The Lab Manager has to approve of the type of material that is to be evaporated . Some materials will foul up the cryopump and results in an expensive repair and much down time. Some materials are toxic. Powder material will "explode".

Check with Technician/Lab Manager to ensure cryopump is running, enough nitrogen gas, cooling water is running, cleanroom exhaust running, no maintenance going on in cleanroom, etc …

(If the cryopump is not running, it will take about 2.5 hours for it to cool down and be ready to operate. This has to be done under Technician/Manager supervision as the cryopump requires special startup not covered in the Edwards Operating Manual.)

Do not press "Stop" or "Reset" button on the main readout as this will put the evaporator into shutdown (2 hours of cryopump warming and another 1 hour to start up the cryopump).

Check that main readout display says "Sealed". Contact Technician/Manager if it reads something else.

Check the temperature gauge at the bottom of the cryopump. It should read 10 to 16 Kelvin (inside scale). Contact Technician/ Lab Manager if it reads more than 16 Kelvin.

Fill out the "Date", "Name", "Start time", "Cryo temp (Kelvin)" on the Log Sheet.

Check the chamber pressure by pressing the arrow key until "Chamb=" appears. Chamber should be under vacuum (less than 500 MB (mbar) .

Open the nitrogen gas valve slowly (behind machine, near the floor)

Press "Vent" button (display will read "Chamber vent").

Open the chamber door latch (to prevent overpressure inside chamber)

When the chamber is up to air, the door will swing freely open and the sound of gas will be heard.

Press "Seal" button to stop nitrogen gas. Display will read "Sealed".

Close nitrogen gas valve (behind machine, near floor) when up to atmosphere

** Call technician if you want a clean viewing window for your evaporation run ***

Load the samples.

- Use an Allen key to remove the plate located at the top inside the evaporator
- Clean the plate with alcohol and vacuum cleaner (Note: leave the lid of the alcohol squeeze bottle slightly open so that pressure will not build up inside)
- Use Allen key to secure the sample onto the plate
- Use carbon tape if anything else needs to be secured
- Put the plate back into the evaporator and tighten with Allen key
- Use the rotary workholder panel to rotate the plate. The button on the left is ON/OFF and the button on the right is 'start' which will start the rotation of the plate.

Load the source materials.

- On the shutter panel, the button labeled SS1 opens the shutter.
- Open the shutter in order to load the source material (gold, nickel, chrome, etc)
- There are 4 crucible positions. Rotate the crucible knob to change to a different crucible.

Load the crucible with source material. If required, use a fine razor blade and tweezers to place your own crucible inside. Be very careful as the crucible may break/crack.

- Check also that the sample can "see" the crucible when the shutter is opened.
- Close the shutter.

Check that the thickness monitor can "see" the crucible when the shutter is open and does not "see" the crucible when the shutter is closed.

If the thickness monitor head needs to be moved a lot, contact the Technician. The thickness monitor cooling lines (tubing) are thin and delicate, easy to break.

If you need to clean the chamber walls or door, use wipes and alcohol and plastic tools.

Check that the window is clean enough to see the crucible.
Do not use any metal object/tweezers on the glass window (will be scratched).
*** Contact the Technician if you wish to have a clean, clear window ***

Clean and vacuum the bottom side of the shutter as there is usually meal flakes here.
There is a vacuum cleaner hose available to vacuum bits of evaporated metal inside the chamber.

Measure the (x,y,z) co-ordinates for the crucible, the thickness monitor head and for the sample(s). This will help determine the "Tooling" Factor, see below.

**** Turn on the thickness monitor by plugging the two cords underneath the main readout chassis.
**** Press "Usage". The "Usage" number should be between 5 to 900. Otherwise the thickness monitor crystal will have to be changed.

*** Press "Test". All lights will come on to verify that they all work. A number between 5000000 and 5999900 will be displayed. If it is significantly different, there is a problem with the monitor. Press 'Test" again to get out of test mode.

