Installation, Operation and Maintenance Instructions
1100°C Rotary Reactor Tube Furnace - HTR Model: 75mm 2416 Controller

HTR 11/75 + 2416 Controller
This manual is for guidance on the use of the Carbolite Gero product specified on the front cover. This manual should be read thoroughly before unpacking and using the furnace or oven. The model details and serial number are shown on the back of this manual. Use the product for the purpose for which it is intended.

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11.1 Environment
1.0 Symbols and Warnings

1.1 Switches and Lights

Instrument switch: when the instrument switch is operated the temperature control circuit is energised.

Heat light: the adjacent light glows or flashes to indicate that power is being supplied to the elements.

1.2 General Warnings

DANGER – Electric shock. Read any warning printed next to this symbol.
WARNING: Risk of fatal injury.

DANGER – Hot surface. Read any warning printed next to this symbol.
WARNING: All surfaces of a product may be hot.

DANGER – Read any warning printed next to this symbol.

Caution – Double Pole/Neutral Fusing
2.0 Installation

2.1 Unpacking and Handling
When unpacking and handling the product, always lift it by its base. Do not use the door or any other projecting cover or component to support the equipment when moving it. Use two or more people to carry the product where possible.

Carefully remove any packing material from inside and around the product before use. Avoid damaging the surrounding insulation when removing packing materials.

NOTE: This product contains Refractory Ceramic Fibre (also known as Alumino Silicate Wool - ASW). For precautions and advice on handling this material see section 7.2.

2.2 Siting and Setting Up
Place the product on a level surface in a well ventilated area.
Site away from other sources of heat and on a non-flammable surface that is resistant to accidental spillage or hot materials.

The surface on which the equipment is mounted should be stable and not subject to movement or vibrations.

The height of the mounting surface is important to avoid operator strain when loading and unloading samples.

Unless otherwise stated elsewhere in this manual, ensure that there is at least 150 mm of free space around the back and sides of the product. Clear space is required above the product to dissipate heat.

Work tubes:

It is recommended that the work tube has either insulation plugs or radiation shields fitted to minimise heat loss from both ends of the work tube. If the work tube has open ends, a significant amount of energy could be radiated from the ends of the work tube. Adjacent surfaces should always be made from a non-flammable material.

Ensure that the ends of the work tube are positioned at least 500 mm away from any adjacent surface so that any energy radiated cannot heat an adjacent surface to a dangerous temperature.
Depending on the application of the product, it may be appropriate to position it under an extraction hood. Ensure the extraction hood is switched on during use.

Ensure that the product is placed in such a way that it can be quickly switched off or disconnected from the electrical supply.

Under no circumstances should any objects be placed on top of the product. Always ensure that any vents on the top of the product are clear of any obstruction. Always ensure all cooling vents and cooling fans (if fitted) are clear of any obstruction.

2.3 Electrical Connections

Connection by a qualified electrician is recommended.

This product requires a single-phase A.C. supply with earth (ground), which may be Live to Neutral non-reversible (polarised), Live to Neutral reversible (non-polarised), or Live to Live.

Check the product rating label before connection. The supply voltage should agree with the voltage on the label and the supply capacity should be sufficient for the current on the label.
2.0 Installation

The supply should be fused at the next size equal to, or higher than the current on the label. A table of the most common fuse ratings is also given towards the back of this manual. When the mains cable is factory fitted, internal fuses are also fitted. It is essential that the operator ensures that the product is correctly fused.

Products with a factory fitted supply cable are designed to be wired directly to an isolator or fitted with a line plug.

Products without a factory fitted supply cable require a permanent connection to a fused and isolated supply. The product's electrical access panel should be temporarily removed, and connections made to the internal terminals.

If the product is to be connected by line plug. The plug should be within reach of the operator and should be easy to remove.

When connecting the product to an isolating switch ensure that both conductors (single phase) or on all live conductors (three phase), and should be within reach of the operator.

The supply MUST incorporate an earth (ground).

**Electrical Connection Details:**

<table>
<thead>
<tr>
<th>Supply</th>
<th>Terminal Label</th>
<th>Cable Colour</th>
<th>Supply Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-phase</td>
<td>L</td>
<td>Brown</td>
<td>Live - Neutral to live</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Blue</td>
<td>Reversible or Live-Live to either power conductor (For USA 200-240V, connect L1)</td>
</tr>
<tr>
<td></td>
<td>PE</td>
<td>Green/ Yellow</td>
<td>to earth (ground) to earth (ground)</td>
</tr>
</tbody>
</table>

2.4 Gas Supply

The product is supplied with a Nitrogen inlet and flow meter as standard. The gas supply must be provided with an on/ off valve and pressure regulator to a maximum of 4 psi. Connect the gas supply to the inlet on the left-hand side. The exhaust box on the right-hand side may be connected to an outlet pipe provided this does not restrict the gas flow. The exhaust incorporates a safety pressure relief valve set to relieve pressure above 1 psi in case the exhaust becomes blocked.

Do not use toxic gases without taking appropriate precautions. The product is not suitable for use with combustible gases.
2.5 Installing a Vessel

Silica vessel: see section 5.4. Handle the vessel with care.
The drive coupling assembly is fitted to the vessel as indicated in fig. 1, using the special spanner provided. Slide the components into place, support part 2 firmly with the hand and tighten part 1 with the spanner. Do not over tighten. The end of the vessel with this assembly fitted becomes the left-hand end.

