Lawrence Berkeley National Laboratory	Cat Code RP3030	SAFETY NOTE	Serial # 10542	Rev A	Page 1 of 13
Author(s) Tom Miller, Derek Shuman	Department Mechanical Engineering	Location Berkeley	Date 8/26/2010		
Title Xenon TPC PMT test chamber Pressure safety note					

Prepared by: Tom Miller 9-3-10
Responsible Designer - Tom Miller

Reviewed by: Joe Dionne 9-8-10
EH&S Pressure Safety Subject Matter Expert - Joe Dionne

Approved by: 9/24/10
Engineering Division Director - Peter Denes

Distribution: Tom Miller, Joe Dionne, Derek Shuman, Peter Denes, Dave Nygren, Azriel Goldschmidt, Ken Chow, Russ Wells

Table of Contents **Page #**

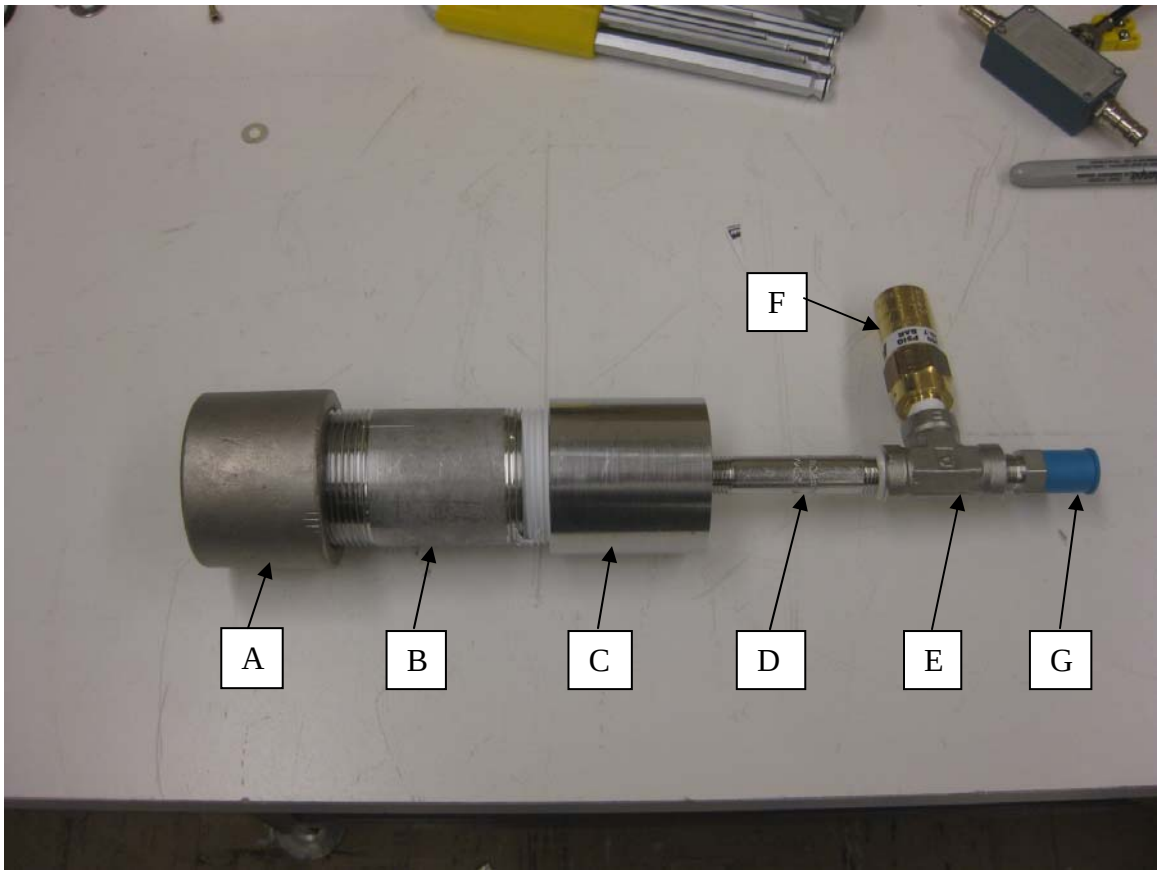


Figure 1

1. Description

This system has been constructed to individually pressure test photomultiplier tubes (PMTs) with argon. These tests will be performed to assure that if one tube fails, it will be the only tube destroyed. The failure of PMTs is not a safety concern, but is a financial concern. All work will be done in 70A 2263A. The test rig has enough hose to allow the user to be in 2263 during the test, if desired.