***** Unplug the thickness monitor to turn it off before proceeding with pumpdown .

Check the O-ring on the evaporator door for hair or dust (especially at the bottom of the door where there is a joint in the o-ring). Use a wipe with a tiny bit of alcohol to clean the O-ring if necessary (use only a very small amount). Clean the sealing surface where the o-rings seals to the chamber. This will ensure that the evaporator is completely sealed.

Close door and latch.

Ensure display reads "Sealed" . If it does not contact Technician/Manager.

Press the "Process" button.

The chamber will begin to be roughed out ("Rough" on the display). Goes to 8 mbar in one minute, 0.6 mbar in 2 minutes, 1.5 E-2 in 4 minutes.

(If there is lots of water vapor in the samples or source material, you can press "Hold" button to keep pumping the chamber. Press "Hold" once again to proceed to next step.)

Eventually the display will read " Pumpdown" (the high vacuum gate valve opens and the cryopump takes over. Goes to 1E-3 mbar quickly.)

The display will next read "Fine pumping" and chamber pressure should slowly drop.
See pumpdown graph.

Before continuing with the rest of this procedure, wait for pressure to drop to 4 to 8 E-6 mbar. (This will take approx. 1 hour if there is no leak).

Wait Wait Wait Wait Wait Wait

When pressure is 4 to 8 E-6 mbar, proceed :

Turn on the thickness monitor by plugging the two cords underneath the main readout chassis.

Set up the thickness Monitor (see thickness Manual for details and principles of operation).
You will need to know the "density" and "acoustical constant (z-value)" for the materials you wish to evaporate. There is a table in the thickness monitor manual. Press 'Data' button to enter data.
(There is only one crystal ("Xtal 1") used to measure thickness.)

The "Tooling" factor is the renormalization constant which depends on how far and what angle the sample and thickness monitor head is relative to the source material. This factor can only be determined by experiment (use SEM to measure the deposited thickness on the sample and compare it to the thickness that the monitor reads). There is also an Excel spreadsheet that can calculate an approximate "Tooling" by entering the (x,y,z) values of the crucible, thickness monitor and sample.

****
E-Gun Operation

The front door on the evaporator should be closed and lock with key. This will make the Interlock light (located on the big power supply unit) turn on.

Turn on the big power supply unit by flipping the breaker upward (ON).

Check that the L1/L2/L3 lights on the big power supply are all on.

Check that the Circuit breaker red lights 1,2,3,4, on the big power supply are all off.

On the e-gun control box, the "Vacuum" light should be on (chamber vacuum is less than 1.0e-5 mbar).
On the e-gun control box, the "Water" light should be on.
On the e-gun control box, the "Rot drive" light should be on.
One the e-gun control box the "Local" light should be on.

Press the ON/OFF button on the e-gun control box. Fans in power supply will come on and Fan light (on the big power supply unit) will glow yellow.

Wait for the "Power" light on the e-gun control box to come on.

Check that the Current knob is turned all the way counterclockwise.

Press " Gun" and a relay will click in the power supply. and the "Gun" light will come on.

Current knob is *** extremely *** sensitive. Turn ** very ** slowly. One can burn a hole through the material holder if the e-beam is too strong.
(Typical setting is 5.47 kVolts, 2 mA Beam current gives a faint glow in the chamber)

If the e-gun current is turned up too quickly, there will be a very large rise in the chamber pressure, the gun will go off (trip) and the vacuum gate valve will close (no pumping).

Keep an eye on the chamber pressure as you turn the current knob. If the pressure goes higher than 6 E-5 MB (millibar), turn down the knob immediately and wait for pressure to recover.

Soak the source material and crucible at low current level until the vacuum recovers.

Melt the source material very slowly to prevent it from spitting/jumping out of the holder.

