

D0 silicon detector Moisture injection.

ENGINEERING NOTE

3823.112-EN-584

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Water addition to silicon dry purge air system.

The system is designed to increase water content in dry air used to purge D0 silicon detector. Moisture will not be added to fiber tracker purge. Currently, the air is dried to -85 deg. C (-120 deg. F). The goal is to increase Dew point of the air to about -40 C to -20 C range. This is done by redirecting a portion of dry air (about 10%) through a bubbler, and then return it to main stream. Air is taken upstream of PRV-6231-I pressure regulator (90 psi) and going to the bubbler (BU-6404-I) through the flow regulator, permitting controlled moisture addition. Water separator (FI-6411-I) and auto drain (MV-6412-I) prevent water break-through in case of bubbler's overflowing. Moist air (saturated with water) is returned to main flow of purge air downstream of PRV-6231-I (55 psi). Water is taken from D0 LCW system. Initial pressure of 110 psi is reduced to 60 psi (PRV-6421-I); expected fill rate is 1 L/min. with 55 psi in the bubbler.

Total airflow in air purge system is 60 cfm. Calculations show that flow through the bubbler should be about:

- 10 scfm to obtain -20 C Dew Point (DP)
- 3.7 scfm to obtain -30 C DP
- 1.3 scfm to obtain -40 C DP

Since the pressure inside the bubbler (and downstream of flow meter/regulator) is 55 psig, flow indicator readings should be:

- 4.6 cfm for -20 C DP
- 1.7 cfm for -30 C DP
- 0.6 cfm for -40 C DP

Water amount that needs to be added to obtain:

- -20 C DP – 1.9 Liters/day (24 hours)
- -30 C DP – 0.7 L/day
- -40 C DP – 0.25 L/day

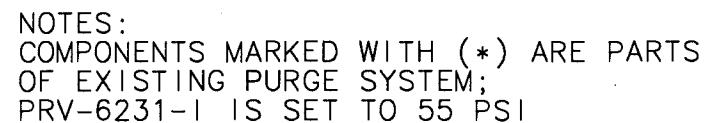
Description of controls and interlocks is made in a separate engineering note. .

Attachments:

Silicon dry purge flow diagram 386201-C2

Proposed additional equipment flow diagram

Additional components list



Silicon purge humidity addition piping components

Device tag	Model/Type	Manufacturer	Device type	System	Location	Size	Memo	Rating
MV-6400-I	63ESW8T NLW1	Whitey	Manual valve	SiDet purge air	Room 215	1/2"		2500 psi
EV-6401-I	7125SN2QN00N0C322C2	Parker	Solenoid valve	SiDet purge air	Room 215	1/4"	Cv=0.4	110 psi MOPD
MV-6403-I	7503125C05	King Instruments	Manual valve	SiDet purge air	Room 215	1/2"	integrated part of FI-6402-I	150 psi
FI-6402-I	7503125C05	King Instruments	Flow indicator	SiDet purge air	Room 215	1/2"	0-8.2 cfm	150 psi
BU-6404-I	43715K45	McMaster	Bubbler housing	SiDet purge air	Room 215			300 psi
MV-6405-I	3703K3	McMaster	Manual valve	SiDet purge air	Room 215	1/2"	integrated part of LI-6406-I	410 psi
LI-6406-I	3703K3	McMaster	Sight glass	SiDet purge air	Room 215			410 psi
LT-6408-I	4696K21	McMaster	Level switch	SiDet purge air	Room 215		Carlo Gavazzi; no direct contact	
LT-6407-I	4696K21	McMaster	Level switch	SiDet purge air	Room 215		Carlo Gavazzi; no direct contact	
LT-6409-I	4696K21	McMaster	Level switch	SiDet purge air	Room 215		Carlo Gavazzi; no direct contact	
PS-6410-I	PSW-805	Omega	Pressure switch	SiDet purge air	Room 215		35 psi trip, 40 psi reset	1000 psi
F-6411-I		Finite filter Inc.	Water separator	SiDet purge air	Room 215	1/2"		300 psi
MV-6412-I	5002K2	McMaster	Manual valve	SiDet purge air	Room 215	1/2"-1/8"	Automatic drain (float)	150 psi
CV-6413-I	8Z-CVL-SS	Parker	Check valve	SiDet purge air	Room 215	1/2"		3000 psi
EV-6414-I	7125SN2QN00N0C322C2	Parker	Solenoid valve	SiDet purge air	Room 215	1/4"	Cv=0.4	110 psi MOPD
MV-6415-I	63ESW8T NLW1	Whitey	Manual valve	SiDet purge air	Room 215	1/2"		2500 psi
HT-6416-I	DMT340-8W0B1A1CEA3A112A1ACB0A0	Vaisala	Humidity transmitter	SiDet purge air	Room 215		Probe fits in MV-6417-I	
MV-6417-I	CF8M	Sharpe	Manual valve	SiDet purge air	Room 215	1/2"		1000 psi
HT-6418-I	DMT340-8W0B1A1CEA3A112A1ACB0A0	Vaisala	Humidity transmitter	SiDet purge air	Room 215		Probe fits in MV-6419-I	
MV-6419-I	CF8M	Sharpe	Manual valve	SiDet purge air	Room 215	1/2"		1000 psi
MV-6420-I	B-1VM4	Swagelock	Manual valve	SiDet purge air	Room 215	1/4"		3000 psi
PRV-6421-I	560	Watts	Pressure regulator	SiDet purge air	Room 215	1/4"	0-125 psi range	300 psi
F-6422-I	SS-4TF-05	Nupro	Filter	SiDet purge air	Room 215	1/4"	230 microns	6000 psi
EV-6423-I	7125SN2QN00N0C111C2	Parker	Solenoid valve	SiDet purge air	Room 215	1/4"	Cv=0.18	110 psi MOPD
EV-6424-I	7125SN2QN00N0C111C2	Parker	Solenoid valve	SiDet purge air	Room 215	1/4"	Cv=0.18	110 psi MOPD
CV-6425-I	SS-4CA-3	Nupro	Check valve	SiDet purge air	Room 215	1/4"	3-50 psi range, set at 3 psi, Cv=0.47	3000 psi

Note: PRV-6230-I, MV-6231-I, PI-6232-I and MV-6233-I are parts existing of original SiDet purge system

Silicon Pet. purge H₂O addition M. Sanyal
7/10/09

Conditions: $P = 55 \text{ psig} = 70 \text{ psia}$

Dew point (DP) = 23°C

- full saturation @ room temp.

$$6000 \text{ ppmv} \Rightarrow 4.5 \text{ mg/L}$$

Water content @ Dew points:

$$- 20^\circ\text{C DP} - 0.75 \text{ mg/L}$$

$$- 30^\circ\text{C DP} - 0.28 \text{ mg/L}$$

$$- 40^\circ\text{C DP} - 0.095 \text{ mg/L}$$

Total flow of purge air - $60 \text{ ft}^3/\text{min}$,
or 1700 L/min

Water addition to achieve

$$- 20^\circ\text{C DP} - 1275 \text{ mg/min} - 1.856 \text{ L/day}$$

$$- 30^\circ\text{C DP} - 476 \text{ mg/min} - 0.685 \text{ L/day}$$

$$- 40^\circ\text{C DP} - 161 \text{ mg/min} - 0.233 \text{ L/day}$$

flow through the bubbler:

$$\text{to get } - 20^\circ\text{C} \quad \frac{1275}{4.5} = 283.3 \text{ L/min} = 10 \text{ scfm}$$

$$- 30^\circ\text{C} \quad \frac{476}{4.5} = 105.8 \text{ L/min} = 3.7 \text{ scfm}$$

$$- 40^\circ\text{C} \quad \frac{161}{4.5} = 35.8 \text{ L/min} = 1.3 \text{ scfm}$$

