5. Maintenance and Common Procedures

This section describes procedures that are likely to be carried out several times during the service life of the instrument. Maintenance procedures are described in section 5.1; these are procedures that are carried out according to specific criteria, which are outlined in the section. Other common procedures are described in section 5.2. These represent modifications to the instrument configuration (filters, slits) and are therefore science-driven.

5.1 Maintenance Procedures

The procedures described here must be carried out from time to time during the life of the instrument. The procedures covered comprise

- Cryocooler maintenance
- Molecular sieve replacement
- Window cleaning and replacement
- Evacuation (described in 4.2.2)

5.1.1 Recommended Maintenance Intervals

The following table summarizes the criteria for carrying out the specific maintenance procedures described below.

Table 5.1.1 - Maintenance Intervals

Procedure	Interval
Cryocooler purge	After drive replacement or evidence of contamination.
Cryocooler Drive replacement	8000 hours (=1 year continuous) operation (prior to that if next scheduled use will significantly exceed 8000 hours between replacements).
Evacuation	Whenever dewar is warmed up. Prior to any cool-down. The instrument should be warmed up for this purpose after 6-12 months of operation (monitor dewar vacuum).
Molecular sieve replacement	Whenever dewar is open >12 hours. Whenever dewar is opened if last change was >6 months ago. If minimum vacuum when cold exceeds 10^{-6}T.
Window cleaning	According to inspection prior to installation on telescope.
Window replacement	Inspection after cleaning shows stains or damage.

5.1.2 Cryocooler Maintenance

This section covers head decontamination (5.1.2.1) and drive replacement (5.2.2.2).

5.1.2.1 Leybold Refrigerator (Cryohead) Decontamination

This procedure is done when the Leybold cryohead 5-100-2LV appears to have a gas contamination. The following procedure is only for this model cryohead. Use of this procedure on any other Leybold series or manufacturer's cryoheads can result in serious damage to the head.. Consult the manufacturer if there is any question. Note that some cryohead motors will burn up if run in a vacuum, so be aware of other manufacturer's decontamination procedures. The procedure outlined below does not utilize a vacuum pump.

There are three common scenarios that require this decontamination procedure. The first is when an otherwise functional cryohead system is run with He gas that contains impurities, which will freeze within the cryohead (particularly in the valves). This reduces the efficiency of the coolers and results in an unforgettable sound from the cooler motors which is delicately referred to as "ratcheting". The second case is when a so-called "sacrificial" cryohead is run on a newly charged system as a cold trap to remove any contaminants before a functional cryohead is installed. The final case is when the interior of a cryohead has been exposed to atmosphere, such as when the displacer and/or seals are replaced.

IMPORTANT: When contaminants are trapped in the cryohead, as in the first two cases above, it is necessary to remove the He lines from the head while it is still cold, and preferably running, as outlined in the following section on System Shutdown. Otherwise, the frozen impurities will vaporize and re-contaminate the system. **However, the decontamination procedure itself must be carried out with the cryohead at room temperature!**

1) Connect research grade helium bottle with >500 psi pressure in bottle, through a regulator set to 250 psi, with a shut-off valve, to the high pressure side of the cryohead. The valve should be closed.
2) With the Leybold charge/purge adapter P/N UC 014 010-U valve closed, connect it to the cryohead return line.
3) Connect cryohead to power source and power up cryohead motor.
4) Slowly open the He gas valve to charge system to 250 psi and close the valve.
5) Open the charge/purge adapter valve to vent the gas slowly down to 50 psi. Close the charge/purge adapter valve.
6) Repeat steps 4 and 5 six times.
7) Slowly open the He gas valve to charge the system to 250 psi and close the valve when done. Turn off the cryohead power supply and disconnect the He gas line and charge/purge adapter. The cryohead is ready to use.

This procedure purges the contaminants from the cryohead and never allows anything but clean helium into the cryohead.

