PAYLOAD HAZARD REPORT		a. NO: GHR-AMS02-004
b. PAYLOAD: Alpha Magnetic Spectrometer-02 (AMS-02) GSE		c. PHASE: III
d. SUBSYSTEM: Pressure Vessels, Pressurized Lines	e. HAZARD GROUP: Pressure Systems	f. DATE: August 2010
g. HAZARD TITLE: Rupture of the AMS-02 Pressurized Components.		i. HAZARD CATEGORY ☒ CATASTROPHIC ☐ CRITICAL

h. APPLICABLE SAFETY REQUIREMENTS:

KHB 1700.7C, Sections: 4.3.3 Pressure/Vacuum Systems and 4.3.8 Cryogenics, KNPR 8715.3 KSC Safety Practices

j. DESCRIPTION OF HAZARD

The rupture of GSE/Flight pressure systems presents a hazard to personnel, KSC facilities, or the orbiter during pad operations.

NOTE: For pressure systems hazard reports for flight hardware see AMS-02-F03, and AMS-02-F05.

(cf. attached GSE pressure systems components tables.)

k. HAZARD CAUSES:

1 Structural failure of pressure vessel(s)/systems.
5. Improper handling during operation, transportation, lifting, filling or securing of pressure vessels.
7. Materials incompatibility.
8. Improper workmanship and/or assembly.
11. Damage to COPV
12. Stress rupture/fatigue failure of the COPVs

l. HAZARD CONTROLS:

(See continuation sheet)

m. SAFETY VERIFICATION METHODS:

(See continuation sheet)

n. STATUS OF VERIFICATION:

(See continuation sheet)

o. APPROVAL	PAYLOAD ORGANIZATION	SSP/ISS
PHASE I		
PHASE II		
PHASE DIII	TRENTMARTIN 8/16/10	[signature] 8/25/10

JSC Form 542B (Rev November 22, 1999) (MS Word September 1997)

PAYLOAD HAZARD REPORT CONTINUATION SHEET	a. NO: GHR-AMS02-004
b. PAYLOAD: Alpha Magnetic Spectrometer-02 (AMS-02) GSE	c. PHASE III

k. HAZARD CAUSES:

1. Structural failure of pressure vessels/systems.

l. HAZARD CONTROLS:

1.3 The TRD GSE pressure system will be designed to have a design burst pressure of 4 x MOP.

1.5 The RICH GSE will be designed to have a design burst pressure of 4 x MOP.

1.6 The TRD Drop Pressure GSE will be designed to have a design burst pressure of 4 x MOP.

m. SAFETY VERIFICATION METHODS:

1.3.1 Demonstration of positive margins of safety. (by means of test, analysis etc.)

1.3.2 Review of TRD design to ensure it has the proper design burst pressure.

1.5.1 Demonstration of positive margins of safety. (by means of test, analysis, etc.)

1.5.2 Review of RICH GSE design to ensure it has the proper design burst pressure.

1.6.1. Demonstration of positive margins of safety. (by means of test, analysis, etc.)

1.6.2. Review of TRD Drop Pressure GSE design to ensure it has the proper design burst pressure.

n. STATUS OF VERIFICATION:

1.3.1 Closed. Luxfer Gas Cylinders Certificate issued on 04/03/2009. The C Box relief valve is set at 1.7 Bar differential (refer to attached matrix).

1.3.2 Closed. Luxfer Gas Cylinders Certificate issued on 04/03/2009. The C Box relief valve is set at 1.7 Bar differential (refer to attached matrix).

1.5.1 Closed to SVTL.

1.5.2 Closed to SVTL.

1.6.1. Closed to SVTL.

1.6.2. Closed to SVTL.

PAYLOAD HAZARD REPORT CONTINUATION SHEET	a. NO: GHR-AMS02-004
b. PAYLOAD: Alpha Magnetic Spectrometer-02 (AMS-02) GSE	c. PHASE III

k. HAZARD CAUSES:

5. Improper handling during operation, transportation, lifting, filling (contingency refilling only), or securing of pressure vessels.

l. HAZARD CONTROLS:

5.1 Approved procedures will be used for operating, transporting, lifting, filling and securing AMS pressure vessels.

5.2 Handling personnel will be trained regarding the hazards associated with AMS-02 pressure vessels.

5.3 Operational restrictions/procedures for large tool control and machinery operations around pressure vessels.

m. SAFETY VERIFICATION METHODS:

5.1.1 Review and approval of procedures to ensure safe handling of GSE and flight hardware.

5.2.1 Review and approval of training and certification process of personnel.

5.3.1 Review and approval of procedures to restrict access.

n. STATUS OF VERIFICATION:

5.1.1 Closed to SVTL.
5.2.1 Closed to SVTL.
5.3.1 Closed to SVTL.

PAYLOAD HAZARD REPORT CONTINUATION SHEET	a. NO: GHR-AMS02-004
b. PAYLOAD: Alpha Magnetic Spectrometer-02 (AMS-02) GSE	c. PHASE: III

k. HAZARD CAUSES:

7. Materials incompatibility.

l. HAZARD CONTROLS:

7.1 Design of system to be compatible with the specific material that it will hold.

7.2 All cleaning materials will be compatible with system materials and working fluids.

m. SAFETY VERIFICATION METHODS:

7.1.1 Review and approval by AMS Materials Group.

7.1.2 Review of design and procedures to ensure appropriate materials usage with hardware.

7.2.1 Review and approval by AMS Materials Group.

n. STATUS OF VERIFICATION:

7.1.1 Closed 06/15/10. The remaining gases in the GSE (nitrogen, CO_2, and Xenon) are inert s and will not adversely affect the GSE used to contain them.

7.1.2 Closed to SVTL.

7.2.1 Closed 06/15/10. The flight hardware (TRD COPVs) was cleaned prior to arrival at KSC with acetone and isopropyl alcohol, which are compatible with tanks. ..

PAYLOAD HAZARD REPORT CONTINUATION SHEET	a. NO: GHR-AMS02-004
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k. HAZARD CAUSES:

8. Improper workmanship and/or assembly.

l. HAZARD CONTROLS:

8.1 System built to design drawings with documented assembly and quality assurance procedures.

8.2 Testing/Operations during operations at CERN and ESTEC validate systems prior to arrival at KSC.

m. SAFETY VERIFICATION METHODS:

8.1.1 QA review to ensure hardware is built per approved drawings.

8.1.2 QA review of as-built hardware to ensure it meets design.

8.2.1 Review of test/operational data from CERN and ESTEC.

n. STATUS OF VERIFICATION:

8.1.1 Closed to SVTL.

8.1.2 Closed to SVTL.

8.2.1 Closed to SVTL.

PAYLOAD HAZARD REPORT CONTINUATION SHEET	a. NO: GHR-AMS02-004
b. PAYLOAD: Alpha Magnetic Spectrometer-02 (AMS-02) GSE	c. PHASE: III

k. HAZARD CAUSES:

11. Damage to COPV.

l. HAZARD CONTROLS:

11.1 Damage control features will be implemented per the AMS-02 COPV Mechanical Damage Control Plan.

m. SAFETY VERIFICATION METHODS:

11.1.1 PO approval of AMS-02 COPV Mechanical Damage Control Plan .

n. STATUS OF VERIFICATION:

11.1.1 Closed 4/08/09. ESCG-4390-09-SP-MEMO-002, *AMS-02 COPV Damage Control Plan*, dated 1/26/09.

PAYLOAD HAZARD REPORT CONTINUATION SHEET	a. NO: GHR-AMS02-004
b. PAYLOAD: Alpha Magnetic Spectrometer-02 (AMS-02) GSE	c. PHASE: III

k. HAZARD CAUSES:

12.. Stress rupture/fatigue failure of the COPVs.

l. HAZARD CONTROLS:

12.1 Refer to AMS-02 flight hazard report AMS-02-F05 for appropriate controls.

12.2 AMS-02 will comply with all KSC COPV access restriction requirements based on AMS-02 data.

12.3

n. SAFETY VERIFICATION METHODS:

12.1.1 Agreement by JSC ES4/Pressure Vessel Technical Monitor/Fracture Control Board Chairman that flight hazard report is sufficient to assess the AMS COPV ground processing risk with respect to stress rupture.

12.2.1 AMS-02 concurrence with KSC access restriction requirements.

12.2.2 AMS-02 will provide the ARDE design burst pressure data.

12.2.3 AMS-02 will provide the temperature at which the maximum ground operating pressure is 1/3 the design burst pressure to KSC. AMS-02 will also provide the pressure at 77F (the maximum temperature in the SSPF).

12.2.3.1 If maximum operating pressures are below 1/3 design burst pressure, no additional controls per KNPR 8715.3 are needed.

