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| **SRFOPS Elnik Furnace Operator Procedure** | | | |
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| **Document Owner:** | Phillip Denney | **Department Owner:** | SRF Operations |

# Purpose and Scope

The purpose of this document is to instructor the operator in the use of the Elnik furnace controls and the associated human machine interface (HMI) controls. This document also itemizes the start-up and shut down of the furnace.

This procedure applies to Elnik furnace and associated operator workstation only.

This procedure does not apply to maintenance, repair, or LOTO. This procedure does not instruct on the preparation or load/unloading of product into the furnace.

# Definitions and Diagrams

The following terms have specific meanings within this procedure.

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| **Term** | **Definition** |
| NA | NA |
| NA | NA |

# Roles and Responsibilities

The following roles have responsibilities described in this document.

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| **Role** | **Responsibility** |
| Operator | Loading, programing, and general operation of the furnace. |
| SME | Subject Matter Expert (SME) may be multiple people with intimate knowledge of software, hardware, or furnace sub-systems. |
| Technical Support Group (TSG) | Non-routine repair and maintenance. Coordinates and approves upgrades including hardware and software. |

# Safety

Safety is covered by room PTW (permit to work), Elnik Furnace Manual, and other associated sub-system manuals. This document is to be used in accordance with JLab ESH manual and lab safety requirements.

# Procedure

## Furnace Controls Overview

The Elnik Furnace is a PLC controlled vacuum furnace integrated with a desktop computer that serves as a human machine interphase (HMI). The computer (HMI) workstation, co-located in the furnace room, is used for developing recipes, furnace control, monitoring, and data collection. In addition, the HMI is used to control the furnace in manual mode for maintenance and testing purposes.

Recipes are written and stored in a preformatted table called a “Profile”. The user has the ability to change parameters such as temperature set points, thermocouple control, ramp rates, and partial pressure infusion (doping). The recipe or “Profile” once written is upload via the computer to the furnace PLC to be executed for automatic furnace run.

Monitoring of the furnace run is also a function of the desktop computer/HMI. The HMI has fault screens, process trend charting, and machine status. The desktop computer is also used as a platform for the RGA software via LabVIEW.

The furnace itself has various other hardware controls and indicators such as emergency stop (EMO), door opening, temperature, and vacuum pump/gauge controls.

## Utilities

### Power

#### There is one source of power for the Elnik fed from Panel DP-LAB-2 CKT 6.

#### Furnace main power disconnect with attached Voltage Verification Unit (VVU). (Figure A)

#### The main breaker fed from DP-LAB-2 CKT 6. (Figure B)

#### Emergency OFF (EMO/ESTOP) (Figure C)

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**Fig. C**

**Fig. B**

**Fig. A**

### Process Cooling Water

#### Furnace cooling water has a supply and return valve. These valves are normally open.

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### Process Gasses

#### Plant nitrogen (GN2) and air (CDA). The compressed air is used to actuate the pneumatics of the machines (i.e. valves, door cylinders). The plant nitrogen is used for back-filling the chamber to atmosphere pressure once the process is complete and operator initiates process. These valves are normally open. Note: Close the valves above pressure regulators, therefore system pressure can be verified relieved via the regulator gauges.

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#### Infusion/Doping Nitrogen (Bottle) – Close bottle valve if working on the system. Note: Gas line needs to be purged of air prior to being put in service.

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### Cryo-Pump / Compressor

#### The furnace has a CTI cryo-pump and 9600 cryo-compressor which operation and control is managed via a “On Board” controller mounted on the front of the furnace. The pump is separated from the furnace chamber by the “high-Vac” gate valve.

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#### The cryo-pump system is a standalone system and only connected to the furnace controls via low voltage signal and dry contacts (i.e. non-powered relay)

#### The cryo-compressor is located in the EBW/furnace service room and is fed from AP-LAB-7. It also has process cooling water supply and return connection.

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## Start-up / Shutdown

### General Instructions:

#### For maintenance under LOTO of Elnik furnace, a task specific procedure and ePAS (PTW and/or IC) must be written and approved.

#### This procedure covers general (i.e. “cold”) start-up or shutdown. Independent system restart(s) may be conducted in accordance using this procedure.

#### Typically, external supplied utilities such as gases, cooling water, or power and not valved-off or disconnected for an operational (non-maintenance) shut down.

### Start-up

#### Procedure - Furnace

##### Verify all utilities valves are OPEN. See section 5.2.3

##### If knife the switch is off, switch to ON position according to ePAS (PTW) switching procedure and with proper PPE and training. See section 2.1Fig A

##### If mushroom EMO is pushed in, pull to ON position. See Section 5.2.1 Fig C

##### Push the green “Power ON” button. It should light green.

#### Procedure – Cryo-Pump/Compressor

##### Cryo-pump/compressor can be turned on before or after the operator computer – HMI

##### Cryo-pump is turned on via the cryo-compressor in the Furnace/EBW service room. Flip the white breaker switch ON (i.e. up position) on the back of the compressor.



