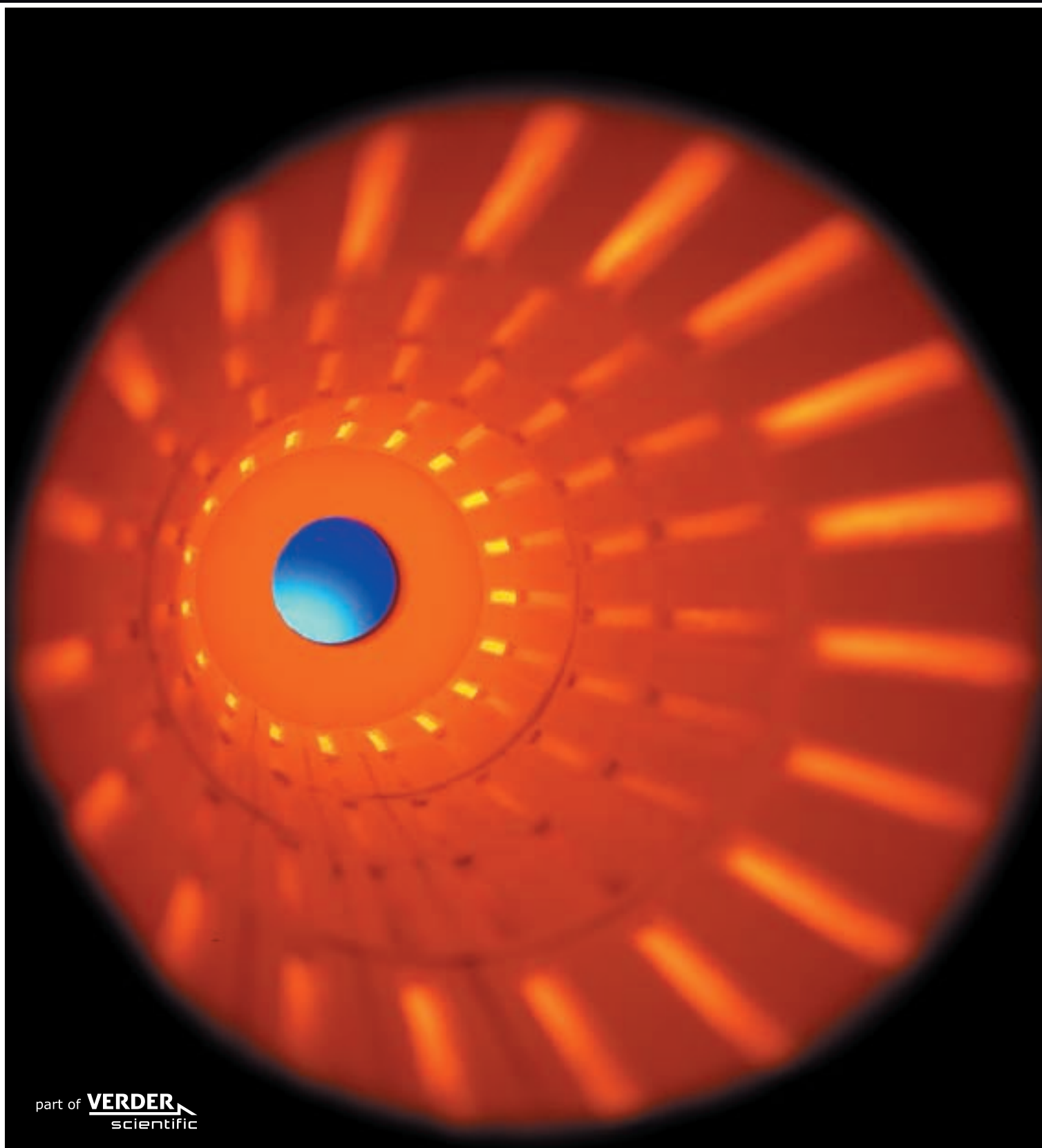


# Laboratory Chamber & Tube Furnaces



# The Technology of Heat



Innovative from the start in Sheffield in 1938 Carbolite took its name from the silicon carbide elements at the heart of its new high temperature combustion furnaces. In the intervening years Carbolite has become the UK's largest manufacturer of laboratory and industrial furnaces and ovens, exporting a wide range of standard and bespoke designs to over 100 countries world-wide.

From its location in the heart of the Peak District National Park, Carbolite has established a reputation for engineering expertise derived from literally hundreds of man-years of practical experience in thermal engineering technology. Expertise that is clearly demonstrated in the quality of design and manufacture of our standard products and that is absolutely vital when interpreting customer's applications into bespoke temperature control solutions. It is this depth of experience in design and manufacture, combined with a wealth of understanding in materials performance and control systems at high temperature, which distinguishes Carbolite from the competition.

Continual product development and strong, interactive relationships with suppliers lets us incorporate the very latest technologies into our products, keeping Carbolite at the forefront in furnace design. One of the most recent developments is the CMAT (Microwave Assist Technology) Furnace, which combines radiant heating furnace technology with the direct heating effect of microwave energy.

Chamber furnaces, with volumes ranging from 3 litres to 10,000 litres, together with single and multi-zone tube furnaces with horizontal, vertical and split tube configurations are supplied equipped with everything from simple set-point controllers, to sophisticated multiple zone, cascade and programmable, temperature control systems.

# CARBOLITE®

Leading Heat Technology



In addition to versatile general laboratory products Carbolite also manufacture a range of application specific furnaces for such uses as Clean Room installations, Strip and Rotary Hearth and Rotary Tube furnaces. As well as for standard compliant testing such as Ashing, Coal & Coke standard analysis techniques, Iron Ore Reduction, Precious Metals Assay, Asphalt Binder Analysis, Tensile Testing and much more.

Carbolite's flexibility and capability to solve customer's individual application requirements have given its products an important place in chemical, materials science, engineering and industrial research, testing and development laboratories, as well as for pilot and production scale manufacturing within aerospace, automotive, surface treatment, tooling, ceramics, glass, pharmaceutical, chemicals, plastics, engineering, electronics, mining & extraction, iron & steel, as well as coal & coke industries around the World.

Carbolite not only regularly supplies products with standards compliant furnace designs, such as for NADCAP (AMS2750D) heat treatment processes, but can also supply fully traceable certification for control, measurement, recording and data acquisition devices, issued by an independent UKAS / NAMAS accredited laboratory.

All of the products featured in this catalogue and more, are available through an extensive worldwide network of dealers and local offices. Carbolite's factory trained field engineers provide a complete range of after sales support and technical advice and guidance on product selection is available from a team of qualified engineers based at Hope or via our website [www.carbolite.com](http://www.carbolite.com)



Page

|           |                                                                                        |
|-----------|----------------------------------------------------------------------------------------|
| <b>3</b>  | <b>Bespoke Furnaces</b>                                                                |
| <b>4</b>  | <b>Chamber Furnace Selection</b>                                                       |
| 5         | ELF 1100° Chamber Furnaces                                                             |
| 6         | CWF 1100°C, 1200°C & 1300°C General Purpose Chamber Furnaces                           |
| 7         | RWF 1100°C & 1200°C Rapid Heating Chamber Furnaces                                     |
| 8         | GPC 1200°C & 1300°C Larger Capacity Laboratory Chamber Furnaces                        |
| 9         | VCF 1200°C Top Loading Chamber Furnaces                                                |
| 10        | HRF 750°C Air Recirculating Chamber Furnaces                                           |
| 11        | LTH 1100°C & 1200°C Top Hat Chamber Furnaces                                           |
| 12/13     | RHF 1400°C, 1500°C & 1600°C Silicon Carbide Heated Furnaces                            |
| 14        | MRF 16/22 CMAT 1600°C Microwave Assist Furnace                                         |
| 15        | CMAT – Carbolite Microwave Assist Technology                                           |
| 16        | HTF 1700°C & 1800°C High Temperature Chamber Furnaces                                  |
| 17        | BLF 1700°C & 1800°C Bottom Loading Furnaces                                            |
| <b>18</b> | <b>Ashing &amp; Burn-off Furnaces</b>                                                  |
| 19        | AAF 1100°C Ashing & Burn-off Furnaces                                                  |
| 20        | ABF 8/28 800°C Afterburner Ashing Furnace                                              |
| 21        | GSM 1100°C Ashing & Burn-off Furnace                                                   |
| 22        | AAF 12/18 1200°C Ashing-Plus Furnace                                                   |
| 23        | BWF 1100°CV & 1200°C Ashing & Burn-off Furnaces                                        |
| <b>24</b> | <b>Tube Furnace Selection</b>                                                          |
| 25        | MTF 900°C, 1000°C, 1200°C Wire Wound Single Zone Tube Furnaces                         |
| 26        | CTF 1200°C Wire Wound Single Zone Tube Furnaces                                        |
| 27        | GHA 1200°C Single Zone Horizontal Tube Furnaces                                        |
| 28        | GVA 1200°C Single Zone Versatile Configuration Tube Furnaces                           |
| 29        | GHC 1200°C Wire Embedded Single Zone Tube Furnaces                                     |
| 30        | GVC 1200°C Wire Embedded Versatile Configuration Three Zone Tube Furnaces              |
| 31        | HST 1200°C Horizontal Single Zone Split Tube Furnaces                                  |
| 32        | VST 1200°C Versatile Single Zone Split Tube Furnaces                                   |
| 33        | TZF 1200°C Wire Wound Horizontal Three Zone Tube Furnaces                              |
| 34        | HZS & TVS 1200°C Wire Embedded Versatile Configuration Three Zone Split Tube Furnaces  |
| 35/36     | STF 1500°C & 1600°C High Temperature Single Zone Tube Furnaces                         |
| 37        | VST 1700°C High Temperature Single Zone Split Tube Furnace                             |
| 38        | CTF 1700°C & 1800°C High Temperature Horizontal Tube Furnaces                          |
| 39        | PVT 1800°C High Temperature Vertical Tube Furnaces                                     |
| 40        | TZF 1500°C 1600°C, 1700°C & 1800°C High Temperature Three Zone Horizontal Tube Furnace |
| 41        | HVT 1200°C & 1500°C High Vacuum Tube Furnaces                                          |
| 42        | HTR 1100°C Rotary Reactor Furnaces                                                     |
| 43        | SPTF Rotating Tube Furnace                                                             |
| <b>44</b> | <b>Application Specific Furnaces</b>                                                   |
| 45        | CDF & CDR Dental Zirconia Sintering Furnaces                                           |
| 46        | MTT Tritium & Carbon-14 Capture Furnace                                                |
| 47        | PTC 12/20 1200°C Portable Thermocouple Calibration Furnace                             |
| 48        | AGD 12/4 1200°C Acid Gas Determinator Furnace                                          |
| 49        | CF 1200°C Cupellation Furnaces for the Assay of Precious Metals                        |
|           | <b>Options</b>                                                                         |
| 50        | Temperature Control Options                                                            |
| 51/53     | Temperature Control Options, Controllers, Programmers & Data Recording / Acquisitions  |
| 54/55     | Tube Furnace Options & Accessories for Air, Modified Atmosphere & Vacuum               |
| 56/57     | Tube Furnace Options, Work Tubes, Temperature & Chemical Compatibility                 |
| 58        | Tube Furnace Options, Work Tubes Accessories                                           |
| 59        | Tube Furnace Options, Furnace Configuration & Stands                                   |
| 60        | Furnace Options, Working With Modified Atmosphere                                      |
| 61        | Furnace Options, Servicing, Maintenance & Parts                                        |





LARGE CAPACITY ROTARY TUBE FURNACE



BINDER BURN-OFF FURNACE WITH CATALYTIC AFTER-BURNER



DUAL BOGIE RAISED HEARTH FURNACE FOR RAPID BATCH CHANGES

**Construction of standard laboratory furnaces is only part of the picture for Carbolite.**

We are regularly asked to design furnaces either to meet the specific requirements of customer's applications, or to enable the use of standard test methods such as those for iron ore reduction or coal and coke testing.

When customers must perform operations within a standards compliant regime such as AMS 2750D or NADCAP for heat treatment applications, then Carbolite has the experience and skills to modify standard designs or engineer bespoke solutions in order to achieve the appropriate levels of compliance.

Perhaps most frequent of all is the situation where customers see a standard model but simply require it a little larger or smaller or to reach a higher temperature. So if you cannot see precisely what you need in our standard range simply get in touch



LARGE CAPACITY 1200°C FURNACE WITH MODIFIED ATMOSPHERE RETORT



MUTIPLE TUBE FURNACE THERMAL TEST RIG



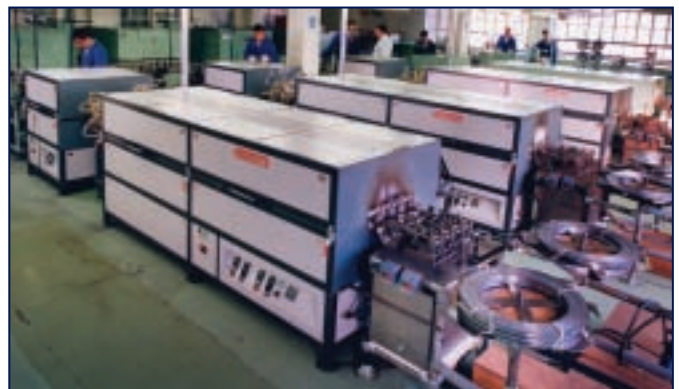
COMBINED IRON ORE REDUCIBILITY LOW TEMPERATURE DISINTEGRATION TEST FURNACE



1200°C THERMAL CYCLING FURNACE FOR THERMOCOUPLE TESTING



TOP-LOADING 1400°C CRUCIBLE FURNACE



A 4 LANE STRIP FURNACE TO OPERATE AT 1100°C

## Selection of a Furnace

### Factors for Chamber Furnace

- ✦ Chamber furnaces enable larger or more awkwardly shaped loads to be heated.
- ✦ The size of the chamber and how it is to be loaded and unloaded determine which style of furnace is best for a given application.
- ✦ For applications involving chemical vapours, gases or humidity always check with Carbolite or your local dealer which furnaces and elements will be best for your application.

### Temperature

- ✦ At Carbolite all products that heat above 600°C using radiant (rather than convection) heating are classified as furnaces.
- ✦ Carbolite chamber furnaces are available with maximum operating temperatures from 750°C to 1,800°C.
- ✦ The chart indicates the models with their maximum operating temperatures and heating method.
- ✦ Continuous operation of a furnace at its maximum temperature will reduce its working life. Continuous operating temperature should be approximately 100°C below maximum.
- ✦ Furnaces are designed and calibrated to operate at high temperatures. Continuous operation below furnace temperatures (of approximately 600°C) will be less accurate and may reduce element life in high temperature furnaces.
- ✦ Each furnace has a uniform working volume; this is a three dimensional region that is controlled within the specified tolerances for temperature uniformity. Select a chamber where this uniform volume is large enough to accommodate the item/s to be heated.

### Chamber Design

- ✦ The simplest and least expensive options are front opening designs with side hinged doors.
- ✦ Front opening 'up and away' vertical lifting doors keep the heated door surface away from the operator offering increased operator comfort and safety.
- ✦ Where tall objects and crucibles need lifting in and out of the chamber, vertical loading chambers with heating elements in the side are available.
- ✦ Bottom loading or 'raised hearth' furnaces offer the ability to rapidly heat items by lifting them up into the chamber or lowering the hearth to cool them.
- ✦ For heavier loads, moving the furnace chamber using a top hat design is a more practical solution.

### Modified Atmosphere

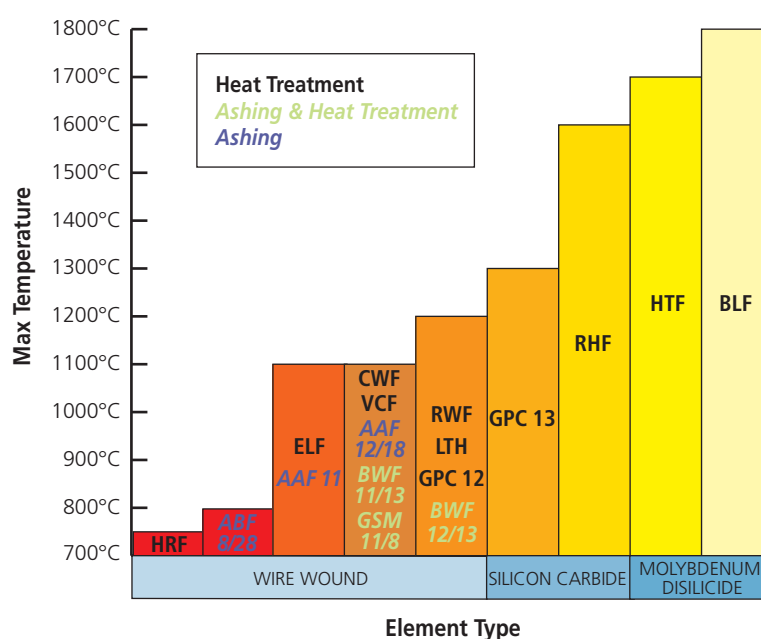
- ✦ To work with inert gases or a modified atmosphere specify one of the following modifications at the time of ordering
  - ✦ A gasket sealed or sand sealed retort in a front opening chamber furnace
  - ✦ An inverted crucible on a modified hearth in a bottom loading or top hat furnace.

### Temperature Control

- ✦ Carbolite furnaces are supplied as standard with accurate PID (proportional, integral and derivative) single 'ramp to set-point' controllers providing accurate control and negligible overshoot of the set temperature.
- ✦ Multisegment and or multi-programme controllers are available as an alternative option for most models.
- ✦ Wherever a furnace will be left operating unattended, or where the user wishes to protect a valuable workload or the furnace elements from damage from accidental overheating, then an over-temperature protection device is strongly recommended.

### Application Specific & Bespoke Designs

- ✦ Carbolite both designs and builds all of the furnaces within the catalogue range, therefore many 'off the shelf' modifications are available as well as fully bespoke customised furnaces for specific customer applications.
- ✦ Carbolite can provide a variety of mechanisms for loading and unloading items from the furnace or for the automation of temperature cycling or quenching.



## ELF Chamber Furnaces

### Standard features

- ✓ 1100°C maximum operating temperature
- ✓ 6, 14 or 23 litre chamber volumes
- ✓ Tilt forward, drop down door with air gap to minimise external temperature
- ✓ Carbolite 301 controller, with single ramp to set-point facility
- ✓ Delayed start & process timer function as standard
- ✓ Vacuum formed, low thermal mass insulation
- ✓ Hard ceramic hearth fitted as standard
- ✓ Ventilated via top mounted ceramic chimney

### Options

*specify these at time of order*

- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)



ELF 11/6

An economical furnace designed for light duty and general laboratory work. Low thermal mass insulation and multiple semi-embedded, free radiating wire wound elements in the chamber sides provide efficient heating.

Ventilation is via a top-mounted ceramic chimney, but if toxic or corrosive fumes are likely, use of one of our dedicated ashing furnaces or a retort should be considered.

| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions              |                         | Temperature uniformity of $\pm 5^{\circ}\text{C}$ within H x W x D (mm) | Volume (litres) | Max power (W)     | Thermo-couple type | Weight (kg) | Power supply      |
|-----------|---------------|---------------------|-------------------------|-------------------------|-------------------------------------------------------------------------|-----------------|-------------------|--------------------|-------------|-------------------|
|           |               |                     | Internal H x W x D (mm) | External H x W x D (mm) |                                                                         |                 | Holding power (W) |                    |             |                   |
| ELF 11/6  | 1100          | 35                  | 165 x 180 x 210         | 580 x 410 x 420         | 115 x 130 x 130                                                         | 6               | 2000<br>900       | K                  | 24          | 230V single phase |
| ELF 11/14 | 1100          | 40                  | 210 x 220 x 310         | 630 x 450 x 520         | 130 x 140 x 220                                                         | 14              | 2600<br>1300      | K                  | 31          | single or 3 phase |
| ELF 11/23 | 1100          | 29                  | 235 x 255 x 400         | 715 x 505 x 690         | 665 x 455 x 610                                                         | 23              | 5000<br>1500      | K                  | 52          | single or 3 phase |



Continuous operating temperature is 100°C below maximum temperature.

Heat up rate is measured to 100°C below max, using an empty chamber.

Holding power is measured at continuous operating temperature.

External dimensions with door closed and include chimney.



## CWF General Purpose Chamber Furnaces

### Standard features

- ✓ 1100°C, 1200°C or 1300°C maximum operating temperature
- ✓ 5, 13 or 23 litre chamber volumes
- ✓ Up & away door keeps heated surface away from the user
- ✓ Carbolite 301 controller with single ramp to set-point facility
- ✓ Delayed start & process timer function
- ✓ Hard wearing alumina element carriers, furnace entrance & hearth
- ✓ Energy efficient low thermal mass insulation
- ✓ Free radiating wire wound elements pitched for optimum uniformity
- ✓ Easy access to elements & controls simplifies maintenance & servicing



CWF 12/13/301

### Options

*specify these at time of order*

- ★ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ★ 2 phase supply
- ★ 8 or 20 segment programmer
- ★ RS232 communications
- ★ A variety of retorts & modifications are available for working with modified atmospheres

A modern design is combined with traditional know-how & technology, to provide a robust and reliable furnace. Easy to access replaceable heating modules makes maintenance simple.

| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                          | Temperature uniformity of $\pm 5^{\circ}\text{C}$ within H x W x D (mm) | Volume (litres) | Max power (W)<br>Holding power (W) | Thermo-couple type | Weight (kg) | Power supply           |
|-----------|---------------|---------------------|-------------------------|------------------------------------------|-------------------------------------------------------------------------|-----------------|------------------------------------|--------------------|-------------|------------------------|
|           |               |                     | Internal H x W x D (mm) | External H x W x D (mm)<br>H (door open) |                                                                         |                 |                                    |                    |             |                        |
| CWF 11/5  | 1100          | *34                 | 135 x 140 x 250         | 585 x 375 x 485 (800)                    | 85 x 90 x 110                                                           | 5               | 2400<br>790                        | K                  | 30          | 230V single phase      |
| CWF 11/13 | 1100          | *74                 | 200 x 200 x 325         | 655 x 435 x 610 (905)                    | 120 x 120 x 185                                                         | 13              | 3100<br>1500                       | K                  | 47          | 230V single or 2 phase |
| CWF 11/23 | 1100          | *36                 | 235 x 245 x 400         | 705 x 505 x 675 (990)                    | 155 x 165 x 285                                                         | 23              | 7000<br>1900                       | K                  | 68          | Universal              |
| CWF 12/5  | 1200          | *40                 | 135 x 140 x 250         | 585 x 375 x 485 (800)                    | 85 x 90 x 125                                                           | 5               | 2400<br>850                        | R                  | 30          | 230V single phase      |
| CWF 12/13 | 1200          | *70                 | 200 x 200 x 325         | 655 x 435 x 610 (905)                    | 120 x 120 x 200                                                         | 13              | 3100<br>1550                       | R                  | 47          | 230V single or 2 phase |
| CWF 12/23 | 1200          | *36                 | 235 x 245 x 400         | 705 x 505 x 675 (990)                    | 155 x 165 x 325                                                         | 23              | 7000<br>2250                       | R                  | 68          | Universal              |
| CWF 13/5  | 1300          | *50                 | 135 x 140 x 250         | 585 x 375 x 485 (800)                    | 85 x 90 x 150                                                           | 5               | 2400<br>1000                       | R                  | 30          | 230V single phase      |
| CWF 13/13 | 1300          | *75                 | 200 x 200 x 325         | 655 x 435 x 610 (905)                    | 120 x 120 x 225                                                         | 13              | 3100<br>1800                       | R                  | 47          | 230V single or 2 phase |
| CWF 13/23 | 1300          | **37                | 235 x 245 x 400         | 705 x 505 x 675 (990)                    | 155 x 165 x 340                                                         | 23              | 7000<br>2500                       | R                  | 68          | Universal              |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating temperature is 100°C below maximum temperature.

Heat up rates are measured on \*240v or \*\*400v supply to 100°C below maximum temperature.

Holding power is measured at the continuous operating temperature.



## RWF Rapid Heating Chamber Furnaces

### Standard features

- ✓ 1100°C or 1200°C maximum operating temperature
- ✓ 5, 13 or 23 litre chamber volumes
- ✓ Ambient to 1100°C in as little as 10 minutes
- ✓ Rapid thermal response from free radiating coiled wire elements
- ✓ Low thermal mass insulation for fast response & energy efficiency
- ✓ Up & away door keeps heated surface away from the user
- ✓ Carbolite 301 controller with single ramp to set-point & process timer
- ✓ Hard wearing, dust free hearth
- ✓ Easy access to elements & controls simplifies maintenance & servicing



RWF 12/5/301

Free radiating wire-wound elements and highly efficient low thermal mass insulation are combined to provide a furnace for light to medium laboratory applications where rapid thermal response is important.