Lightly lubricate the drive coupling assembly and the product drive wheels, using 300 °C grease. Place the vessel onto the product by pushing it into the exhaust box on the right-hand side and lowering it onto the right-hand support wheels and the left-hand drive wheels.

Connect the left-hand end coupling according to fig. 2, using hand pressure only.
3.0 2416 Controller

3.1 Description

This manual applies to the 2416, 2416CG and 2416P8 controllers. Special customer requirements may result in changes to the available parameters and the navigation diagram. It is not possible to list all the possibilities in this manual.

2416CG Controller

The Eurotherm model 2416CG is a digital instrument with PID control algorithms which may be used as a simple controller or an 8-segment programmer. The 2416P8 is an eight-program model in which the programs can be stored independently or can be linked by a “call” parameter to form a single long program.

The 2416 Controller features:

- Easy use as a simple temperature controller, where on setting the required temperature the controller immediately attempts to reach and maintain it. Fig.1 indicates the type of temperature response when used in this way.
- By using one program segment, the control can be extended to include ramp-to-set-point. Fig.2 shows the effect.
- Alternatively, the 2416 Controller may be used as an 8-segment programmer, with each segment being a "Ramp", a "Step", a "Dwell", or "End". The program can be set to cycle if required. See fig. 3.
- Optional “modules” are available, in particular:
  - RS232 and RS432/485 digital communications modules;
  - Analogue communication modules;
  - “PDSIO” modules for communication with other controllers of similar or higher specification, for example, to allow cascade control;
  - Alarm modules, which can be used to drive visible or audible alarms, or to provide volt-free contacts for customer use.
Fig 1 - Simple Control

Fig 2 - Control with Ramp-to-Setpoint
Seg 1 = Ramp
Sep 2 = End (Dwell)

Fig 3 - A Program

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Temperature</td>
</tr>
<tr>
<td>T2</td>
<td>Time</td>
</tr>
<tr>
<td>SP</td>
<td>Setpoint</td>
</tr>
<tr>
<td>AT</td>
<td>Actual Temperature</td>
</tr>
<tr>
<td>WSP</td>
<td>Working Setpoint</td>
</tr>
<tr>
<td>R</td>
<td>Ramp</td>
</tr>
<tr>
<td>D</td>
<td>Dwell</td>
</tr>
<tr>
<td>S</td>
<td>Step</td>
</tr>
<tr>
<td>E</td>
<td>End</td>
</tr>
</tbody>
</table>
3.2 Operation

Most Carbolite Gero products are fitted with an instrument switch which cuts off power to the controller and other parts of the control circuit. See section 1.0 for operating instructions.

To operate the 2416 Controller there must be power to the furnace or oven and the instrument switch must be on. If a time switch is included in the furnace or oven circuit, this must be in an ON position.

2416CG - Operation

When switched on, the controller lights up, goes through a short test routine and then displays the measured temperature and setpoint. Depending on its state when it was last switched off, it may start to control to the current setpoint of program. The output light glows or flashes to indicate that the control is occurring.

The buttons and indicators are used for the following purposes:

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Output Light</td>
</tr>
<tr>
<td>B</td>
<td>Not Used</td>
</tr>
<tr>
<td>C</td>
<td>Page</td>
</tr>
<tr>
<td>D</td>
<td>Scroll</td>
</tr>
<tr>
<td>E</td>
<td>Down</td>
</tr>
<tr>
<td>F</td>
<td>Up</td>
</tr>
<tr>
<td>G</td>
<td>Run/Hold</td>
</tr>
<tr>
<td>H</td>
<td>Setpoint Temperature (SP)</td>
</tr>
<tr>
<td>I</td>
<td>Measured Temperature</td>
</tr>
</tbody>
</table>
### The unit is always in 'Auto' mode

<table>
<thead>
<tr>
<th>Auto/Manual</th>
<th>Disabled.</th>
<th>The unit is always in 'Auto' mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN/HOLD</td>
<td></td>
<td>Used to start, stop or pause a program. Short presses cause it to alternate between 'Run' and 'Hold', but if it is held for 2 seconds the programmer goes into 'Reset' mode where it behaves as a simple controller.</td>
</tr>
<tr>
<td>Up + Down</td>
<td>▲ + ▼</td>
<td>To adjust the value of a parameter. Used to change the setpoint when the unit is being used as a simple controller ('Reset' mode). Holding down gives an accelerated parameter change.</td>
</tr>
<tr>
<td>Page</td>
<td></td>
<td>Allows access to the parameters within the controller; most lists and parameters are hidden from the operator as they contain factory-set values which should not be altered. A single press of the page key shows the temperature units, normally °C; further presses reveal the lists indicated in the Navigation Diagram.</td>
</tr>
<tr>
<td>Scroll</td>
<td></td>
<td>Allows access to the parameters within a list. A single press displays the temperature units; further presses reveal the parameters in the current list. Some parameters are display-only, others may be altered by the operator.</td>
</tr>
<tr>
<td>Page + Scroll</td>
<td>▲ + ▼</td>
<td>Press together to cause an immediate return to the 'Home List'</td>
</tr>
</tbody>
</table>

### Operation as a Simple Controller

Press RUN/HOLD for 2 seconds to go into 'Reset' mode. Use down ▼ or up ▲ from the 'Home List' (i.e. when the temperature is displayed) to adjust the setpoint. The unit starts to control in the way indicated in Fig. 1.