The test chamber is approximately 2-1/2" dia and 12" OAL and consists of the following components (see figure 1.) It is not ASME coded or DOT approved.

This system was assembled by a pressure installer.

The responsible users will be Dave Nygren and Azriel Goldschmidt.

Component	Pressure rating(psi)	Rating Source
A) High pressure forged blk steel 1-1/2" pipe cap	3000	McMaster
B) Seamless threaded pipe nipple 304 SST 1-1/2" dia x 4" lg. Per ASTM A312	1150	LLNL appendix D

C) 1-1/2" dia x 1/4" dia threaded reducing coupling 304 SST	1000	McMaster
D) Seamless threaded pipe nipple 304 SST 1/4" dia x 2-1/2" lg per ASTM A312	2400	LLNL appendix D
E) High pressure pipe tee 304 SST 1/4" FNPT	5600	McMaster
F) Relief valve	300	McMaster
G) 1/4" MNPT to 1/4" male VCR adapter	8000	Swagelok

For the purposes of PMT testing, the MOP is 19 bar (280 psia) and the MAWP is 20.7 bar (300psia.)

The operating environment for the system is ~22C and 1 bar.

2. Hazards

The primary hazard, stored energy, is low at 395J. The other notable hazard is disposing of broken glass if the PMT breaks during testing. PMT fragments can easily be dumped into a cardboard box for safe disposal, so this hazard is also minimal. There are no flammable, cryogenic or radioactive hazards.

3. Calculations

All components in the system are rated, therefore no calculations need to be performed on them. The stored energy is computed with the following formula:

$$U = \frac{P_h V_h}{\gamma - 1}\left[1 - \left(\frac{P_l}{P_h}\right)^{\frac{\gamma-1}{\gamma}}\right]$$

where

Vh = the volume of the vessel

Ph = the absolute pressure in the vessel

Pl = the absolute pressure to which the vessel would drop if it burst.

γ = The adiabatic exponent or ratio of specific heats, C_p/C_v.

In this case,

Vh = 2.00e-4 m^3 (12.2 in^3) Computed using inside dimensions of cylinder

Ph= 1.9MPa (275 psia)

Pl= 0.1Mpa (14.7 psia, absolute ambient pressure)