### Options

*specify these at time of order*

- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ 2 phase supply at no extra cost above 13 litres
- ✦ 8 or 20 segment programmer
- ✦ RS232 communications
- ✦ A variety of retorts & modifications is available for working with modified atmospheres

| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                          | Volume (litres) | Max power (W)     | Thermo-couple type | Weight (kg) | Power supply           |
|-----------|---------------|---------------------|-------------------------|------------------------------------------|-----------------|-------------------|--------------------|-------------|------------------------|
|           |               |                     | Internal H x W x D (mm) | External H x W x D (mm)<br>H (door open) |                 | Holding power (W) |                    |             |                        |
| RWF 11/5  | 1100          | 10                  | 130 x 160 x 250         | 585 x 375 x 485 (800)                    | 5               | 2750<br>680       | K                  | 28          | 230V single phase      |
| RWF 11/13 | 1100          | 11                  | 195 x 210 x 325         | 655 x 435 x 610 (905)                    | 13              | 5000<br>1200      | K                  | 45          | 230V single or 2 phase |
| RWF 11/23 | 1100          | 13                  | 220 x 260 x 400         | 705 x 505 x 675 (990)                    | 23              | 9100<br>1800      | K                  | 65          | Universal              |
| RWF 12/5  | 1200          | 12                  | 130 x 160 x 250         | 585 x 375 x 485 (800)                    | 5               | 2750<br>820       | R                  | 28          | 230V single phase      |
| RWF 12/13 | 1200          | 13                  | 195 x 210 x 325         | 655 x 435 x 610 (905)                    | 13              | 5000<br>1450      | R                  | 45          | 230V single or 2 phase |
| RWF 12/23 | 1200          | 15                  | 220 x 260 x 400         | 705 x 505 x 675 (990)                    | 23              | 9100<br>2100      | R                  | 65          | Universal              |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating temperature is 100°C below maximum temperature.  
Heat up rate is measured to 100°C below max, using an empty chamber.  
Holding power is measure at continuous operating temperature.

## GPC Larger Capacity Laboratory Chamber Furnaces

### Standard features

- ✓ 1200°C or 1300°C maximum operating temperature
- ✓ 36, 65, 131 or 200 litre chamber volumes
- ✓ Free radiating coiled wire elements
- ✓ Low thermal mass insulation for fast response & energy efficiency
- ✓ Up & away door, keeps heated surface away from the user
- ✓ Carbolite 301 controller, with single ramp to set-point & process timer
- ✓ Hard wearing refractory hearth plate, resists damage & supports heavier loads
- ✓ Heating elements are easily serviced from the front of the chamber



GPC 12/36/3216P1

### Options

*specify these at time of order*

- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ 8 or 20 segment programmer
- ✦ RS232 communications
- ✦ A range of inconel (NiCr) retorts to work with modified atmospheres up to 1100°C

Designed for general workshop and laboratory use, the GPC range has the styling and features of the laboratory furnace range with the advantages of a larger chamber size and higher loading capacity.

| Model      | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                            | Volume (litres) | Max power (W) | Thermo-couple type | Weight (kg) | Power supply |
|------------|---------------|---------------------|-------------------------|--------------------------------------------|-----------------|---------------|--------------------|-------------|--------------|
|            |               |                     | Internal H x W x D (mm) | External H x W x D (mm)<br>H (door open)   |                 |               |                    |             |              |
| GPC 12/36  | 1200          | 37                  | 250 x 320 x 450         | 810 x 690 x 780 (1105)                     | 36              | 9000          | R                  | 100         | Universal    |
| GPC 12/65  | 1200          | 40                  | 278 x 388 x 595         | 885 x 780 x 945 (1245)                     | 65              | 14000         | R                  | 165         | 3 phase      |
| GPC 12/131 | 1200          | 150                 | 350 x 500 x 750         | 1652 x 1110 x 1280 (2310)<br>Floorstanding | 131             | 18000         | R                  | 400         | 3 phase      |
| GPC 12/200 | 1200          | –                   | 400 x 600 x 900         | 1702 x 1350 x 1350 (2410)<br>Floorstanding | 200             | 24000         | R                  | 518         | 3 phase      |
| GPC 13/36  | 1300          | 47                  | 250 x 320 x 450         | 810 x 690 x 780 (1105)                     | 36              | 9000          | R                  | 120         | Universal    |
| GPC 13/65  | 1300          | 45                  | 278 x 388 x 595         | 885 x 780 x 945 (1245)                     | 65              | 14000         | R                  | 165         | 3 phase      |
| GPC 13/131 | 1300          | –                   | 350 x 500 x 750         | 1652 x 1110 x 1280 (2310)<br>Floorstanding | 131             | 18000         | R                  | 400         | 3 phase      |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating temperature is 100°C below maximum temperature.

Heat up rate is measured to 100°C below max, using an empty chamber.

Holding power is measured at continuous operating temperature.

## VCF Top Loading Laboratory Chamber Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ 5, 10, 23 or 100 litre chamber volumes
- ✓ Free radiating wire elements in all 4 sides of chamber
- ✓ Vented top opening door
- ✓ Angled control panel, protected but clearly visible
- ✓ Carbolite 301 controller, with single ramp to set-point & process timer
- ✓ Thermocouple protected by ceramic sheath
- ✓ Top accessible elements for easy servicing

### Options

*specify these at time of order*

- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ 8 or 20 segment programmer
- ✦ RS232 communications



VCF 12/5/3508/P10

A floor standing furnace design which is particularly suitable for applications involving tall crucibles or heavy samples, where the top loading format makes sample handling much easier.

| Model      | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                                                | Volume (litres) | Max power (W)<br>Holding power (W) | Thermo-couple type | Weight (kg) | Power supply       |
|------------|---------------|---------------------|-------------------------|----------------------------------------------------------------|-----------------|------------------------------------|--------------------|-------------|--------------------|
|            |               |                     | Internal H x W x D (mm) | External H x W x D (mm)<br>H (door open)                       |                 |                                    |                    |             |                    |
| VCF 12/5   | 1200          | 102                 | 260 x 155 x 130         | 660 x 530 x 405<br>–<br>Floorstanding                          | 5               | 2500<br>900                        | R                  | 50          | Single phase       |
| VCF 12/10  | 1200          | 138                 | 365 x 180 x 155         | 765 x 555 x 430<br>(910)<br>Floorstanding                      | 10              | 3000<br>1200                       | R                  | 60          | Single phase       |
| VCF 12/23  | 1200          | 125                 | 450 x 250 x 200         | 850 x 600 x 500<br>850 + 105 (inc. handle)<br>Floorstanding    | 23              | 6000<br>2500                       | R                  | 130         | Optional Universal |
| VCF 12/100 | 1200          | 150                 | 600 x 410 x 410         | 1100 x 930 x 950<br>1250 + 210 (inc. chimney)<br>Floorstanding | 100             | 15000<br>6000                      | R                  | 200         | 3 phase            |

'Universal' models are easily altered between 1 phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating temperature is 100°C below maximum temperature.  
Heat up rate is measured to 100°C below max, using an empty chamber.  
Holding power is measured at the continuous operating temperature.

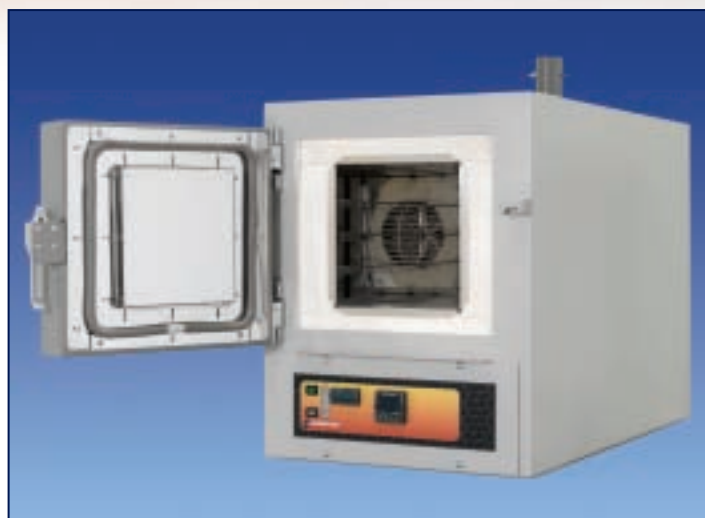
## HRF Air Recirculating Chamber Furnaces

### Standard features

- ✓ 750°C maximum operating temperature
- ✓ 22, 45, 112 or 324 litre chamber volumes
- ✓ Resistance wire elements in both sides of chamber
- ✓ Stainless steel liner
- ✓ Combination of low thermal mass and refractory board insulation.
- ✓ Carbolite 301 controller, with single ramp to set-point & process timer
- ✓ Safe outer case temperature

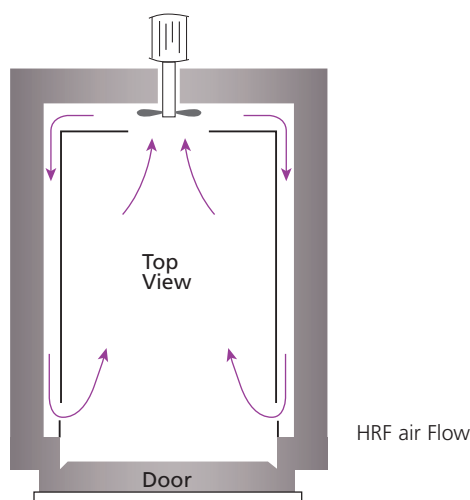
### Options *specify these at time of order*

- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ 8 or 20 segment programmer
- ✦ RS232 communications
- ✦ Shelves & runners




HRF 7/22C/3216P1/OT

A powerful fan and airguide system provide good uniformity and rapid heat transfer for applications such as; stress relieving, tempering, normalising and annealing. The stainless steel liner has 3 shelf runners with shelves available as an additional option.



| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions              |                         | Shelves fitted/accepted | Volume (litres) | Max power (W) | Thermo-couple type | Weight (kg) | Power supply     |
|-----------|---------------|---------------------|-------------------------|-------------------------|-------------------------|-----------------|---------------|--------------------|-------------|------------------|
|           |               |                     | Internal H x W x D (mm) | External H x W x D (mm) |                         |                 |               |                    |             |                  |
| HRF 7/22C | 750           | 63                  | 220 x 200 x 495         | 590 x 450 x 870         | 0/3                     | 22              | 3000          | K                  | 61          | Single phase     |
| HRF 7/45  | 750           | –                   | 295 x 265 x 560         | 840 x 600 x 1000        | 0/3                     | 45              | 6000          | K                  | –           | Optional 3 phase |
| HRF 7/112 | 750           | –                   | 400 x 400 x 700         | 1550 x 1000 x 1600      | 0/0                     | 112             | 18000         | K                  | 480         | 3 phase          |
| HRF 7/324 | 750           | –                   | 600 x 600 x 900         | 1800 x 1200 x 2280      | 1/1                     | 324             | 24000         | K                  | 1000        | 3 phase          |

 External dimensions with door closed and include chimney.  
Heat up rate is measured to 100°C below max, using an empty chamber.  
HRF 7/33 and HRF 7/45 have 3 integral shelf runners.



## LTH Top Hat Chamber Furnaces

### Standard features

- ✓ 1100°C or 1200°C maximum operating temperature
- ✓ 3.5, 31 & 49 litre chamber
- ✓ Rapid heating powerful free radiating wire elements & efficient low thermal mass insulation
- ✓ Rapid sample cooling can be achieved by raising the chamber
- ✓ Electrically elevated element chamber (the 3.5 litre chamber raises or lowers in 5 seconds)
- ✓ Chamber rises to full internal height for easy loading
- ✓ All around heating chamber provides maximum heat transfer & uniformity
- ✓ During loading, elements switch off & are fully retracted
- ✓ Separate control module on 2 metre conduit for 3.5, 31 & 49 litre models
- ✓ Hard wearing ceramic hearth
- ✓ Two handed elevator operation, with audible alarm and emergency stop button, for operator safety (except for LTH 12/3)



BLF 12/3 (with gas purged platform)

### Options

*specify these at time of order*

- ✦ Over-temperature protection (always recommended for unattended operation or protection of valuable samples)
- ✦ Optional gas inlet
- ✦ Refractory metal bell jar to improve gas usage when working with modified atmosphere
- ✦ 8 or 20 segment programmer
- ✦ RS232 communications
- ✦ Optional leg extension stand for LTH/31 (illustrated)

This furnace configuration enables very easy sample loading and rapid heating and cooling from lowering and raising the heated chamber on the hearth. It is also ideal for use with a modified atmosphere using an inverted crucible and optional gas inlet hearth.



LTH 11/49

LTH 11/31 + STAND

| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                     | Volume (litres) | Max power (W) | Thermo-couple type | Weight (kg) | Power supply |
|-----------|---------------|---------------------|-------------------------|-------------------------------------|-----------------|---------------|--------------------|-------------|--------------|
|           |               |                     | Internal H x W x D (mm) | External H x W x D (mm)             |                 |               |                    |             |              |
| BLF 12/3  | 1200          | —                   | 190 x 150 (Ø)           | 975 x 750 x 530<br>Bench mounted    | 3               | 2600          | N                  | 38          | Single phase |
| LTH 11/31 | 1100          | —                   | 500 x 250 x 250         | 1900 x 500 x 600<br>370 x 225 x 375 | 31              | 8000          | N                  |             | 3 phase      |
| LTH 11/49 | 1100          | —                   | 400 x 350 x 350         | 2200 x 640 x 1057                   | 49              | 9000          | N                  |             | 3 phase      |



Continuous operating temperature is 100°C below maximum temperature.  
Heat up rate is measured to 100°C below max, using an empty chamber.

## RHF Silicon Carbide Heated Furnaces to 1600°C

### Standard features

- ✓ 1400°C, 1500°C or 1600°C maximum operating temperature
- ✓ 3, 8, 15 or 35 litre chamber volumes
- ✓ Silicon carbide heating elements, providing long life at elevated temperatures & able to withstand the stresses of intermittent operation
- ✓ Carbolite 301 PID controller, with single ramp to set-point & process timer
- ✓ Controllers extend heating performance by compensating for the effects of element ageing
- ✓ Hard wearing refractory brick hearth and door surrounds
- ✓ Low thermal mass chamber insulation for energy efficiency & rapid heating & cooling

### Options

*specify these at time of order*

- ✦ 2 phase electrical supply for 3 litre models (& for RHF 14/8)
- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ 8 or 20 segment programmer
- ✦ RS232, RS485 communications
- ✦ A range of furnace tables & floor stands are available



RHF 16/3/3508P1

Typically reaching 1400°C in under 40 minutes the RHF range provides rapid heating and is ideally suited to the rigorous firing cycles demanded from laboratory furnaces.

### Power Supplies for Silicon Carbide Furnaces

The characteristics of the control systems that are used with silicon carbide elements result in maximum power supply requirements that are not as intuitively derived as those for furnaces using other heating technologies. For this reason a more detailed description of the maximum power supply that is required per phase has been included in the specification table.

## RHF Silicon Carbide Heated Furnaces to 1600°C

| Model                                                                                                                                                                                                                                                                                                                                         | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                       | Volume (litres) | Holding power (W) | Thermo-couple type | Weight (kg) | Power supply required per phase                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------|-------------------------|---------------------------------------|-----------------|-------------------|--------------------|-------------|--------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                               |               |                     | Internal H x W x D (mm) | External H x W x D (mm) H (door open) |                 | Max Power (W)     |                    |             |                                                                                |
| RHF 14/3                                                                                                                                                                                                                                                                                                                                      | 1400          | 33                  | 120 x 120 x 205         | 655 x 435 x 610 (905)                 | 2.9             | 1900<br>4500      | R                  | 42          | <i>a1</i> =30A, <i>a2</i> =15A                                                 |
| RHF 14/8                                                                                                                                                                                                                                                                                                                                      | 1400          | 22                  | 170 x 170 x 270         | 705 x 505 x 675 (990)                 | 7.8             | 3200<br>8000      | R                  | 64          | <i>a1</i> =50A, <i>a2</i> =25A                                                 |
| RHF 14/15                                                                                                                                                                                                                                                                                                                                     | 1400          | 35                  | 220 x 220 x 310         | 810 x 690 x 780 (1105)                | 15              | 2900<br>10000     | R                  | 125         | <i>a1</i> =62A, <i>h3</i> =22A, <i>d3</i> =38A                                 |
| RHF 14/35                                                                                                                                                                                                                                                                                                                                     | 1400          | 38                  | 250 x 300 x 465         | 885 x 780 x 945 (1245)                | 35              | 6000<br>16000     | R                  | 179         | <i>h3</i> =35A, <i>d3</i> =60A, <i>k3</i> =35A                                 |
| RHF 15/3                                                                                                                                                                                                                                                                                                                                      | 1500          | 45                  | 120 x 120 x 205         | 655 x 435 x 610 (905)                 | 2.9             | 2000<br>4500      | R                  | 46          | <i>a1</i> =36A, <i>a2</i> =18A                                                 |
| RHF 15/8                                                                                                                                                                                                                                                                                                                                      | 1500          | 40                  | 170 x 170 x 270         | 705 x 505 x 675 (990)                 | 7.8             | 3500<br>8000      | R                  | 61          | <i>h3</i> =17.5A, <i>d3</i> =30A, <i>b3</i> =38A, <i>g3</i> =17.5A             |
| RHF 15/15                                                                                                                                                                                                                                                                                                                                     | 1500          | 46                  | 220 x 220 x 310         | 810 x 690 x 780 (1105)                | 15              | 3000<br>10000     | R                  | 125         | <i>a1</i> =75A, <i>h3</i> =25A, <i>e3</i> =43A                                 |
| RHF 15/35                                                                                                                                                                                                                                                                                                                                     | 1500          | 46                  | 250 x 300 x 465         | 885 x 780 x 945 (1245)                | 35              | 6200<br>16000     | R                  | 178         | <i>h3</i> =35A <i>e3</i> =60A, <i>g3</i> =35A, <i>j3</i> =5A                   |
| RHF 16/3                                                                                                                                                                                                                                                                                                                                      | 1600          | 42                  | 120 x 120 x 205         | 655 x 435 x 610 (905)                 | 2.9             | 2300<br>4500      | R                  | 42          | <i>a1</i> =36A, <i>a2</i> =8A, <i>a3</i> =30A                                  |
| RHF 16/8                                                                                                                                                                                                                                                                                                                                      | 1600          | 35                  | 170 x 170 x 270         | 705 x 505 x 675 (990)                 | 7.8             | 4000<br>8000      | R                  | 61          | <i>h3</i> =18A, <i>e3</i> =29A, <i>b3</i> =34A, <i>g3</i> =18A, <i>k3</i> =18A |
| RHF 16/15                                                                                                                                                                                                                                                                                                                                     | 1600          | 58                  | 220 x 220 x 310         | 810 x 690 x 780 (1105)                | 15              | 3500<br>10000     | R                  | 140         | <i>a1</i> =73A, <i>h3</i> =25A, <i>a3</i> =42A, <i>k3</i> =25A                 |
| RHF 16/35                                                                                                                                                                                                                                                                                                                                     | 1600          | 56                  | 250 x 300 x 465         | 1530 x 900 x 1020 (1885)              | 35              | 1100<br>16000     | R                  | 270         | <i>h3</i> =40A, <i>e3</i> =62A, <i>g3</i> =37A, <i>k3</i> =40A                 |
| <i>a1</i> =Single 200-240V, <i>a2</i> =380-415V 2 phase + N, <i>a3</i> =200-240V 3 phase delta, <i>b3</i> =200-208V 3 phase delta, <i>d3</i> =200-220V 3 phase delta, <i>e3</i> =230-240V 3 phase delta, <i>g3</i> =380-415V 3 phase no N, <i>h3</i> =380-415V 3 phase + N, <i>j3</i> =440-480V 3 phase no N, <i>k3</i> =440-480V 3 phase + N |               |                     |                         |                                       |                 |                   |                    |             |                                                                                |



Continuous operating temperature is 100°C below maximum temperature.

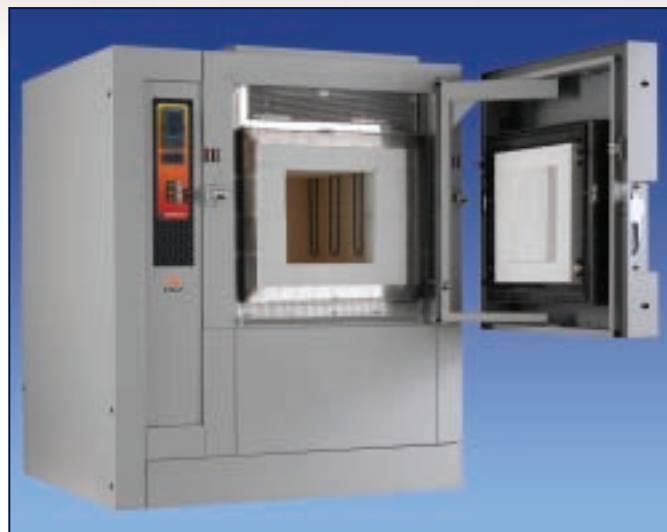
Heat up rate is measured to 100°C below max, using an empty chamber.

Holding power is measured at the continuous operating temperature.

## MRF 16/22 CMAT Microwave Assist Technology Furnace

### Standard features

- ✓ 1600°C maximum operating temperature
- ✓ Purpose built design, revolutionary microwave assist technology furnace
- ✓ Simultaneous direct heating of microwave susceptible materials & radiant heating by molybdenum disilicide elements
- ✓ Independent control of microwave & radiant heating
- ✓ nanodac™ programmable controller with TFT graphic display and datalogging
- ✓ Over-temperature protection
- ✓ Manual or programmable control of both heat sources
- ✓ Double safety interlock cuts power on door opening
- ✓ Microwave test meter
- ✓ Safety limits for microwave containment to BS EN 60519-6:2002 part 6.1 (emissions <5mW/cm<sup>2</sup> @ 50mm)



MRF 16/22

### Options

*specify these at time of order*

- ✦ Ability to store & re-use additional programs
- ✦ Fixed or wheeled stands
- ✦ Optional upgrade to nanodac programmer / DAC graphical recorder / data export
- ✦ Optional direct infrared PID control of element & microwave power using measurement from the sample
- ✦ Additional infrared digital imaging kit for the MRF-IR

The capability to heat samples using the combined effects of radiant heating and direct microwave heating using a purpose built MAT (Microwave Assist Technology) furnace.

Independent control of radiant heating and either continuous or pulsed microwave energy from 0 to 100% of output level.