Note that to use the Ramp Rate feature, as in Fig. 2, it is necessary to create a program. See the following sections.
### 3.3 Programming

Note that a currently active segment cannot be altered - put the programmer into 'Hold' or 'Reset' whenever it is necessary to do so to alter a parameter. Go into 'Reset' mode (i.e. press RUN/HOLD for 2 seconds) before starting to create or modify a program.

Press page \( \text{Page} \) until 'ProG LiSt' is displayed.

Press scroll \( \text{Scroll} \) to reveal the 'Holdback' and 'Loop Count' parameters. See sections 3.3.3 and 3.3.4 for a description of these.

Press scroll \( \text{Scroll} \) to display 'SEG.n' (segment number); use down \( \text{Down} \) or up \( \text{Up} \) to move to the segment to be adjusted or created.

Press scroll \( \text{Scroll} \) to see the 'tYPE' (segment type); use down \( \text{Down} \) or up \( \text{Up} \) to change the required segment type – see the table below.

Press scroll \( \text{Scroll} \) to access the parameters appropriate to the type of segment chosen – see the following table – and use down \( \text{Down} \) or up \( \text{Up} \) to alter the values.

The final segment should be of type 'End', unless all program segments are used. Segments after 'End' are ignored.

<table>
<thead>
<tr>
<th>Segment Type</th>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>RmP.r</td>
<td>TGT</td>
<td>The target setpoint for this segment</td>
</tr>
<tr>
<td></td>
<td>RATE</td>
<td>The ramp rate (rate of temperature change) in °/ minute</td>
</tr>
<tr>
<td>RmP.t</td>
<td>TGT</td>
<td>The target setpoint for this segment</td>
</tr>
<tr>
<td></td>
<td>dur</td>
<td>The duration of the segment. The controller calculates the rate of temperature rise necessary to achieve this duration.</td>
</tr>
<tr>
<td>Dwel</td>
<td>dur</td>
<td>The time in minutes to remain at the previous target temperature. 10ths of a minutes are allowed.</td>
</tr>
<tr>
<td>SteP</td>
<td>tGt</td>
<td>A new target temperature to be achieved as quickly as possible.</td>
</tr>
<tr>
<td>CaLL</td>
<td>PrG.n</td>
<td>Only applicable to 2416P8. Calls another stored program given by 'PrG.n' as a subroutine, running it the number of times given by 'cyc.n'.</td>
</tr>
<tr>
<td></td>
<td>cyc.n</td>
<td></td>
</tr>
<tr>
<td>End</td>
<td>End.t</td>
<td>'Dwel!' holds the temperature at the last target value. 'RSET' returns to simple controller operation; if the setpoint is set to zero then this effectively turns the heating off. 'SoP' sets the power to 0% – use of this is not recommended.</td>
</tr>
</tbody>
</table>

#### 3.3.1 Programming Tips

Make sure the basic setpoint is set to zero to avoid unexpected heating at the end of a program.
If all segments are used so that there is no 'End' segment, then on completion the program automatically goes into 'Dwell'.
Dwell segments of length zero can be included. This is a way of allowing space for future program changes.
For an example of program creation, see section 3.3.6.

3.3.2 Multi-program model (2416P8)
The 'Program Edit' list contains the extra parameter 'PrG.n' and the 'Run' list contains the extra parameter 'PrG'. These features allow selection of the program to be edited or to be operated.
The extra segment type 'cALL' allows one program to call another as a subroutine; use this feature to create one or more long programs.

3.3.3 Holdback
"Holdback' can be used to prevent the program from operating ahead of the actual heating or cooling.
In the program list, scroll to the 'Holdback' parameter and use down ▼ or up ▲ to set the holdback type as follows:

<table>
<thead>
<tr>
<th>Band</th>
<th>Holdback applies to both heating and cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lo</td>
<td>Holdback applies to heating only</td>
</tr>
<tr>
<td>Hi</td>
<td>Holdback applies to cooling only</td>
</tr>
<tr>
<td>Off</td>
<td>Holdback is off</td>
</tr>
</tbody>
</table>

Set 'Hb.V' to the value in °C beyond which holdback is to operate. Type 'BAand' and a value of 10 °C is often a suitable combination, if holdback is required. In this case, if the actual temperature deviates outside ±10 °C from the working setpoint, the holdback lamp of the front of the controller flashes and the program is held up until the temperature comes within range again.
The standard setting for holdback is OFF.

3.3.4 Program Cycling
The 'Loop Count' parameter 'CYC.n' can be set to control the number of times the program is run.
If 'CYC.n' = 1, the program stops at the end segment.
If 'CYC.n' = 5 (for example), the program runs 5 times: at the 'End' segment it returns to segment 1, until the 5th time through when it stops.
If 'CYC.n' = cont, the program never ends: it cycles continuously.

3.3.5 Running a Program
Press Run/ Hold to light up the 'Run' light. The program starts to operate.
To view the progress of a program from the 'Home' list, press scroll ▼ to reveal the current segment ('SEG') and the total program time remaining in hours ('PrG.t').
For a more detailed view, press page \( \text{\textbullet} \) to access the 'Run' list page and scroll \( \text{\textbullet} \) to see its contents as shown in the Navigation Diagram below. Provided the unit is first put into 'Hold' mode, temporary changes may be made to parameters; these apply only until the program ends or is reset.

To pause a program, press Run/ Hold; the 'Hold' light comes on. To terminate a program, press Run/ Hold for 2 seconds; the 'Run' and 'Hold' lights go out.

While the program is operating, the working setpoint is shown in the lower display.