γ=1.666 for monatomic gasses such as argon

U=395J

4. Pressure testing

See figure A1 below for the test apparatus layout

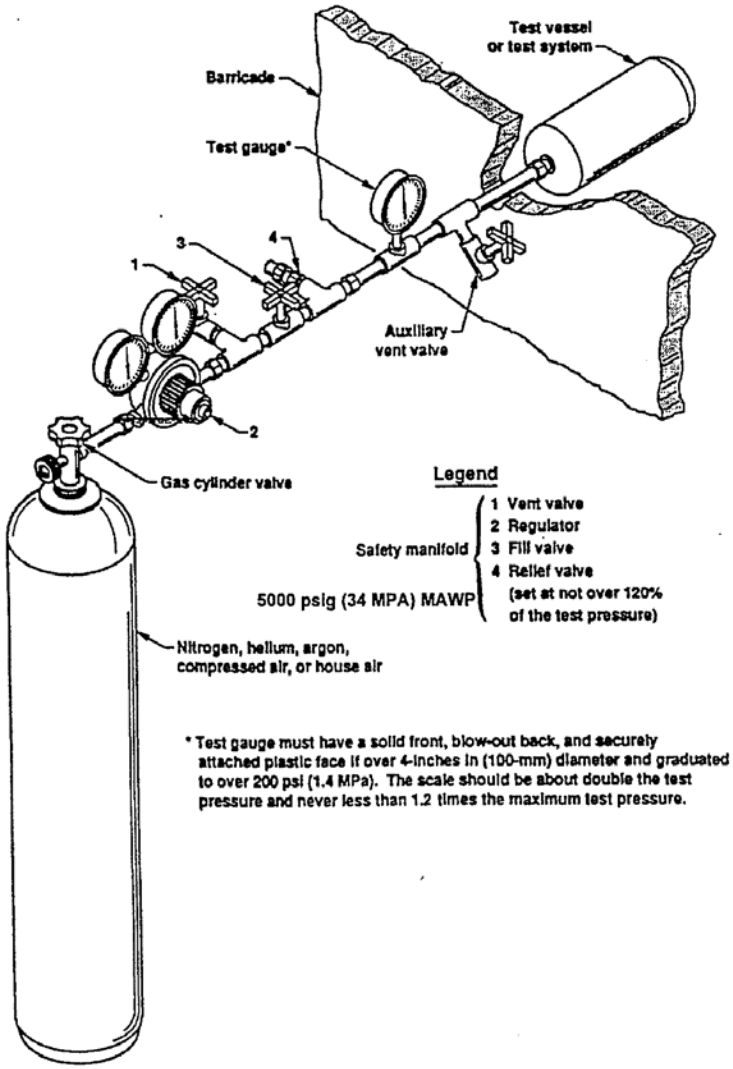


Figure A1 – Gas Test System

Testing is to be performed by a Certified Pressure Installer, and witnessed by the Responsible Designer, at a minimum.

Test as follows:

1. Procure:
a. Gas cylinder of clean Ar, N2, CO2, or dry air with supply pressure above 2000 psig.
b. Calibrated test gauge(s) for reading 375 psig to within 5% accuracy. Gauge maximum scale pressure should not be less that 1.2x or more than 4x the test pressure. Electronic gauges (calibrated) are permissible, and are not subject to the above range limitations.
c. Regulator(s), to provide above pressures in (b) to fit cyl. in (a).
d. 32 ft. long high pressure clean gas service (e.g. McMaster P/N 5665K34 2-3 ea) or PTFE lined high pressure chemical hose (e.g McMaster P/N 5830K21, or similar), 2000 psig rated (min.), and fittings to connect to test chamber at G.
e. Pressure relief valve set to 400 psig
f. Test pressure isolation valve, and fill vent valve, rated for test gas maximum pressure.
g. Test pressure release vent valve on Tee, both rated for test gas maximum pressure.
2. Assemble remote gas cylinder, regulator(RT), test gauge(GT), test isolation valve(TV), vent valve(VV), fill valve (VF) as shown in fig. A1 above, and locate around corner from experiment, out of line sight, and behind wall of cabinets. Survey for, and remove any hazardous material (such as radioactive sources, flammable liquids, glassware, etc.) from line of sight to test area. Have fire extinguishers on hand.
3. Install 400psi relief valve in place of F for the test.

4. Back off RT handle fully.
5. Open VF
5. Open test gas cyl. valve 1-2 turns.
6. Screw in RT handle slowly until GT reads 375psi
7. Close VF
8. Hold for 5 minutes, if pressure >370psi, back off regulator fully, close test gas cylinder valve, and release system pressure through VV
9. Reinstall item F (20.7 bar relief valve)

5. Labeling

A copy of the LBNL Pressure Test Record is attached in the appendix after pressure testing is completed.

Attach a copy of the LBNL Pressure Tested label here

6. Associated procedures

Operating procedure:

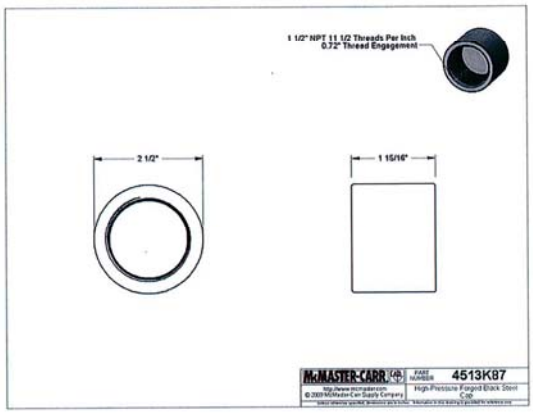
1. Remove A from B
2. Insert PMT into item B, pins first
3. Apply teflon tape to threads of item B.
4. Install A using pipe wrenches on A and B
5. Back off RT handle fully.
6. Open VF
7. Open test gas cylinder valve 1-2 turns.
8. Screw in RT handle slowly until GT reads 280psi (19 bar)
9. Close VF
10. Hold for 2 minutes
11. Back off regulator fully, close test gas cylinder valve, and slowly release system pressure through VV.
12. Remove A and unload PMT