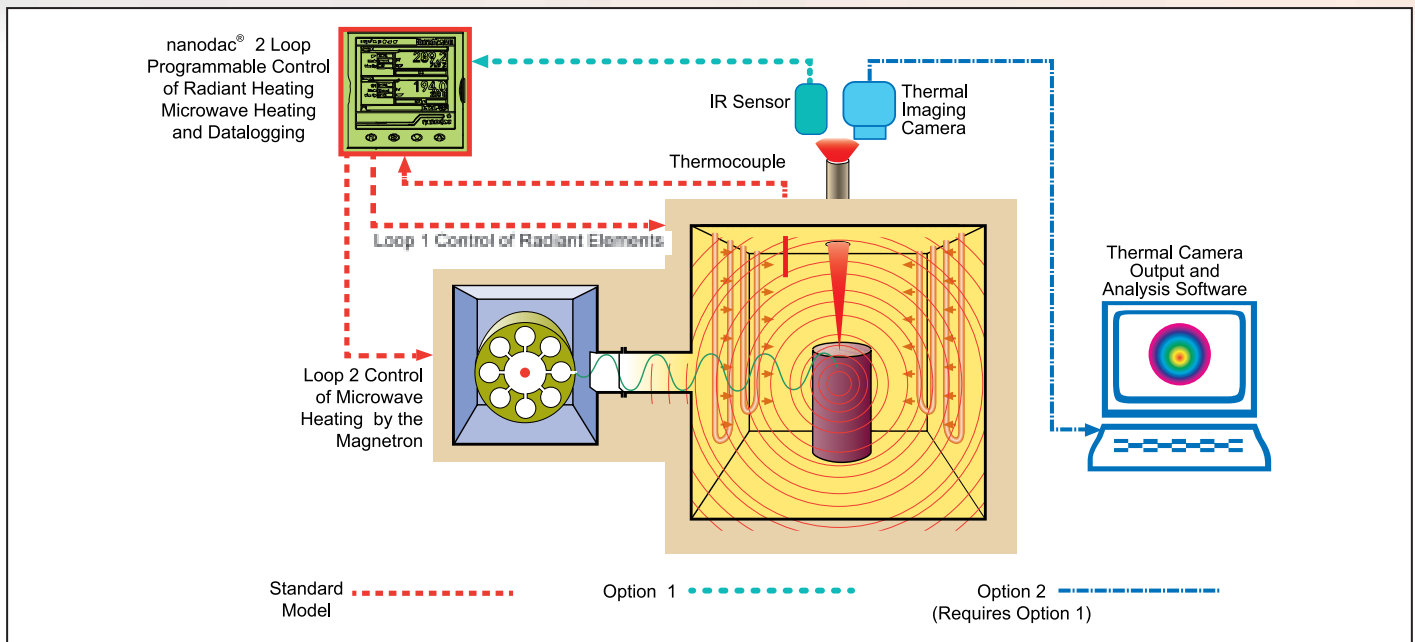
Optionally available with infrared feedback measurement and control. This enables direct measurement of sample temperature for observation or control purposes. In addition an infrared digital camera system, available for the MRF-IR 16/22 can be used to capture heterogeneous heating effects.

| Model        | Max temp (°C) | Max power (kW) | Radiant heating power (kW) | Micro power (kW) | Micro Freq'y (MHz) | Dimensions              |                         | Volume (litres) | Max distributed load (kg) | Net Weight (kg) | Power supply |
|--------------|---------------|----------------|----------------------------|------------------|--------------------|-------------------------|-------------------------|-----------------|---------------------------|-----------------|--------------|
|              |               |                |                            |                  |                    | Internal H x W x D (mm) | External H x W x D (mm) |                 |                           |                 |              |
| MRF 16/22    | 1600          | 12             | 9                          | 1.8              | 2450               | 232 x 245 x 396         | 1090 x 910 x 925        | 22              | 7.5                       | 290             | 3 phase      |
| MRF 16/22 IR | 1600          | 12             | 9                          | 1.8              | 2450               | 232 x 245 x 396         | 1090 x 910 x 925        | 22              | 7.5                       | 290             | 3 phase      |





## CMAT – Carbolite Microwave Assist Technology



CMAT Standard Design and Optional Additions

### Background

Carbolite CMAT furnaces have been developed to use in combination, radiant heating elements and microwave energy using a method pioneered by UK technology and innovation company C-Tech\*.

Having tested prototype furnaces and kilns they sought organisations able to commercialise the concept in a standard furnace design. Carbolite holds the European licence to develop and commercialise this technology and from this has developed our CMAT furnaces. Our strong working relationship with the North American licence holder who offers support means that Carbolite is able to supply the unique benefits of the MRF 16/22 world wide.

#### The Benefits of MAT (Microwave Assist Technology)

The MRF offers the potential for improved:

- ✦ Sintering densities at lower temperatures, using less energy.
- ✦ Sequential removal of binder (burn-off) and sintering, by preferentially heating binders.
- ✦ Reduced energy consumption by rapid direct heating of the sample.
- ✦ More uniform heating effects throughout the sample providing similar crystal structure and phase boundary properties at the surface and within the sample interior.

In a conventional furnace when the surface of a sample is heated by radiation the internal volume of the sample only heats through conduction. The limiting speed of conduction causes a thermal gradient to form which can

result in early surface hardening followed by cracking and bloating of the surface.

In the CMAT, sample materials which are susceptible to microwave interaction couple with the microwave energy to cause frictional heating at the molecular level throughout the volume of the sample.

To be susceptible to microwave heating a material should have components which have a high dielectric potential but where the molecular structure produces enough frictional resistance to these components aligning with the oscillating microwave energy for frictional heating to occur.

The MRF 16/22 uses a 2.45 MHz magnetron emitting energy at 1.8kW to generate this effect, in addition to molybdenum disilicide radiant heating elements. Unlike devices which simply use microwaves to heat susceptible blocks which then radiate heat onto the sample, the CMAT furnace is able to heat the sample using both infrared radiant heat and microwaves. The MRF 16/22's fully flexible programmable controller enables the sequence, intensity and phasing (pulsed or continuous microwave) of the radiant and microwave heating effects to be combined with unmatched flexibility.

The MRF 16/22 is unique in concept yet manufactured to a standard repeatable design.

\*C-Tech Innovation Limited  
Capenhurst Technology Park  
Capenhurst  
Chester  
CH1 6EH

## HTF High Temperature Chamber Furnaces

### Standard features

- ✓ 1700°C & 1800°C maximum operating temperature
- ✓ From 4 to 27 litre capacities
- ✓ Outstanding performance from molybdenum disilicide heating elements
- ✓ Up & away parallel opening door keeps hot face away from user
- ✓ Compatible with intermittent or continuous use
- ✓ Advanced refractory interior, used in combination with energy efficient low thermal mass insulation
- ✓ 8 Segment programmable controller with separate over-temperature protection
- ✓ Digital RS232 communications (HTF17/5, HTF17/10, HTF18/4 & HTF18/8)
- ✓ Fan cooling for low external case temperature.



HTF 17/10/3216P1

### Options

*specify these at time of order*

- ✦ Optional 2 phase electrical supply for 3 litre models (& for RHF 14/8)
- ✦ 20 Segment programmable controller
- ✦ RS232 & RS485 communications (RHF17/25, HTF18/15 & HTF18/27)
- ✦ Fieldbus & Ethernet connectivity
- ✦ A range of data acquisition devices & chart recorders

Suitable for either intermittent or continuous operations, these furnaces provide dependable high temperature performance with programmable control and overtemperature protection as standard.



HTF 18/27/3216P1

| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                       | Volume (litres) | Max power (W) | Digital RS232 Comms | Thermo-couple type | Weight (kg) | Power supply         |
|-----------|---------------|---------------------|-------------------------|---------------------------------------|-----------------|---------------|---------------------|--------------------|-------------|----------------------|
|           |               |                     | Internal H x W x D (mm) | External H x W x D (mm) H (door open) |                 |               |                     |                    |             |                      |
| HTF 17/5  | 1700          | 50                  | 158 x 150 x 225         | 565 x 830 x 650 (850)                 | 5               | 4050          | Standard            | B                  | 109         | Single               |
| HTF 17/10 | 1700          | 44                  | 227 x 200 x 225         | 565 x 830 x 650 (850)                 | 10              | 5920          | Standard            | B                  | 176         | Single or 2 phase    |
| RHF 17/25 | 1700          | 45                  | 300 x 275 x 300         | 1800 x 1100 x 680 (2600) Floor        | 25              | 9600          | Option              | B                  | 515         | 3 phase              |
| HTF 18/4  | 1800          | 65                  | 140 x 140 x 190         | 565 x 830 x 650 (850)                 | 4               | 4650          | Standard            | 20/40              | 175         | Single phase         |
| HTF 18/8  | 1800          | 56                  | 210 x 190 x 190         | 565 x 830 x 650 (1105)                | 8               | 6200          | Standard            | 20/40              | 150         | Single or 2 phase    |
| HTF 18/15 | 1800          | 70                  | 220 x 220 x 300         | 1580 x 690 x 800 (1105) Floor         | 15              | 7900          | Option              | 20/40              | 365         | Single, 2 or 3 phase |
| HTF 18/27 | 1800          | 55                  | 300 x 300 x 300         | 1610 x 780 x 945 (1245) Floor         | 27              | 8180          | Option              | 20/40              | 509         | 3 phase              |



Continuous operating temperature is 100°C below maximum temperature.  
Heat up rate is measured to 100°C below max, using an empty chamber.

## BLF Bottom Loading Furnaces

### Standard features

- ✓ 1700°C & 1800°C maximum operating temperature
- ✓ 3 to 21 litre capacities
- ✓ Ideal for; sintering high performance ceramics, melting glass under high temperature, or working with modified atmospheres
- ✓ Extremely rapid heating & cooling cycles can be achieved through raising & lowering the hearth
- ✓ Electrically operated elevator hearth, protects operator from the chamber's radiant heat & gives easy loading of workpieces & crucibles
- ✓ Excellent temperature uniformity as a result of the round chamber
- ✓ Overtemperature protection to protect load or furnace during unattended operation
- ✓ Programmable 3216P1 controller & separate over-temperature protection
- ✓ Molybdenum disilicide heating elements



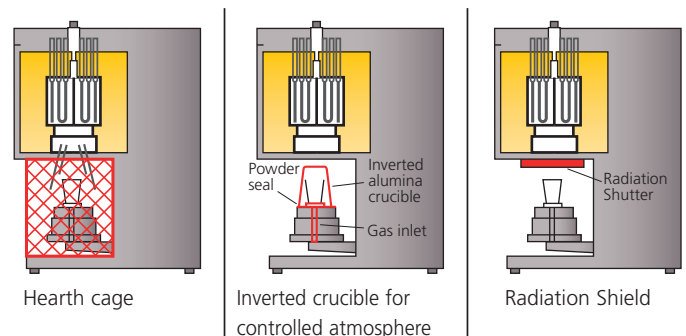
BLF 17/3/3508P1

### Options

*specify these at time of order*

- ✦ Compatible crucibles
- ✦ Modified hearth for the introduction of gases
- ✦ Adaptation to introduce thermocouple or stirrer through the chamber top
- ✦ Rotating hearth option
- ✦ Radiation shutters
- ✦ Hearth cages
- ✦ RS232 & RS485 communications
- ✦ Fieldbus & Ethernet connectivity
- ✦ DAQ or graphical recorders

Rapid heating and cooling are achievable by raising and lowering the hearth, whilst the operator is protected from direct exposure to radiant heat from the chamber.



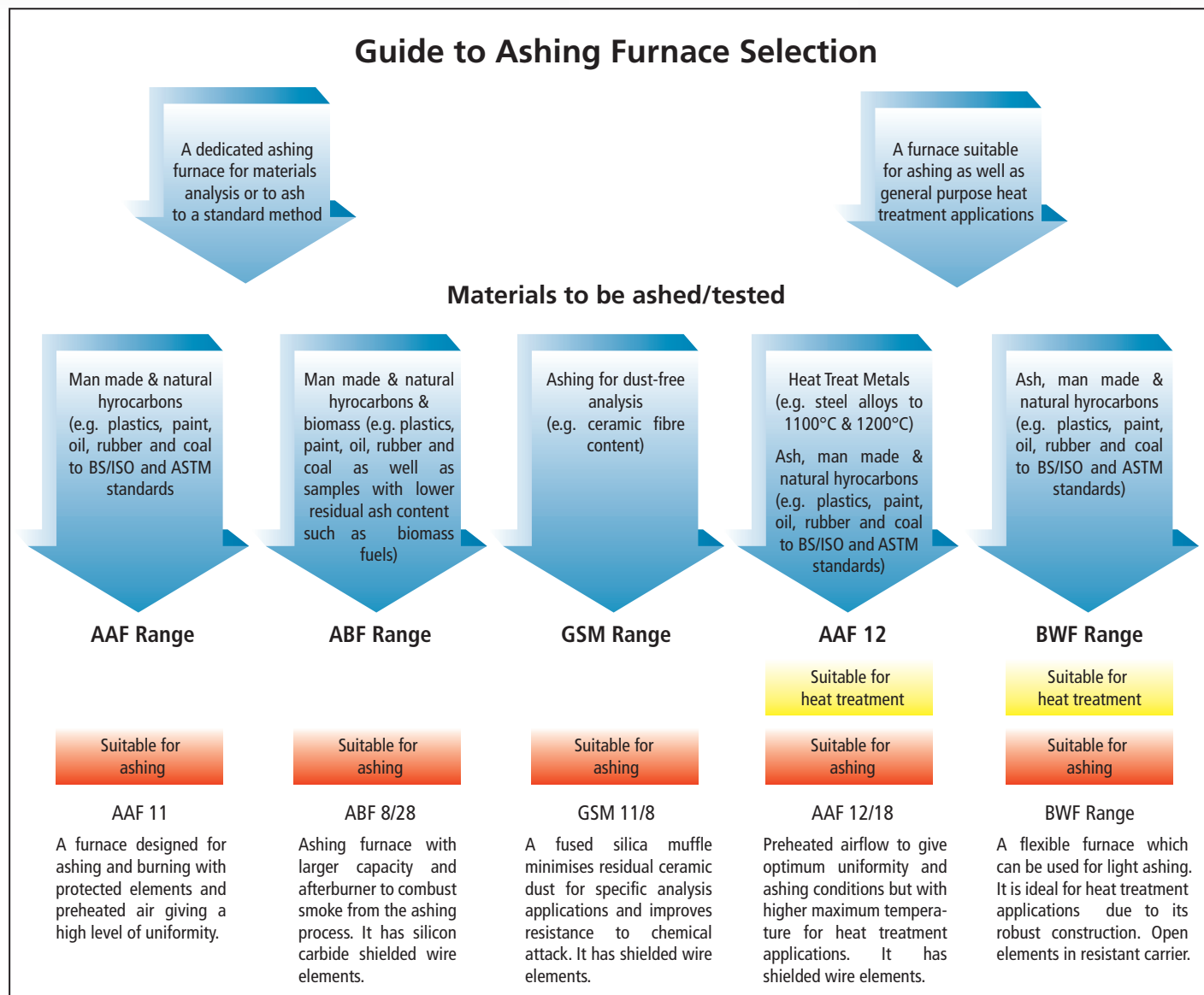
| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions                  |                                     | Volume (litres) | Max power (W) | Thermo-couple type | Weight (kg) | Power supply |
|-----------|---------------|---------------------|-----------------------------|-------------------------------------|-----------------|---------------|--------------------|-------------|--------------|
|           |               |                     | Internal Height x Diam (mm) | External H x W x D (mm)             |                 |               |                    |             |              |
| BLF 17/3  | 1700          | 80                  | 190 x 150                   | 975 x 750 x 530<br>Bench mounted    | 3               | 4125          | B                  | 155         | Single       |
| BLF 17/8  | 1700          | 80                  | 250 x 200                   | 1950 x 1360 x 800<br>Floor standing | 8               | 8130          | B                  | 424         | 3 phase      |
| BLF 17/21 | 1700          | 180                 | 300 x 300                   | 1850 x 1250 x 850<br>Floor standing | 21              | 12000         | B                  | 600         | 3 phase      |
| BLF 18/3  | 1800          | 110                 | 190 x 150                   | 975 x 750 x 530<br>Bench mounted    | 3               | 4775          | 2                  | 155         | Single phase |
| BLF 18/8  | 1800          | 110                 | 250 x 200                   | 1950 x 1360 x 800<br>Floor standing | 8               | 7010          | 2                  | 424         | 3 phase      |



Continuous operating temperature is 100°C below maximum temperature.  
Heat up rate is measured to 100°C below max, using an empty hearth.

# ASHING & BURN-OFF FURNACES

## Introduction to Ashing & Burn-off Furnaces



One of the most common applications for laboratory furnaces is to heat combustible samples in order to analyse the ash residue. There are several important considerations which help to identify the most suitable furnace for the task –

### Selecting the Correct Furnace

Because there is no single answer to all of these questions Carbolite offers a range of furnaces with characteristics tailored to ashing and burnoff applications and are always happy to help with selection of the correct furnace.

- Does the ashing process have to conform to a given test method protocol such as those laid down in ISO / ASTM other published standards?
- Does the ashing or burn-off process generate aggressive fumes that could damage the furnace or be hazardous?
- Will the furnace provide an adequate airflow to fully combust the sample?

- How large are the samples which must be heated in order to provide a sufficiently large residue of ash for analysis?
- How intensive is the work cycle and how many samples must be processed?
- Is there a requirement to use the furnace for applications other than ashing or burn-off?
- Would contamination of the ash with traces of alumina or silica (from conventional insulation materials) be detrimental?



## AAF Ashing & Burn-off Furnaces

### Standard features

- ✓ 1100°C maximum operating temperature
- ✓ Ideal for ashing foods, plastics, coal & other hydrocarbon materials
- ✓ Designed to comply with BS 1016-104.4:1998, ISO 1171:2010, & ASTM D3174-04: 2010 (3 & 7 Litre models only)
- ✓ Wire elements are protected from chemical & mechanical damage by a hard wearing alumina based liner
- ✓ AAF 11/18 offers increased protection of the elements from carbon & corrosive atmospheres using silicon carbide tiles.
- ✓ Air inlet & tall chimney give airflow of 4 to 5 changes per minute (AAF11/7)
- ✓ Low chamber height holds airflow close to samples for optimum combustion
- ✓ Powerful elements with graded winding compensate for heat loss due to high airflow
- ✓ Preheating of air before it enters the chamber gives excellent uniformity
- ✓ Large floor area allows for large number of samples
- ✓ AAF 11/18 has two tier shelf doubling sample capacity
- ✓ Racks & hearth trays as below



AAF 11/7/301

### Options

*specify these at time of order*

- ♦ 2 phase electrical supply for AAF 11/7

| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                                        | Volume (litres) | Max power (W)<br>Holding power (W) | Thermo-couple type | Weight (kg) | Power supply     |
|-----------|---------------|---------------------|-------------------------|--------------------------------------------------------|-----------------|------------------------------------|--------------------|-------------|------------------|
|           |               |                     | Internal H x W x D (mm) | External H x W x D (mm)<br>H (door open)               |                 |                                    |                    |             |                  |
| AAF 11/3  | 1100          | 140                 | 90 x 150 x 250          | 585 x 375 x 485 (800)<br>780 height to top of chimney  | 3               | 2100<br>1270                       | K                  | 22          | Single           |
| AAF 11/7  | 1100          | 155                 | 90 x 170 x 455          | 650 x 430 x 740 (905)<br>1060 height to top of chimney | 7               | 4000<br>2300                       | K                  | 63          | Single / 2 phase |
| AAF 11/18 | 1100          | 70                  | 235 x 196 x 400         | 705 x 505 x 675 (990)<br>1015 height to top of chimney | 18              | 7080<br>3500                       | K                  | 70          | Universal        |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating temperature is 100°C below maximum temperature.

Heat up rate is measured to 100°C below max, using an empty chamber.

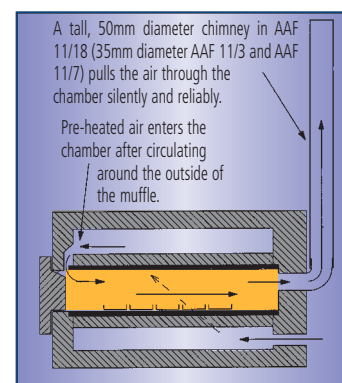
Holding power is measured at the continuous operating temperature.

### Standard accessories

| Model     | 2 tier rack system for sample trays with 80mm gap | Non-perforated sample trays (qty) w x d (mm) | Perforated sample trays (qty) w x d (mm) | Loading handle |
|-----------|---------------------------------------------------|----------------------------------------------|------------------------------------------|----------------|
| AAF 11/3  | —                                                 | (x1) 133 x 200                               | —                                        | (x1)           |
| AAF 11/7  | —                                                 | (x1) 163 x 326                               | —                                        | (x1)           |
| AAF 11/18 | (x1)                                              | —                                            | (x2) 163 x 326                           | (x1)           |



TRAYS SUPPLIED WITH FURNACES



## ABF Afterburner Ashing Furnace

### Standard features

- ✓ 800°C maximum operating temperature – ashing chamber
- ✓ 28 Litre chamber volume
- ✓ Afterburner rated for up to 40g carbon per ashing load
- ✓ 3216P1 Programmable controller
- ✓ Independent control of afterburner temperature up to 950°C
- ✓ Silicon carbide shielded wire wound elements
- ✓ Silicon carbide hearth
- ✓ Mesh sample trays & loading handle



ABF 8/28

### Options

*specify these at time of order*

- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ Optional dual level rack and sample trays
- ✦ Optional three phase operation
- ✦ Optional floor stand

The ABF 8/28 offers a 28 litre chamber with large floor space and a fan assisted pre-exhaust afterburner to combust smoke before it exits from the chimney.

### Standard accessories

Supplied with 2 tier stacking mesh sample trays (each 60 x 225 x 300) H x W x D mm and loading handle.

| Model    | Max temp (°C) | Dimensions              |                                            | Volume (litres) | Max power (W)     | Thermo-couple type | Weight (kg) | Power supply |
|----------|---------------|-------------------------|--------------------------------------------|-----------------|-------------------|--------------------|-------------|--------------|
|          |               | Internal H x W x D (mm) | External H x W x D (mm)                    |                 | Holding power (W) |                    |             |              |
| ABF 8/28 | 800           | 210 x 290 x 445         | 980 x 600 x 750<br>1160 (inc. chimney 180) | 28              | 8000<br>3828      | K                  | 120         | Universal    |

'Universal' models are easily altered between single phase (220V), 3 phase + neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Holding power is measured at 500°C.  
Heat up rate is measured to 100°C below max, using an empty chamber.

## GSM Ashing & Burn-off Furnaces

### Standard features

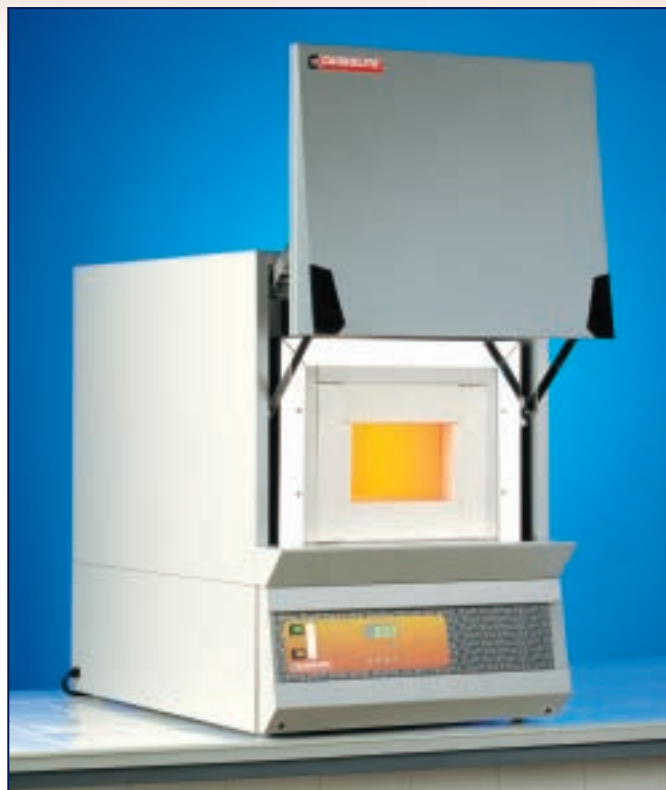
- ✓ 1100°C maximum operating-temperature
- ✓ Fused quartz furnace chamber, ideal for analyses where  $\text{Al}_2\text{O}_3$  or  $\text{SiO}_2$  could contaminate test results
- ✓ Chamber lining offers superior containment of corrosive & aggressive vapours such as  $\text{H}_2\text{SO}_4$ ,  $\text{HNO}_3$ ,  $\text{HCL}$
- ✓ Moulded ceramic fibre door plug

### Options

*specify these at time of order*

- ✦ Gas Inlet for modified atmospheres (the fused quartz liner provides improved containment)
- ✦ Sample trays & racks as below

For advice on managing corrosive or aggressive materials (within your furnace), please contact Carbolite



GSM 11/8

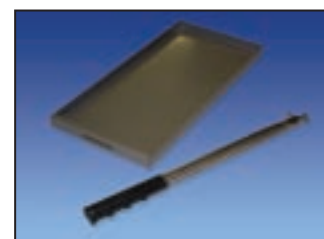
| Model    | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                                          | Volume (litres) | Max power (W)<br>Holding power (W) | Thermo-couple type | Weight (kg) | Power supply |
|----------|---------------|---------------------|-------------------------|----------------------------------------------------------|-----------------|------------------------------------|--------------------|-------------|--------------|
|          |               |                     | Internal H x W x D (mm) | External H x W x D (mm)<br>H (door open)                 |                 |                                    |                    |             |              |
| GSM 11/8 | 1100          | 70                  | 120 x 175 x 345         | 655 x 435 x 750 (895)<br>1060mm height to top of chimney | 8               | 3050<br>1700                       | K                  | 57          | Single       |



Continuous operating-temperature is 100°C below maximum temperature.  
Heat up rate is measured to 100°C below max, using an empty chamber.  
Holding power is measured at the continuous operating-temperature.  
The maximum depth to accommodate the door opening arc is 810mm.