3.3.6 Program example

The following sequence of entries creates and runs the program.

1. Press page \( \text{\textbullet} \) key until 'ProG LiSt' is displayed.
2. Press scroll \( \text{\textbullet} \) until 'CYC.n' is displayed and use the arrow key to select 1.
3. Press scroll \( \text{\textbullet} \) until 'SEG.n' is displayed and use the arrow key to select 1.
4. Press scroll \( \text{\textbullet} \) until 'tYPE' is displayed and use the arrow key to select rmP.r.
5. Press scroll \( \text{\textbullet} \) until 'tGt' is displayed and use the arrow key to select 600.
6. Press scroll \( \text{\textbullet} \) until 'rAtE' is displayed and use the arrow key to select 5.0.
7. Press scroll \( \text{\textbullet} \) until 'SEG.n' is displayed and use the arrow key to select 2.
8. Press scroll \( \text{\textbullet} \) until 'tYPE' is displayed and use the arrow key to select dwEl.
9. Press scroll \( \text{\textbullet} \) until 'dur' is displayed and use the arrow key to select 60.0.
10. Press scroll \( \text{\textbullet} \) until 'SEG.n' is displayed and use the arrow key to select 3.
11. Press scroll \( \text{\textbullet} \) until 'tYPE' is displayed and use the arrow key to select rmP.t.
12. Press scroll \( \text{\textbullet} \) until 'tGt' is displayed and use the arrow key to select 400.
13. Press scroll \( \text{\textbullet} \) until 'dur' is displayed and use the arrow key to select 60.0.
14. Press scroll \( \text{\textbullet} \) until 'SEG.n' is displayed and use the arrow key to select 4.
15. Press scroll \( \text{\textbullet} \) until 'tYPE' is displayed and use the arrow key to select 'dwEll'.
16. Press scroll \( \text{\textbullet} \) until 'dur' is displayed and use the arrow key to select 30.
17. Press scroll \( \text{\textbullet} \) until 'SEG.n' is displayed and use the arrow key to select 5.
18. Press scroll \( \text{\textbullet} \) until 'tYPE' is displayed and use the arrow key to select rmP.r.
19. Press scroll \( \text{\textbullet} \) until 'tGt' is displayed and use the arrow key to select 30.
20. Press scroll \( \text{\textbullet} \) until 'rAtE' is displayed and use the arrow key to select 5.0.
21. Press scroll \( \text{\textbullet} \) until 'SEG.n' is displayed and use the arrow key to select 6.
22. Press scroll \( \text{\textbullet} \) until 'tYPE' is displayed and use the arrow key to select 'End'.
23. Press scroll \( \text{\textbullet} \) until 'End.t' is displayed and use the arrow key to select 'dwEll'.
24. Press the page \( \text{\textbullet} \) key until you return to the main display.
25. Press the 'Run' key. The program operates.
3.4 Controller Options

As options can be ordered in a variety of combinations and for a variety of purposes, exact instructions are not given here. The full Eurotherm manual may be required to determine customer parameter settings. To reveal or hide parameters in the controllers it is necessary to go into configuration mode, a security code is needed. Please consult Carbolite Gero.

3.4.1 Digital Communications - RS232

If the RS232 option is supplied, the furnace is fitted with one sub-miniature D-socket connected to the controller comms module. RS232 is suitable for direct connection to a personal computer (PC) using a “straight through” cable as follows (the linked pins at the computer end are recommended but may not be necessary). The cable is usually 9-pin at the furnace end and 9-pin at the computer, but other alternatives are shown in parentheses.

<table>
<thead>
<tr>
<th>Product end of cable female (25-pin) 9-pin</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx</td>
<td>(2) 3</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>Tx</td>
<td>(3) 2</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com</td>
<td>(7) 5</td>
<td>5 (7) Com</td>
</tr>
</tbody>
</table>

3.4.2 Digital Communications - RS485

If an RS485 option is supplied, the furnace is fitted with two D-sockets. Connection between products is by “straight” cable as follows:

<table>
<thead>
<tr>
<th>Product end of cable female (25-pin) 9-pin</th>
<th>RS485 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) female</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>(2) 3</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>+</td>
<td>(3) 2</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com</td>
<td>(7) 5</td>
<td>5 (7) Com</td>
</tr>
</tbody>
</table>

3.4.3 Comms Address

Typically the comms address is set to 1, but this can be changed. In the case of RS485 and multiple instruments it is necessary to set different addresses. To change the address value, access the level 2 list. In level 2 press the page key until the COMMS parameter is displayed. Press up ▲ down ▼ to select the address value.

3.4.4 Alarm Option

When an alarm board is fitted, which consists of a relay with voltage free contacts, for operator use, the contacts are taken to a panel plug on the control panel, wired as
indicated:

![Diagram](image)

The purpose of the 2 amp fuse is to break the circuit to prevent overloading on the circuit due to high voltage.

The instrument configuration and parameters available to the operator depend on the customer requirements.

### 3.5 Temperature Controller Replacement

Before handling the controller: wear an anti-static wrist strap or otherwise avoid any possibility of damage to the unit by static electricity. Refer to the detailed instructions supplied with the replacement controller.

Ease apart the two lugs at the side; grip the instrument and withdraw it from its sleeve; push in the replacement.
3.6 Navigation Diagram
4.0 2132 Over-Temperature Controller Description (if fitted)

4.1 Description

This over-temperature controller is fitted and supplied ready to use by Carbolite Gero. It is a digital instrument with a latching alarm, requiring no additional panel controls. The controller features easy setting of over-temperature setpoint and reading of current temperature by the over-temperature sensor.