7. References

Iron and Steel Pipe Fittings and Pipe

Part Number: 4513K87 $7.44 Each

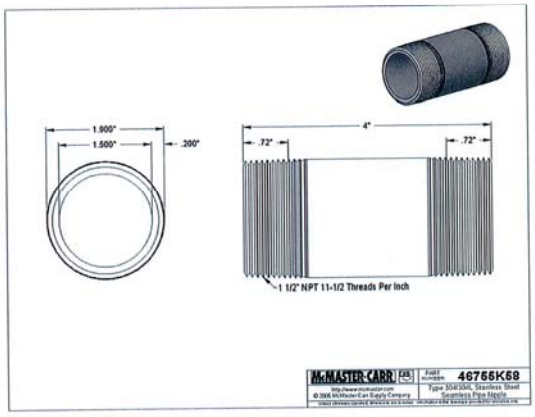
Shape	Cap
Cap Type	Round Head
Pipe to Pipe Connection	NPT x NPT
System of Measurement	Inch
Pipe Size	1-1/2"
Finish	Black
Steel	Forged Steel
Maximum Pressure @ 72° F	3000 psi
For Use With	Schedule 160 steel pipe nipples
Specifications Met	American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM)
ANSI Specification	ANSI B1.20.1
ASME Specification	ASME B1.20.1, ASME B16.11, ASME SA105
ASTM Specification	ASTM A105



Stainless Steel Pipe Fittings and Pipe

Part Number: 46755K58 $28.61 Each

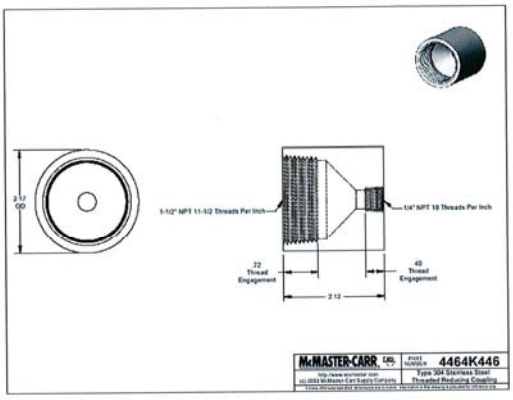
Shape	Nipple
Nipple Type	Threaded Ends
Pipe Construction	Seamless
Schedule	80
Pipe to Pipe Connection	NPT x NPT
System of Measurement	Inch
Pipe Size	1-1/2"
Outside Diameter	1.9"
Inside Diameter	1.5"
Length	4"
Wall Thickness	.200"
Material	Type 304/304L Stainless Steel
Specifications Met	American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM)
ANSI Specification	ANSI B1.20.1
ASTM Specification	ASTM A312, ASTM A733
ASME Specification	ASME B1.20.1, ASME SA312



Stainless Steel Pipe Fittings and Pipe

Part Number: 4464K446 $29.63 Each

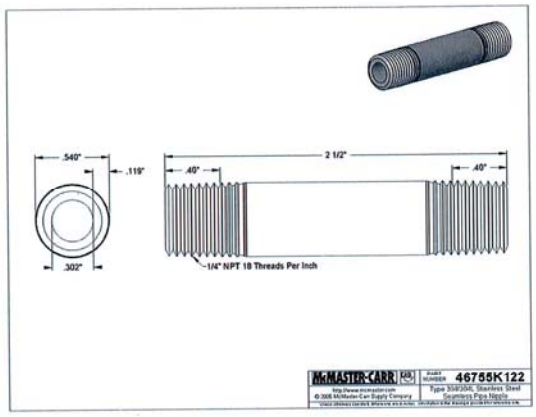
Shape	Coupling
Coupling Type	Reducing Coupling
Pipe to Pipe Connection	NPT x NPT
System of Measurement	Inch
Pipe Size	1-1/2" reduced to 1/4"
Material	Type 304 Stainless Steel
Maximum Pressure @ 72° F	1000 psi
Maximum Pressure Note	For steam, maximum pressure is 150 psi @ 366° F.
Flanges	Use low-pressure threaded stainless steel
Specifications Met	American Society for Testing and Materials (ASTM), Manufacturers Standardization Society (MSS)
ASTM Specification	ASTM A182
MSS Specification	MSS SP-114