### Optional accessories

| Model    | Non-perforated Inconel sample trays (qty) w x d x l (mm) | Loading handle |
|----------|----------------------------------------------------------|----------------|
| GSM 11/8 | (x1) 143 x 280 x 15                                      | (x1)           |



ACCESSORY SAMPLE TRAY & LOADING HANDLE

## AAF 12/18 Ashing-Plus Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ Ideal for ashing foods, plastics, coal & other hydrocarbon materials
- ✓ The higher operating temperature makes this a flexible general purpose furnace also suitable for standards compliant ashing.
- ✓ Silicon carbide tile protect the elements from carbon & corrosive atmospheres
- ✓ Air inlet & tall chimney give high airflow
- ✓ Powerful elements with graded winding compensate for heat loss due to high airflow
- ✓ Preheating of air before it enters the chamber gives excellent uniformity
- ✓ Large floor area allows for large number of samples
- ✓ AAF 12/18 has two tier shelf doubling sample capacity



AAF 12/18

| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                                                         | Volume (litres) | Max power (W)     | Thermo-couple type | Weight (kg) | Power supply |
|-----------|---------------|---------------------|-------------------------|-------------------------------------------------------------------------|-----------------|-------------------|--------------------|-------------|--------------|
|           |               |                     | Internal H x W x D (mm) | External H x W x D (mm)<br>H (door open)                                |                 | Holding power (W) |                    |             |              |
| AAF 12/18 | 1200          | 70                  | 235 x 196 x 400         | 705 x 505 x 675 (990)<br>1015 height to top of chimney<br>Bench mounted | 18              | 7080<br>3500      | K                  | 70          | Universal    |

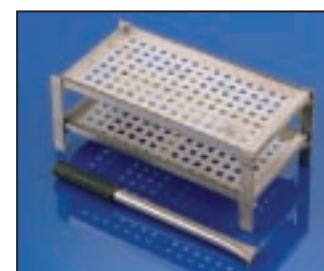
'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating-temperature is 100°C below maximum temperature.  
Heat up rate is measured to 100°C below max, using an empty chamber.  
Holding power is measured at the continuous operating-temperature.

**Standard accessories (for the range 1000°C to 1100°C high temperature accessories are available)**

| Model     | 2 tier rack system for sample trays with 80mm gap | Perforated sample trays (qty) w x d (mm) | Loading handle |
|-----------|---------------------------------------------------|------------------------------------------|----------------|
| AAF 12/18 | (x1)                                              | (x2) 163 x 326                           | (x1)           |



ACCESSORY SAMPLE TRAYS & RACK



## BWF Ashing & Burn-off Furnaces

### Standard features

- ✓ 1100°C or 1200°C maximum operating-temperature
- ✓ Ideal for ashing larger samples or working with non-standard crucibles
- ✓ Good uniformity & compensation for heat loss from graded wire wound elements in side mounted, hard wearing alumina carriers
- ✓ Excellent resistance to wear from refractory brick door surround & hearth
- ✓ Enhanced airflow from high chimney & door vents for full combustion

### Options

*specify these at time of order*

- ✦ Optional 2 phase electrical supply
- ✦ Optional racks & hearth trays as below



BWF 11/13/301

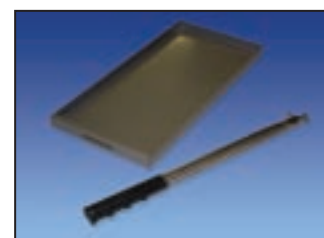
| Model     | Max temp (°C) | Heat-up time (mins) | Dimensions              |                                                       | Volume (litres) | Max power (W)     | Thermo-couple type | Weight (kg) | Power supply     |
|-----------|---------------|---------------------|-------------------------|-------------------------------------------------------|-----------------|-------------------|--------------------|-------------|------------------|
|           |               |                     | Internal H x W x D (mm) | External H x W x D (mm)<br>H (door open)              |                 | Holding power (W) |                    |             |                  |
| BWF 11/13 | 1100          | 115                 | 200 x 200 x 325         | 655 x 435 x 610 (905)<br>800 height to top of chimney | 13              | 3100<br>1200      | K                  | 47          | Single           |
| BWF 12/13 | 1200          | 130                 | 200 x 200 x 325         | 655 x 435 x 610 (905)<br>800 height to top of chimney | 13              | 3100<br>1500      | K                  | 47          | Single / 2 phase |



Continuous operating temperature is 100°C below maximum temperature.  
Heat up rate is measured to 100°C below max, using an empty chamber.  
Holding power is measured at the continuous operating temperature.

Optional accessories (for the range 1000°C to 1100°C high temperature accessories are available)

| Model     | Non-perforated sample trays (qty) w x d (mm) | Loading handle |
|-----------|----------------------------------------------|----------------|
| BWF 11/13 | (x1) 163 x 326                               | (x1)           |
| BWF 12/13 | (x1) 163 x 326                               | (x1)           |



ACCESSORY SAMPLE TRAY & LOADING HANDLE

# TUBE FURNACES

## Selection of a Tube Furnace

### Factors for Selecting a Tube Furnace

- ✦ Tube furnaces are frequently the most economical way to heat a small sample.
- ✦ Rapid temperature changes are possible by simply using a push-rod to move the sample along the length of the tube (although care must be taken not to cause thermal shock to the tube or sample boat).
- ✦ Additionally the work tube makes controlling the temperature uniformity and atmosphere around the specimen much easier.

### Temperature

- ✦ It is recommended to allow at least 100°C extra heating range above the desired working temperature.
- ✦ The chart below indicates the standard models available and their maximum operating temperatures from 900°C to 1800°C.
- ✦ Different heating technologies are utilised to achieve each given temperature range.

### Size & Worktubes

- ✦ Some furnaces, most often those with wire wound elements, are supplied with an integral worktube, usually because the resistance wire element is wound directly onto the worktube.
- ✦ For some tube furnaces an accessory worktube is essential.
- ✦ An accessory worktube may be preferred either because of its material properties or to protect (where there is one) the element bearing worktube.
- ✦ See the 'Tube Furnace Options' section for advice on selecting the correct worktube.

### Single or Three Zone

- ✦ Tube furnaces provide a high level of uniformity.
- ✦ For improved uniformity accessory end plugs or radiation shields should be purchased, especially for tube diameters > 25mm id.
- ✦ The length of the central uniform zone can be further increased by adding heated zones at the ends in the form of a three-zone furnace design.

### Modified Atmosphere or Vacuum

- ✦ Tube furnaces are ideal when the sample must be heated in an inert atmosphere or a vacuum.
- ✦ A combination of end seals protected by thermal radiation shields should be considered. A longer worktube to is required to accommodate these.

### Horizontal or Vertical

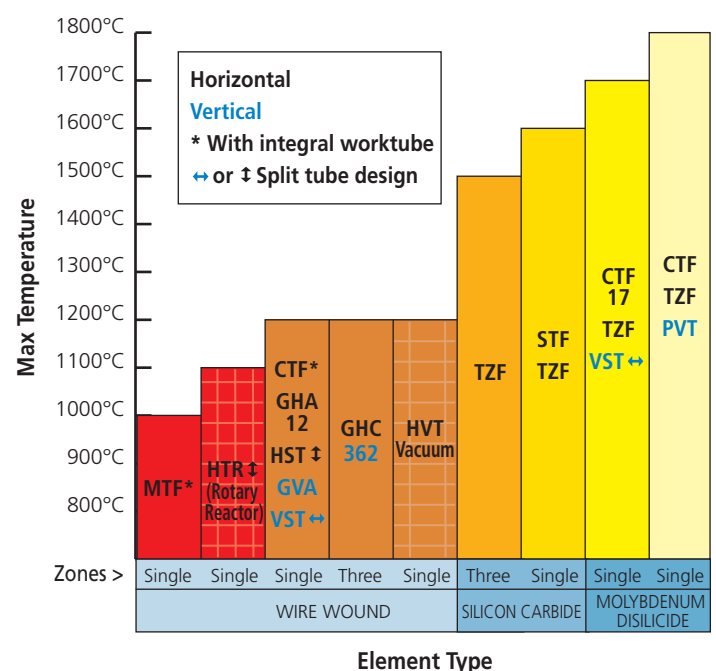
- ✦ Most Carbolite tube furnaces are available in horizontal and vertical configurations.
- ✦ When used vertically, end seals are strongly recommended to minimise the effects of convection currents through the worktube.
- ✦ In vertical configurations the furnace body is separate from the control module and attached by a 2 metre conduit.

### Split Tube

- ✦ Both vertical and horizontally configured furnaces are available with the furnace body split and hinged along its length.
- ✦ This enables easy access where worktubes are to be changed between jobs or where the furnace is to be wrapped around the sample for example in tensile test rigs.

### Application Specific & Bespoke Designs

Rotary reactor, elevator tube and high vacuum tube furnaces are just some of the standard variations of tube furnace available from Carbolite. Many other bespoke modifications can be provided offering alternative temperature ranges, dimensions, physical configurations, sample handling and functionality such as rotating tubes. Simply contact Carbolite or your local distributor for a quotation.



# MTF Wire Wound Single Zone Tube Furnaces

## Standard features

- ✓ 1000°C or 1200°C maximum operating temperature
- ✓ 15mm, 25mm or 38mm heated tube inner diameters
- ✓ 130mm, 250mm, 400mm or 850mm heated tube length
- ✓ Integral wirewound worktube
- ✓ Control module, with furnace mounted directly on top
- ✓ Carbolite 301 controller, with single ramp to set-point facility
- ✓ Delayed start / process timer function as standard
- ✓ Horizontal tube configuration



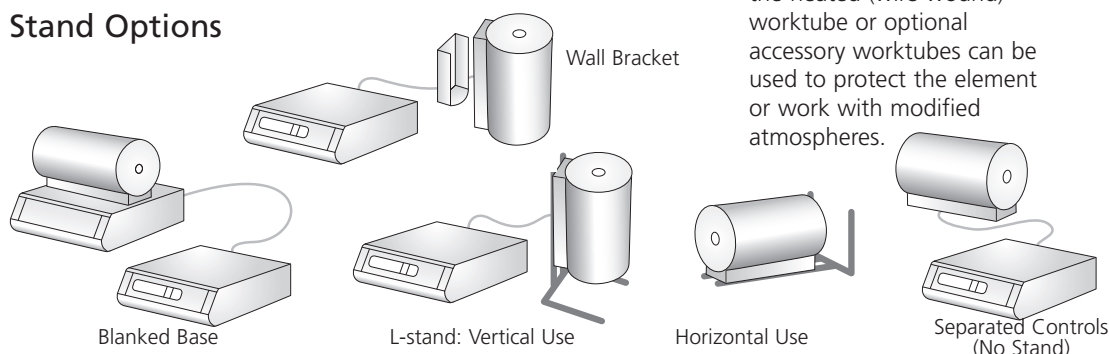
MTF 12/38/250

## Options

*specify these at time of order*

- ★ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ★ Non-permeable inner worktube to contain modified atmosphere
- ★ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ★ Insulation plugs & radiation shields to prevent heat loss & improve uniformity (recommended for vertical use)
- ★ Gas injection & vacuum compatible tube end seal assemblies

## Stand Options



MTF 10/15/130

Starting with the compact MTF/9 through to the 850mm long MTF 12/38 850, these tube furnaces can be used by placing samples directly into the heated (wire wound) worktube or optional accessory worktubes can be used to protect the element or work with modified atmospheres.

| Model         | Max temp (°C) | Heat-up time (mins) | Dimensions                     |                         |                          | *Uniform length ±5°C (mm) | Max power (W)     | Thermo-couple type | Weight (kg) | Power supply |
|---------------|---------------|---------------------|--------------------------------|-------------------------|--------------------------|---------------------------|-------------------|--------------------|-------------|--------------|
|               |               |                     | Fixed tube inner diameter (mm) | Heated tube length (mm) | External H x W x D (mm)  |                           |                   |                    |             |              |
|               |               |                     |                                |                         | Furnace body length (mm) |                           | Holding power (W) |                    |             |              |
| MTF 10/15/130 | 1000          | 5                   | 15                             | 130                     | 360 x 200 x 203<br>150   | 30                        | 400<br>100        | K                  | 3           | Single phase |
| MTF 10/25/130 | 1000          | 10                  | 25                             | 130                     | 265 x 150 x 175<br>150   | 45                        | 400<br>100        | K                  | 3           | Single phase |
| MTF 12/25/250 | 1200          | 15                  | 25                             | 250                     | 375 x 370 x 375<br>300   | 60                        | 700<br>200        | N                  | 10          | Single phase |
| MTF 12/38/250 | 1200          | 25                  | 38                             | 250                     | 375 x 450 x 375<br>300   | 90                        | 1000<br>300       | N                  | 15          | Single phase |
| MTF 12/25/400 | 1200          | 30                  | 25                             | 400                     | 430 x 370 x 375<br>450   | 100                       | 1000<br>200       | N                  | 10          | Single phase |
| MTF 12/38/400 | 1200          | 25                  | 38                             | 400                     | 430 x 450 x 375<br>450   | 130                       | 1500<br>300       | N                  | 15          | Single phase |
| MTF 12/38/850 | 1200          | –                   | 38                             | 850                     | 430 x 900 x 375<br>900   | 600                       | 2800              | N                  | –           | Single phase |



Continuous operating temperature is 100°C below maximum temperature.

Heat up rate is measured to 100°C below max, using an empty tube & end plugs.

Holding power is measured at the continuous operating temperature. \*Uniform temperature lengths are measured with end plugs fitted.

## CTF Wire Wound Single Zone Tube Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ 65mm, 75mm or 100mm worktube inner diameters
- ✓ 550mm, 700mm or 900mm heated tube length
- ✓ Integral wirewound worktube
- ✓ Carbolite 301, PIP controller with digital set & display
- ✓ Delayed start / process timer function as standard
- ✓ Horizontal tube configuration
- ✓ Horizontal configuration with furnace located on top of controller base



CTF 12/65/550

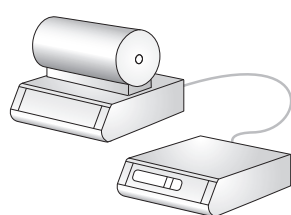
Provides the advantages of a larger diameter and longer worktube than the MTF range, with the option of adding accessory worktubes in order to use modified atmospheres or to protect the wire wound element tube.

### Options

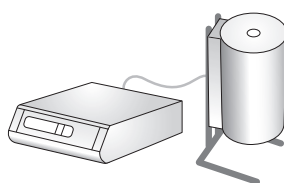
*specify these at time of order*

- ✦ Alternative 'blank-base' or 'separated-base' configurations
- ✦ Optionally configured for 2 phase electrical supply
- ✦ Non-permeable inner worktube to contain modified atmosphere
- ✦ Range of impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity
- ✦ Gas injection & vacuum compatible tube end seal assemblies
- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ 8 or 20 segment programmer
- ✦ RS232 communications & graphical recorders

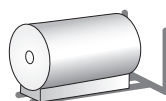
### Stand Options



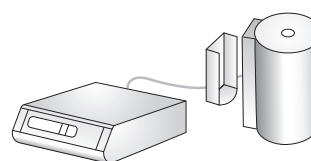
Blanked Base



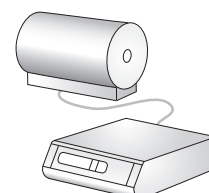
L-stand: Vertical Use



Horizontal Use



Wall Bracket



Separated Controls  
(No Stand)

| Model          | Max temp (°C) | Heat-up time (mins) | Dimensions                     |                    |                          | *Uniform length ±5°C (mm) | Max power (W) | Thermo-couple type | Weight (kg) | Power supply            |
|----------------|---------------|---------------------|--------------------------------|--------------------|--------------------------|---------------------------|---------------|--------------------|-------------|-------------------------|
|                |               |                     | Fixed tube inner diameter (mm) | Heated tube length | External H x W x D (mm)  |                           |               |                    |             |                         |
|                |               |                     |                                |                    | Furnace body length (mm) |                           |               |                    |             |                         |
| CTF 12/65/550  | 1200          | 45                  | 65                             | 550                | 525 x 625 x 360<br>600   | 230                       | 2000          | N                  | 25          | Single phase or 2 phase |
| CTF 12/75/700  | 1200          | 45                  | 75                             | 700                | 525 x 775 x 360<br>750   | 265                       | 3000          | N                  | 28          | Single phase or 2 phase |
| CTF 12/100/900 | 1200          | 90                  | 100                            | 900                | 525 x 975 x 360<br>950   | 640                       | 4500          | N                  | 35          | Single phase or 2 phase |



Continuous operating temperature is 100°C below maximum temperature.

Heat up rate is measured to 100°C below max, using an empty tube & end plugs.

\*Uniform temperature lengths are measured with end plugs fitted.

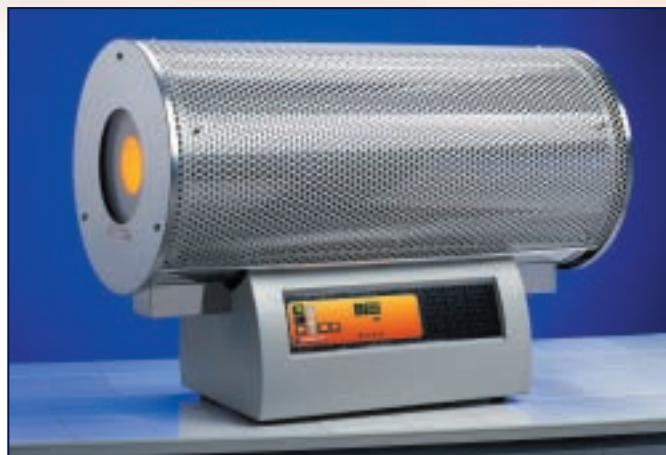
\*\* To ensure tube end temperatures that are compatible with sealing assemblies, worktubes extending beyond the standard length are required when working with modified atmosphere. Radiation shields may also be required.



## GHA Single Zone Horizontal Tube Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ Accepts worktubes with outer diameters from 20 to 170mm
- ✓ Worktubes with 300, 450, 600, 750, 900, 1050 or 1200mm heated tube length
- ✓ Long life, rapid heating, resistance wire elements mounted in rigid, vacuum formed insulation modules
- ✓ Carbolite 301, PID controller with digital set & display
- ✓ Delayed start / process timer function as standard
- ✓ Horizontal configuration
- ✓ Furnace mounted directly on top of controller base unit



GHA 12/75/600/301

### Options

*specify these at time of order*

- ✦ Full range of alternative 'blank-base' & 'separate-base' configurations available
- ✦ Non-permeable inner worktubes to contain modified atmosphere
- ✦ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity
- ✦ Gas injection & vacuum compatible tube end seal assemblies
- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ 8 or 20 segment programmer
- ✦ RS232 communications & graphical recorders

A range designed for working using accessory worktubes, whose physical characteristics and chemical resistance can be matched to the specific application.

*Requires but does not include an appropriate accessory worktube up to 170mm outer diameter.*

| Model       | Max temp (°C) | Heat-up time (mins) | Dimensions                  |                              |                 |                                |                          | *Average uniform length ±5°C (mm) | Max power (W) | Thermo-couple type | Weight (kg) | Power supply                 |
|-------------|---------------|---------------------|-----------------------------|------------------------------|-----------------|--------------------------------|--------------------------|-----------------------------------|---------------|--------------------|-------------|------------------------------|
|             |               |                     | Max o/d accessory tube (mm) | Tube* / Worktube length (mm) |                 |                                | External H x W x D (mm)  |                                   |               |                    |             |                              |
|             |               |                     |                             | Heated*                      | For work in air | **For modified atmosphere work |                          |                                   |               |                    |             |                              |
| GHA 12/300  | 1200          | 90                  | 170                         | 300                          | 500             | 900                            | 670 x 526 x 468<br>480   | 201                               | 2300          | N                  | –           | Single or 2 phase            |
| GHA 12/450  | 1200          | 97                  | 170                         | 450                          | 650             | 1050                           | 670 x 676 x 468<br>630   | 262                               | 3100          | N                  | 37          | Single, 3 phase or Universal |
| GHA 12/600  | 1200          | 92                  | 170                         | 600                          | 800             | 1200                           | 670 x 826 x 468<br>780   | 414                               | 3900          | N                  | 40          | Universal                    |
| GHA 12/750  | 1200          | 97                  | 170                         | 750                          | 950             | 1350                           | 670 x 976 x 468<br>930   | 448                               | 4600          | N                  | 51          | Universal                    |
| GHA 12/900  | 1200          | –                   | 170                         | 900                          | 1100            | 1500                           | 670 x 1126 x 468<br>1080 | –                                 | 5400          | N                  | 55          | Universal                    |
| GHA 12/1050 | 1200          | 83                  | 170                         | 1050                         | 1250            | 1650                           | 670 x 1276 x 468<br>1230 | 448                               | 6200          | N                  | –           | Universal                    |
| GHA 12/1200 | 1200          | –                   | 170                         | 1200                         | 1400            | 1800                           | 670 x 1426 x 468<br>1380 | –                                 | 7000          | N                  | –           | Universal                    |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



**Continuous operating temperature is 100°C below maximum temperature.**

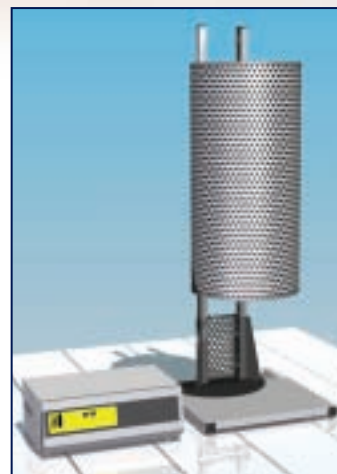
Heat up rate is measured to 100°C below max, using an empty tube & end plugs.

\*Average of uniform lengths at 100°C intervals from 800°C to 1200°C, measured with end plugs fitted. \*\* To ensure tube end temperatures that are compatible with sealing assemblies, worktubes extending beyond the standard length are required when working with modified atmosphere. Radiation shields may also be required.

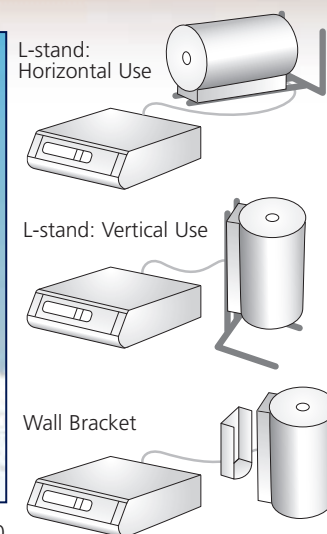
## GVA Single Zone Versatile Configuration Tube Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ Accepts worktubes with outer diameter of up to 170mm
- ✓ Accepts worktubes with 300, 450, 600, 750, 900, 1050 or 1200mm heated tube length
- ✓ Removable tube adaptors simplify working with different tube diameters
- ✓ Long life, rapid heating, resistance wire elements mounted in rigid, vacuum formed insulation modules
- ✓ Supplied with versatile 'G' stand kit, for free standing horizontal, vertical (adjustable height) or wall mounted installation
- ✓ Control module with 2 metre conduit to furnace cradle
- ✓ Carbolite 301, PID controller with digital setting & display
- ✓ Delayed start / process timer function as standard



GVA 12/750



### Options

*specify these at time of order*

- ✦ Non-permeable inner worktubes to contain modified atmosphere
- ✦ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ Available without stand (comprising control module & furnace body with cradle only)
- ✦ Available without foot (for horizontal mounting or wall mounting using additional bracket)
- ✦ Wall mounting bracket
- ✦ Control module on longer 6 metre conduit

- ✦ 'Blanked-base'
- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity (strongly recommended for vertical operation)
- ✦ Gas injection & vacuum compatible tube end seal assemblies
- ✦ 2 phase, 3 phase or 'universal' power supply, depending upon model
- ✦ 8 or 20 segment programmer
- ✦ RS232 communications & graphical recorders

The versatile furnace body and stand design enable operation in a vertical position or mounting onto a test rig or wall bracket with the control module linked to the furnace through a two metre (or optionally longer) flexible conduit.