4.2 Operation

4.2.1 Controls

Most Carbolite Gero products are fitted with an instrument switch which cuts off power to the controller and other parts of the control circuit.

To operate the controller, power must be supplied to the product and the instrument switch must be on. If a time switch is included in the product circuit, this must be in the 'ON' position.

When an over-temperature condition occurs, the controller cuts the power to a contactor, which in turn cuts power to the heating elements. Power is not restored until the controller is 'reset'.

Some components will operate after the over-temperature feature isolates the power supply e.g. cooling fans will continue to operate, provided that there is a power supply to the product. In some cases the product may not do so, if other options (such as a door switch) are fitted.
4.2.2 Operation

When switched on, the controller lights up, goes through a short test routine and then displays the measured temperature or the over-temperature setpoint.

The page key allows access to parameter lists within the controller.

A single press of the page key displays the temperature units, normally set to °C; further presses reveal the lists indicated in the navigation diagram. See section 4.4.

The scroll key allows access to the parameters within a list. Some parameters are display-only; others may be altered by the operator.

A single press of the scroll key in the 'Home' list displays the temperature units; further presses reveal the parameters in the current list indicated in the navigation diagram.

To return to the 'Home' list at any time, press page and scroll together, or wait for 45 seconds.

The down and up keys are used to alter the setpoint or other parameter values.

4.2.3 Over-Temperature Operation

Use down and up to alter the over-temperature setpoint. This should normally be set a little above the working temperature (for example 15 °C above). The product is supplied with the over-temperature set at 15 °C above the furnace or oven maximum working temperature.

Press scroll twice view the present temperature as measured by the over-temperature controller. Press it twice, the first press shows the temperature units (°C).

4.2.4 Over-Temperature Alarm

If an over-temperature condition occurs, the OP2 indicator flashes and an alarm message 2FSH also flashes, alternating with the setpoint. Power to the heating elements is disconnected.

4.2.5 Resetting the Over-Temperature Alarm

To acknowledge the alarm press scroll and page together.

If the alarm is acknowledged while there is still an over-temperature condition, the OP2 indicator stops flashing but continues to glow. The 2FSH alarm continues to flash until the over-temperature condition is cleared (by the temperature falling), when normal operation resumes.

If the alarm is acknowledged when the temperature has dropped (or after the over-temperature setpoint has been raised) so that the over-temperature condition no longer exists, then the furnace or oven immediately resumes normal operation.

4.2.6 Sensor Break

The over-temperature cut-out system also operates if the over-temperature control thermocouple breaks or becomes disconnected. The message S.br flashes where the measured temperature is normally displayed.
4.3 Audible Alarm

If an audible alarm is supplied for use with the over-temperature controller, it is normally configured to sound on over-temperature condition and to stop sounding when the alarm is acknowledged as given in section 4.2.

Note: the alarm may sound during controller start-up.

4.4 Navigation Diagram

<table>
<thead>
<tr>
<th>HL</th>
<th>Home List</th>
<th>Page Key</th>
<th>Black = Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTSP</td>
<td>Over-Temperature</td>
<td>Scroll Key</td>
<td>Dashed = Through to other options</td>
</tr>
<tr>
<td></td>
<td>Setpoint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AL</td>
<td>Access List</td>
<td>!</td>
<td></td>
</tr>
</tbody>
</table>
|     |                     | For factory access to list and parameters not available to the operator.
5.0 Operating Cycle

This product is fitted with an instrument switch which cuts off power to the control circuit.
Connect the product to the electrical supply.
Operate the instrument switch to activate the temperature controller. The controller becomes illuminated and goes through a short test cycle. Depending on the lid, the motor setting and the over-temperature controller (if fitted), the vessel may start to rotate.

Over-Temperature option only. If the digital over-temperature option has not yet been set as required, set and activate it according to the over-temperature controller instructions.

As the product heats up, the heat light glows steadily at first and then flashes as the product approaches the desired temperature. For more information on temperature control see the controller instructions.

Over-Temperature option only. If the over-temperature circuit has tripped, an indicator on the over-temperature controller flashes and the heating elements are isolated. Find and correct the cause before resetting the over-temperature controller according to the instructions supplied.

To turn the product off, set the instrument switch to its off position. The controller display will go blank. If the product is to be left unattended, isolate it from the electrical supply.

5.1 Vessel and Gas Supply

Only fill the vessel to a level below the central tube extensions, so that powder cannot work along the tube during operation.

Do not exceed the following maximum weights of load (applicable to silica glass vessels):

The vessel oscillation is controlled by a unit on the front panel, which has an on/off switch and a rotary dial. The dial sets speeds between 1 and 8 cycles per minute. The vessel rotates in alternate directions through an angle of 315°.

Set the flow meter to the desired rate of gas flow.
The maximum weight of load for the model HTR 11/75 is 120 gm.
The maximum weight of load for the model HTR 11/150 is 950 gm.

5.2 General Operator Safety

Heating element life is shortened by overheating. Do not leave the product at high temperature when it is not required. The maximum temperature is shown on the product rating label and in section 11.0 towards the back of this manual.
5.0 Operating Cycle

Ensure that the vessel is rotating whenever the product is at a high temperature, to prevent sagging.

Do not operate the product with toxic gases unless suitable exhaust disposal precautions are in force.