##### Follow cryo-pump manual to perform a regeneration cycle.

#### Procedure – Computer

##### Turn ON desktop computer.

##### After boot-up click on the auto-launch ICON for Elnik HMI

### Shutdown

#### General Instructions

#### Shutdown of Elink may consist of a partial or full shutdown of all systems.

#### It is best to leave the chamber under vacuum so that cleanliness if the chamber and heating elements is preserved.

#### Procedure Computer

#### Use Elnik HMI controls to verify the furnace is not running and in manual mode on the “Status Display” screen. See section 5.5.2

#### Perform a vent of the chamber ONLY if you wish to expose the chamber to atmosphere while shutdown. See section 5.11

#### Verify or switch the high-vac valve to the closed position.

#### Verify Roughing pump is OFF

#### Use the RGA System Screen to put the RGA into Manual and turn off via the Elnik front Panel. See section 5.9.1and 5.4.8

#### Exit the program via the Main Menus Screen

#### Procedure Furnace

#### Press the EMO mushroom button

#### Switch furnace knife switch to off according to ePAS (PTW) switching procedure and with proper PPE and training. See section 5.2.1Fig A

#### Procedure Cryo-Pump/Compressor

#### Switch white breaker down (OFF) at the cryo compressor in the EBW/Furnace Service room

## Furnace Controls

### General Controls Layout and Function(s)

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### Hot Zone Indicators: Analog current meter for each of the three heating zones (elements) in the furnace hot zone.

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### Pirani/Convectron Gauge Controller: Monitors furnace vacuum.

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### Furnace Status Indicators: Indicator lights for general machine status, includes general internal temperature readout for visual reference prior to opening furnace door (interlocked). EMO (Emergency Stop) as indicated.

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### Door Lock Open/Close Button: Used to open door only after furnace is at atmospheric temperatures, pressures (interlocked), and cycle complete.

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### Cryo-Pump Controller: See cryo-pump onboard controller for detailed instructions.

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### RGA and Turbo Pump Controls: Vacuum gauges and turbo pump controller for in-process RGA sampling circuit.

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### Not Used: For maintenance purposes only.

## HMI / Operators Work Station

### The human machine interface (HMI) is the program residing on the desktop computer at the operator workstation. The HMI is the interface to the Elnik furnace and initiates, monitors, and records the furnace run. The HMI also has maintenance and set-up interfaces, and the ability to manually operate the furnace.

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### Main Menu Screen: Used to navigate to other screens and as a login to the system.

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### Status Display: Primary operator interface to monitor furnace status and operation conditions.

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### Profiler: Used to view, load, write and edit profiles.

#### File list Screen: This screen appears after clicking on the Profiler button from Main Menu or Status Display screens. It is used to select a run profile to edit or create. A “Confirm” button appears once the edit or create file is clicked.

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#### Profile Editor: This screen is used to edit an existing profile and load the file for a run.

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#### Profile Name: Editable Name that appears in the File list

#### Enable Step: Click on the stop symbol to add a segment. Also known as segments.

#### Segment Type: May be a Ramp or a Soak step.

#### Rate or Time: If a segment is selected as a Ramp then a time (min) is entered deg C/min. (i.e. 5°/min). If a Soak is selected then time (min) is entered.

#### Temperature Setpoint: Temperature at which the segments ramps to or soaks at.

#### Chamber Temperature Control: If “No” then chamber is solely controlled by furnace thermocouples. If “Yes”, then survey thermocouple(s) will control the furnace temp. If multiple survey thermocouples are selected then an average is taken for control.

#### TC Tolerance: A deviation can be set to the ramp or soak to move to the next step as opposed to getting to the exact temperature.

#### Heat On: Furnace heat zone is active and on.

#### Gas Injection: Enables gas injection.

#### Partial Pressure: Set the partial pressure limit for gas injection.

#### HiVac Cycle: This allows the heaters to cycle to maintain the high vacuum. The set point is entered in the Global Settings screen.

#### Hard Shut-Off: If vacuum gets to a high-high point and the vacuum is spoiled. The set point is entered in the Global Settings screen.

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## Trend Screen: Used to monitor process variables such as vacuum, temperature, set points, and N2. This is a user customizable data log and trending application.

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## Service/Maintenance Screen: Informational screen used to record usage hours on pumps and thermocouples for maintenance purposes.