5.1.2.2 Leybold Refrigerator 5-100-2LV (Cryohead) Removal & Installation

This section describes removal of the drive unit assembly for replacement or inspection, and installation of the new or inspected unit afterward.

5.1.2.2.1 Removal of the Drive Unit Assembly:

Use *only* the following procedure to disassemble a room temperature cryohead. This method is used when internal inspection of the cryohead is needed or an instrument can't be taken apart or have a loss of vacuum.

Warning: removal of drive unit assembly from the cylinder for any length of time can damage the displacers beyond repair.

Displacers must be handled with clean room gloves and stored in a vacuum chamber under vacuum, if not reinstalled in a cylinder in 1 hour or less.

1) Use the Leybold charge/purge adapter and purge the helium gas from the cryohead (remove residual pressure).
2) Loosen, then remove the seven screws located around the drive unit assembly and cylinder.
3) Once the screws are removed, pull the drive unit assembly straight out. **Do not touch displacers or cylinder walls without clean room gloves!**
4) Before going any further, ensure that the Teflon seal on the second stage displacer is captured. This is accomplished by slipping a solid ring, referred to as a wedding band, over the Teflon seal split ring. To slip the solid ring over the Teflon seal split ring, squeeze the Teflon seal split ring together and carefully slide the solid ring over it. The cryohead is now ready for inspection or can be properly packaged and returned to Leybold for repair.

5.1.2.2.2 Installation of the Drive Unit Assembly:

Do not touch displacers or cylinder walls without clean room gloves!

1) Inspect the cylinder walls for excessive wear and contamination prior to installing the drive unit assembly. If cleaning is necessary use a lint-free wipe and a clean dry air source to wipe and/or blow out the particles. If you must use a solvent, make sure that the cylinder is *completely* dry before installing the drive unit assembly.
2) Inspect the O-ring for damage and cleanliness, clean or replace if necessary, using Parker #2-150 V747-75. Lubricate the O-ring with a light coat of Dow Corning High Vacuum grease. Before installing the cryohead ensure that the Teflon seal on the displacer is captured.

3) Push the drive unit assembly in until you feel the 2nd stage displacer contact the cylinder. Then while lightly pushing in, rotate the drive unit assembly 180 degrees. This will allow the second stage displacer to align in its cylinder and continue to move inward. This movement will cause the wedding band to slip off of the Teflon seal. **Do not pull drive unit assembly out without removing fully and checking the Teflon seal.** If any movement out is made, the Teflon seal could expand, and if the displacer is pushed back in without the ring installed, this would damage the Teflon seal.
4) The second stage is now sealed and the drive unit assembly can be pushed the rest of the way until it meets the cylinder. Install all of the screws and tighten in a cross pattern.
5) The Leybold Cryohead Decontamination Procedure (5.1.2.1) should be performed *immediately.*

5.1.3 Changing Molecular Sieve

This section describes the procedures to remove and replace the GNIRS molecular sieve.

5.1.3.1 Preparation

GNIRS contains a "getter" consisting of a box containing molecular sieve (Linde 5A). This getter is connected to the second stages of cryocoolers 1 and 2, and operates at a temperature <30K when the instrument is cold.

At this temperature, the molecular sieve traps material efficiently, including both residual outgassing from the dewar shell and passive shields, and leakage through the dewar O-rings. Much of this material is expelled when the instrument is warmed to room temperature, but water vapor and similar volatiles are partially retained. Over time, the molecular sieve becomes saturated with material, and must be baked or replaced in order to restore its capacity. If the contamination is from water only (as opposed to oil, paint G-10 out-gassing, or similar substances), baking is sufficient. Otherwise, plan to replace the molecular sieve.

Note that the procedures described here apply *only* to Linde 5A. Do not mix with other materials or substitute something else.

5.1.3.2 Removing Sieve Box

- Warm the instrument if necessary (4.2.5)
- Backfill with dry nitrogen gas (4.2.6)
- Remove the rear truss, if attached (8.3.3). Removal of thermal enclosures or other trusses is not required.
- Remove the rear dewar shell and molecular sieve (8.4.2). It is not necessary to remove the rear active shield.