5.3 Operator Safety

The ceramic materials used in the product manufacture become electrically conductive to some extent at high temperatures. DO NOT use any conductive tools within the product without isolating it. If a metal work tube is used, it must be earthed (grounded).

The elements are isolated when the lid is open or the instrument switch is switched off. For full safety, disconnect the product from the electrical supply.

Avoid burns. Carbolite Gero can supply tongs, face masks and heat resistant gloves. Before you remove a hot object from the product, make sure you have a safe place to put it down.

Take care: the vessel may be hot but look cold.

CAUTION: The product is designed for operators who understand their process. DO NOT use the equipment with dangerous gases or materials without proper safety precautions. This is the customer’s responsibility: Carbolite Gero can only advise on precautions for specific processes if asked.

5.4 Care of the Vessel (Silica)

The fused silica (“quartz”) vessel is fragile and expensive: at all times take care in handling it. Always make sure that there is somewhere safe to put it down before moving it.

Fused silica has a high resistance to thermal shock. Nevertheless, avoid sudden temperature changes. For example: do not allow cold water to splash onto a hot vessel.

5.5 Devitrification and Chemical Attack (Silica)

Fused silica is liable to devitrify at high temperature. This is a recrystallisation process which is greatly affected by surface conditions and therefore by contaminants in the furnace atmosphere. At 1000 °C only a highly contaminated atmosphere has a noticeable effect, but at 1100 °C the rate of devitrification may become significant.

A devitrified vessel eventually fails. Failure is likely to be by cracking after cooling below 300 °C.

Impurities such as alkali or alkaline earth ions, which occur in dust and perspiration, should be avoided. It is advisable to handle the vessel with clean gloves or a dry cloth and to touch the central (hot) part as little as possible.

The silica vessel should be cleaned with pure alcohol and wiped dry with a clean cloth.
The specific substances used by the customer’s process may, of course, be prime causes of devitrification, as they may attack the vessel inner surface chemically and by abrasion. Carbolite Gero can advise, or seek external advice, on specific materials, if requested.

The following lists some elements and compounds known to cause devitrification. The list is not exhaustive.

<table>
<thead>
<tr>
<th>Severe Below 1000 °C</th>
<th>Na Fe Co Sn LiCl SnCl₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe Above 1000 °C</td>
<td>Mg Ba Mn Cu Sb MgO BaCO₂ NaCl KCl CsCl BaCl₂</td>
</tr>
<tr>
<td>Less Severe</td>
<td>Al As Sn(OH)₂ Ba(OH)₂ CaCO₃ CaCl₂</td>
</tr>
<tr>
<td>Not known to cause devitrification up to 1100 °C</td>
<td>Ca B Ti Zr V Nb Ta Cr Mo W Ni Ag Zn Cd Hg C Si Pb S Se Ir H₂O CaO Al₂O SiO₂ P₂O₅ MoO₃ WO₃ ThO₂ RbCl NaBr KBr NaI KI MgCl₂ AlCl₃</td>
</tr>
</tbody>
</table>

Some substances chemically attack silica. In particular, hydrofluoric acid attacks it at all temperatures and phosphoric acid above 150 °C. Concentrated alkaline solutions may attack at high temperatures, while carbon and some metals may cause reduction.
## 6.0 Maintenance

### 6.1 General Maintenance
Preventive rather than reactive maintenance is recommended. The type and frequency depends on the product use; the following are recommended.

### 6.2 Maintenance Schedule

<table>
<thead>
<tr>
<th>Maintenance Procedure</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bi-Annually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annually</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit (if fitted)</td>
<td>Set an over-temperature setpoint lower than the displayed temperature and check for an over-temperature alarm as detailed in the relevant controller manual</td>
<td></td>
</tr>
<tr>
<td>Over-Temperature Safety Circuit (if fitted)</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td>Safety Switch Function</td>
<td>Set a safe temperature above ambient, and open the lid to see if the heater light goes out and the vessel stops rotating</td>
<td></td>
</tr>
<tr>
<td>Safety Switch Function (split models only)</td>
<td>Electrical measurement</td>
<td></td>
</tr>
<tr>
<td>Electrical Safety (external)</td>
<td>Visual check of external cables and plugs</td>
<td></td>
</tr>
<tr>
<td>Electrical Safety (internal)</td>
<td>Physically check all connections and cleaning of the power plate area</td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Calibration</td>
<td>Tested using certified equipment, frequency dependent on the standard required</td>
<td></td>
</tr>
<tr>
<td>Operational Check</td>
<td>Check that all functions are working normally</td>
<td></td>
</tr>
<tr>
<td>Operational Check</td>
<td>Thorough inspection and report incorporating a test of all functions</td>
<td></td>
</tr>
<tr>
<td>Drive Mechanism</td>
<td>Lightly grease the drive mechanism with the grease provided. Check all parts are in alignment.</td>
<td></td>
</tr>
</tbody>
</table>
### 6.0 Maintenance

<table>
<thead>
<tr>
<th>Seals (if fitted)</th>
<th>Check all seals and O-rings and clamps</th>
</tr>
</thead>
</table>

**Performance**

<table>
<thead>
<tr>
<th>Element Circuit</th>
<th>Electrical measurement</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Power Consumption</th>
<th>Measure the current drawn on each phase / circuit</th>
</tr>
</thead>
</table>
6.0 Maintenance

6.2.1 Cleaning
Soot deposits may form inside the furnace, depending on the process. At appropriate intervals remove these by heating as indicated in the General Operation Notes.