@ 55 psig readings will be

$$- 20^\circ\text{C DP} \quad 10 \sqrt{\frac{14.7}{14.7+55}} = 4.6 \text{ cfm}$$

$$- 30^\circ\text{C DP} \quad \Rightarrow 1.7 \text{ cfm}$$

$$- 40^\circ\text{C DP} \quad \Rightarrow 0.6 \text{ cfm}$$

Silicon purge H₂O addition M. S. L. 7/10/09
Control Solenoids sizing

1. Water $P = 120 \text{ psi} - \text{down to } 65 \text{ psi}$
Air pressure - 55 psi

$$\Delta P = 10 \text{ psi} = 1.7 \text{ bar}$$

$$q \approx 0.5 \text{ lpm}$$

$$N_1 = 14.42$$

$$q = N_1 C_v \sqrt{\frac{\Delta P}{G_f}}$$

$$H_2O - G_f = 1$$

$$C_v = \frac{q}{N_1 \sqrt{\Delta P}} = \frac{0.5}{14.42 \sqrt{1.7}} = 0.026$$

1/8 NPT 3/32 orifice $C_v = 0.2 - \text{OK}$

2. Air

$$P_1 = 90 \text{ psig} = 7.22 \text{ bar}$$

$$P_2 = 55 \text{ psig} = 4.81 \text{ bar} \quad P_2 > 1/2 P_1$$

$$\Delta P = 2.4 \text{ bar}$$

$$q = N_2 C_v P_1 \left(1 - \frac{2\Delta P}{3P_1}\right) \sqrt{\frac{\Delta P}{P_1 G_g T_1}}$$

$$N_2 = 6950$$

$$T = 23^\circ\text{C} = 296 \text{ K}$$

$$G_g = 1$$

$$q = 6950 C_v \cdot 7.22 \left(1 - \frac{2 \cdot 2.4}{3 \cdot 7.22}\right) \sqrt{\frac{2.4}{7.22 \cdot 296}}$$

$$= 1309 C_v$$

$$q = 15 \text{ scfm} = 425 \text{ slpm}$$

$$C_v = \frac{425}{1309} = 0.33$$

CCW pressure - 120 psig

PRV - 6421-1 set at 60 psig

pressure in bubble - 50 psig

going thru EV-6423-1, EV-6424-1

and CV-6425-1

$$K_{sc} = \frac{891 \cdot 0.364^4}{0.18^2} = 483 \quad K_{cv} = \frac{891 \cdot 0.364^4}{0.47^2} = 70.8$$