*Requires but does not include an appropriate accessory worktube 19.5mm to 170mm outer diameter.*

| Model       | Max temp (°C) | Dimensions                  |                              |                 |                                |                                                  |                              | Max power (W) | Thermo-couple type | W't (kg) | Power supply                 |
|-------------|---------------|-----------------------------|------------------------------|-----------------|--------------------------------|--------------------------------------------------|------------------------------|---------------|--------------------|----------|------------------------------|
|             |               | Max o/d accessory tube (mm) | Tube* / Worktube length (mm) |                 |                                | External Furnace body (inc stand) H x W x D (mm) | Clearance under furnace (mm) |               |                    |          |                              |
|             |               |                             | Heated*                      | For work in air | **For modified atmosphere work |                                                  |                              |               |                    |          |                              |
|             |               |                             | Furnace body length (mm)     |                 |                                | Control module H x W x D (mm)                    |                              |               |                    |          |                              |
| GVA 12/300  | 1200          | 170                         | 300<br>480                   | 500             | 900                            | 1345 x 468 x 662<br>225 x 600 x 380              | 251 to 778                   | 2300          | N                  | –        | Single or 2 phase            |
| GVA 12/450  | 1200          | 170                         | 450<br>630                   | 650             | 1050                           | 1418 x 468 x 662<br>225 x 600 x 380              | 177 to 702                   | 3100          | N                  | –        | Single, 3 phase or Universal |
| GVA 12/600  | 1200          | 170                         | 600<br>780                   | 800             | 1200                           | 1418 x 648 x 662<br>225 x 600 x 380              | 177 to 550                   | 3900          | N                  | –        | Universal                    |
| GVA 12/750  | 1200          | 170                         | 750<br>930                   | 950             | 1350                           | 1793 x 468 x 662<br>225 x 600 x 380              | 177 to 777                   | 4600          | N                  | 50       | Universal                    |
| GVA 12/900  | 1200          | 170                         | 900<br>1080                  | 1100            | 1500                           | 1860 x 468 x 662<br>225 x 600 x 380              | 100 to 702                   | 5400          | N                  | 57       | Universal                    |
| GVA 12/1050 | 1200          | 170                         | 1050<br>1230                 | 1250            | 1650                           | 1943 x 468 x 662<br>225 x 600 x 380              | 26 to 627                    | 6200          | N                  | 68       | Universal                    |
| GVA 12/1200 | 1200          | 170                         | 1200<br>1380                 | 1400            | 1800                           | 2018 x 468 x 662<br>225 x 600 x 380              | 26 to 551                    | 7000          | N                  | –        | Universal                    |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating temperature is 100°C below maximum temperature.

\*\* To ensure tube end temperatures that are compatible with sealing assemblies, worktubes extending beyond the standard length are required when working with modified atmospheres. Radiation shields may also be required. Heat up rate is measured to 100°C below max, using an empty tube & end plugs.

## GHC Wire Embedded Three Zone Tube Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ Excellent uniformity results from the heated length divided into 3 zones each with its own controller & thermocouple
- ✓ Power to the end zones is automatically adjusted to compensate for heat loss, even without end plugs fitted
- ✓ Provides a longer uniform zone than that which can be achieved in a single zone tube furnace
- ✓ Heated tube lengths of 450, 600, 750, 900, 1050, or 1380mm
- ✓ Accepts accessory worktubes with outer diameter up to 170mm
- ✓ All three zones are controlled to the same set-point
- ✓ Horizontal configuration with furnace mounted onto control module
- ✓ PID controller with single ramp to setpoint & process timer.



GHC 12/1200/3216P1 with over-temp

Three zone control provides a considerably longer uniform temperature zone than is possible with single zone furnaces. However if a programmed controlled cooling ramp is required then specify the 'Retransmission of Setpoint' control option at the time of ordering.

*Requires but does not include an appropriate accessory worktube up to 170mm outer diameter.*

### Options

*specify these at time of order*

- ✦ End zones of either 150mm or 300mm long
- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity
- ✦ Gas injection & vacuum compatible tube end, seal assemblies
- ✦ 8 & 20 segment programmable controllers
- ✦ RS232 communications & graphical recorders
- ✦ 'Retransmission of Setpoint' control configuration to facilitate programmed cooling
- ✦ Alternative furnace sizes can be supplied upon request

| Model       | Max temp (°C) | Heat-up time (mins) | Dimensions                  |                              |                 |                                |                          | *Average uniform length ±5°C (mm) | Max power (W)            | Thermo-couple type | W't (kg) | Power supply              |
|-------------|---------------|---------------------|-----------------------------|------------------------------|-----------------|--------------------------------|--------------------------|-----------------------------------|--------------------------|--------------------|----------|---------------------------|
|             |               |                     | Max o/d accessory tube (mm) | Tube• / Worktube length (mm) |                 |                                | External H x W x D (mm)  |                                   |                          |                    |          |                           |
|             |               |                     |                             | Heated•                      | For work in air | **For modified atmosphere work |                          |                                   | Furnace body length (mm) |                    |          |                           |
| GHC 12/450  | 1200          | 98                  | 170                         | 450                          | 750             | 1050                           | 672 x 676 x 468<br>630   | 300                               | 3100<br>1500             | N                  | 6.5      | Single phase or Universal |
| GHC 12/600  | 1200          | 64                  | 170                         | 600                          | 900             | 1200                           | 672 x 827 x 468<br>780   | 440                               | 3900<br>1800             | N                  | 40       | Universal                 |
| GHC 12/750  | 1200          | 74                  | 170                         | 750                          | 1050            | 1350                           | 672 x 976 x 468<br>930   | 500                               | 4600<br>2200             | N                  | 40       | Universal                 |
| GHC 12/900  | 1200          | 79                  | 170                         | 900                          | 1200            | 1500                           | 672 x 1126 x 468<br>1080 | 640                               | 5400<br>2800             | N                  | 51       | Universal                 |
| GHC 12/1050 | 1200          | 100                 | 170                         | 1050                         | 1350            | 1650                           | 672 x 1276 x 468<br>1230 | 880                               | 6200<br>2800             | N                  | 55       | Universal                 |
| GHC 12/1200 | 1200          | –                   | 170                         | 1200                         | 1500            | 1800                           | 672 x 1426 x 468<br>1380 | –                                 | 7000<br>3100             | N                  | –        | Universal                 |

\*'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies

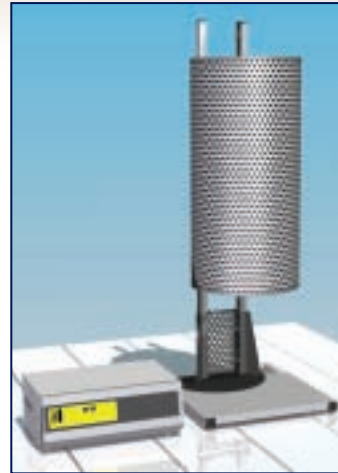


Continuous operating temperature is 100°C below maximum temperature.  
Heat up rate is measured to 100°C below max, using an empty tube & end plugs.  
Holding power is measured at the continuous operating temperature.  
Uniform length measured with end plugs fitted.

## GVC Wire Embedded Versatile Configuration Three Zone Tube Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ Excellent uniformity results from the heated length's division into 3 zones each with its own controller & thermocouple
- ✓ Power to the end zones is automatically adjusted to compensate for heat loss
- ✓ Provides a longer uniform zone than can be achieved in a single zone tube furnace
- ✓ Heated lengths of 450, 600, 750, 900, 1050, or 1380mm
- ✓ Accepts accessory work tubes with maximum outer diameter of 170mm
- ✓ All three zones are controlled to the same set-point
- ✓ Vertical configuration with separate control module
- ✓ PID controller with single ramp to setpoint & process timer.



GVC 12/750

### Options

*specify these at time of order*

- ✦ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ Available without stand (comprising control module & furnace body with cradle)
- ✦ Available without foot (for horizontal mounting or wall mounting using additional bracket)
- ✦ Wall mounting bracket
- ✦ Control module on longer 6 metre conduit
- ✦ 'Blank base' mounting option
- ✦ Gas injection & vacuum compatible tube end seal assemblies

- ✦ Insulation plugs & radiation shields are strongly recommended to prevent heat loss & improve uniformity (and are essential for vertical operation)
- ✦ 3 phase or 'universal' power supply, depending upon model
- ✦ 8 or 20 segment programmer
- ✦ 'Retransmission of Setpoint' control configuration to facilitate programmed cooling
- ✦ RS232 communications & graphical recorders
- ✦ Alternative furnace sizes can be supplied upon request

Providing the benefits of a three zone tube furnace in the form of an extended uniform zone together with versatile furnace mounting options and a separate control module linked through a 2 meter flexible conduit.

*Requires but does not include an appropriate accessory worktube with maximum 170mm outer diameter.*

| Model       | Max temp (°C) | Heat-up time (mins) | Dimensions                   |                              |                 |                                |                                                                            | Clearance under furnace H (mm) | *Average uniform length ±5°C (mm) | Max power (W)<br>Holding power (W) | Thermo-couple type | W't (kg) | Power supply                 |
|-------------|---------------|---------------------|------------------------------|------------------------------|-----------------|--------------------------------|----------------------------------------------------------------------------|--------------------------------|-----------------------------------|------------------------------------|--------------------|----------|------------------------------|
|             |               |                     | Max o/d access-ory tube (mm) | Tube* / Worktube length (mm) |                 |                                | External Furnace<br>H x W x D (mm)<br><br>Control module<br>H x W x D (mm) |                                |                                   |                                    |                    |          |                              |
|             |               |                     |                              | Heated*                      | For work in air | **For modified atmosphere work |                                                                            |                                |                                   |                                    |                    |          |                              |
|             |               |                     |                              |                              |                 |                                |                                                                            |                                |                                   |                                    |                    |          |                              |
| GVC 12/450  | 1200          | 75                  | 170                          | 450<br>630                   | 750             | 1050                           | 1418 x 468 x 662<br>225 x 600 x 380                                        | 177 to 702                     | 300                               | 3100<br>1500                       | N                  |          | Single, 3 phase or Universal |
| GVC 12/600  | 1200          | 80                  | 170                          | 600<br>780                   | 900             | 1200                           | 1418 x 468 x 662<br>225 x 600 x 380                                        | 177 to 550                     | 440                               | 3900<br>1800                       | N                  |          | Single phase or Univeral     |
| GVC 12/750  | 1200          | 92                  | 170                          | 750<br>930                   | 1050            | 1350                           | 1793 x 468 x 662<br>225 x 600 x 380                                        | 177 to 777                     | 500                               | 4600<br>2200                       | N                  | 50       | Single phase or Univeral     |
| GVC 12/900  | 1200          | 111                 | 170                          | 900<br>1080                  | 1200            | 1500                           | 1860 x 468 x 662<br>225 x 600 x 380                                        | 100 to 702                     | 640                               | 5400<br>2800                       | N                  | 57       | Single phase or Univeral     |
| GVC 12/1050 | 1200          | 122                 | 170                          | 1050<br>1230                 | 1350            | 1650                           | 1943 x 468 x 662<br>225 x 600 x 380                                        | 26 to 627                      | 880                               | 6200<br>2800                       | N                  | 68       | Single phase or Univeral     |
| GVC 12/1200 | 1200          | 81                  | 170                          | 1200<br>1380                 | 1500            | 1800                           | 2018 x 468 x 662<br>225 x 600 x 380                                        | 26 to 551                      | –                                 | 7000<br>3100                       | N                  | –        | Single phase or Univeral     |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating temperature is 100°C below maximum temperature.

Heat up rate is measured to 100°C below max, using an empty tube & end plugs. Holding power is measured at the continuous operating temperature. Uniform length measured with end plugs fitted. Allow 100mm to right side for the conduit to exit the control module.



## HST Horizontal Single Zone Split Tube Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ Accepts worktubes with outer diameters up to 110mm
- ✓ Heated tube lengths of 200, 300, 400, 600, 900mm
- ✓ Furnace splits into two halves to accommodate reactor vessels, large workpieces or samples fixed into a test rig
- ✓ Long life, rapid heating, resistance wire elements mounted in rigid, half cylindrical vacuum formed insulation modules
- ✓ Control module with 2 metre conduit to furnace
- ✓ Carbolite 301 controller, with single ramp to set-point facility
- ✓ Delayed start / process timer function as standard



HST 12/70/600

### Options

*specify these at time of order*

- ✦ Non-permeable inner worktubes and end seal assemblies for modified atmosphere
- ✦ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ Available with 'L' stand kit for vertical or horizontal use
- ✦ Wall mounting bracket
- ✦ Control module on longer 6 metre conduit
- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity
- ✦ 2 phase, 3 phase or 'universal' power supply, depending upon model

- ✦ 8 or 20 segment programmer
- ✦ RS232 communications & graphical recorders

*Requires but does not include an appropriate accessory worktube 19.5mm to 110mm outer diameter.  
Please specify worktube diameter when ordering split tube furnaces.*

| Model      | Max temp (°C) | Heat-up time (mins) | Dimensions                  |                              |                 |                                |                                                                              | *Average uniform length ±5°C (mm) | Max power (W) | Thermo-couple type | W't (kg) | Power supply                 |
|------------|---------------|---------------------|-----------------------------|------------------------------|-----------------|--------------------------------|------------------------------------------------------------------------------|-----------------------------------|---------------|--------------------|----------|------------------------------|
|            |               |                     | Max o/d accessory tube (mm) | Tube* / Worktube length (mm) |                 |                                | External Furnace (inc stand) H x W x D (mm)<br>Control module H x W x D (mm) |                                   |               |                    |          |                              |
|            |               |                     |                             | Heated*                      | For work in air | **For modified atmosphere work |                                                                              |                                   |               |                    |          |                              |
|            |               |                     |                             | Furnace body length (mm)     |                 |                                |                                                                              |                                   |               |                    |          |                              |
| HST 12/200 | 1200          | 45                  | 110                         | 200<br>350                   | 350             | 650                            | 350 x 325 x 410<br>222 x 370 x 376                                           | 100                               | 1000          | N                  | 26       | Single or 2 phase            |
| HST 12/300 | 1200          | 45                  | 110                         | 300<br>450                   | 450             | 750                            | 350 x 425 x 410<br>222 x 370 x 376                                           | 150                               | 1500          | N                  | 28       | Single, 3 phase or Universal |
| HST 12/400 | 1200          | 45                  | 110                         | 400<br>550                   | 550             | 850                            | 350 x 525 x 410<br>222 x 370 x 376                                           | 200                               | 2000          | N                  | 32       | Universal                    |
| HST 12/600 | 1200          | 45                  | 110                         | 600<br>750                   | 750             | 1050                           | 350 x 725 x 410<br>222 x 370 x 376                                           | 300                               | 3000          | N                  | 38       | Universal                    |
| HST 12/900 | 1200          | 45                  | 110                         | 900<br>1050                  | 1050            | 1350                           | 350 x 1025 x 410<br>222 x 370 x 376                                          | 450                               | 4500          | N                  | 60       | Universal                    |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



**Continuous operating temperature is 100°C below maximum temperature.**

Heat up rate is measured to 100°C below max, using an empty tube & end plugs.

\*Average of uniform lengths at 100°C intervals from 800°C to 1200°C, measured with end plugs fitted.

\*\* To ensure tube end temperatures that are compatible with sealing assemblies, worktubes extended beyond the standard length are required when working with modified atmospheres. Radiation shields may also be required.

Allow 100mm to right side for the conduit to exit the control module.

## VST Vertical Single Zone Split Tube Furnaces

### Standard features

- ✓ 1200°C Maximum operating temperature
- ✓ Accepts worktubes with outer diameters up to 110mm
- ✓ Heated lengths of 200, 300, 400, 600, 900mm
- ✓ Furnace hinges into two halves to accommodate reactor vessels, large workpieces or samples fixed into a test rig
- ✓ Long life, rapid heating resistance wire elements mounted in rigid, half cylindrical vacuum formed insulation modules
- ✓ Supplied in 'near-hinge' configuration complete with stand
- ✓ Control module with 2 metre conduit to furnace cradle
- ✓ Carbolite 301 controller, with single ramp to set-point facility
- ✓ Delayed start / process timer function as standard



VST 12/600/3508P1 (near hinge)

- ✦ 8 or 20 segment programmer
- ✦ RS232 communications & graphical recorders

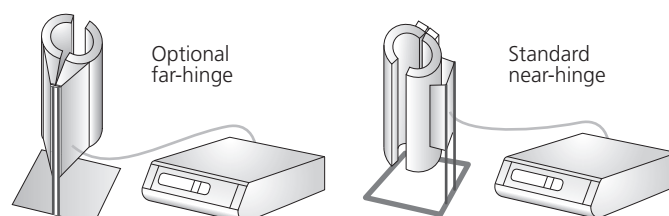
### Options

*specify these at time of order*

- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity
- ✦ 'Far-hinge' configuration providing wider opening of furnace body
- ✦ Non-permeable inner worktubes to contain modified atmosphere
- ✦ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ Control module on longer 6 metre conduit
- ✦ Gas injection & vacuum compatible tube end seal assemblies
- ✦ 3 phase or 'universal' power supply, depending upon model

The free standing vertical design is ideal for wrap around heating applications such as extension test rigs or vertical reaction tubes. The 'far hinge' option opens wider for greater flexibility in application.

*Usually requires but does not include an appropriate accessory worktube 19.5mm to 110mm outer diameter. End plugs are strongly recommended when using vertical tube furnaces.*



| Model      | Max temp (°C) | Heat-up time (mins) | Dimensions                  |                               |                 |                                |                                                    | Max power (W)     | Thermo-couple type | W't (kg) | Power supply                       |
|------------|---------------|---------------------|-----------------------------|-------------------------------|-----------------|--------------------------------|----------------------------------------------------|-------------------|--------------------|----------|------------------------------------|
|            |               |                     | Max o/d accessory tube (mm) | Tube ° / Worktube length (mm) |                 |                                | External Furnace (inc stand)                       |                   |                    |          |                                    |
|            |               |                     |                             | Heated°                       | For work in air | **For modified atmosphere work |                                                    |                   |                    |          |                                    |
|            |               |                     |                             | Furnace body length (mm)      |                 |                                | H x W x D (mm)<br>Control module<br>H x W x D (mm) | Holding power (W) |                    |          |                                    |
| VST 12/200 | 1200          | 45                  | 110                         | 200<br>350                    | 500             | 800                            | 300 x 350 x 350<br>222 x 370 x 376                 | 1000<br>800       | N                  | 24       | Single                             |
| VST 12/300 | 1200          | 45                  | 110                         | 300<br>450                    | 600             | 900                            | 400 x 350 x 350<br>222 x 370 x 376                 | 1500              | N                  | 25       | Single                             |
| VST 12/400 | 1200          | 45                  | 110                         | 400<br>550                    | 700             | 1000                           | 500 x 350 x 350<br>222 x 370 x 376                 | 2000<br>900       | N                  | 26       | Single                             |
| VST 12/600 | 1200          | 45                  | 110                         | 600<br>750                    | 900             | 1200                           | 700 x 350 x 350<br>222 x 370 x 376                 | 3000<br>1100      | N                  | 32       | Single,<br>3 phase or<br>Universal |
| VST 12/900 | 1200          | 45                  | 110                         | 900<br>1050                   | 1200            | 1500                           | 1000 x 350 x 350<br>222 x 370 x 376                | 4500              | N                  | 44       | Single,<br>3 phase or<br>Universal |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



**Continuous operating temperature is 100°C below maximum temperature.**

Heat up rate is measured to 100°C below max, using an empty tube & end plugs. Holding power is measured at the continuous operating temperature. \*Average of uniform length measured with end plugs fitted.

\*\* To ensure tube end temperatures that are compatible with sealing assemblies, worktubes extending beyond the standard length are required when working with modified atmospheres. Radiation shields may also be required. Allow 100mm to right side for the conduit to exit the control module.

## TZF Wire Wound Horizontal Three Zone Tube Furnaces

### Standard features

- ✓ 1200°C maximum operating temperatures
- ✓ Excellent uniformity results from division of the heated length into 3 zones each with its own controller & thermocouple.
- ✓ Provides a longer uniform zone than can be achieved in single zone tube furnace
- ✓ Power to the end zones is automatically adjusted to compensate for heat loss
- ✓ All three zones are controlled to the same set-point
- ✓ Heated lengths of 400, 550, 700 or 900mm
- ✓ Models accepting worktubes with outer diameters of 38mm to 90mm
- ✓ Horizontally mounted on control module base



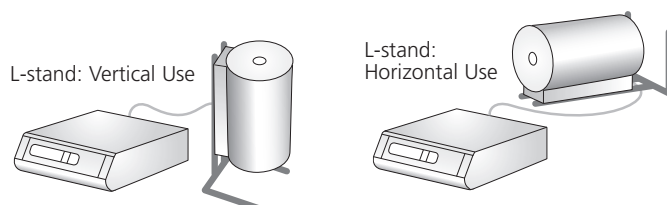
TZF 12/75/700/3216P1

Comprising an horizontal furnace body with three zone wire wound worktube element that is equipped as standard with 'Back to Back' zone control. It can be used directly or with accessory worktubes.

### Options

*specify these at time of order*

- ✦ Shorter end zone option to provide extended uniform length (optionally in 2 phase configuration)
- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity
- ✦ Gas injection & vacuum compatible worktube end seal assemblies
- ✦ Separate control module on 2 metre or 6 metre conduit
- ✦ 'L' style flexible stand option for vertical or independent mounting
- ✦ 8 or 20 segment programmer
- ✦ 'Retransmission of Setpoint' zone control configuration for programmed cooling
- ✦ RS232 communications & graphical recorders
- ✦ Alternative furnace sizes can be supplied upon request



| Model          | Max temp (°C) | Heat-up time (mins) | Dimensions                  |                         |                             |                          | *Uniform length ±5°C (mm) | Max power (W) | Thermo-couple type | Weight (kg) | Power supply           |
|----------------|---------------|---------------------|-----------------------------|-------------------------|-----------------------------|--------------------------|---------------------------|---------------|--------------------|-------------|------------------------|
|                |               |                     | Max o/d accessory tube (mm) | Heated tube length (mm) | Overall furnace length (mm) | External H x W x D (mm)  |                           |               |                    |             |                        |
|                |               |                     |                             |                         |                             | Furnace body length (mm) |                           |               |                    |             |                        |
| TZF 12/38/400  | 1200          | 25                  | 25                          | 400                     | 450                         | 430 x 450 x 375<br>450   | 305                       | 1175<br>700   | N                  | 32          | Single                 |
| TZF 12/65/550  | 1200          | 45                  | 50                          | 550                     | 600                         | 525 x 625 x 360<br>600   | 390                       | 1817<br>600   | N                  | 38          | Single<br>3 phase      |
| TZF 12/75/700  | 1200          | 45                  | 60                          | 700                     | 750                         | 525 x 775 x 360<br>750   | 540                       | 2755<br>800   | N                  | 46          | Single<br>3 phase      |
| TZF 12/100/900 | 1200          | 120                 | 80                          | 900                     | 950                         | 525 x 975 x 360<br>950   | 754                       | 4150<br>1000  | N                  | 54          | Single or<br>Universal |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating temperature is 100°C below maximum temperature.

Heat up rate is measured to 100°C below max, using an empty tube & end plugs.

Holding power is measured at the continuous operating temperature.

Uniform length measured with end plugs fitted.

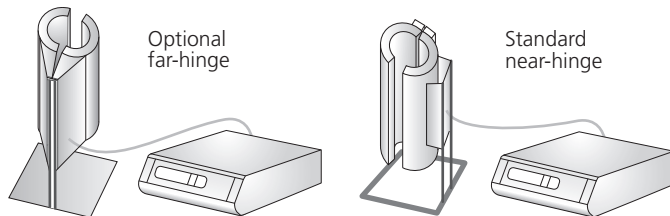
## HZS & TVS Wire Embedded Versatile Configuration Three Zone Split Tube Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ Accepts accessory worktubes with maximum outer diameters up to 110mm
- ✓ Heated length of 600mm or 900mm
- ✓ Versatile horizontal (HZS) or vertical (TVS) configuration furnaces with separate control module on 2 metre conduit
- ✓ Furnace splits into two halves to accommodate reactor vessels, large workpieces or samples fixed into a test rig
- ✓ Long life, rapid heating, resistance wire elements mounted in rigid, half cylindrical vacuum formed insulation modules
- ✓ Carbolite 301 controller, with single ramp to set-point facility with two back to back 2132 controllers
- ✓ Delayed start / process timer function as standard



TVS 12/600/3216P (near hinge)



- ★ Wall mounting bracket
- ★ 'Far-hinge' configuration alternatives for the vertical TVS range
- ★ Control module on longer 6 metre conduit
- ★ Gas injection & vacuum compatible tube end seal assemblies
- ★ 3 phase or 'universal' power supply
- ★ 8 or 20 segment programmer
- ★ RS232 communications & graphical recorders

### Options

*specify these at time of order*

- ★ With end zones either 150mm long or with three approximately equal length zones
- ★ Insulation plugs & radiation shields to prevent heat loss & improve uniformity (strongly recommended for vertical tubes)
- ★ Non-permeable inner worktubes to contain modified atmosphere
- ★ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ★ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ★ Available with 'L' stand kit for vertical and horizontal use

Ranges of horizontal (HZS) and vertical (TVS) three zone split tube furnaces heated using wire wound elements. These offer the advantages of increased uniform heated length and a furnace body capable of versatile horizontal, vertical or 'L' stand mounting.