Stainless Steel Pipe Fittings and Pipe

Part Number: 46755K122 $6.59 Each

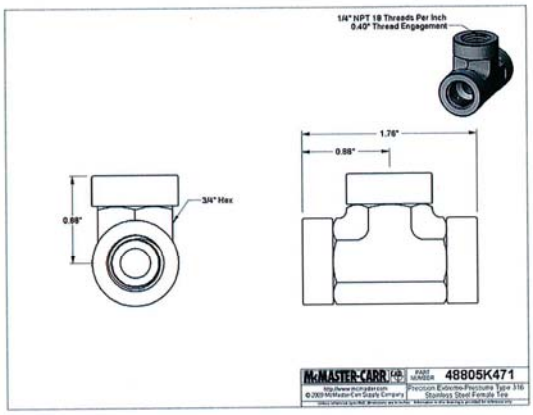
Shape	Nipple
Nipple Type	Threaded Ends
Pipe Construction	Seamless
Schedule	80
Pipe to Pipe Connection	NPT x NPT
System of Measurement	Inch
Pipe Size	1/4"
Outside Diameter	.54"
Inside Diameter	.302"
Length	2-1/2"
Wall Thickness	.119"
Material	Type 304/304L Stainless Steel
Specifications Met	American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM)
ANSI Specification	ANSI B1.20.1
ASTM Specification	ASTM A312; ASTM A733
ASME Specification	ASME B1.20.1, ASME SA312



Stainless Steel Pipe Fittings and Pipe

Part Number: 48805K471 $28.53 Each

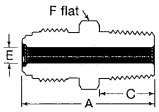
Shape	Tee
Tee Type Pipe to Pipe	Female Tee
Pipe to Pipe Connection	NPT x NPT
System of Measurement	Inch
Pipe Size	1/4"
Material	Type 316 Stainless Steel
Maximum Pressure @ 72° F	5600 psi
Maximum Pressure Note	For steam, maximum pressure is 5600 psi @ 300° F.
Specifications Met	American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME)
ANSI Specification	ANSI B1.20.1, ANSI B31.1, ANSI B31.3
ASME Specification	ASME B1.20.1



8 VCR Metal Gasket Face Seal Fittings

Bodies

*Male NPT Connector*①



NPT Size	VCR Size	Ordering Number	Dimensions A	C	E	F	Working Pressure Ni	SS	Cu
Dimensions, in. (mm)							psig (bar)		
1/16	1/8	SS-2-VCR-1-1②	1.07 (27.2)	0.38 (9.6)	0.09 (2.3)③	3/8	9000 (620)	9000 (620)	7200 (496)
1/8	1/8	SS-2-VCR-1-2②	1.07 (27.2)	0.38 (9.6)	0.09 (2.3)③	7/16	9000 (620)	9000 (620)	7200 (496)
	1/4	SS-4-VCR-1-2	1.31 (33.3)		0.18 (4.6)	5/8	8000 (551)	10 000 (689)	6400 (440)
1/4	1/4	SS-4-VCR-1-4	1.49 (37.8)	0.56 (14.2)	0.18 (4.6)	5/8	8000 (551)	10 000 (689)	6400 (440)
	1/2	SS-8-VCR-1-4	1.65 (41.9)		0.28 (7.1)③	15/16	3500 (241)	4300 (296)	2800 (192)
3/8	1/2	SS-8-VCR-1-6	1.65 (41.9)	0.56 (14.2)	0.38 (9.6)	15/16	3500 (241)	4300 (296)	2800 (192)
1/2	1/2	SS-8-VCR-1-8	1.84 (46.7)	0.75 (19.1)	0.40 (10.2)	15/16	3500 (241)	4300 (296)	2800 (192)
3/4	3/4	SS-12-VCR-1-12	2.19 (55.6)	0.75 (19.1)	0.62 (15.7)	1 5/16	3000 (206)	3700 (254)	2400 (165)
1	1	SS-16-VCR-1-16	2.47 (62.7)	0.94 (23.9)	0.87 (22.1)	1 5/8	2400 (165)	3000 (206)	1900 (130)

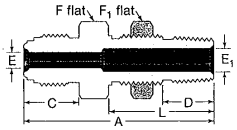
Select male connectors are available with ISO/BSP tapered thread (RT) ends. Contact your authorized Swagelok representative.