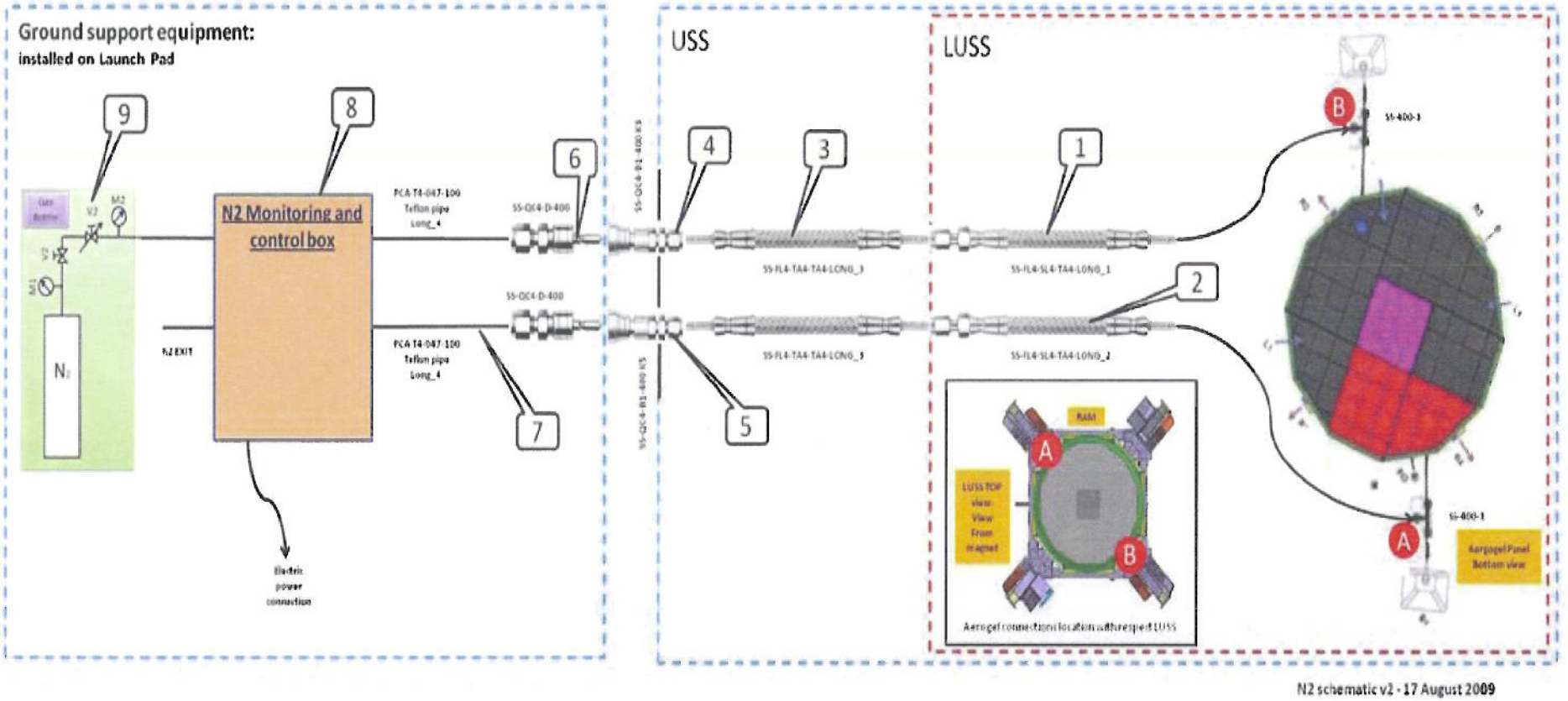
12.2.3.2 If maximum operating pressures are above 1/3 design burst pressure, KSC will determine operational controls.

n. STATUS OF VERIFICATION:

12.1.1 Closed to SVTL.
12.2.1 Closed to SVTL.
12.2.2 Closed to SVTL.
12.2.3 Closed to SVTL.
12.2.3.1 Closed to SVTL.
12.2.3.2 Closed to SVTL.