*Requires but does not include an appropriate accessory worktube up to 110mm outer diameter.*

*Please indicate worktube diameter at time of ordering.*

| Model      | Max temp (°C) | Heat-up time (mins) | Dimensions                  |                              |                 |                                |                                                                            | *Average uniform length ±5°C (mm) | Max power (W)<br>Holding power (W) | Thermo-couple type | W't (kg) | Power supply         |
|------------|---------------|---------------------|-----------------------------|------------------------------|-----------------|--------------------------------|----------------------------------------------------------------------------|-----------------------------------|------------------------------------|--------------------|----------|----------------------|
|            |               |                     | Max o/d accessory tube (mm) | Tube* / Worktube length (mm) |                 |                                | External Furnace<br>H x W x D (mm)<br><br>Control module<br>H x W x D (mm) |                                   |                                    |                    |          |                      |
|            |               |                     |                             | Heated*                      | For work in air | **For modified atmosphere work |                                                                            |                                   |                                    |                    |          |                      |
|            |               |                     |                             |                              |                 |                                |                                                                            |                                   |                                    |                    |          |                      |
| HZS 12/600 | 1200          | 45                  | 110                         | 600<br>750                   | 900             | 1200                           | 350 x 725 x 410<br>225 x 570 x 380                                         | 500                               | 3000<br>—                          | N                  | 40       | 3 phase or Universal |
| HZS 12/900 | 1200          | 45                  | 110                         | 900<br>1050                  | 1200            | 1500                           | 350 x 1050 x 410<br>225 x 570 x 380                                        | 750                               | 4500<br>1100                       | N                  | 65       | 3 phase or Universal |
| TVS 12/600 | 1200          | 45                  | 110                         | 600<br>750                   | 600             | 750                            | 700 x 350 x 350<br>225 x 570 x 380                                         | 500                               | 3000<br>—                          | N                  | 34       | 3 phase or Universal |
| TVS 12/900 | 1200          | 45                  | 110                         | 900<br>1050                  | 1200            | 1050                           | 1000 x 350 x 350<br>225 x 570 x 380                                        | 750                               | 4500<br>—                          | N                  | 44       | 3 phase or Universal |

'Universal' models are easily altered between single phase (220V), 3 phase+neutral (e.g. 380/220V) and delta (e.g. 220V) electrical supplies



Continuous operating temperature is 100°C below maximum temperature.

Heat up rate is measured to 100°C below max, using an empty tube & end plugs. Holding power is measured at the continuous operating temperature. Uniform length measured with end plugs fitted. Allow 100mm to right side for the conduit to exit the control module.



## STF High Temperature Single Zone Tube Furnaces

### Standard features

- ✓ 1500°C & 1600°C maximum operating temperatures
- ✓ Using worktubes of 60 or 90mm outer diameter
- ✓ Accepts worktubes with 180, 450 or 610mm heated tube length
- ✓ Silicon carbide heating elements
- ✓ Horizontal configuration
- ✓ Carbolite 301 controller, with single ramp to set-point facility
- ✓ Delayed start / process timer function as standard

### Options

*specify these at time of order*

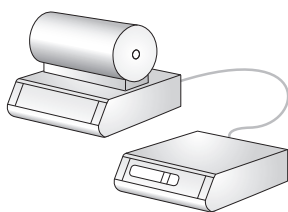
- ✦ Available with 'L' stand kit or wall bracket for vertical or horizontal use
- ✦ Available in 'Blank-stand' or 'Separate-stand' configurations
- ✦ Non-permeable inner worktubes to contain modified atmosphere
- ✦ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation)
- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity-recommended for vertical tubes
- ✦ Gas injection & vacuum compatible tube end, seal assemblies
- ✦ 3 Phase or 'universal' power supply, depending upon model
- ✦ 8 or 20 Segment programmer
- ✦ RS232 communications & graphical recorders



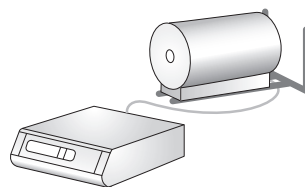
STF 15/180/301 (L STAND OPTION)

A range of tube furnaces offering the higher temperatures that are available from silicon carbide heating elements, with the additional option of a vertical 'L' stand and separate controller if preferred. The user must select an accessory worktube specific to their application.

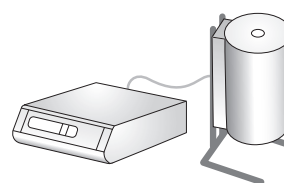
*Requires but does not include an appropriate accessory worktube 19.5mm to either 60mm or 90mm outer diameter.*



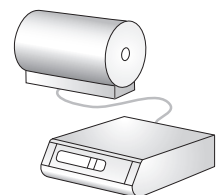
Blanked Base



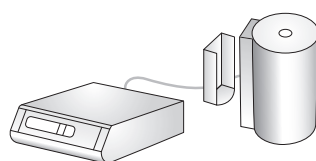
L-stand: Horizontal Use



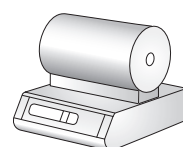
L-stand: Vertical Use



Separated Controls  
(No Stand)



Wall Bracket

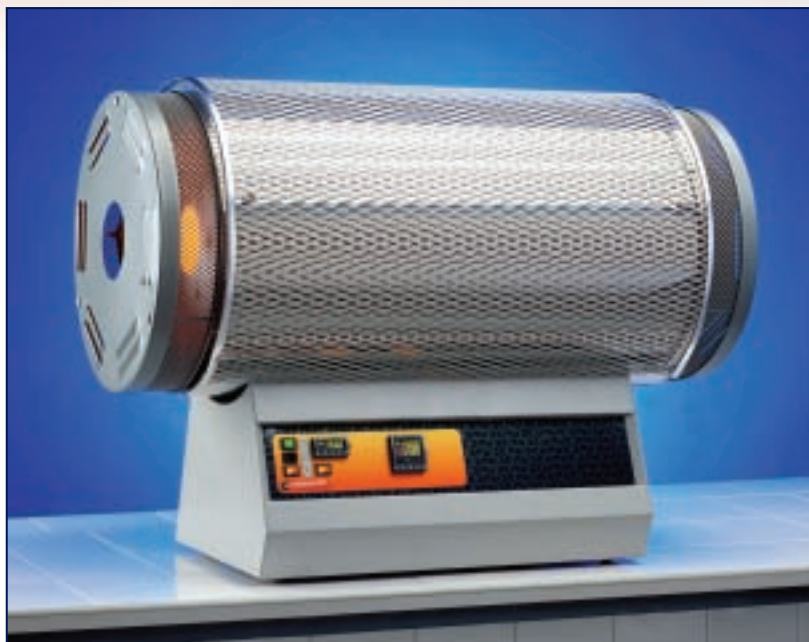


Normal Construction  
(Horizontal)

## STF High Temperature Single Zone Tube Furnaces

### Power Supplies for Silicon Carbide Furnaces

The characteristics of the control systems that are used with silicon carbide elements result in maximum power supply requirements that are not as intuitively derived as those for furnaces using other heating technologies. For this reason a more detailed description of the maximum power supply that is required per phase has been included in the specification table.



STF 15/610 with over-temp

| Model      | Max temp (°C) | Heat-up time (mins)                                        | Dimensions                   |                              |                 |                                |                          | Uni-form length ±10°C (mm) | Holding power (W) | T/C type | W't (kg) | Power supply required per phase                                                                |
|------------|---------------|------------------------------------------------------------|------------------------------|------------------------------|-----------------|--------------------------------|--------------------------|----------------------------|-------------------|----------|----------|------------------------------------------------------------------------------------------------|
|            |               |                                                            | Max o/d access-ory tube (mm) | Tube* / Worktube length (mm) |                 |                                | External H x W x D (mm)  |                            |                   |          |          |                                                                                                |
|            |               |                                                            |                              | Heated*                      | For work in air | **For modified atmosphere work | Furnace body length (mm) |                            |                   |          |          |                                                                                                |
| STF 15/180 | 1500          | Rate will vary with state of oxidation and age of elements | 60                           | 180                          | 600             | 900                            | 500 x 600 x 375<br>600   | 80                         | —<br>1500         | R        | 29       | <i>a1</i> =12A, <i>d1</i> =24A                                                                 |
| STF 15/450 | 1500          |                                                            | 90                           | 450                          | 900             | 1200                           | 660 x 830 x 445<br>900   | 350                        | 3800<br>5500      | R        | 34       | <i>a1</i> =39A, <i>a2</i> =19.5A, <i>c3</i> =25A                                               |
| STF 15/610 | 1500          |                                                            | 90                           | 610                          | 1200            | 1500                           | 660 x 1130 x 445<br>1200 | 400                        | 4200<br>6000      | R        | 45       | <i>a1</i> =39A, <i>b1</i> =44A, <i>a2</i> =19.5A, <i>a3</i> =34A                               |
| STF 16/180 | 1600          |                                                            | 60                           | 180                          | 600             | 900                            | 500 x 600 x 375<br>600   | 80                         | —<br>2500         | R        | 29       | <i>a1</i> =21A                                                                                 |
| STF 16/450 | 1600          |                                                            | 90                           | 450                          | 900             | 1200                           | 660 x 830 x 445<br>900   | 350                        | —<br>6000         | R        | 40       | <i>a1</i> =47A, <i>a2</i> =24A, <i>h3</i> =21A, <i>a3</i> =39A, <i>g3</i> =21A                 |
| STF 16/610 | 1600          |                                                            | 90                           | 610                          | 1200            | 1500                           | 660 x 1130 x 445<br>1200 | 400                        | —<br>7000         | R        | 50       | <i>a1</i> =50A, <i>a2</i> =25A, <i>h3</i> =25A, <i>i3</i> =27A, <i>d3</i> =43A, <i>e3</i> =46A |

*a1*=Single 200-240V, *b1*=Single 200-208V, *d1*=Single 110-120V, *a2*=380-415V 2 phase + N, *a3*=200-240V 3 phase delta, *c3*=Single 200-208V 3 phase + N, *d3*=200-220V 3 phase delta, *e3*=230-240V 3 phase delta, *f3*=19.5A, *g3*=380-415V 3 phase no N, *h3*=380-415V 3 phase + N, *i3*=400-415 3 phase + N



Continuous operating temperature is 100°C below maximum temperature.

Holding power is measured at the continuous operating temperature.

Uniform length measured with end plugs fitted.

\*\* To ensure tube end temperatures that are compatible with sealing assemblies, worktubes extending beyond the standard length are required when working with modified atmospheres. Radiation shields may also be required.

## VST Vertical Single Zone Split Tube Furnaces

### Standard features

- ✓ 1700°C Maximum operating temperature
- ✓ Heated tube length of 250mm
- ✓ Three models for tubes with outer diameters up to 32mm, 32 to 66mm and 66 to 90mm
- ✓ Furnace splits into two halves to accommodate reactor vessels, large workpieces or samples fixed into a test rig
- ✓ Molybdenum disilicide elements to 1700°C
- ✓ Supplied in 'near-hinge' configuration complete with stand
- ✓ Control module with 2m conduit to furnace cradle
- ✓ Carbolite 3216P1 controller with 16 paired segment programmability
- ✓ Over-temperature protection, from secondary controller



VST 17/250

### Options

*specify these at time of order*

- ✦ Non permeable inner worktubes to contain modified atmosphere
- ✦ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ✦ Control module on longer 6m conduit
- ✦ Insulation plugs & radiation shields are strongly recommended for high temperature vertical tube furnaces to prevent heat loss & improve uniformity.
- ✦ Gas injection & vacuum compatible tube end seal assemblies
- ✦ 20 segment programmer
- ✦ RS232 Communications & graphical recorders

The free standing vertical design is ideal for wrap around heating applications such as extension test rigs or vertical reaction tubes. Two hinge designs ('near hinge' or 'far-hinge') provide a wider opening furnace body and hence even more application flexibility.

*Usually requires but does not include an appropriate accessory worktube 32mm, 66mm or 90mm maximum outer diameter.*



VST 17/250/90

| Model         | Max temp (°C) | Heat-up time (mins) | Dimensions                  |                              |                 |                                |                                                       | Max power (W) | Thermo-couple type | Weight (kg) | Power supply |
|---------------|---------------|---------------------|-----------------------------|------------------------------|-----------------|--------------------------------|-------------------------------------------------------|---------------|--------------------|-------------|--------------|
|               |               |                     | Max o/d accessory tube (mm) | Tube* / Worktube length (mm) |                 |                                | External Furnace (inc stand) H x W x D (mm)           |               |                    |             |              |
|               |               |                     |                             | Heated*                      | For work in air | **For modified atmosphere work |                                                       |               |                    |             |              |
|               |               |                     |                             |                              |                 |                                | Control module H x W x D (mm)                         |               |                    |             |              |
| VST 17/250/32 | 1700          | –                   | 32                          | 250                          | 550             | 850                            | 865 x 600 x 705<br>630 x 600 x 490                    | 4500          | B                  | 173         | Single phase |
| VST 17/250/66 | 1700          | –                   | 66                          | 250                          | 550             | 850                            | 865 x 600 x 705<br>630 x 600 x 490                    | 4500          | B                  | 173         | Single phase |
| VST 17/250/90 | 1700          | –                   | 90                          | 250                          | 1050            | 1500                           | 1566 x 750 x 880<br>floor standing<br>630 x 600 x 490 | 4500          | B                  | –           | Single phase |



Continuous operating temperature is 100°C below maximum temperature.

Holding power is measured at the continuous operating temperature.

\*Average of uniform length measured with end plugs fitted.

\*\* To ensure tube end temperatures that are compatible with sealing assemblies, worktubes extending beyond the standard length are required when working with modified atmospheres.

Radiation shields or insulation plugs very strongly recommended for high temperature vertical tube furnaces.

## CTF High Temperature Horizontal Tube Furnaces

### Standard features

- ✓ 1700°C & 1800°C maximum operating temperature
- ✓ Utilising molybdenum disilicide elements
- ✓ Using worktubes with outer diameters of up to 90mm
- ✓ 300mm or 600mm heated tube lengths
- ✓ Horizontal configuration
- ✓ 8 Segment programmable controller & separate over-temperature protection

### Options

*specify these at time of order*

- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity
- ✦ Gas injection & vacuum compatible worktube end, seal assemblies
- ✦ Tube supports essential for use with high vacuum seals
- ✦ 2 phase or 3 phase or power supply
- ✦ 20 segment programmer
- ✦ RS232 communications & graphical recorders
- ✦ Alternative furnace sizes can be supplied upon request



CTF 17/75/300/3216P1

Designed for high temperature applications utilising high temperature RCA (recrystallised alumina) worktubes. Vertical elements heat an horizontal tube.

*Requires but does not include an appropriate RCA (recrystallised alumina) accessory worktube 19.5mm to 90mm maximum outer diameter.*

| Model      | Max temp (°C) | Heat-up time (mins)                                        | Dimensions                  |                         |                             |                                                     | Uniform length ±5°C (mm) | Max power (W)<br>Holding power (W) | Thermo-couple type | Weight (kg) | Power supply         |
|------------|---------------|------------------------------------------------------------|-----------------------------|-------------------------|-----------------------------|-----------------------------------------------------|--------------------------|------------------------------------|--------------------|-------------|----------------------|
|            |               |                                                            | Max o/d accessory tube (mm) | Heated tube length (mm) | Overall furnace length (mm) | External H x W x D (mm)<br>Furnace body length (mm) |                          |                                    |                    |             |                      |
| CTF 17/300 | 1700          | Rate will vary with state of oxidation and age of elements | 90                          | 300                     | 650                         | 880 x 720 x 630<br>650                              | 200                      | 4125<br>2500                       | B                  | 126         | Single               |
| CTF 17/600 | 1700          |                                                            | 90                          | 600                     | 950                         | 880 x 1020 x 630<br>950                             | 400                      | 6875<br>3800                       | B                  | 220         | Single, 2 or 3 phase |
| CTF 18/300 | 1800          |                                                            | 90                          | 300                     | 650                         | 945 x 720 x 630<br>650                              | 200                      | 6000<br>5200                       | 2 <sup>‡</sup>     | 130         | Single               |
| CTF 18/600 | 1800          |                                                            | 90                          | 600                     | 950                         | 945 x 1020 x 630<br>950                             | 400                      | 9300<br>5700                       | 2 <sup>‡</sup>     | 230         | Single, 2 or 3 phase |



Continuous operating temperature is 100°C below maximum temperature.

Holding power is measured at the continuous operating temperature.

Uniform length measured with end plugs fitted.

<sup>‡</sup>A Carbolite proprietary thermocouple design.



## PVT High Temperature Vertical Tube Furnaces

### Standard features

- ✓ 1800°C maximum operating temperature
- ✓ Utilising lanthanum chromite elements (these generally achieve slower heating rates than other element materials)
- ✓ Using worktubes with maximum outer diameters of 60, 90, 115 or 140mm
- ✓ Heated lengths of 200mm or 350mm
- ✓ Vertical (only) configuration using the 'L' stand assembly
- ✓ Separate control module on 2 metre conduit
- ✓ 8 Segment programmable controller incorporating over-temperature protection

### Options

*specify these at time of order*

- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity (strongly recommended for vertical tubes)
- ✦ Gas injection & vacuum compatible tube end, seal assemblies
- ✦ 20 segment programmer
- ✦ RS232 communications & graphical recorders
- ✦ Alternative furnace sizes can be supplied upon request



PVT 18/125/350 (with custom shortened stand)

For slower heating, high temperature applications requiring a vertically orientated tube furnace body, which accepts RCA (recrystallised alumina) accessory worktubes.

*Requires but does not include an appropriate RCA (recrystallised alumina) accessory worktube 19.5mm to either 60mm, 90mm, 115mm or 140mm outer diameter, depending on the model.*

**Note:** Lanthanum chromite elements may give off small amounts of chromium vapour in use, which can cause contamination or slight pink colouration when work is carried out without the use of a worktube.

| Model          | Max temp (°C) | Heat-up time (mins)                                        | Dimensions                  |                         |                                     |                          | Max power (W)     | Thermo-couple type | Weight (kg) | Power supply       |
|----------------|---------------|------------------------------------------------------------|-----------------------------|-------------------------|-------------------------------------|--------------------------|-------------------|--------------------|-------------|--------------------|
|                |               |                                                            | Max o/d accessory tube (mm) | Heated tube length (mm) | External Furnace<br>H x W x D (mm)  | Furnace body length (mm) | Holding power (W) |                    |             |                    |
|                |               |                                                            |                             |                         | Control module<br>H x W x D (mm)    |                          |                   |                    |             |                    |
| PVT 18/50/200  | 1800          | Rate will vary with state of oxidation and age of elements | 60                          | 200                     | 850 x 700 x 810<br>222 x 570 x 375  | -                        | 5500<br>4000      | 2‡                 | 270         | 2 phase or 3 phase |
| PVT 18/75/350  | 1800          |                                                            | 90                          | 350                     | 1000 x 700 x 810<br>222 x 570 x 375 | -                        | 9000<br>5000      | 2‡                 | 300         | 3 phase            |
| PVT 18/100/350 | 1800          |                                                            | 115                         | 350                     | 1000 x 700 x 810<br>222 x 570 x 375 | -                        | 6000<br>5000      | 2‡                 | 400         | 3 phase            |
| PVT 18/125/350 | 1800          |                                                            | 140                         | 350                     | 1000 x 700 x 810<br>222 x 570 x 375 | -                        | 9300<br>7000      | 2‡                 | 500         | 3 phase            |



Continuous operating temperature is 100°C below maximum temperature.

Holding power is measured at the continuous operating temperature.

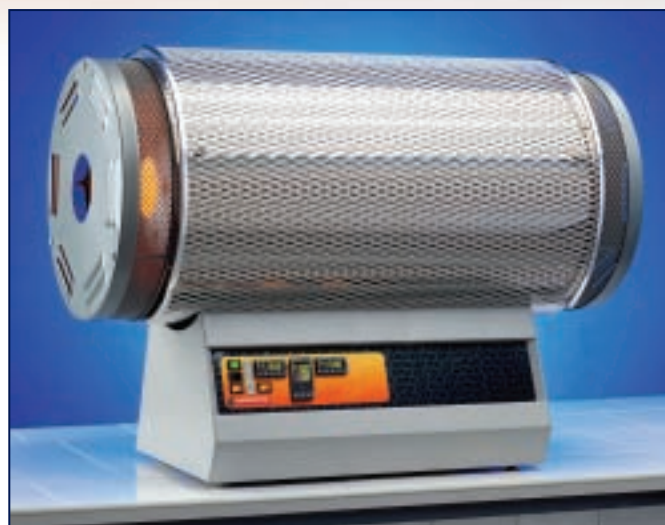
Uniform length measured with end plugs fitted.

<sup>‡</sup>A Carbolite proprietary thermocouple design.

## TZF High Temperature Three Zone Horizontal Tube Furnaces

### Standard features

- ✓ 1800°C maximum operating temperature
- ✓ Accepts worktubes with outer diameters of up to 90mm
- ✓ Heated lengths of 600 or 610mm
- ✓ Includes end-zone controller using "back to back" control configuration
- ✓ Carbolite 301 controller with simple ramp to set points facility (TZF 15 & TZF 16)
- ✓ 8 segment programmable temperature control (TZF 17 & TZF 18)
- ✓ Overtemperature protection (TZF 17 & TZF 18)
- ✓ Delayed start / process timer function as standard



TZF 15/610

Range of silicon carbide & molybdenum disilicide heated three zone furnaces supplied with 'Back to Back' controls as standard. Where programmed cooling rates are required or the option of vertical orientation is chosen then 'Retransmission of Setpoint' control should be requested at time of order.

*Requires but does not include an appropriate accessory worktube up to 90mm outer diameter.*

**Note:** 1700°C or 1800°C furnaces have case configuration similar to the CTF series.

### Options

*specify these at time of order*

- ✦ Non-permeable inner worktubes to contain modified atmosphere
- ✦ Impervious inner worktubes to protect against chemical attack or damage from thermal shock
- ✦ Over-temperature protection (recommended to protect valuable contents & for unattended operation) (TZF 15 & TZF 16)
- ✦ Insulation plugs & radiation shields to prevent heat loss & improve uniformity
- ✦ Control module with 2 metre conduit to furnace cradle
- ✦ Gas injection & vacuum compatible tube end seal assemblies
- ✦ 2 phase, 3 phase or 'universal' power supply, depending upon model
- ✦ 20 segment programmer
- ✦ RS232 communications & graphical recorders
- ✦ 'Retransmission of Setpoint' control configuration to facilitate programmed cooling

| Model                                                                                                                               | Max temp (°C) | Heat-up time (mins) | Dimensions                  |                              |                 |                                |                         | Max power (W)     | T/C type | W't (kg) | Power supply required per phase |
|-------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------|-----------------------------|------------------------------|-----------------|--------------------------------|-------------------------|-------------------|----------|----------|---------------------------------|
|                                                                                                                                     |               |                     | Max o/d accessory tube (mm) | Tube* / Worktube length (mm) |                 |                                | External H x W x D (mm) |                   |          |          |                                 |
|                                                                                                                                     |               |                     |                             | Heated*                      | For work in air | **For modified atmosphere work |                         | Holding power (W) |          |          |                                 |
| TZF 15/610                                                                                                                          | 1500          | 75                  | 90                          | 1200                         | 1500            | 1650                           | 660 x 1130 x 445        | 8000<br>4000      | R        | 44       | a1=60A, h3=22A, e3=38A          |
| TZF 16/610                                                                                                                          | 1600          | –                   | 90                          | 1200                         | 1500            | 1500                           | 660 x 1130 x 445        | 9150<br>4500      | R        | 181      | c1=62A, h3=25A, e3=40A          |
| TZF 17/600                                                                                                                          | 1700          | 150                 | 90                          | 600                          | 1200            | 1500                           | 880 x 1020 x 630        | 9000<br>3800      | B        | 280      | a1=46A, b1=48A, h3=28A, e3=34A, |
| TZF 18/600                                                                                                                          | 1800          | 150                 | 90                          | 600                          | 1200            | 1500                           | 645 x 1020 x 630        | 9300              | 2‡       | 280      | a1=40A, b3=30A, e3=28A, h3=24A  |
| a1=Single 200-240V, b1=200-208V, c1= Single 220-240V, d3=200-220V 3 phase delta, e3=230-240V 3 phase delta, h3=380-415V 3 phase + N |               |                     |                             |                              |                 |                                |                         |                   |          |          |                                 |



Continuous operating temperature is 100°C below maximum temperature.

Uniform length measured with end plugs fitted. Heat up rate will vary with the age and the oxidation state of the elements.

<sup>‡</sup>A Carbolite proprietary thermocouple design.

## HVTT High Vacuum Tube Furnaces

### Standard features

- ✓ 1200°C & 1500°C maximum operating temperature
- ✓ Capable of  $10^{-5}$  mbar vacuum in clean empty worktube.
- ✓ Complete with worktube with inner diameters of either 50, 60, 80 or 75mm
- ✓ Worktube with heated lengths of 450mm, 550mm or 700mm
- ✓ Vacuum provided by two stage rotary sliding vane pump & turbo-molecular pump
- ✓ Manually operated roughing / backing baffle valve
- ✓ Pirani gauge low vacuum monitor
- ✓ Penning gauge high vacuum monitor
- ✓ Worktube connects to the vacuum system via 90° stainless steel radiused connection
- ✓ Access to the worktube is via removable stainless steel vacuum flange
- ✓ Radiation shields at both ends of worktube maintain uniformity without reducing pump speeds
- ✓ The vacuum system & all controls are mounted within the base unit



HVTT TURBO-MOLECULAR HIGH VACUUM TUBE FURNACE

A range of 5 standard units capable of high vacuum operation which also form a base from which bespoke customer designs can be developed in order to meet specific application requirements.