***** It is very unlikely you will need more than 200 mA for metals. Do not operate more than 30 minutes at currents above 250 mA ********

Cr 25-40 mA
Al (very tricky to evaporate) 60 mA
Au 100 mA
Ti 30-40 mA
Pd 16 mA

Open the shutter when ready to evaporate and at the same time press "Open" on the thickness monitor.

Close shutter when thickness is reached on the monitor readout.

Turn down the e-gun Current knob slowly to avoid huge thermal shock.

****

If you wish to evaporate another material without opening the vacuum chamber, follow the steps below:

Make sure current knob is turned all the way off (counter clockwise).

Switch off the Gun (press "Gun")

Rotate crucible to next source material if required.

Rotate the holder to the next sample if required.

Set thickness monitor parameters to the next material.

Turn on the Gun.

Proceed with soaking and melting as described above.

****

When there is no more evaporation to be done:

Turn down the current knob on the e-gun.

Turn off the e-gun by pressing the “Gun” button.

Turn off the power by pressing the “ON/OFF” button.

Turn off the big power supply unit by flipping the breaker down.

Turn off the thickness monitor by unplugging the two cords underneath the readout chassis.

Wait about 20 minutes or more for e-gun and chamber to cool off.
(the crucible will cool off quickly, the samples might be warm/hot, the shutter will remain quite hot/warm as it is closest to the crucible during evaporation).

When cool, press “Seal” to close the vacuum valve.

Open the nitrogen valve slowly (behind machine, near the floor)

Press “Vent” button and open the chamber door latch (to prevent overpressure inside chamber)

When the chamber is up to air, the door will swing freely open and the sound of gas will be heard.

Press the “Seal” button to stop the nitrogen gas.

Close nitrogen valve when up to atmosphere

Be careful not to inhale any fine particulates from the chamber or get any fine particulates under your gloves and on your skin.

Remove samples.
Remove crucible /source material (if required). Use a fine razor blade and tweezers to lift the crucible out. Be ** careful ** as the crucible may break/crack.

Keep your crucible in a clean place.

If required, clean the chamber with wipes and vacuum cleaner.

Close door and latch.

Check that the readout says “Sealed”. If it does not, contact Technician/ Manager.

Press “Process” button to pump out the chamber.

When chamber is less than 100 mbar, press “Seal” button.

Make sure all buttons are in the UP position on the “Rotary Workholder” panel.

Make sure all buttons are in the UP position on the “Source Shutter” panel.

Fill out the Log Sheet End Time, Description (type of metal evaporated, current used, evaporation time, thickness, etc)

Report any equipment problems or quirks to the Technician/ Lab Manager.

*** Do not press “Stop” or the “Reset” buttons as this will put the evaporator into shutdown (2 hours to warm up cryopump and another 1.5 hours to cool down)

****

Notes :

1. Evaporator is for approved metals only. Some metals are toxic. Some are reactive and will foul the cryopump resulting in expensive repair.

2. Typical pressure during evaporation is 1 to 3 x 10^{-5} mbar range.

3. Do not run electron gun if pressure is greater than 6 x 10^{-5} mbar (filament will burn out).

4. Very gradually/slowly increase electron current. The pressure will increase due to absorbed water vapor, adsorbed air being heated off all the surfaces inside the chamber.

5. Do not run more than 30 minutes at currents greater than 250 mA.

6. Each metal requires a special crucible material (graphite, carbon, refractory, intermetallic).

7. Crucibles are about 2 cc volume. Fill 0.6 to 0.8 only.

8. Typical deposition rate is 0.1 nm/sec

9. If sample is put closer to source, evaporation is faster but uniformity is worse for a large sample and sample will get hotter.

10. There is no sample cooling so doing a long, hot evaporation will make the sample get hot.

11. Evaporated films more than 1 micron take a long time, uses lots of source metal and will have adhesion, stress problems.

12. Cross contamination (from other metals) : inspect the lip near the crucible. If there is a build up, notify technician.

13. See www.lesker.com for tables on metals, evaporation rates, etc.