HIGH VACUUM PORTABLE PUMPING STATION SUITABLE FOR ACCELERATOR USE*

P. Stattel, J. Briggs, W. DeBoer, R. Skelton
AGS Department, Brookhaven National Laboratory
Upton, New York 11973

Introduction

The need for a Portable Pump Station for Ultra High Vacuum use became apparent when the "Isabelle" collider was first being designed. A Portable Pump Station had to be developed which contained the following features.

1) Maneuverability
2) Compact size
3) Rugged
4) Self protected against various failures
5) Capable of running unattended
6) Capable of reaching 10^{-9} Torr.

The Pump Station that was developed and other variations are the subject of this paper. Emphasis will be on the Isabelle and HITL versions.

Description of Major Components

Balzers DUO 012A and DUO 016B - Mechanical Pumps - a two stage rotary vane pump with gas ballast valve and air cooling. This pump is equipped with a safety shut off valve which instantly isolates the vacuum chamber and vents the pump in the event the pump is stopped.

Balzers ONF 100 - Mist Filter - fitted to the exhaust port of the Mechanical Pump thus protecting the environment from any oil mist which is generated by the pump.

Balzers TPU 110 and TPU 170 - Turbo-Molecular Pumps - an air cooled, overhung rotor with ball bearings lubricated by a wick lubricator. The TPU designates conflate flange (6") with heating jacket.

Balzers TCP 270 and TCP 300 - Electronic Drive Unit - drive units for both turbos incorporate feedback from a hall probe located in the stator of the turbo to control rpm. Drive unit has a counter to monitor operating hours, an indicator which monitors % full rpm and a switch which controls the turbo heating jacket ON, OFF.

Balzers TVF 010 - 6V Vent Valve - vent valve mounted on side of both turbos at a point in between the compression stages where the gas entering is distributed evenly between the high vacuum and backing pressure sides.

Balzers TCF 101 and TCF 102 - Controls operation of TVF 010 can be set to vent from 0-30 minutes after the system is shut down. The venting time can also be set. This controller has NiCd batteries which allows operation after the system is shut off.

Balzers TCS 101 and TCS 301R - Pumping Unit Controls - Mounted on pump stand behind the turbo controller and the vent valve module. These Pumping Unit Controls allow the mechanical pump to be turned on when the turbo pump is powered. It also serves as an interlock against various ac failures.

Table I. Major Components
(see Figures 1 & 2)

The station that was developed consists of the following major components:

DESCRIPTION	ISABELLE		HITL	
	MANUFACTURER	MODEL	MANUFACTURER	MODEL
Mechanical Pump	Balzers	DUO 012	Balzers	DUO 16B
Mist Filter	Balzers	ONF 100	Same	Same
Turbomolecular Pump	Balzers	TPU 110	Balzers	TPU 170
Turbomolecular Controller	Balzers	TCP 270	Balzers	TCP 300
6V Vent Valve	Balzers	TVF 010	Same	Same
Vent Valve Control	BNL	533E-00.01A	Balzers	TCF 102
Pumping Unit Control	Balzers	TCS-101	Balzers	TCS 301R
Base Frame	Balzers	Series 11	Balzers	Series 12
Hand Operated Angle Valve	Balzers	BPV15 500	Same	Same
Solenoid Angle Valve	--	--	Balzers	BPV28 509
Electropneumatic Angle Valve	Varian	951-5088	--	--
Convectron Gauge and Controller	--	--	Granville Phillips	275
Thermocouple Gauge and Controller	Hastings	VH-3	--	--
Ion Gauge and Controller with P.C.	Granville Phillips	271-004	Same	Same
BNL Control Chassis	BNL	533E-02.01-3	Same	Same
8" Wheels Swivel Caster	Caster Corp.	16-MO-08-01-5	Same	Same
8" Wheels Rigid Caster	Caster Corp.	16-MO-08201-R	Same	Same
Waber 6 Way Outlet Strip	Waber	UL24CB-6-2884	Same	Same
Air Switch	United Elec. Cont. Co.	156	--	--

*Work performed under the auspices of the U.S. Department of Energy.

0018-9499/85/1000-3800$01.00© 1985 IEEE

Balzers Series 11 and Series 12 - Base and Frame - All of the above mentioned Balzers items are mounted on this frame. The frame is 23"L, 11-3/4"H, 13-3/4"W.

Balzers BPV15 500 - Hand Operated Angle Valve - External Leak Detector is connected at this point. Leak Detecting is accomplished with Pump Station Mechanical Pump "off".

Balzers BPV28 509 - Solenoid operated 2-3/4" angle value - or Varian #951-5088 - Electropneumatic 2-3/4" angle value (modified) - used to isolate the pump station from the volume being pumped on. Both are equipped with a set of limit switches which indicate if valve is OPEN or CLOSED.

