PIPE}^2}{4} \cdot L_{PIPING}$$

$$= \frac{\pi (.402_{IN})^2}{4}[50\,ft][12\,IN/ft] + \frac{\pi (.622\,IN)^2}{4}[300\,ft][12\,IN/ft]$$

$$= 1170\,IN^3 \qquad = 1170\,IN^3\left[\frac{1\,ft}{12\,IN}\right]^3 = .68\,ft^3$$

$$= 1170\,IN^3\left[\frac{2.54\,cm}{IN}\right]^3 = 19,174\,cc = \boxed{19,200\,cc}$$

$$P = 2420\,psig = 2435\,PSIA \times \frac{0.10135\,MPa}{14.7\,psi} = \boxed{16.8\,MPa}$$

↑ PRESSURE DURING PT

$$U_{gas} = \frac{P_1 V_1}{\gamma - 1}\left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]$$

STORED ENERGY OF GAS
REF. DOE PRESSURE SAFETY DRAFT MANUAL
APPENDIX C, PG. 11

WHERE:

$\gamma = C_p/C_v = 1.4$ FOR AIR

P_1 = CONTAINER PRESSURE (MPa)

P_2 = ATMOSPHERIC PRESSURE (MPa)

V = VOLUME (cc)

U_{gas} = STORED ENERGY (JOULES)

SUBSTITUTING

$$U_{gas} = \frac{(16.8\,MPa)(19,200\,cc)}{1.4-1}\left[1 - \left(\frac{0.10135\,MPa}{16.8\,MPa}\right)^{\frac{1.4-1}{1.4}}\right]$$

$$\boxed{U_{gas} = 620,000\ JOULES}$$

$$E = 6.2\times10^5\,J \times .737561\,\frac{ft\cdot lb}{J} = \boxed{4.57\times10^5\ ft\cdot lbs}$$

$$E = 460,000\ ft\text{-}lbs$$

WEIGHT OF EQUIVALENT EXPLOSIVE;

$$Wt = \frac{4.57 \times 10^5 \text{ Ft-lbs}}{3.42 \times 10^3} = \boxed{134 \text{ grams TNT}}$$

$$= 0.29 \text{ lbs TNT}$$

THIS IS A RESPECTABLE AMOUNT OF ENERGY. COULD LAUNCH A PROJECTILE WITH HIGH VELOCITY IF THERE IS A MECHANICAL FAILURE.

WILL USE A BARRIER BETWEEN PERSONNEL AND MOST LIKELY FAILURE POINTS, COMPRESSOR SKID IN GAS SHED AND PUMP ROOM COMPONENTS.

- ESTIMATE RATE OF PRESSURE INCREASE DURING TEST.

INGERSOLL RAND COMPRESSOR $\dot{V} = 5$ cfm

$$\frac{dP}{dt} = \frac{14.7 \text{ psi}}{0.68 \text{ ft}^3} \times \frac{5 \text{ ft}^3}{\text{min}} = 108 \text{ psi/min}$$

TIME TO GET TO 2420 PSIG.

$$t = \frac{2420 \text{ psi}}{108 \text{ psi/min}} = \underline{22.4 \text{ min}}$$

PUMPING SPEED IS SUFFICIENTLY SLOW TO ENABLE STOPPING THE COMPRESSOR BEFORE BLOWING THE 2500 PSIG RELIEF.

FERMI NATIONAL ACCELERATOR LABORATORY
BD/Cryogenic Department

03/06/02

To: Winslow Baker Chairman, D0 Upgrade Review

From: Michael Geynisman Chairman, D0 Cryogenic Safety Review Panel

Subject: Review of Dzero high-pressure air piping

The Dzero Cryogenic Safety Panel received a request from Russ Rucinski to review the documentation for the pressure testing permit for the section of the high pressure piping, which has been added to the Dzero Instrument Air System.

The piping and its components have MAWP of 2200 psig, therefore should be reviewed per FES&HM Chapter 5031.1 and Chapter 5034. The test pressure will be 2420 psig and the existing compressor will be used to pressurize the piping. The high-pressure tube trailer will be isolated from the tested piping.

Russ Rucinski provided me with the modified P&I drawing, pressure testing permit, schematic and procedure for the pressure test, list of component ratings, and additional calculations supporting the safety measures pertinent to the pressure test. I have reviewed the package and found that the added piping and its components satisfy the requirements of the FES&HM. The pressure testing permit and procedure are sufficient for safe testing.