GROUND SUPPORT PRESSURE SYSTEM COMPONENTS

COMPONENT	MAXIMUM OPERATING PRESSURE (MOP)	DESIGN MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP)	PROOF PRESSURE	DESIGN BURST PRESSURE	PROOF TEST DATE	**COMMENTS** (GAUGE OR REGULATOR RANGE, RELIEF SETTINGS, ETC.)
TRD Pressure Stabilization System						
Commercial gas bottle	70 bar (1029 psia)	200 bar (2940 psia)	300 bar (4410 psia)	COTS item	March 2009	Regulator 1-2 bar abs. (15-30 psia)
1/8" stainless steel tubing	2 bar abs (30 psia)					Relief valve in Box-C opens at 1.7 bar diff. (25 psid)


Ground support equipment:
installed on Launch Pad
9
8
6
4
3
1
2
5
7
N2 Monitoring and control box
N2 EXIT
Electric power connection
USS
LUSS
RAM
A
B
N2 schematic v1 - 17 August 2009

RICH GSE

ITEM	QTY	COMPONENT DESCRIPTION	COMPONENT NAME	MAXIMUM OPERATING PRESSURE (MOP)	DESIGN MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP) DESIGN MAXIMUM ALLOWABLE	PROOF PRESSURE	DESIGN BURST PRESSURE	PROOF PRESSURE TEST DATE	COMMENTS (GAUGE OR REGULATOR RANGE, RELIEF SETTINGS, ETC.)
1	1	N2 Bottle and Regulator (K)	N2 Standard K bottle	200 bar	200 bar		NA		Standard COT's K Bottle.
2	3	Pressure Valves	Pressure Valves				NA		
3		P1 (Gauge 1)	P1 (Gauge 1)	315 bar	315 bar		NA		
4		P2 (Gauge 2)	P2 (Gauge 2)	16 bar	16 bar		NA		
5		P3 (Gauge 3)	P3 (Gauge 3)	2.5 bar	2.5 bar		NA		
6	1	Monitoring and Control Box		2.5 bar	NA*	NA*	NA	NA*	
7	ar	Teflon pipe	PFA-T4-047-100	2.5 bar	200 (13.7) (at 70F) **	NA*	1757.9 psi (121 bar)	NA*	
8	2	Quick Disconnects male	SS-QC4-D-400	2.5 bar	3000psi (206 bar)	NA*	Based on Tube Data	NA*	
9	1	Quick Disconnects female	SS-QC4-B1-400K5	2.5 bar	3000psi (206 bar)	NA*	Based on Tube Data	NA*	
10	1	Quick Disconnects female	SS-QC4-B1-400K3	2.5 bar	3000psi (206 bar)	NA*	Based on Tube Data	NA*	
11	2	Connector	SS-400-61	2.5 bar	8000psi (550 bar)	NA*	Based on Tube Data	NA*	
12	2	T-Connector	SS-400-3	2.5 bar	8000psi (550 bar)	NA*	Based on Tube Data	NA*	

Notes

* Fluid system that contains this component operates at a pressure just slightly above atmosphere and is in effect a venting /purge system by design. The fluid system with the exception of the Nitrogen bottle item 1 is not desinged or intended to maintain pressure.

**Zues Technical Bulletin on approximate Burst Pressure Rating for PFA Tubing.
http://www.zeusinc.com/technicalservices/technicalbulletins/technicalinformation/burstpressure.aspx
Tensile Strength T = 4000psi (approximate)

