If you are using a printed copy of this procedure, and not the on-screen version, then you MUST make sure the dates at the bottom of the printed copy and the on-screen version match.
The on-screen version of the Collider-Accelerator Department Procedure is the Official Version. Hard copies of all signed, official, C-A Operating Procedures are available by contacting the ESSHQ Procedures Coordinator, Bldg. 911A

C-A OPERATIONS PROCEDURES MANUAL

15.5.38 Cryo Pump Start-up

(Vacuum Group Procedure VA-008.18.1.38)

Note: This document was formerly a C-A Group Procedure. The content of the group procedure was reviewed by the Technical Supervisor. All approvals and/or issue dates of the original group procedure are maintained for present use.

Hand Processed Changes

HPC No.	Date	Page Nos.	Initials

Approved: _____***Signature on File***_____ _____
Collider-Accelerator Department Chairman Date

S. Gill

Vacuum Group Procedure VA-008.18.1.38
Original Issue Date: 01/01/00
Revision 01

1. Purpose:

To provide an effective procedure for AGS vacuum technicians to start up a cryopump.

2. Responsibilities:

The AGS vacuum supervisor shall be responsible for the implementation of this procedure.

5 OPERATING THE CRYOPUMP

Introduction

After the cryopump has been bolted to the vacuum system, and the cryopump and system have been found to be leak tight, the cryopump must be rough pumped and cooled to operating temperatures before the cryopump can be used.

Rough Pumping

The cryopump has to be rough pumped to a pressure of less than 25 millitorr (microns) before the cryopump can be started. If the internal volume of the cryopump contains too high a pressure, heat will be conducted through the gas from the pump walls to the cryoarrays. By proper roughing an insulating vacuum is created in the cryopump prior to cooldown, insuring proper cryopump performance.

The internal surfaces of the cryopumps have to be sufficiently outgassed before the refrigerator is started. If the outgassing rate is too high when the refrigerator is started, the pressure inside the pump will rise to levels that break the insulating vacuum before the cryoarrays have cooled to temperatures at which they start pumping.

CAUTION

A molecular sieve trap or liquid nitrogen trap must be installed in line with any mechanical oil-sealed pump used with the cryopump. The trap must be maintained at regular intervals. Failure to do so can cause oil backstreaming into the cryopump. This will permanently damage the second-stage array, causing decreased hydrogen pumping speed and capacity.

On initial installation of the cryopump, the roughing pump should continue to pump for at least 60 minutes after the pressure has reached 25 millitorr so that any contamination or outgassing can be eliminated. On subsequent regenerations the roughing pump should continue to pump for 30 minutes after the pressure has reached 25 millitorr. A NW-40 flange on the side of the pump body is designed for roughing. Either a two-stage mechanical pump or staged sorption pumps can be used for roughing.

If a mechanical pump is used, precautions must be taken so that oil does not migrate (backstream) from the mechanical pump into the cryopump.

The oil will plug the pumping sites of the charcoal on the second-stage cryoarray. Backstreaming can be easily prevented by using a molecular sieve trap or a liquid nitrogen trap between the mechanical pump and the cryopump. It is important to have a trap installed and to have it regenerated at routine intervals (whenever the cryopump is regenerated). Otherwise, the trap becomes ineffective.

If sorption pumps are used for roughing, they should be staged. In staging two VacSorbs, the first VacSorb is valved in at atmospheric pressure and valved out a pressure between 1 torr and 10 torr when gas flow is still in the viscous region. Valving the sorption pump out at these pressure levels will trap all the gas molecules into the sorption pump. This prevents the gases with light atomic weights, such as hydrogen, helium and neon from backmigrating into the cryopump. The second VacSorb is then valved in to reduce the pressure below 25 millitorr.

Cooldown

After the cryopump volume has been sufficiently roughed below 25 millitorr, turn on the cryopump by switching the main power switch/circuit breaker on the compressor. Close the roughing valve 20 minutes after starting the cryopump compressor for optimum cooldown. Periodically check vacuum pressure to see that it stays below 25 millitorr. If the pressure goes above 50 millitorr, reopen the roughing valve to reduce the pressure below 25 millitorr, then close the roughing valve.

If the pump has a main high vacuum isolation valve connecting it to the system, this valve should be closed during cooldown. This will prevent gases from the system from condensing on the cryoarray surfaces. After approximately 20 minutes, the cryopump will have started to cool down significantly and the pressure inside the pump should drop below 1 millitorr.

It will take approximately 65 minutes (85 minutes for the optional 30 liter array) for the second-stage of the cryopump to cool down from room temperature to 20K. The temperature can be read from the second-stage temperature indicator(s): a) the remote sensor with display and/or b) the hydrogen vapor pressure thermometer. When the display reads less than 20K or the needle on the hydrogen thermometer has moved into the blue range indicated on the dial, the pump is ready for use. If the cryopump is not cold after 2 hours, refer to the diagnostic section.

Crossover

Once the cryopump has cooled to operating temperatures as indicated on the second-stage temperature sensor, it has attained its full pumping speed and its capacity for retaining all gases. It is ready to be valved into the system. Cryopumps have a unique and very desirable feature in that they can take very high impulsive throughputs, an order of magnitude above their steady-state throughput capability. This provides shorter roughing times by allowing the mechanical pump to be valved off at high pressure. Valving off the roughing pump when the pressure is still in the viscous flow region also reduces the probability of oil backstreaming into the chamber.