G.P. 275 Convectron - or Hastings VH-3 - gives pressure indication from atmosphere to 1 micron.

G.P. 271-004 - Ion Gauge Controller with Process Control - capable of reading to 2×10^{-11} Torr (nitrogen equivalent). Process control possible to 10^{-9} Torr when Controller is set to read Log scale.

BNL DWG #533E-02.01-3 - Pump Station Control Unit - controls the operation of the Pump Station.

1) Pump Station POWER "START", "STOP".
2) Electropneumatic or solenoid operated valve "OPEN", "CLOSE".
3) Station protect in "AUTO" mode.

Caster Corp. - 16-MO-08-01-S - swivel Caster 8" rubber wheels mounted on rear of Pump Station. Size of wheels and the swivel feature allow the station to be easily maneuvered.

Caster Corp. - 16-MO-08201-R - rigid Caster 8" rubber wheels mounted on front of Pump Station.

Waber Strip - 6 Way Outlet - UL24CB-6-2884 - 115V, 6 outlets into which all Pump Station line cords are plugged. When Pump Station is disabled.

United Electric Controls Co. - Model 156 - air switch used with the Varian electropneumatic valve. Contacts are used to indicate air is connected to station.

Pump Station Construction

The bulk of the Pump Station is made up of the Balzers Series 11 base frame as shown in Figure 1. To the bottom of the base frame is attached the two pieces of 1/4" cold rolled steel plate. Mounted under the rear plate are two 8" rubber wheels on swivel casters. These wheels are placed 18" apart. Under the front plate are two 8" rubber wheels on rigid casters. These wheels are placed ~18" apart. On the outside edge of the front plate are placed two 1-1/2" x 1/4" cold rolled steel supports. The supports are illustrated in Figure 1. The upper 13" of each support are bent to an angle of ~45° from perpendicular. This portion of the support is used to mount the G.P. 271, the BNL Control Chassis with the G.P 275 and on some carts a power supply to recharge the vent valve circuit. The supports mounted in this fashion act as a means of pushing the Pump Station to wherever it is needed.

The Series 11 base frame houses the DUO 012A Mechanical Pump on the bottom with the TPU 110 or TPU 170 Turbo Pumps mounted vertically on the top of the Pump Stand. Along with the Turbo Pump, the TCP 270 or TCP 300 Turbo Control chassis is mounted, as part of the Turbo Control Unit the TCF 101 Vent Valve Control and the TCS Pumping Unit Control are located. These units are all neatly packaged under a Balzer supplied cover. This package is mounted on the left side of Pump Station just behind the steel supports. For the Isabelle Pump Stations, it was necessary to mount the TPU 110 Turbo-Molecular Pumps vertically. This was accomplished by attaching the pump to a 1/4" by 6" high, 6" wide steel 90° angle bracket. 2-3/4" conflate interconnect lines are used between the Mechanical Pump and Turbo Pump.

A 6 volt dc Vent Valve (Balzer TVF 010) is connected to the TPU 110 or TPU 170. The valve is connected to the TCF 101 Vent Valve Control Unit. This unit allows delayed venting over a settable time frame. The Delay time can also be set. Nicad batteries inside the TCF 101 allow the venting to occur even though the Pump Station is not powered. The Isabelle Pump Stations have a BNL made Vent Valve circuit which activates when the Pump Station is turned OFF and the Electropneumatic Valve is closed. Vent period is 20 sec. A 6 volt gelyte battery which is kept charged by a power supply mounted on the steel supports, allows the station to be vented when the Pump Station is turned off.

The Angle Valve which isolates the Pump Station from the volume to be pumped varies with station design. For Isabelle, a Varian #951-5088 Electropneumatic valve was used. This was modified so that a shaft protrudes from the top of the valve cover which moves with the valve. Off this shaft a micro switch is mounted which connects to the BNL Vent Valve Circuit. Being Electropneumatic, this valve requires air to operate and as such, a source of air is required wherever this Pump Station is used. For HITL, a Balzer solenoid operated Angle Valve is used (BPV28 509) in place of the Varian #951-5088.

The Isabelle Pump Stations have Hastings VH-3 Thermocouple Gauges which read from atmosphere to 1 micron. The HITL Pump Stations have Granville Phillips Convectron 275 Gauges which cover the same range. These gauges are used exclusively to read vacuum and to indicate a vacuum trend.

To read the high vacuum in both the Isabelle and HITL Pump Stations a Granville Phillips Model 271-004 Ion Gauge Controller with Process Control is used. The gauge used is a tungsten filament type in each case. This was chosen over the Thoriated Iridium type because of its sensitivity stability. This controller is manually operated and is used to interlock the Station in Automatic Mode. Here, one of the Process Control Channels is used to interlock the station against vacuum failure with the 271 operated in the log mode.