5.1.3.3 Sieve Preparation

Under normal circumstance, the only significant contaminants of the getter will be air and water. These can be removed by baking, and the sieve can then be re-used. If other contaminants are known (or suspected) to be present, replace the contaminated sieve material with fresh material, and then proceed to the next step.

The molecular sieve can be baked in the getter box. The preferred arrangement is a vacuum oven capable of holding the box. Bake the getter box under vacuum, at 250° C, until you are ready to install it back in the instrument, but not less than 24 hours. If time permits, the getter should be purged with dry nitrogen gas once or twice while in the oven. (See the manufacturer's instructions for additional information.)
Although the box can be stored under vacuum more or less indefinitely, absorption of contaminants will be minimized if it is removed from the vacuum for re-installation while it is still hot. Wrap it in clean aluminum foil until it is cool enough to handle (<60° C)

5.1.3.4 Replacement

The replacement should take place while the getter box is still hot, but it must be cool enough to handle.

- Complete all other re-assembly work on the instrument that might be required, including detector installation and installation of the aft shields and dewar shell. Installation of external structures (trusses, thermal enclosures) can be postponed.
- Install the getter box, then attach the aft dewar shell (8.4.2)
- Pump out the dewar, including dry nitrogen purge (4.2.2)

The interval between installation in the instrument and the initial evacuation should be kept as short as practical in order to minimize contamination.

The instrument is now ready to be cooled.

5.1.4 Entrance Window Cleaning and Replacement

The entrance window is exposed to the environment whenever GNIRS is being used for observations or for many calibration and test procedures. Unfortunately, the general environment in the telescope dome is far from being a "clean-room" environment, so there is a real possibility of contamination.

The environmental cover should always be closed when the instrument does not need to "see light", and dry air (or dry nitrogen) should always be flowing across the window when the cover is open. This will minimize contamination, but not eliminate it.

Fig. 5.1 Left: Environmental Cover on the front dewar shell. Dry air purge is not connected in this image. Right: Entrance Window cell.

5.1.4.1 Inspection

The entrance window should always be inspected *prior* to preparing the instrument for use, and *after* any prolonged use on the telescope.

Use a bright light to look for dust, stains, and other contamination, as well as cracks or chips. Contamination will almost always be on the outside, but be aware that it might be on the inside of the window. The most common contaminants will be small particles (dust, hairs, etc.). If the window is chipped or cracked, it must be replaced, since the fractures will tend to propagate with time, and may lead to catastrophic loss of vacuum.

Do not touch the window surface. Use of a facemask is recommended. See 8.7.1 for more information on precautions when handling optics.

If no contamination is seen, close the environmental cover and continue planned activities. If contamination is seen, attempt cleaning the window.

5.1.4.2 Cleaning

The procedure to be followed depends on the level of contamination. If only loose particles are present, follow step 1, which may be carried out with the window still mounted in the instrument. Otherwise, proceed to step 2.

Step 1 - Mild Cleaning for Light Contamination (dust, lint particles)

1. Use an air bulb to blow off any loose contamination from the surface of the optic before proceeding to the cleaning steps. If this step does not remove the contamination, continue to Step 2.
2. **Note:** Avoid using shop airlines because they usually contain significant amounts of oil and water, which will contaminate the optical surface. Airlines with filtering suitable for optics cleaning can be used.

3. **Note:** Avoid the use of portable compressed cleaners such as Effadusters. The propellant evaporates quickly and can produce a localized region of very cold air which can crack the entrance window.

Step 2 - Mild Cleaning for Light Contamination (smudges, fingerprints)

It is strongly recommended that this procedure be carried out with the window *removed* from the instrument. See sections 8.6.1 for general procedures and 8.6.2 for specifics of window removal. If it is not possible to do this, localized cleaning with the window installed *may* be successful, if carried out with caution.