### Options

*specify these at time of order*

- ✦ Overtemperature protection (recommended in all cases of unattended operation or where valuable samples are to be processed)
- ✦ Vertical configurations also available
- ✦ A variety of gas backfill systems are available
- ✦ Additional safety systems for use with combustible atmospheres
- ✦ Automatic & semi-automatic vacuum systems
- ✦ Air or water cooled diffusion pump
- ✦ Oil-free pump options available
- ✦ Cooling water failure alarm
- ✦ Three zone control for improved uniformity
- ✦ Special vertical & custom build configurations
- ✦ 8 or 20 segment programmer
- ✦ RS232/RS484 communications & graphical recorders

| Model                                               | Max temp (°C) | Dimensions                   |                         |                                 | Max power (W)     | Thermo-couple type | Weight (kg) | Power supply required per phase |
|-----------------------------------------------------|---------------|------------------------------|-------------------------|---------------------------------|-------------------|--------------------|-------------|---------------------------------|
|                                                     |               | Worktube inner diameter (mm) | Heated tube length (mm) | External Furnace H x W x D (mm) | Holding power (W) |                    |             |                                 |
| HVTT 12/50/550                                      | 1200          | 50                           | 550                     | 1450 x 1700 x 600               | 2000<br>1600      | N                  | –           | <i>c1</i> =14.5A                |
| HVTT 12/60/700                                      | 1200          | 60                           | 700                     | 1450 x 1700 x 600               | 3000<br>1800      | N                  | –           | <i>c1</i> =18.5A                |
| HVTT 12/80/700                                      | 1200          | 80                           | 700                     | 1450 x 1700 x 600               | 3500<br>2800      | N                  | –           | <i>c1</i> =21A                  |
| HVTT 15/50/450                                      | 1500          | 50                           | 450                     | 1565 x 1700 x 600               | 5500<br>4800      | R                  | –           | <i>c1</i> =45A, <i>a2</i> =26A  |
| HVTT 15/75/450                                      | 1500          | 75                           | 450                     | 1565 x 1700 x 600               | 5500<br>4800      | R                  | –           | <i>c1</i> =45A, <i>a2</i> =26A  |
| <i>c1</i> =220-240V, <i>a2</i> =380-415 2 phase + N |               |                              |                         |                                 |                   |                    |             |                                 |



Continuous operating temperature is 100°C below maximum temperature.  
Holding power is measured at the continuous operating temperature.

## HTR Rotary Reactor Furnaces

### Standard features

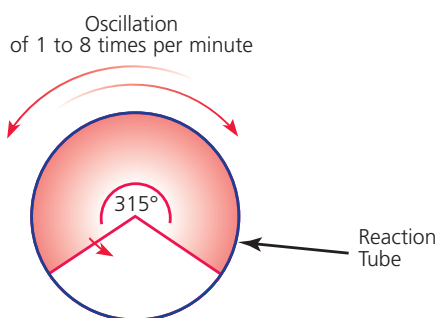
- ✓ 1100°C maximum operating temperature
- ✓ Developed in partnership with the Imperial College of Science & Technology, London
- ✓ Digital PID temperature control
- ✓ Heating is provided by long life, rapid heating, resistance wire elements mounted in rigid, half cylindrical vacuum formed insulation modules
- ✓ The fluted internal surface of the reactor ensures good mixing as the variable speed electric drive system oscillates the reactor tube
- ✓ A positive break safety interlock switch cuts power to the elements when the heating chamber is open
- ✓ Gas enters the reactor through a flexible silicon rubber tube
- ✓ A 30mm flow meter calibrated for nitrogen is provided
- ✓ A single seal gasket directs the reactor exhaust into a removable stainless steel exhaust box from where a gas outlet would enable piping to an extraction system



HTR 11/75

These furnaces combine many of the advantages of fluidised bed reactors with those of a rotary kiln. The sample can be simultaneously heated and agitated under a controlled atmosphere. This overcomes the long reaction times required when using conventional muffle furnaces or static tube under a flowing atmosphere.

*Includes fused quartz reaction vessel.*



### Options

*specify these at time of order*

- ★ Over-temperature protection (recommended in all cases of unattended operation or where valuable samples are to be processed)
- ★ Single or multiple flow meters calibrated for different gases
- ★ Hydrogen detectors & gas safety system
- ★ 8 or 20 segment programmer
- ★ RS232 communications & graphical recorders

### Applications

- ✓ Applications in lab scale calcination of materials
- ✓ Calcining arsenical gold ores under neutral atmospheres to remove sulphur & arsenic
- ✓ Analysis of sulphur ores in metallurgical slags
- ✓ Operation as a low temperature rotary reactor furnace to remove organic solvent from oxide pigment materials
- ✓ Roasting sulphide ores to convert them to oxides
- ✓ Determination of silica content in rice husks
- ✓ Low temperature calcination of limestone & dolomite
- ✓ Calcining colliery spoils at up to 1000°C

| Model      | Max temp (°C) | Heat-up time (mins)               | Dimensions                                  |                               |                            |                                               | Max power Holding power (W) | Thermo-couple type | Weight (kg) | Power supply |
|------------|---------------|-----------------------------------|---------------------------------------------|-------------------------------|----------------------------|-----------------------------------------------|-----------------------------|--------------------|-------------|--------------|
|            |               | Cooling time with lid open (mins) | Reaction chamber dimensions (mm) & Capacity | Oscillation frequency per min | Rotation in each direction | External H x W x D (mm)<br>Lid up<br>Lid down |                             |                    |             |              |
| HTR 11/75  | 1100          | 11<br>15                          | 75 x 100<br>50ml                            | 1 to 8                        | 315°                       | 480 x 1140 x 550<br>800 x 1140 x 680          | 1500<br>400                 | K                  | 40          | Single       |
| HTR 11/150 | 1100          | 21<br>15                          | 150 x 200<br>700ml                          | 1 to 8                        | 315°                       | 540 x 1300 x 900<br>950 x 1300 x 900          | 3000<br>1000                | K                  | 95          | Single       |



Continuous operating temperature is 100°C below maximum temperature.  
Holding power is measured at the continuous operating temperature.



## SPTF Rotating Tube Furnaces

### Standard features

- ✓ 1200°C, 1500°C or 1600°C maximum operating temperature
- ✓ Based upon standard CTF12/75700, CTF12/100/900, STF 15/610 or STF 16/610 standard furnaces
- ✓ Provides laboratory scale simulation of industrial rotary calcining kilns
- ✓ Powders are heated & agitated within the tube ensuring that all of the sample becomes exposed to the atmosphere
- ✓ A 0 to 5° tilting mechanism controls throughput



ROTATING TILTING SPLIT TUBE FURNACE  
(guards removed for illustrative purposes)

### Options

*specify these at time of order*

- ✦ Plain tubes are available in ceramic, quartz or heat resistant metal alloys as well as shaped vessels in quartz & metal equipped with agitation blades.
- ✦ Variable speed drives from 1 to 10 rpm
- ✦ Vibratory feed mechanisms
- ✦ Atmosphere control systems



COMPACT BENCH TOP ROTATING TILTING  
TUBE FURNACE

Large and fully bespoke designs are available  
up to pilot plant scale (see below)



# APPLICATION SPECIFIC FURNACES

One of the natural outcomes arising from customers approaching Carbolite to modify standard furnaces or to manufacture completely bespoke products to meet specific application needs, is the growth of a range of furnaces that are designed for distinctive applications. Applications can range from calcining powders at a laboratory scale through to assaying precious metals for marking under the International Hallmarking Convention.

More frequently furnaces are designed to enable testing to a specific ISO, BS/EN or ASTM standard method.

As with all the other furnaces in the Carbolite range, the standard design is frequently available with a wide range of alternative voltage configurations and controller options. The furnaces described on these pages can also provide the basis for customised designs.



## CDF & CDR Dental Zirconia Sintering Furnaces

### Standard features

#### CDF - Carbolite Dental Furnace

- ✓ Optimised for operation from a standard 13A or 16A single phase mains supply
- ✓ Uniform heating from non-contaminating silicon carbide elements
- ✓ Flexible programming of temperature profiles using 3216P1 controller
- ✓ Timed programmable operation for overnight processing
- ✓ Highly uniform, accurately heated working zone
- ✓ Complete with sintering tray & 200g of zirconium support beads 2mm Ø

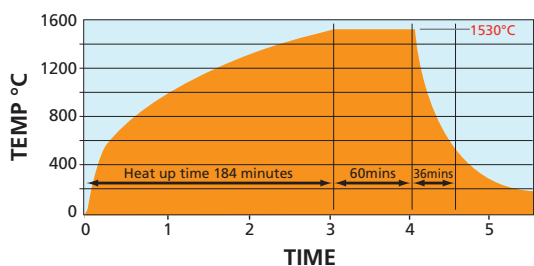
#### CDR - Carbolite Rapid Dental Furnace

- ✓ Provides rapid sintering in under 3 hours
- ✓ 1530°C in 70 minutes (on 16A supply)
- ✓ Non-contaminating silicon carbide elements
- ✓ Fast forced air cooling
- ✓ 1 litre capacity chamber
- ✓ Complete with sintering tray & 200g of zirconium support beads 2mm Ø
- ✓ Ideal for small crowns & frameworks

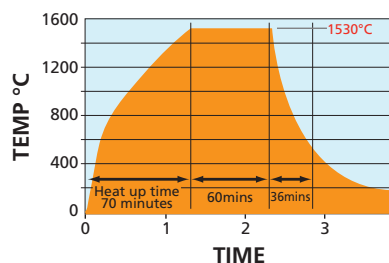


CDF 15/1B

#### CDR 15/1 Rapid Cycle Furnace on 13A Mains Supply



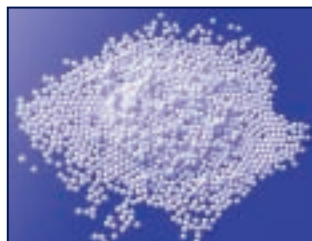
#### CDR 15/1 Rapid Cycle Furnace on 16A Mains Supply



### Options

*specify these at time of order*

- ✦ Over-temperature protection (recommended to protect valuable contents or for unattended operation)
- ✦ More advanced programmer options for more programs or more complex temperature profiles
- ✦ Argon atmosphere kit enabling samples to be processed under argon (or other inert gas)
- ✦ Spare sinter trays
- ✦ Spare sinter support beads
- ✦ RS 232 Control



| Model     | Max temp (°C) | Time to max (mins) | Dimensions              |                         | Vol (l) | Max power (W) | Holding power (W) | Weight (kg) | Power supply             |
|-----------|---------------|--------------------|-------------------------|-------------------------|---------|---------------|-------------------|-------------|--------------------------|
|           |               |                    | Internal H x W x D (mm) | External H x W x D (mm) |         |               |                   |             |                          |
| CDF/15/1B | 1530          | 126†               | 80 x 90x 150            | 655 x 382 x 535         | 1       | 2000          | 1145              | 42          | 13A† or 16A single phase |
| CDR/15/1  | 1530          | 70*                | 80 x 90x 150            | 655 x 382 x 535         | 1       | 3680          | 1145*             | 45          | 13A or 16A* single phase |



† Heating rate achieved on a 13A mains supply  
\* Heating rate achieved on a 16A mains supply

## MTT Tritium & Carbon-14 Capture Furnace

### Standard features

- ✓ Tube furnace configured for capture by combustion of  $^3\text{H}$  &  $^{14}\text{C}$  isotopes in oxygen
- ✓ Sample capacity up to 20ml provides more accurate determinations
- ✓ Originally developed in partnership with AEA Technology
- ✓ 3 quartz glass work-tubes
- ✓ Three sets of glass gas bubblers
- ✓ All connectors including the molecular sieve, waste aerosol trap
- ✓ Unique catalyst optimisation manifold
- ✓ 3 charges of copper wire catalyst
- ✓ 8 stage programmable temperature control for sample specific combustion protocols & optimum presentation of combustion products to the catalyst
- ✓ Over-temperature protection of sample & catalyst
- ✓ RS485 communications & control
- ✓ Software storage & recall of specific sample protocols
- ✓ Free from plastic or rubber components into which tritium can migrate
- ✓ A comprehensive process instruction manual



MTT

Utilising a catalyst assisted combustion technique this apparatus is suitable for capturing organically bound carbon-14 and tritium in 'free water' as well as 'fixed' (in concrete, steel or graphite). A catalyst is used to ensure complete combustion of all thermal decomposition products. These are captured for liquid scintillation assay.

This gives greater confidence of complete combustion than 'wet oxidation' techniques and avoids coloured contamination of scintillation media by botanical samples.

The capacity to handle large samples gives increased sensitivity and reduced sampling error. The economical easily replaceable generic sample tube and easily decontaminated bubbler train in an all glass design avoids the potential for carry over from one test to the next.

Computer control enables multiple individual units to be addressed and remotely controlled even in hazardous areas.

### Options

*specify these at time of order*

- ✦ Additional sets of bubblers (sets of 4)
- ✦ Additional sets of combustion boats (packs of 6)
- ✦ Additional work tubes
- ✦ Additional copper catalyst (packs of 3 charges)



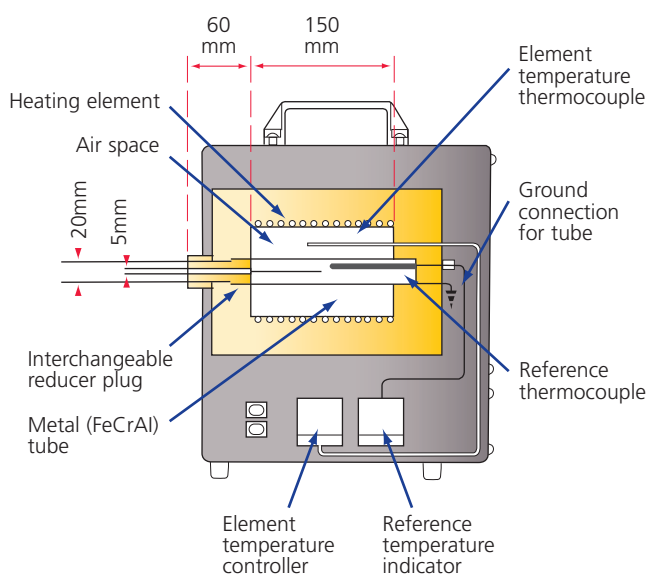
## PTC 12/20 Portable Thermocouple Calibration Furnace

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ High stability heat source with temperature range 400 to 1200°C
- ✓ Accepts thermocouples up to 7.5mm diameter
- ✓ Thermocouple is inserted & compared to the PTC 12/20's displayed temperature
- ✓ PID temperature control & separate temperature display to 1.0°C resolution
- ✓ Portable & self contained
- ✓ The special work tube design provides a much higher temperature uniformity than is typical for a furnace of this size
- ✓ The metallic worktube is earthed for operator safety when testing metal sheathed mineral insulated mineral thermocouples
- ✓ Weighing in at only 8kg, the rapid heat up and stabilisation of the PTC 12/20 make it ideal to set up and use in the lab or on site



PTC 12/20



### Options

*specify these at time of order*

- ✦ Factory calibration certificate stating the error between the workspace temperature & the displayed value at 700°C, 900°C, & 1100°C.
- ✦ A UKAS traceable calibration certificate for customer defined setpoints is available.
- ✦ A UKAS traceable thermocouple is available.

| Model     | Max temp (°C) | Heat-up time (mins) | Continuous temp (°C) | Temp range (°C) | Stability (°C)   | Dimensions              |                      |                         | Max power (W) | Thermo-couple type | W't (kg) | Power supply          |
|-----------|---------------|---------------------|----------------------|-----------------|------------------|-------------------------|----------------------|-------------------------|---------------|--------------------|----------|-----------------------|
|           |               |                     |                      |                 |                  | Heated tube length (mm) | Cavity diameter (mm) | External H x W x D (mm) |               |                    |          |                       |
| PTC 12/20 | 1200          | 20 (to 1150°C)      | 1150                 | 400 to 1200     | ± 0.5 (@ 1150°C) | 150                     | 20                   | 399 x 310 x 225         | 1100          | N                  | 8.8      | Single phase 120-240V |



Continuous operating temperature is 50°C below maximum temperature.

## AGD Acid Gas Determinator Furnaces

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ Designed for combustion testing of electrical cable to BS EN 50267-1:1999
- ✓ Cable samples are heated within the worktubes at a controlled rate of rise, whilst a small flow of air is passed over the samples & analysed (using separate apparatus) for acidity
- ✓ Four IAP tube design gives increased working capacity
- ✓ Fast resistance wire heating at <40 mins to 800°C (better than 20°C/min to 1000°C)
- ✓ Digital temperature controller providing precise setting & repeatability
- ✓ Highly stable temperature control – the temperature at the centre of each tube will be within  $\pm 5^\circ\text{C}$  over a length of 300mm\*\*
- ✓ Low thermal mass insulation
- ✓ Power control by solid state relay, incorporating zero voltage switching

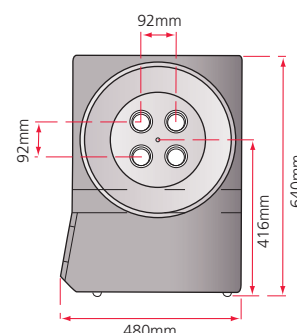
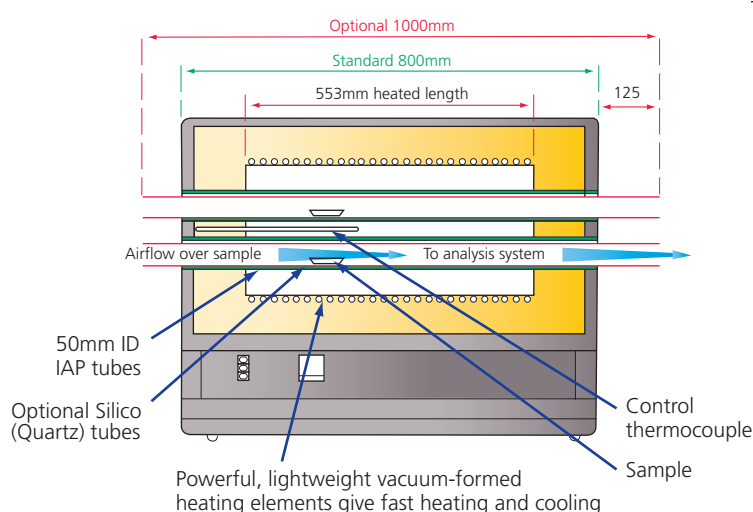


AGD 12/4 with 4 optional fused silica tubes

### Options

*specify these at time of order*

- ✦ Fused silica inner tubes 41mm inner diameter x 45mm outer diameter x 1000mm (NOTE fused silica tends to devitrify when used above 1000°C)
- ✦ Programmable control to provide automatic cooling after the timed hold at maximum that is required by the standard



| Model    | Max temp (°C) | Temp range (°C) | Heat-up time (mins) to 1000°C | Dimensions    |                                                |                         | Max power (W) | Thermo-couple type | Weight (kg) | Power supply                      |
|----------|---------------|-----------------|-------------------------------|---------------|------------------------------------------------|-------------------------|---------------|--------------------|-------------|-----------------------------------|
|          |               |                 |                               | No. worktubes | Worktube dimensions L x inner Ø x outer Ø (mm) | External H x W x D (mm) |               |                    |             |                                   |
| AGD 12/4 | 1200          | 400 to 1200     | <40                           | 4             | 800 x 50 x 60                                  | 640 x 800 x 480         | 4500          | N                  | 52          | Single Phase 220-240V 50/60Hz 20A |



\* Heat up time is measured 100°C maximum temperature with empty tubes.

\*\* With no gas flow – BSEN 50267-1 1999 requires  $\pm 17.5^\circ\text{C}$  with a 'small' gas flow.

IAP is Impervious Aluminous Porcelain.

Continuous operating temperature is 100°C below maximum temperature.

## CF Series Cupellation Furnaces for the Assay of Precious Metals

### Standard features

- ✓ 1200°C maximum operating temperature
- ✓ Models with a maximum charge capacity of 15, 24, 50 or 60 number 8 cupels
- ✓ Alternatively 24, 32, 72, or 90 number 6 cupels
- ✓ Designed for testing using the cupellation method to ISO11426:1999 the standard test method used by the United Kingdom Assay Office, a reference quantitative assay method laid down by the International Hallmark Convention
- ✓ The CF furnaces are internationally renowned for their close temperature uniformity and hazardous fume control\*
- ✓ Airflow controlled by an adjustable valve, is preheated before entering the work chamber
- ✓ Silicon carbide elements mounted above & below the chamber provide even heating of cupels, have good resistance to thermal shock & offer extended working life at high temperatures
- ✓ Fumes are extracted through insulated exhaust duct, with removable chamber below chimney to collect condensed lead
- ✓ Up & away counterbalanced vertically opening door complete with observation hole
- ✓ Silicon carbide lined roof & hearth resist the corrosive fumes emitted during the cupellation process
- ✓ Includes 7 day, 24 hour timeswitch



CF 24

### Options

*specify these at time of order*

- ✦ Modified configurations are available to fit existing fume extraction systems

**Note:** The furnace should be positioned beneath an efficient fume extraction system preferably fitted with a proprietary lead filter

\* Fumes are extracted through an insertable exhaust duct and removable container below the chimney.

| Model                                                                                                                                                                                                | Max temp (°C) | Dimensions              |                                                                               | Volume (litres) | Max power (W) | Thermo-couple type  | Weight (kg) | Power supply required per phase                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------|-------------------------------------------------------------------------------|-----------------|---------------|---------------------|-------------|------------------------------------------------------------------|
|                                                                                                                                                                                                      |               | Internal H x W x D (mm) | External H x W x D (mm)                                                       |                 |               |                     |             |                                                                  |
| CF 15                                                                                                                                                                                                | 1200          | 125 x 220 x 350         | 1059 x 950 x 950 (bench mounted)<br>225 x 600 x 380 (Separate control module) | 15              | 9000          | Pt/Pt 13% Rh Type R |             | <i>a1</i> =68A, <i>h3</i> =23A, <i>a3</i> =40A                   |
| CF 24                                                                                                                                                                                                | 1200          | 205 x 255 x 460         | 2110 x 1050 x 1070 (floor standing)                                           | 24              | 13000         | Pt/Pt 13% Rh Type R | 306         | <i>a1</i> =87A, <i>h3</i> =28A, <i>a3</i> =50A<br><i>j3</i> =30A |
| CF 50                                                                                                                                                                                                | 1200          | 230 x 350 x 540         | 2100 x 1150 x 1100 (floor standing)                                           | 50              | 20000         | Pt/Pt 13% Rh Type R |             | <i>h3</i> =45A, <i>e3</i> =78A, <i>k3</i> =45A                   |
| CF 60                                                                                                                                                                                                | 1200          | 250 x 400 x 650         | 2100 x 1200 x 1200 (floor standing)                                           | 60              | 31000         | Pt/Pt 13% Rh Type R |             | <i>h3</i> =62A <i>a3</i> =107A. <i>k3</i> =62A                   |
| <i>a1</i> =Single 200-240V, <i>a3</i> =200-240V 3 phase delta, <i>e3</i> =230-240V 3 phase delta, <i>h3</i> =380-415V 3 phase + N, <i>j3</i> =440-480V 3 phase no N, <i>k3</i> =440-480V 3 phase + N |               |                         |                                                                               |                 |               |                     |             |                                                                  |

## Temperature Control Options

(★ Specify at the time of order)

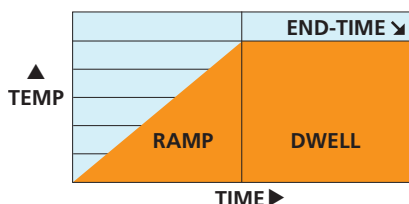
### 301 Standard Controller



The controller that is offered as standard with virtually all Carbolite furnaces. The only exceptions being those tube and chamber furnaces operating above 1700°C, where more specialised power control technology is required and those products whose special applications require more complex control e.g. ABA 7/35, multizone tube furnaces etc.

The 301 enables setting of a single ramp rate to set point and incorporates a process timer. Setting is via a smooth wipe clean membrane panel with large bright display.