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## Global Settings

### The “Global Settings” has several functions for furnace control.

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### Vacuum Settings:

#### Process Start/Restart Setpoint: Is the vacuum level at which the heaters are to be turned on.

#### Heat Soft Disable Setpoint: Is the vacuum level at which the heaters will shut off.

#### Heat Disable Setpoint: Is the vacuum level at which the process is halted due to severe vacuum loss.

### Overrides:

#### Process Gas: Rate of the mass flow controller will inject gas in CC/min

#### Partial Pressure: Is the maximum pressure the gas will inject before stopping. This overrides the profile setting.

### Mass Flow Controller Settings: These settings (P, I, D Gains) are used to tune the mass flow controller (MFC) for gas injection.

### Control: Used to control the MFC is automatic or manual mode. In manual mode, the flow rate can be adjusted.

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## RGA Screen

### The RGA (residual gas analyzer) control screen has the following four functions:

#### Monitor the status valves, pressures, and pumps via the PI&D graphic.

#### Open and Start the RGA software.

#### Turn on/off the RGA

#### Control the RGA valves and pumps in manual or automatic.

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### The RGA LabVIEW data log software is initiated via the RGA control screen.

##### Open the RGA software via the RGA Screen.

##### Upon starting a run. Press the white arrow (turns black) at the top left of the RGA LabVIEW and then press the yellow button. This will pull up a window to enter a file name.

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##### The RGA software records and graphs a variety of parameters including partial pressures of elements and molecules, temperature, pressures, and some valve positions vs time.

##### Note: Though the RGA software captures the same parameters as the Trend screen, it also provides the impurities and trace gases captures via the analyzer.

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## Perform a Furnace Run

### Load cavity into furnace and attach survey thermocouples.

### Open File list screen and select file to edit. Click “Confirm” button.

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### Either Edit profile in Profile Editor Screen or Click “Load File to Run” button.

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### Click on the “RGA System” button to open screen to toggle RGA to “ON” and “Auto”.

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### Click on “Start RGA Software” button to open Labview software from the System Status Screen. Follow direction in section 5.8 to starts RGA

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### Navigate to the Status Display screen and verify the following:

#### Current Program list the profile filename you selected.

#### System is in Automatic

#### RGA is ON

#### No Faults and cryo temperatures look good.

### Click the “Start Auto Run” Button

### At any time you can open the Trend Screen by clicking button from the status display screen.

### The furnace will pump down to vacuum with all profiles. Often users request a pump down prior to a heated profile run to check the chamber for contamination (via the RGA).

### At the end of the run and the furnace will cool back down, but will remain under vacuum.

## Venting and Opening the Furnace

### Note: The furnace door(s) is interlocked and cannot be opened if the inside temperature is above 75 deg C and/or under vacuum.

### Verify run is complete and furnace is cool.

### Turn OFF the Ion Gauge at IG1 switch.

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### Below 75 deg 75 C a “VENT” button will appear. Click to start process.

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### The status display will show venting graphic and at any time you can stop the process by clicking stop vent.

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### Upon venting, the chamber will unlock the door, but cannot be opened until the chamber pressure is above 770 torr and equalizes with atmosphere.

### Note: In addition to the lock release, the furnace chamber has a lift-plate pressure relief to prevent the over pressurization.

### After unloading chamber, the chamber door shall be closed. Common practice when furnace is not in use is to perform a pump down profile cycle to preserve the chamber quality from contamination.

### END

# References

|  |  |
| --- | --- |
| **Document No.** | **Title** |
| M-2012 | Elnik Model M2012 Operators Manual High Temp Horiz Vacuum Furnace Job:297, SN:366 |
| 8040444 | CTI Cryogenics 9600 Compressor Installation, Operation, and Maintenance Instructions |
| 8040410 | CTI Cryogenics On-Board Installation and Maintenance Instructions |
| Rev 1.9 (May 2009) | SRS (Stanford Research Systems) Operators Manual: Model RGA100, RGA200, and RGA300 Residual Gas Analyzer |

# Release and Revision History

|  |  |  |
| --- | --- | --- |
| **Rev #** | **Major Changes** | **Effective Date:** |
| 0 | Initial version | 21 FEB 2023 |
| 1 | Transferred to new template, Revised for software upgrade, added startup/shutdown instructions. | 24 OCT 2024 |
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# Approvals

|  |  |  |  |
| --- | --- | --- | --- |
| **Approved by:** | **Name:** | **Signature:** | **Date:** |
| Document Owner | Philip Denny |  | 25 OCT 2024 |
| Document Co-Owner | Roland Overton |  | 25 OCT 2024 |
| Reviewer SME Software | Tom Goodman |  | 25 OCT 2024 |
| Reviewer SME Hardware | Danny Forehand |  | 25 OCT 2024 |

For Project Procedures: Refer to the Project Execution Procedure SRF-11-PR-001