$$P=\frac{T(x^2-y^2)}{y^2\left(1+\frac{x^2}{y^2}\right)}$$

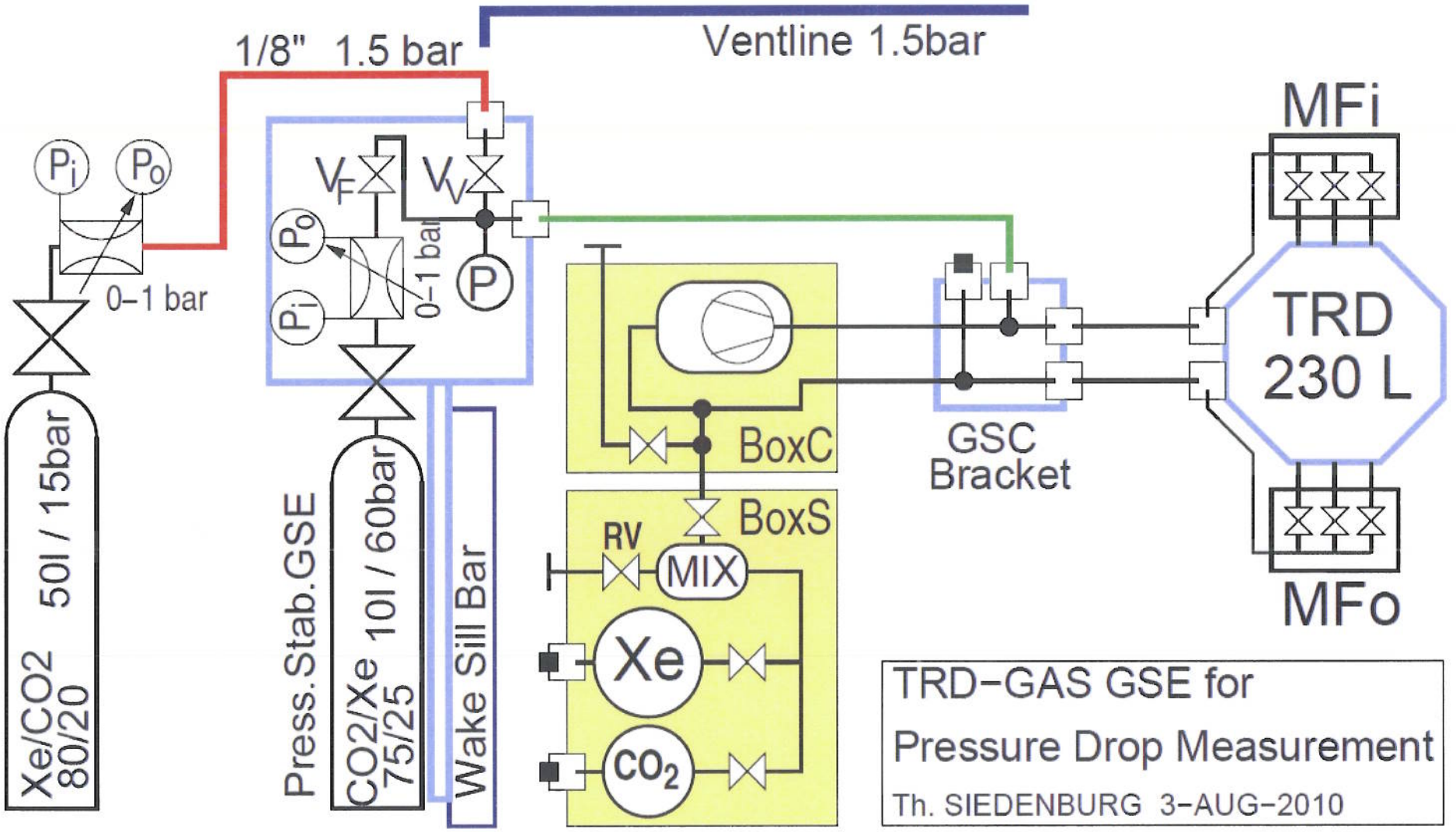
P=Burst Pressure

$X=\frac{OD}{2}$

$Y=\frac{ID}{2}$

T=Tensile Strength

P (Burst for PFA-T4-047-100) approximate 1757.9 psi (121 bar)


1/8" 1.5 bar
Ventline 1.5bar
MFi
MFo
TRD
230 L
GSC
Bracket
BoxC
BoxS
RV
MIX
Xe
CO2
Pi
Po
VF
VV
P
0–1 bar
0–1 bar
Xe/CO2
80/20
50l / 15bar
Press.Stab.GSE
CO2/Xe
75/25
10l / 60bar
Wake Sill Bar
TRD-GAS GSE for
Pressure Drop Measurement
Th. SIEDENBURG 3-AUG-2010

GROUND SUPPORT PRESSURE SYSTEM COMPONENTS

COMPONENT	MAXIMUM OPERATING PRESSURE (MOP)	DESIGN MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP)	PROOF PRESSURE	DESIGN BURST PRESSURE	PROOF TEST DATE	**COMMENTS** (GAUGE OR REGULATOR RANGE, RELIEF SETTINGS, ETC.)
Regulator Air Liquide HBS-300-1	15 bar	200 bar	> 200 bar	> 200 bar	Type-Test	0-1 bar above atm at outlet
1/8" stainl. steel gas line	1 bar above atm	200 bar		880 bar		
Xenon PreMix 50l gas bottle # 015106	15 bar	200 bar	300 bar	> 500 bar	Nov.2002	
Xenon 50l gas bottle # 383430	80 bar	200 bar	256 bar		May 2006	