1. Saturate an unused cotton swab or a cotton ball with methanol or propanol. Gently wipe the surface with the saturated cotton. **Do not rub hard.** Use only the weight of the saturated cotton ball.
2. Drag the cotton across the surface just fast enough so that the liquid evaporates right behind the cotton. This should leave no streaks. If this step does not remove the contamination, **stop and seek advice from a professional optician.**
3. **Note:** Use only paper-bodied cotton swabs and high-quality surgical cotton balls.
4. **Note:** Reagent grade methanol and propanol are required.
5. **Note:** Do not use acetone, as it will leave streaks on the surface of the entrance window.

If the window remains contaminated after cleaning, it is necessary to replace it or have it cleaned by a professional optician in an optics lab. In the latter case, it may be a good idea to replace the window temporarily rather than wait for the cleaned window to be returned.

5.1.4.3 Replacement

The general procedures for handling optics are described in 8.7.1. The procedures required to remove and replace the window are described in 8.7.9. These procedures require that the instrument be warmed up (4.2.5) and at ambient pressure (4.2.6).

GNIRS is supplied with 3 spare windows, so the supply is quite finite. The instrument scientist should be notified of any window change, so the frequency of replacement can be monitored and further spares can be ordered if necessary. With proper care and protection, a window ought to last several years and the spares provided ought to out-last the scientific usefulness of the instrument.

5.2 Common Procedures

The procedures listed here will likely be performed several times during the service life of the instrument. Unlike maintenance procedures, they are carried out only as needed. The procedures described here comprise

- Filter changes
- Slit mask changes

These procedures do not require complete disassembly of the instrument; see the individual sections for the steps required.

5.2.1 Changing Filters

This section describes the procedures to install and remove GNIRS filters.

5.2.1.1 Preparation - Additional Materials

GNIRS filter logbook
Filter(s) to be installed
Delrin spacers for filter(s) to be installed
Storage boxes for filter(s) to be removed

GNIRS filters should have an optical thickness equivalent to 3.0 mm of BK7. Filters with a different optical thickness will defocus the image on the slit. Delrin spacers are required on each side of the filter to protect the filter. The combined thickness of the filters plus spacers should be 4.0 +/- 0.5 mm. Spacers can be combined if required. Some extra spacers were provided with the instrument, but may not provide the thicknesses required for a filter procured at a later date; if so, you will need to make an appropriate spacer or spacers.

5.2.1.2 Preparation of the Instrument

- Warm the instrument if necessary (4.2.5)
- Backfill with dry nitrogen gas (4.2.6)
- Remove cables, helium lines, and coolant lines from the front truss (8.3.1)
- Remove the front truss (8.3.3). Removal of thermal enclosures or other trusses is not required.
- Remove the front dewar shell (8.4.2).
- Remove the front active shield (8.4.4)

If you are only changing filters and will do so during a single work day, it is not necessary to remove the detector or change the molecular sieve.

5.2.1.3 Filter Wheel Removal and Filter Installation

Remove the filter wheel (8.5.9). Note that in this configuration it will be necessary to remove the rear filter wheel motor in order to clear the bulkhead shields. Remove the motor for filter wheel 2 by removing the 5 M3 screws that attach it to the filter wheel housing. Don't lose the screws or the associated G-10 stand-offs.

Install the filter wheel in the filter wheel changing fixture (see 8.2.3) with the filter wheel to be worked on facing up. If you are changing filters in both wheels it will necessary to remove the mechanism, turn it over, and put it back after you finish with one wheel. Turn the wheel by hand to access the filter position of interest.

Fig. 5.2.1.3 Filter cell.

To remove a filter:

Remove the four screws holding the filter cover in place, remove the cover, the top Delrin spacer(s) and the filter. Handle the spacer carefully so as not to scratch the filter. Put the filter into its storage box, replace the Delrin spacer, the cover, and the screws.

To install a filter:

Remove the four screws holding the filter cover in place, remove the cover and any Delrin spacers. Put in the bottom Delrin spacer appropriate to your filter, then take the filter out of its storage box and put it in place. Put the top spacer(s) in place carefully, centering it on the filter. Put the cover over the filter and spacers carefully, then use the four screws to fasten it in place.