The maximum impulsive throughput capability of the cryopump is 300 Torr-liters. This means the cryopump can take a gas burst of 300 Torr-liters and still recover.

Given the impulsive throughput limit of 300 Torr-liters and vacuum system volume, the crossover pressure can be determined:

$$\text{Maximum Crossover Pressure} = \frac{\text{Inpulsive Throughput}}{\text{Chamber Volume}}$$

For a 200 liter belljar, the maximum crossover pressure would be:

$$\text{MCP} = \frac{\text{300 Torr-liters}}{\text{200 liters}} = \text{approx. 1500 millitorr}$$

If there is an impulsive gas load over 300 Torr-liters, the cryopump may not recover. The temperature of the cryoarrays will warm up to a point where the previously condensed gases will be evolved. The pressure inside the cryopump will rise to a point where the gas in it will conduct heat from the room temperature pump wall to the cryoarrays. Under these conditions, the cryopump may never return to proper operating temperatures until a regeneration cycle is implemented.

Steady-State Operation

After properly valving the cryopump into the work chamber, the operating temperature of the cryopump should be maintained below 20K for optimum performance (blue range on the vapor thermometer dial). The steady-state operating parameters such as pump speed, capacity and throughput are given in the Cryopump Data Sheet.

1 SAFETY INFORMATION

SCOPE

Operating personnel must always be aware of areas of hazards. Safe practices and procedures should always be used and followed. Do not take shortcuts. Do not disable interlocks and always remember the warnings and cautions called out when operating or working around a cryopump.

The information contained in this section is a summary of the operator's related safety precautions. The warnings and cautions are arranged in the order they appear in this manual.

Users of cryopumps should be alert to two levels of hazards identified by the following symbols:

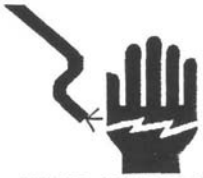
⚠ WARNING

Warnings are used when failure to observe instruction or precautions could result in injury or death to humans or animals.

⚠ CAUTION

Cautions are used when failure to observe instructions could result in significant damage to equipment and/or facilities.

⚠ WARNING



HIGH VOLTAGE

Hazardous voltage. Can shock, burn, or cause death. Turn off power when working in this area. Extreme caution should be used if power is required to make measurements.

WARNING

HIGH PRESSURE

Gas pumped on the cold surfaces of the cryopump can cause explosive high pressure in the pump when the pump is brought back to room temperature.
The pressure relief valve is designed to prevent built-up pressure. Never alter, restrain, or remove the pressure relief valve.

WARNING

POISONOUS AND/OR CORROSIVE COMPOUNDS

Pumping hazardous gases or vapors can result in the presence of hazardous materials during operation or after regeneration that can cause severe injury or death. Always vent the pump and relief valve to a safe location. Take other appropriate precautions for hazardous materials that may remain in the pump.

WARNING

COLD SURFACE

The internal cryoarrays remain cold for some time after power is turned off. They could cause severe frostbite if handled when cold. Never disassemble the pump and handle the cryoarrays unless you have determined they are at room temperature.

WARNING

EXPLOSION

Pumping combustible gases can result in explosive mixtures existing in the pump below the main seal.
Never install an ionization gauge or other source of ignition below the main seal. Never alter, restrain or remove the pressure relief valve.

CAUTION

The cap screw must be removed from bottom of compressor. Failure to remove cap screw can result in equipment damage.

CAUTION

The compressor must be operated in a level, upright position. When being handled or shipped the unit should not be tipped on its side or inverted.

CAUTION

The helium used in the refrigerator must always be high purity. Failure to use helium of the specified purity will result in contamination of the refrigerator and can cause damage to the cryopump.

CAUTION

The helium charge pressure in the refrigerator during operation must always be within specification. Incorrect pressure will result in loss of refrigeration power and/or automatic shutdown.

CAUTION

The compressor must be supplied with cooling water as specified. Insufficient water cooling will result in the compressor overheating and automatic shutdown.

CAUTION

The compressor must be operated within the specified voltage range. Operating at an incorrect voltage may result in overcurrent and/or compressor damage.

CAUTION

The compressor must never be operated with the adsorber disconnected and the expander connected. Operation in this mode may result in expander motor burnout because of lack of cooling.

CAUTION

The helium hoses must not be bent to less than an 8 inch radius. A smaller radius may overstress the hose and could cause helium leakage.

CAUTION

The cryopump body must never be operated for extended periods of time in high intensity neutron or gamma radiation fields. Organic materials inside the expander will degrade.

CAUTION

If a heated gas purge is used, do not heat gas above 100°C or damage to the second-stage array can occur.

CAUTION

A molecular sieve trap or liquid nitrogen trap must be installed in line with any mechanical oil-sealed pump used with the cryopump. The trap must be maintained at regular intervals. Failure to do so can cause oil backstreaming into the cryopump. This will permanently damage the second-stage array, causing decreased hydrogen pumping speed and capacity.

CAUTION

The roughing valve must be closed 30 minutes after chilldown has started. Failure to do so can cause oil backstreaming into the cryopump which can permanently damage the second-stage array.