Therefore, I would like to recommend PPD Safety Section to approve the testing.

cc: D. Allspach
A. Klebaner
R. Rabehl
R. Rucinski

Martha Heflin

Subject: FW: Review of Dzero high pressure air piping (fwd)

-----Original Message-----
From: Russ Rucinski [mailto:rucinski@fnal.gov]
Sent: Wednesday, March 06, 2002 3:56 PM
To: Winslow Baker; Michael Geynisman
Cc: martha@fnal.gov; Winslow Baker

> -----Original Message-----
> From: Winslow Baker [mailto:winbaker@fnal.gov]
> Sent: Wednesday, March 06, 2002 3:05 PM
> To: martha@fnal.gov
> Cc: Winslow Baker
> Subject: Review of Dzero high pressure air piping (fwd)
>
>
> Hi Martha,
> Are you the one to sign this pressure test permit? I expect it
> doesn't require a pORC of its own, just the final result does.
>
> Thanks,
> Win
>
> ---------- Forwarded message ----------
> Date: Wed, 06 Mar 2002 11:36:47 -0600
> From: Michael Geynisman <hope@fnal.gov>
> To: Winslow Baker <winbaker@fnal.gov>
> Cc: Bill Freeman <wfree@fnal.gov>, Russell Rucinski <rucinski@fnal.gov>,
> Arkadiy Klebaner <klebaner@fnal.gov>, Del Allspach
<allspach@fnal.gov>,
> Roger Rabehl <rabehl@fnal.gov>
> Subject: Review of Dzero high pressure air piping
>
> The Dzero Cryogenic Safety Panel received a request from Russ Rucinski to
> review the documentation for
> the pressure testing permit for the section of the high pressure piping,
> which has been added to the
> Dzero Instrument Air System.
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> The piping and its components have MAWP of 2200 psig, therefore should be
> reviewed per FES&HM Chapter
> 5031.1 and Chapter 5034. The test pressure will be 2420 psig and the
> existing compressor will be used
> to pressurize the piping. The high pressure tube trailer will be isolated
> from the tested piping.
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> Russ Rucinski provided me with the modified P&I drawing, pressure testing

> permit, schematic and
> procedure for the pressure test, list of component ratings, and additional
> calculations supporting the
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package
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> piping and its components satisfy the requirements of the FES&HM. The
> pressure testing permit and
> procedure are sufficient for safe testing.
>
> Therefore, I would like to recommend PPD Safety Section to approve the
> testing permit.
>
> --
> Michael Geynisman, P.E.
> Beams Division / Cryogenics
> Fermilab, PO Box 500, MS313, Batavia, IL 60510 USA
> ph. 630-840-2191, fax 630-840-4322
> hope@fnal.gov
> ----------
> There is ALWAYS a ray of HOPE on the horizon!
> ==========
>
> Winslow Baker wrote:
>
> > Hi Mike,
> > I understand your Committee is the most familiar with this
> > installation, so would you please review this pipe for DZero? I am
> > sending you the packet that Bill gave me via surface mail.
> >
> > Thanks,
> > Win
> >
> > ----------
> > Hi, Win:
> >
> > This note is to request a review of some new high pressure piping at
> DZero,
> > as briefly described below and in the attached cover sheet. I will
bring
> > the mechanical drawings to your office at lunchtime today, along with
> paper
> > copies of the relevant Dzero engineering notes and permits related to
the
> > system. If, possible we'd like for this review to be completed in the
> > next couple of weeks. Let's shoot for Friday, March 8 2002.
> >
> > The DZero technical contact for this review is Russ Rucinski
> > (rucinski@fnal.gov, x 2888).
> >
> > Thanks.
> >

> > Bill Freeman
> > -----Original Message-----
> > From: Russ Rucinski [mailto:rucinski@fnal.gov]
> > Sent: Monday, February 18, 2002 4:14 PM
> > To: Bill Freeman
> > Subject: Review of high pressure air piping
> >
> > I need to have a new section of high pressure piping reviewed. The
scope
> is
> > small, only the addition of 50 feet or so of piping and some new valves.
> It
> > needs a peer review per FESHM 5031.1, including a pressure test.
> >
> > Attached is a cover memo explaining the task and review material. Hard
> copy
> > is in your mailbox. Let me know if you need anything else.
> >
> > It would be ideal to be able to complete the review and pressure test
and
> > pORC for the pumping compressor within a few weeks.
> >
> > Thanks,
> >
> > Russ
>