The product's outer surface may be cleaned with a damp cloth. Do not allow water to enter the interior of the case or chamber. Do not clean with organic solvents.

6.3 Calibration
After prolonged use, the controller and/or thermocouple may require recalibration. This is important for processes that require accurate temperature readings or for those that use the product close to its maximum temperature. A quick check using an independent thermocouple and temperature indicator should be made from time to time to determine whether full calibration is required. Carbolite Gero can supply these items.

Depending on the controller fitted, the controller instructions may contain calibration instructions.

6.4 After-Sales Service
Carbolite Gero Service has a team of Service Engineers who can offer repair, calibration and preventive maintenance of furnace and oven products both at the Carbolite Gero factory and at customers’ premises throughout the world. A telephone call or email often enables a fault to be diagnosed and the necessary parts to be despatched.

In all correspondence please quote the serial number and model type given on the rating label of the product. The serial number and model type are also given on the back of this manual when supplied with the product.

Carbolite Gero Service and Carbolite Gero contact information can be found on the back page of this manual.

6.5 Recommended Spare Parts and Spare Parts Kit
Carbolite Gero can supply individual spare parts or a kit of the items most likely to be required. Ordering a kit in advance can save time in the event of a breakdown.

Each kit consists of one thermocouple, one sheath, one solid state relay and set of elements.

When ordering spare parts please quote the model details as requested above.

6.6 Power Adjustment
The control system incorporates electronic power limiting, but for the model listed in this manual the power limit is set to 100%. The power limit parameter OP.Hi may be accessible to the operator, but should not generally be altered.
In some cases the supply voltage may be outside the range 220-240 V or the 3-phase equivalent, the power limit parameter may be set to a value other than 100%. Do not increase the value to 100%, see section 10.0 for details of power limit settings.
7.0 Repairs and Replacements

7.1 Safety Warning - Disconnection from Power Supply

Immediately switch the product off in the event of unforeseen circumstances (e.g. large amount of smoke). Allow the product to return to room temperature before inspection.

Always ensure that the product is disconnected from the electrical supply before repair work is carried out.

Caution: Double pole/neutral fusing may be used in this product.

7.2 Safety Warning - Refractory Fibre Insulation

Insulation made from High Temperature Insulation Wool
Refractory Ceramic Fibre, better known as (Alumina silicate wool - ASW).

This product contains alumino silicate wool products in its thermal insulation. These materials may be in the form of blanket or felt, formed board or shapes, slab or loose fill wool.

Typical use does not result in any significant level of airborne dust from these materials, but much higher levels may be encountered during maintenance or repair.

Whilst there is no evidence of any long term health hazards, it is strongly recommended that safety precautions are taken whenever the materials are handled.

Exposure to fibre dust may cause respiratory disease.

When handling the material, always use approved respiratory protection equipment (RPE-eg. FFP3), eye protection, gloves and long sleeved clothing.

Avoid breaking up waste material. Dispose of waste in sealed containers.

After handling, rinse exposed skin with water before washing gently with soap (not detergent). Wash work clothing separately.

Before commencing any major repairs it is recommended to make reference to the European Association representing the High Temperature Insulation Wool industry (www.ecfia.eu).

Further information can be provided on request. Alternatively, Carbolite Gero Service can quote for any repairs to be carried out either on site or at the Carbolite Gero factory.

7.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
### 7.4 Solid-State Relay Replacement

Disconnect the product from the power supply and remove the appropriate cover as given above.

Make a note of the wire connections to the solid state relay and disconnect them. Remove the solid state relay from the base panel or aluminium plate. Replace and reconnect the solid state relay ensuring that the bottom of it has good thermal contact with the base panel or aluminium plate. Replace the access panel.

### 7.5 Thermocouple Replacement

Disconnect the product from the power supply. Remove terminal cover to gain access to the thermocouple connections. Make a note of the thermocouple connections.

Thermocouple cable colour codings are:

<table>
<thead>
<tr>
<th>Thermocouple leg</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>positive (type K)</td>
<td>green</td>
</tr>
<tr>
<td>negative</td>
<td>white</td>
</tr>
</tbody>
</table>

Disconnect the thermocouple from its terminal block and withdraw the thermocouple from its sheath by bending the metal tag or releasing the screw to release. It is also advisable to remove the sheath and shake out any broken pieces of thermocouple. Re-assemble with a new thermocouple, observing the colour coding, ensuring that the thermocouple is not twisted as it is being inserted and that the metal tag is bent back to grip the sheath. Refit the element access panel.
7.6 Element Replacement

See section 7.2 - wearing a face mask is required.

The element is supplied complete with the surrounding stainless steel half-cylindrical inner chamber.

Disconnect the furnace from the electrical supply and remove the back panel. Work with the furnace lid open, with no vessel in place.

Make a careful note of the colours and positions of all the electrical connections to the inner cylindrical chamber and thermocouple.

Disconnect the thermocouple and element connections from their terminal blocks.

Remove the thermocouple. It may also be necessary to remove the thermocouple sheath: loosen the retaining screw and withdraw the sheath.

Supporting the weight of the inner chamber, loosen 4 screws holding brackets to the top plate; loosen and remove 4 screws holding the chamber to the brackets.

Lift out the inner chamber.

Fit the new chamber by reversing the process. Take care to make all connections to the correct terminals. Do not over tighten the connectors in porcelain terminal blocks.