Log all filter changes in the log book on the pages corresponding to the individual filters and to the filter wheels. It is very difficult to keep track of filters if you do not do this!

Remove the filter wheel, and slide it back into the housing (8.5.9). It can only be installed in the correct orientation (wheel 1 towards front of instrument). Attach the motor assembly for wheel 2 and attach the cables.

5.2.1.4 Completion

- Attach the front active shield (8.4.4)
- Attach the front dewar shell (8.4.2)
- Pump out the dewar, including dry nitrogen purge (4.2.2)
- Attach the front truss and reconnect cables and hoses (8.3.3, 8.3.1)

The instrument is now ready to be cooled.

The filter configuration tables (`fw1.lut` and/or `fw2.lut`) should also be updated to reflect the changes you have made. See sections 7.1, 7.2, and the Software Manual for further discussions of configuration updates.

5.2.2 Changing Slit Mask

This section describes the procedures to install and remove the GNIRS slit mask.

Fig. 5.2.2 Slit mask assembly.

5.2.2.1 Preparation - Additional Materials

Slit mask to be installed
Storage box for mask to be removed

The GNIRS slit masks are photo-etched on thin copper and then oxide coated. The etching process leads to slit "walls" that are at an angle of roughly 45 degrees to the mask surface, so that one side has an acute angle (knife edge) and the other side has an oblique angle. The side with the knife edge should always be installed facing forward. Use a microscope to identify the front and back of any new slit mask.

Presently available masks for GNIRS are the science slit mask and the test slit mask. The former contains only slits, covering a scientifically useful range of widths; the latter contains a more limited slit selection but also two sets of pinholes and an array of horizontal slits. See the GNIRS drawings for details on the individual masks and to get a template if another mask needs to be made.

5.2.2.2 Preparation of the Instrument

- Run the slit slide to its negative (soft) limit (7.1). This can be done cold or warm, and can follow some or all of the steps listed below.
- Warm the instrument if necessary (4.2.5)
- Backfill with dry nitrogen gas (4.2.6)
- Remove cables, helium lines, and coolant lines from the front truss (8.3.1)
- Remove the front truss (8.3.3). Removal of thermal enclosures or other trusses is not required.
- Remove the front dewar shell (8.4.2).
- Remove the front active shield (8.4.4)

If you are only changing the slit mask and will do so during a single work day, it is not necessary to remove the detector or change the molecular sieve.

5.2.2.3 Mask Holder Removal and Mask Installation

Remove the "left" slit slide access cover (8.5.10). Note that in the actual orientation, this will be on the *right* side as you face the bench. It may be necessary to undo some cabling to remove the cover and the slit module.

Remove the slit module. Do not remove the IFU (or dummy IFU, if present). You can use a pair of M5 bolts screwed into the front of the slit module to help if necessary. If the decker slide is blocking access, you can push it aside manually. There will be some resistance from the decker drive if you have to do this; it is normal. You can of course move the decker slide under computer control if it is still connected at this point.

See the assembly drawings for the slit module (89-NOAO-4200-0053). Remove the back of the module, and then the slit mask. Install the new mask, making sure that the front of the mask is facing the front of the module. Reassemble the module, and reinstall in the slit slide (8.5.10). Put the old mask in its box.

5.2.2.4 Completion

- Attach the front active shield (8.4.4)
- Attach the front dewar shell (8.4.2)
- Pump out the dewar, including dry nitrogen purge (4.2.2)
- Attach the front truss and reconnect cables and hoses (8.3.3, 8.3.1)

The instrument is now ready to be cooled.

The configuration table (`gnirsMechanisms`) should also be updated to reflect the changes you have made. See sections 7.1, 7.2, and the Software Manual for further discussions of configuration updates. You may need to check exact slit positions for the new mask when cold, in order to provide precise positions for the configuration table.