$$C_{v_{sc}} = 0.18 \quad C_{v_{check}} = 0.47$$

1/4" pipe $d = 0.364"$

$$\Sigma K = 483 + 483 + 70.8 = 1037$$

$$\rho = 62.3 \text{ lb/ft}^3$$

$$q = 0.525 \cdot d^2 \sqrt{\frac{\Delta P}{\Sigma K \cdot \rho}}$$

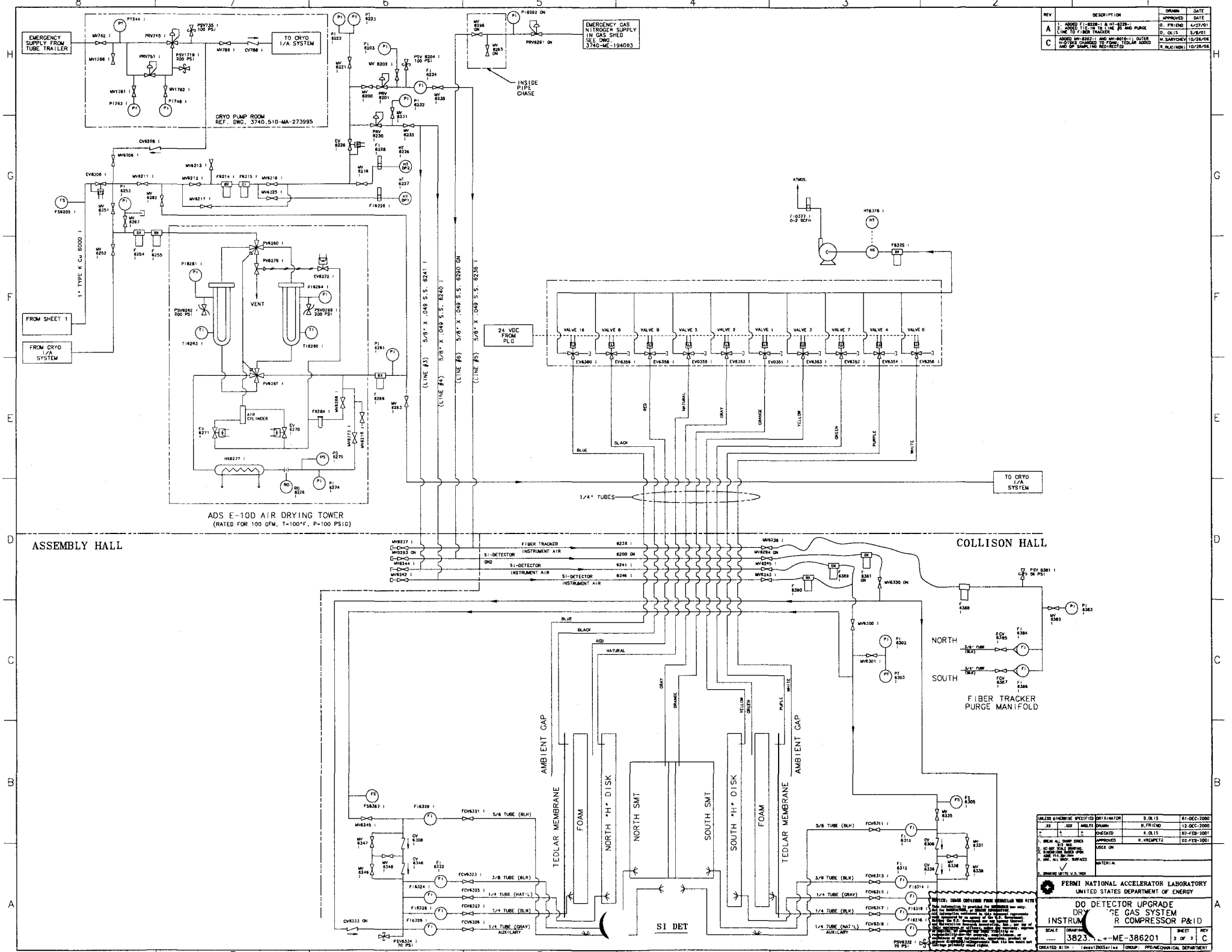
$$q = 0.525 \cdot 0.364^2 \sqrt{\frac{1}{1037 \cdot 62.3}} =$$

$$= 6.12 \cdot 10^{-4} \text{ ft}^3/\text{sec} = 3.67 \cdot 10^{-2} \text{ ft}^3/\text{min} =$$

$$= 1 \text{ gpm}$$

22-141 501 55575
22-142 100 55575
22-143 100 55575
22-144 100 55575

44-144 100 55575



REV	DESCRIPTION	ORIGIN	DATE
A	ISSUED FOR CONSTRUCTION	D. P. HEND	12/27/91
B	REVISIONS TO THE LINE 10 TUBES TRACKER	D. O. L. S.	12/28/91
C	ADDED MV-8227 AND MV-8228 TO THE LINE 10 TUBES TRACKER AND OF SAMPLING REDIRECTED	M. SANCHEZ	10/26/98

UNLESS OTHERWISE SPECIFIED				ORIGIN	D. O. L. S.	DATE
REV	USER	DESCRIPTION	ORIGIN	D. P. HEND	B. FRIEND	12-DEC-2000
1	DESIGNED	DO DETECTOR UPGRADE	DESIGNED	D. O. L. S.	DO DETECTOR UPGRADE	12-DEC-2000
2	APPROVED	DO DETECTOR UPGRADE	APPROVED	K. PROSPER	DO DETECTOR UPGRADE	12-DEC-2000
3	SCALE	DO DETECTOR UPGRADE	SCALE	DO DETECTOR UPGRADE	DO DETECTOR UPGRADE	12-DEC-2000
4	SCALE	DO DETECTOR UPGRADE	SCALE	DO DETECTOR UPGRADE	DO DETECTOR UPGRADE	12-DEC-2000
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8	SCALE	DO DETECTOR UPGRADE	SCALE	DO DETECTOR UPGRADE	DO DETECTOR UPGRADE	12-DEC-2000
9	SCALE	DO DETECTOR UPGRADE	SCALE	DO DETECTOR UPGRADE	DO DETECTOR UPGRADE	12-DEC-2000
10	SCALE	DO DETECTOR UPGRADE	SCALE	DO DETECTOR UPGRADE	DO DETECTOR UPGRADE	12-DEC-2000