① VCR components with fixed threads must remain stationary during installation. These fitting connections should be assembled only to glands with rotating male or female threaded nuts.

② Not designed for gasket retainer assembly.

③ May contain internal diameter transitions.

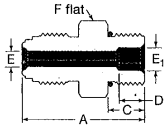
*Male NPT Bulkhead Connector*①



NPT Size	VCR Size	Ordering Number	Dimensions A	C	D	E	E_1	F	F_1	L	Panel Hole Dia	Max Panel Thickness	Working Pressure Ni	SS	Cu
Dimensions, in. (mm)													psig (bar)		
1/4	1/4	SS-4-VCR-A1-4M	2.21 (56.1)	0.62 (15.7)	0.56 (14.2)	0.18 (4.6)	0.28 (7.1)	13/16	13/16	1.24 (31.5)	21/32 (16.8)	0.38 (9.7)	8000 (551)	8000 (551)	6400 (440)
	1/2	SS-8-VCR-A1-4M	2.34 (59.4)	0.75 (19.1)		0.40 (10.2)		15/16					3500 (241)	4370 (301)	2800 (192)

① VCR components with fixed threads must remain stationary during installation. These fitting connections should be assembled only to glands with rotating male or female threaded nuts.

*Straight Thread O-Ring Seal Male Connector*①



Straight Thread Size	VCR Size	Uniform O-Ring② Size	Ordering Number	Dimensions A	C	D	E	E_1	F	Working Pressure Ni	SS	Cu
Dimensions, in. (mm)										psig (bar)		
9/16-18	1/4	906	SS-4-VCR-1-00032	1.33 (33.8)	0.39 (9.9)	0.25 (6.4)	0.18 (4.6)	0.28 (7.1)	3/4	4500 (310)	4500 (310)	4500 (310)
7/8-14	1/2	910	SS-8-VCR-1-00176	1.66 (42.2)	0.50 (12.7)	0.40 (10.2)	0.28 (7.1)	0.59 (15.0)	1	3500 (241)	3500 (241)	2800 (192)
9/16-18	1/2	906	SS-8-VCR-1-01081	1.48 (37.6)	0.39 (9.9)	–	0.28 (7.1)	0.28 (7.1)	15/16	3500 (241)	3500 (241)	2800 (192)

① VCR components with fixed threads must remain stationary during installation. These fitting connections should be assembled only to glands with rotating male or female threaded nuts.

② Fluorocarbon FKM is standard, other materials are available. O-rings are assembled with a silicone vacuum grease.

Swagelok

Stainless Steel Pipe

- Seamless, annealed, Schedule 40.
- CRES, Type 304.
- Per ASTM A312.
- Allowable stress: SE = 18800 psi.

Table D-9. Stainless steel, Schedule 40.

IPS	o.d.	Nominal wall thickness	MAWP			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/8	0.405	0.068	2.84	19.59	6.18	42.62
1/4	0.540	0.088	2.40	16.55	6.03	41.59
3/8	0.675	0.091	2.08	14.34	4.91	33.86
1/2	0.840	0.109	1.76	12.14	4.66	32.14
3/4	1.050	0.113	1.55	10.69	3.82	26.34
1	1.315	0.133	1.35	9.31	3.55	24.48
1-1/4	1.660	0.140	1.20	8.28	2.92	20.14
1-1/2	1.900	0.145	1.15	7.93	2.64	18.21
2	2.375	0.154	1.04	7.17	2.23	15.38
2-1/2	2.875	0.203	1.04	7.17	2.44	16.83
3	3.500	0.216	0.97	6.69	2.11	14.55
3-1/2	4.000	0.226	0.93	6.41	1.93	13.31
4	4.500	0.237	0.90	6.21	1.79	12.34
5	5.563	0.258	0.86	5.93	1.57	10.83