The control of the entire Pump Station is through the BNL Control Chassis mounted on the steel supports. The Station 208V, 1ϕ input power is into this unit. A "Line Power" neon light indicates power is connected. The sequence of operation is described in the next section "Interlock Logic". This chassis is common to both the Isabelle and HITL version of the Pump Station.

Interlock Logic

A. To begin a pumping sequence

1) Push momentary START switch on BNL Control unit. This will latch the main line contactor.
2) If main switch on TCP is energized, the Turbo and Mechanical Pump will activate.

3) Monitor pump down by means of the Convectron 275 or the Hastings VH-3.

4) With the "Pneumatic Valve Mode" sw on the BNL panel set to "Open" the "Valve Open" mom switch can be pushed.

5) High vacuum progress can be monitored by the G.P. 271.

6) To protect the Pump Station, the Pneumatic Valve Mode sw can be set to "Auto", providing the G.P. 271 is in the "Log" mode of operation and the process control set point is properly set.

7) The Pump Station will shut down totally in the "Automatic" mode and the Turbo will vent automatically if the following occurs:

a) Power failure.
b) Vacuum failure.
c) Turbo-Molecular Pump failure.
d) Mechanical Pump failure.

B. The station can be used as a leak check station by:

1) Connecting the Leak Detector to the manual angle valve.

2) Turn off the DUO 012A and allow the Turbo pump to be backed by the Leak Detector through the manual angle valve.

3) The interlock features will still provide the same protection listed above.

System Variations

The previous discussions involve the Pump Stations developed for Isabelle and HITL, another variation exists which utilizes a Leybold Heraeus Trivac D16A Mechanical Pump, Balzers TPU 110 Turbo-Molecular Pump and Balzers TCPO 270 Turbo Controller. Interface of the Trivac D16A to the Balzers TCP 270 was accomplished by purchasing a Balzer TCS 301R Pumping Unit Control and appropriate equipment cover. A base frame was constructed using welded uni-strut which approximates the Balzers Series 11 design. A 1/4" cold rolled steel plate completely covers the bottom of the frame. Placement of the components approximates that of the Isabelle Pump Station. The front equipment supports are welded to the base frame and serve as the mechanism for transporting the Pump Station. All other aspects of the Pump Station design incorporated features found on the Isabelle Pump Station. To date two of these stations have been built with no problems experienced.

Conclusion

The BNL Control Circuit with Balzer Turbo-Molecular Pumps and Controllers associated with a Balzers TCS 301R will interface most mechanical pumps and give equivalent system control. By utilizing a similar base frame design with 8" diameter wheels (swivel caster on front of cart) a compact, mobile Pump Station can be assembled. This station is completely protected and is capable of reaching pressures of 10^{-9} Torr (nitrogen).

References

1. H.C. Hseuh, I. Feigenbaum, M. Manni, P. Stattel R. Skelton, paper E40 this proceeding.

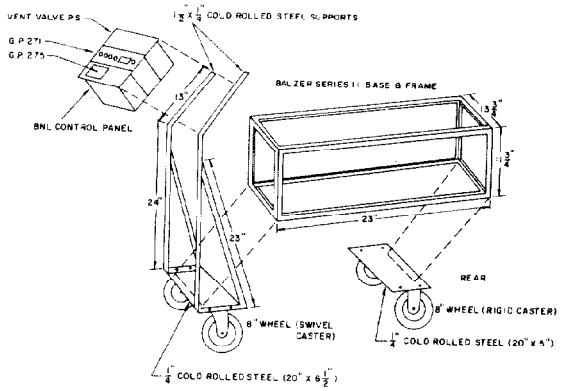

Fig. 1 - Pump station frame construction (Isabelle - AGS)

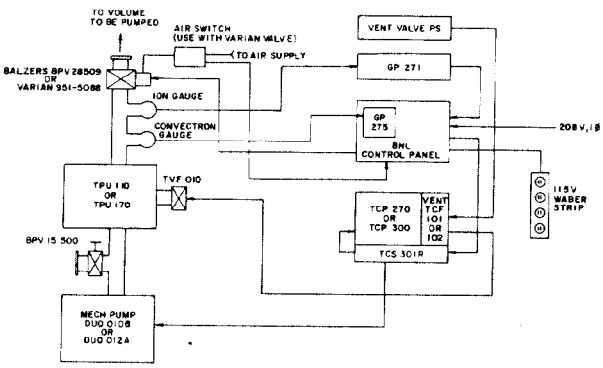

Fig. 2 - Pump station system configuration.