Let the furnace heat up at its maximum rate to 900 °C without interruption and then dwell for 1 hour. Fumes may be emitted: this should be done in conditions of good ventilation.

Check that the furnace is controlling properly to rule out the possibility that the element failed because of a fault in the control system.

If you have any problems with this procedure, please contact the Carbolite Gero service division.
### 8.0 Fault Analysis

#### A. Furnace Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The HEAT light is ON</td>
<td>The heating element has failed</td>
</tr>
<tr>
<td>2.</td>
<td>The HEAT light is OFF</td>
<td>The controller shows a very high temperature or code such as S.br</td>
</tr>
<tr>
<td></td>
<td>The controller shows a low temperature</td>
<td>The door switch(es) (if fitted) may be faulty or need adjustment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The contactor/relay (if fitted) may be faulty</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The heater switch (if fitted) may be faulty or need adjustment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The SSR could be failing to switch on due to internal failure, faulty logic wiring from the controller, or faulty controller</td>
</tr>
<tr>
<td></td>
<td>There are no lights glowing on the controller</td>
<td>Check the supply fuses and any fuses in the furnace control compartment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty or not receiving a supply due to a faulty switch or a wiring fault.</td>
</tr>
</tbody>
</table>
### 8.0 Fault Analysis

#### B. Product Overheats

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Product only heats up when the instrument switch is ON</td>
<td>The controller shows a very high temperature</td>
<td>The controller is faulty</td>
</tr>
<tr>
<td></td>
<td>The controller shows a low temperature</td>
<td>The thermocouple may be faulty or may have been removed out of the heating chamber</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The thermocouple may be connected the wrong way around</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The controller may be faulty</td>
</tr>
<tr>
<td><strong>2.</strong> Product heats up when the instrument switch is OFF</td>
<td>The SSR has failed &quot;ON&quot;</td>
<td>Check for an accidental wiring fault that could have overloaded the SSR</td>
</tr>
</tbody>
</table>
9.0  Wiring Diagrams

9.1  104-4-1036

110 V - 120 V Models
9.0  Wiring Diagrams

9.2  104-4-1036

208 V-240 V Models
10.0  Fuses and Power Settings

10.1  Fuses

F1 - F3: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th>F</th>
<th>Internal Supply Fuses</th>
<th>Fitted if supply cable fitted. Fitted on board to some types of EMC filter.</th>
<th>GEC Safeclip of the type shown (glass type F up to 16 A) 38 mm x 10 mm type F fitted on EMC filter circuit board(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2</td>
<td>Auxiliary Circuit Fuses</td>
<td>May be omitted up to 25 Amp/phase supply rating.</td>
<td>2 Amps glass type F On board: 20 mm x 5 mm Other: 32 mm x 6 mm</td>
</tr>
<tr>
<td>F3</td>
<td>Heat Light Fuses</td>
<td>May be omitted up to 25 Amp/phase supply rating.</td>
<td>2 Amps glass type F 32 mm x 6 mm</td>
</tr>
</tbody>
</table>

Customer Fuses: Required if no supply cable fitted. Recommended if cable fitted. See rating label for current; See table below for fuse rating.

Access to internal fuses is by the removal of the back panel of the product base or control box.

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTR 11/75</td>
<td>1-phase</td>
<td>208-240</td>
<td>10 A</td>
</tr>
</tbody>
</table>

10.2  Power Settings

The power limit settings (parameter OP.Hi) for this model are voltage dependant. The figures represent the maximum percentage of time that controlled power is supplied to the elements. Do not attempt to "improve performance" by setting a value higher than the recommended values. To adjust the parameter refer to the "Changing the Maximum Output Power" of the control section of the manual.

<table>
<thead>
<tr>
<th>Volts</th>
<th>200 V</th>
<th>208 V</th>
<th>220 V</th>
<th>230 V</th>
<th>240 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (%)</td>
<td>100</td>
<td>100</td>
<td>89</td>
<td>82</td>
<td>75</td>
</tr>
</tbody>
</table>

Please refer to the rating label for product specific information.
11.0 Specifications

Carbolite Gero reserves the right to change the specification without notice.

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>Vessel Capacity (gm)</th>
<th>Net Weight (approx) (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High temperature Rotary Reactor heated by resistance wire embedded in ceramic fibre</td>
<td>1100</td>
<td>1.5</td>
<td>120</td>
<td>53</td>
</tr>
</tbody>
</table>

11.1 Environment

The models listed in this manual contains electrical parts and should be stored and used in indoor conditions as follows:

Temperature: 5 °C - 40 °C

Relative humidity: Maximum 80 % up to 31 °C decreasing linearly to 50 % at 40 °C
Service Record

<table>
<thead>
<tr>
<th>Engineer Name</th>
<th>Date</th>
<th>Record of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The products covered in this manual are only a small part of the wide range of ovens, chamber furnaces and tube furnaces manufactured by Carbolite Gero for laboratory and industrial use. For further details of our standard or custom built products please contact us at the address below, or ask your nearest stockist.

For preventive maintenance, repair and calibration of all furnace and oven products, please contact:

**Carbolite Gero Service**
Telephone: + 44 (0) 1433 624242
Fax: +44 (0) 1433 624243
Email: ServiceUK@carbolite-gero.com

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**Carbolite Gero Ltd,**
Parsons Lane, Hope, Hope Valley, S33 6RB, England.
Telephone: + 44 (0) 1433 620011
Fax: + 44 (0) 1433 621198
Email: Info@carbolite-gero.com
www.carbolite-gero.com

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