The 301 provides precise PID (Proportional Integral Derivative) control meaning that ramp rates and set points are very closely adhered to and the risk of overshoot at the end of the ramp is largely avoided.



#### Options

#### 301 Over-temperature Control ★

This has a variable setpoint to protect either the chamber or the load. Selection of this option provides an additional independent thermocouple and protection circuit that is fully integrated with the regular 301 controller. Whilst all Carbolite furnaces are designed to fail safe in the event of a controller malfunction, over-temperature protection is strongly recommended for unattended operation or where valuable loads are to be processed.



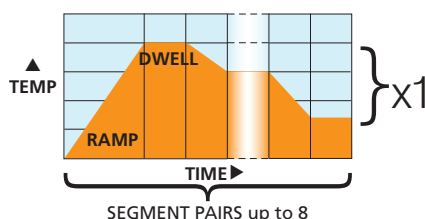
### RS232 Communications ★

This permits a single controller to communicate with a computer and requires but does not include suitable PC based software (for example iTools) and connection cables.



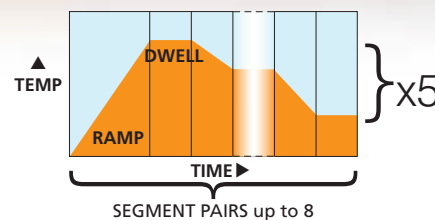
### 3216P1 ★

This controller offers programmable control using up to 8 segments, each segment comprising a ramp followed by dwell. The dwell may be set to zero time. Programme segments can not be configured as output events.



### 3216P5 ★

This controller has all the functionality of the 3216P, with additional capability of being able to store and retrieve up to 5 separate programs.



#### Options

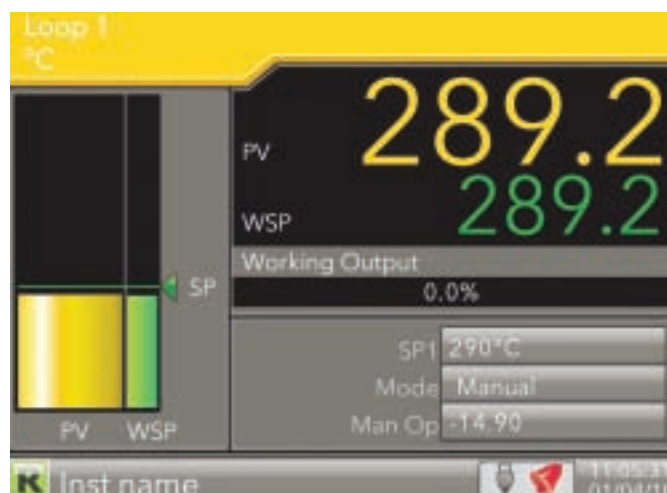
#### RS232 & RS484 Communications ★

The 3216P1 and 3216P5 controllers both have the option to add RS232 or RS485 communications. This requires but does not include suitable PC based software (for example iTools) and connection cables.



RS232 permits a single controller to communicate with a computer. RS485 permits multiple controllers to communicate with a single computer.

### Eurotherm nanodac™ Recorder & PID Controller ★



In this configuration the nanodac™ combines precision PID temperature control, with variable high and low temperature alarms and 50MB of non-volatile flash memory. The full colour 3.5" VGA display screen can be switched to display text in English, French, German, Italian and Spanish and is operated via 4 push button controls. Note this configuration does not include independent over-temperature protection.

Data is continuously logged into either CSV (comma separated variable) or UHH (Eurotherm Hydra History) a proprietary secure data format. Data can be archived onto an 8MB USB flash drive or via EtherNET using industry standard (TCP/IP – FTP) File Transfer Protocol to an IP address on a networked server. Up to 4 channels can be recorded, with up to 14 virtual channels that can be set to record trends, alarms, communications, or maths functions such as totals or averages.

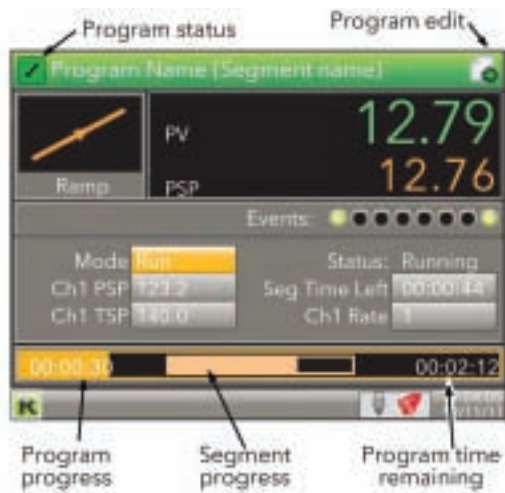
Included with the nanodac are iTools lite and Review QuickChart lite software able to directly open logged files and display in them in chart form.



## Temperature Control Options

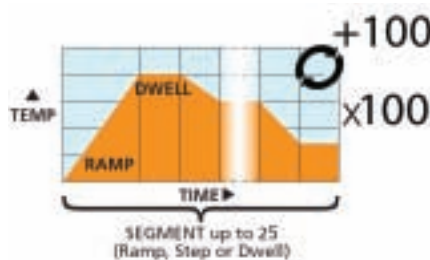
(★ Specify at the time of order)

### Eurotherm nanodac™ Recorder & PID Programmable Controller ★



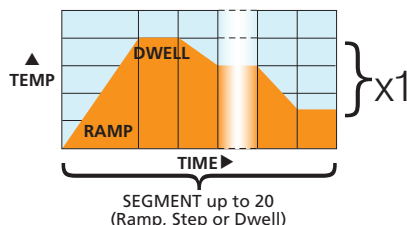
In this configuration the nanodac can hold up to 100 programs locally, each program supporting up to 25 ramps (in the form or rates to set point or time to set point) or dwell segments.

Holdback values can be set by segment. The nanodac is also able to load access to a further 100 programs that can be easily retrieved via FTP or USB memory stick. Whole programs or sequences or sections can be cycled or run continuously. Up to 8 events can be associated with a program segment and effect actions using up to 3 relay or logic outputs. Note that some configurations may require additional components.



### 3508P1 ★

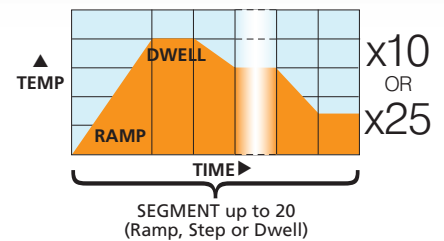
This controller offers programmable control in which 20 segments may be set as ramp, step or dwell and may also be configured to control output events. (where 'step' is an immediate rise or fall in setpoint temperature). The 3508 series provide a more comprehensive display of information.



### 3508P10 & 3508P25 ★

The 3508P10 and 3508P25 have all of the functionality of the 3508P1 with the additional capability to store and retrieve 10 and 25 programs respectively.

Additionally individual programs can be linked together into longer or more complex sequences.



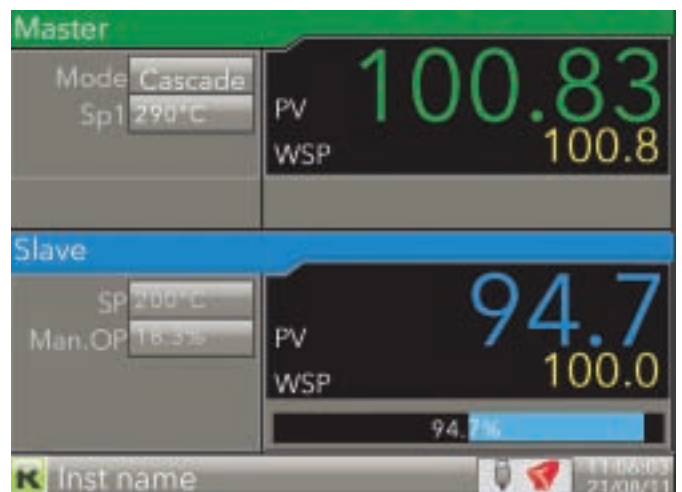
### Options

#### Over-temperature Control ★

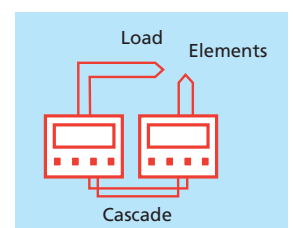
This has a variable setpoint to protect either the chamber or the load. Where the main controller is from the 3216 or 3508 series this is provided by an addition of an independent 2132 controller. Whilst all Carbolite furnaces are designed to fail safe in the event of a controller malfunction over-temperature protection is strongly recommended for unattended operation or where valuable loads are to be processed.



#### Cascade Control ★



This should be considered for even more precision and ability to counteract many of the performance effects that result from placing different loads into the chamber. In particular faster heating of loads which have high thermal capacity is possible. A standard controller operates by sensing the temperature close to the elements. In cascade control the primary controller's operation is modified by a second control loop, which is used to sense the temperature of the load. It is essential that the controller is a dual loop 3508 series controller or nanodac equipped with advanced control loop option.



## Temperature Control Options

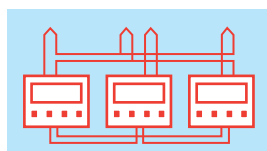
(✦ Specify at the time of order)

### Three Zone Control ✦

This usually has the function in triple zone tube furnaces of extending the length of the uniform heated zone.

### Back-to-back Control

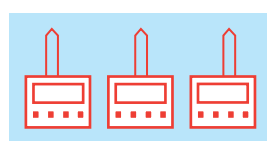
This configuration is supplied as stand for all Carbolite three zone tube furnaces. Normally a master 301 controller operates with two 2132 end-zone controllers.



Back-to-back

### Independent ✦

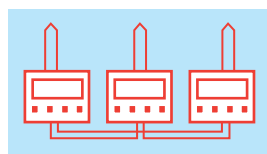
This configuration is available as a no-charge option for three zone tube furnaces and comprises three independent controllers with either 301 or 2132 end zone controllers each with independent thermocouples in their respective zones.



Independent

### Setpoint Retransmission ✦

This optional configuration should be selected for three zone tube furnaces where programmed cooling using a 3216 or 3508 controller is required, in order that the slave end zones adhere to the cooling profile.



Setpoint retransmission

### Three Zone Cascade Control ✦

As in single zone furnaces, cascade control allows faster heating of the furnace load and more precise control of the load temperature. A 3508 controller is required, the end zones are controlled using (non-programmable) 3216CC controllers.

## Chart Recorders & DAQs (Data Acquisition Devices) ✦

This is just a small selection of the options that are available for recording data from Carbolite furnaces. If you require advice please contact Carbolite for further information.

**NOTE:** Please confirm with Carbolite whether the chart recorder can be fitted within the standard furnace case, in some instances it may require mounting in a separate case.

### Eurotherm nanodac™ DAQ Recorder only ✦

In this configuration the nanodac can be used in combination with a conventional controller as a paperless chart recorder. Data is continuously logged into either CSV (comma separated variable) or UHH (Eurotherm Hydra History) a proprietary secure data format. Data can be archived onto an 8MB USB flash drive or via EtherNET using industry standard (TCP/IP – FTP) File Transfer Protocol to an IP address on a networked server. Up to 4 channels can be recorded, with up to 14 virtual channels that can be set to record trends, alarms, communications, or maths functions such as totals or averages.

Included with the nanodac are **iTools lite** and **Review QuickChart lite** software able to directly open logged files and display in them in chart form.

### 4102 Series 100mm Wide Compact Strip Chart Recorder ✦

The 4102 series are compact and economical 100mm strip chart recorders, providing recording for up to 4 (continuous pen) or 6 (multi-point) process variables.



### 4103 Series 100mm Wide Strip Chart Recorder ✦

The 4103 is a high specification, 100mm strip chart recorder, providing continuous recording for up to 6 process variables. Information such as channel descriptor, alarm set point and scale information can be viewed on a high resolution VFD display.



| Model | Channels (pens) | User programmable | Accuracy To paper (%) | Speed mm/hr ✦                                                               | Annotation ✦ |
|-------|-----------------|-------------------|-----------------------|-----------------------------------------------------------------------------|--------------|
| 4102C | 1               | ✗                 | 0.25                  | 10, 30, 60, 120 or 5, 20, 60, 120 or 20, 30, 60, 120 or 30, 60, 120, 300 or | Extra option |
| 4102C | 2               | ✗                 |                       |                                                                             | Extra option |
| 4102M | 6               | ✗                 |                       |                                                                             | Standard     |
| 4103C | 1               | ✓                 |                       | Software selectable                                                         | Standard     |
| 4103C | 2               | ✓                 |                       |                                                                             | Standard     |
| 4103M | 6               | ✓                 |                       |                                                                             | Standard     |

## Temperature Control Options

✦ Specify at the time of order

### 6100 & 6180 Series Digital Data Acquisition, Recording & Display ✦

A series of digital data acquisition recorders which can function as stand-alone paperless recorders or with more advanced models can be integrated in to computer networks. All have the capability to archive data via USB flash memory devices or onto a networked server using Ethernet FTP or Modbus TCP (although the 6100E is Slave configuration only)



6100 series data recorders have a 5/14" TFT touch screen interface whilst the 6180 series data recorders have a 12.1" TFT touch screen interface.

| Model               | Function                   | Channels          | Display Screen                     | On-board Memory for history (Mb) | USB ports | Serial Ports |
|---------------------|----------------------------|-------------------|------------------------------------|----------------------------------|-----------|--------------|
| <b>nanodac</b>      | PID control & record       | 4                 | 5.5" TFT & software allocated keys | 50                               | USB       | 0            |
| <b>6100E</b>        | record analogue input      | 3/6*<br>*optional | 5.5" VGA touchscreen               | 8                                | 1         | 0            |
| <b>6100A</b>        | record analogue input      | 6                 | 12.1" VGA touchscreen              | 32 or 96                         | up to 3   | up to 2      |
| <b>6180A</b>        | record analogue input      | 12                | 12.1" XGA touchscreen              | 32 or 96                         | up to 3   | up to 2      |
| <b>6100XIO</b>      | record digital comms input | 18                | 5.5" VGA touchscreen               | 32                               | 1         | 2            |
| <b>6180XIO</b>      | record digital comms input | 48                | 12.1" XGA touchscreen              | 32                               |           | 2            |
| <b>6180 AeroDAQ</b> | record analogue input      | 6                 | 12.1" XGA touchscreen              | 32                               | 3         | 2            |

The 6100XIO and 6180XIO data recorders record digital data and so must be used with controllers that are equipped with digital communications. This overcomes potential issues from the attenuation of analogue signals over distance.

The 6180AeroDAQ is a recorder configuration that has been optimised for NADCAP – AMS 2750D applications and includes thermocouple monitoring functionality for this purpose. Always confirm with Carbolite that your preferred data recorder can be accommodated within the furnace structure, alternative a stand-alone case may be required.



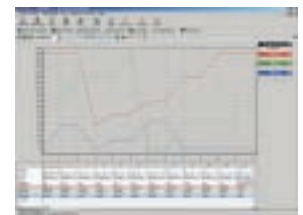
The following software options are available for use with the 6100A, 6100XIO and 6180 series data recorders for the 6100 Series (these options are not compatible with the 6100E model)

Batching  
Grouping  
Screen Builder  
Bridge 0  
software a

### iTools Software

A versatile suite of software that allows Carbolite furnaces that have been fitted with appropriate digital communications hardware to be set-up, recorded and monitored from a PC. The supplied license is for a single PC to communicate with one furnace using RS232 or with many furnaces using RS485.

**NOTE: The 301 controller is not compatible with RS485 communications.**



## Calibration Certificates

A number of calibration options can be supplied each of which is available with either a factory certificate of calibration or a certificate from a UKAS accredited laboratory and hence traceable to a UK National Standard.



**Factory issued certificate for the thermocouple only calibrated at 3 temperature points ✦**

**UKAS traceable certificate for the thermocouple only calibrated at 3 temperature points ✦**

**Factory issued certificate for the temperature controller (or temperature display) 3 point calibration ✦**  
At 3 points of our choosing.

**UKAS traceable certificate for the temperature controller (or temperature display) 3 point calibration ✦**  
At 3 points of our choosing.

**Factory issued certificate for the specific individual combination of thermocouple & temperature controller (or temperature display) 3 point calibration ✦**

**UKAS traceable certificate for the specific individual combination of thermocouple & temperature controller (or temperature display) 3 point calibration ✦**

## For Advice and Specifications to Comply with NADCAP (AMS 2750D) for Heat Treatment Applications

Please contact Carbolite for advice on this or any other standards compliance issues.



## Tube Furnace Options & Accessories for Heating

**ID** Inner Diameter  
**OD** Outer Diameter

**Up to 900, 1000, 1200°C**  
**15 ~ 38mm ID**  
**130 ~ 400mm heated length**

**MTF 9, 10 or 12 Series**

**Up to 1200°C**  
**65 ~ 105mm ID**  
**550 ~ 900mm heated length**

**CTF or TZF 12 Series**

**Suitable for  
heating in air**

**Furnace including**  
**Standard length work tube**  
**+ Insulation end plugs type C**  
(ref 51-50-1 or 51-50-2)



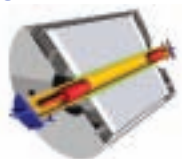
**Furnace**  
**+ Standard length work tube**  
**+ Insulation end plugs type C**  
(ref 51-50-1 or 51-50-2)



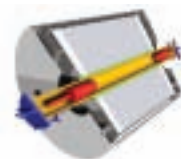
**Suitable for  
an inert gas  
atmosphere**



**Furnace including**  
**Standard length work tube**  
**+ Extended work tube type D**  
(with OD smaller than the integral  
work tube's ID & length + 300mm)  
**+ Insulation end plugs type D**  
(ref 51-50-1)  
**+ Gas tight end seals** (ref 41-37-1)



**Furnace**  
**+ Standard length work tube**  
**+ Extended work tube type D**  
(with OD smaller than the integral work tube's ID  
& length + 300mm or 250mm for CTF 12/100/900)  
**+ Insulation end plugs type D**  
(ref 41-50-11 or 41-50-12)  
**+ Gas tight end seals** (ref 41-37-1 or 41-37-2)



**Suitable for  
'low' vacuum  
to 10<sup>-3</sup> mbar  
using NW  
flange seals)**



**Furnace including**  
**Standard length work tube**  
**+ Extended work tube type D**  
(with OD smaller than the integral  
work tube's ID & length + 300mm)  
**+ Insulation end plugs type D**  
(ref 51-50-1)  
**+ Low vacuum end seals**  
(ref 41-37-1 + 51-39-1 or 59-39-2 or  
51-39-3)



**Furnace**  
**Standard length work tube**  
**+ Extended work tube type D**  
(with OD smaller than the integral  
work tube's ID & length + 600mm)  
**+ Radiation end shields**  
(ref 41-51-1 or 41-51-2)  
**+ Low vacuum end seals**  
(ref 41-37-5 or 41-37-6 + 51-39-1 or 59-39-2 or  
51-39-3)



**Suitable for  
'high' vacuum  
to 10<sup>-5</sup> mbar)**



**Furnace including**  
**Standard length work tube**  
**+ Extended work tube type D**  
(with OD smaller than the integral  
work tube's ID & length + 300mm)  
**+ Radiation end shields** (ref 41-51-1)  
**+ High vacuum end seals**  
(ref 44-37-5 or 44-37-6 + 51-39-1 or  
59-39-2 or 51-39-3)



**Furnace**  
**Standard length work tube**  
**+ Extended work tube type D**  
(with OD smaller than the integral  
work tube's ID & length + 600mm)  
**+ Radiation end shields**  
(ref 44-51-1 or 44-51-2)  
**+ High vacuum end seals**  
(ref 41-37-5 or 41-37-6 + 51-39-1 or 59-39-2 or  
51-39-3)



**Please note that additional components are required for vertical configurations**  
**Thermocouple entry glands are available for both gas tight and vacuum end seals**  
**Tube supports 49-64-1 recommended for extended length tubes**



in **AIR**, **MODIFIED ATMOSPHERE** & **VACUUM**

**Up to 1200°C**  
**65 ~ 170mm OD**  
**300 ~ 1200mm heated length**

**G or split 12 Series**

**Furnace**

**Standard length work tube** (up to the max OD & heated length + 200mm)  
**+ Insulation end plugs type C**  
(ref 51-50-1 or 51-50-2)



**Up to 1600°C**  
**60 ~ 90mm OD**  
**180 ~ 610mm heated length**

**STF or TZF 16 or 16 Series**

**Furnace**

**+ Standard length work tube** (up to the max CD & heated length)  
**+ Insulation end plugs type C**  
(ref 51-50-3 or 51-50-4)



**Up to 1800°C**  
**90 ~ 140mm OD**  
**200 ~ 600mm heated length**

**CTF, TZF 17, 18 or PVT Series**

**Furnace**

**+ Standard length work tube** (up to the max OD & heated length + 600mm)  
**+ Insulation end plugs type C**  
(ref 51-50-5 or 51-50-6)



**Furnace**

**+ Extended work tube type D** (up to the max CD & heated length + 600mm)  
**+ Insulation end plugs type D**  
(ref 51-50-11 or 41-50-12)  
**+ Gas tight end seals**  
(ref 41-37-1 or 41-37-2)



**Furnace**

**+ Extended work tube type D** (up to the max CD & heated length + 300mm)  
**+ Insulation end plugs type D**  
(ref 51-50-13 or 41-50-14)  
**+ Gas tight end seals**  
(ref 41-37-3 or 41-37-4)



**Furnace**

**+ Extended work tube type D** (up to the max OD & heated length + 900mm)  
**+ Insulation end plugs type C**  
(ref 51-50-15)  
**+ Gas tight end seals**  
(ref 41-37-3 or 41-37-4)



**Furnace**

**+ Extended work tube type D** (up to the max OD & heated length + 600mm)  
**+ Radiation end shields**  
(ref 41-50-5 or 41-50-6)  
**+ Low vacuum end seals**  
(ref 41-37-1 or 41-37-2 + 51-39-1 or 51-39-2 or 51-39-3)



**Furnace**

**+ Extended work tube type D** (up to the max OD & heated length + 300mm)  
**+ Radiation end shields**  
(ref 41-51-3 or 41-51-4 or 45-51-5)  
**+ Low vacuum end seals with water cooling**  
(ref 41-37-3 or 41-37-4 + 51-39-1 or 51-39-2 or 51-39-3)



**Furnace**

**+ Extended work tube type D** (up to the max OD & heated length + 900mm)  
**+ Insulation end shields** (ref 41-50-15)  
**+ Low vacuum end seals with water cooling**  
(ref 41-37-3 or 41-37-4 + 51-39-1 or 51-39-2 or 51-39-3)



**Furnace**

**+ Extended work tube type D** (up to the max OD & heated length + 600mm)  
**+ Radiation end shields**  
(ref 50-51-6 or 50-51-7 or 50-51-8)  
**+ High vacuum end seals**  
(ref 41-37-5 or 41-37-6 + 51-39-1 or 51-39-2 or 51-39-3)



**Furnace**

**+ Extended work tube type D** (up to the max OD & heated length + 300mm)  
**+ Radiation end shields**  
(ref 50-51-6 or 50-51-7)  
**+ High vacuum end seals with water cooling** (ref 44-37-7 or 44-37-8 + 51-39-1 or 51-39-2 or 51-39-3)



**Furnace**

**+ Extended work tube type D** (up to the max OD & heated length + 900mm)  
**+ Radiation end shields**  
(ref 50-51-6 or 50-51-7 or 50-51-8)  
**+ High vacuum end seals with water cooling** (ref 44-37-7 or 44-37-8 + 51-39-1 or 51-39-2 or 51-39-3)



**□ Standard work tube materials are not suitable for vacuum use above 1500°C, please contact Carbolite for alternatives**

## Work tubes - temperature & chemical compatibility

| Tube Material                                            | Physical & chemical properties |                              |                                                                                                        | Maximum temperatures in air °C |          |
|----------------------------------------------------------|--------------------------------|------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------|----------|
|                                                          | Porous(P) / Impervious (I)     | ‡Resistance to thermal shock | Chemical resistance                                                                                    | Horizontal                     | Vertical |
| <b>Silimanite</b><br>(AL2O3SiO2)                         | P                              | Good                         | Good chemical resistance <b>but porous</b>                                                             | 1500                           | 1600     |
| <b>IAP</b><br>(Impervious aluminous porcelain)           | I                              | Very good                    | Good chemical resistance against gases with the exception of fluorine                                  | 1400                           | 1500     |
| <b>Mullite</b><br>(3Al2O3.2SiO2.A)                       | I                              | Very good                    | Resistant to flux sulphurous or carbonaceous atmospheres                                               | 1500                           | 1550     |
| <b>RCA</b><br>(Recrystallised alumina)                   | I                              | Good                         | Highly resistant to chemical attack, except fluorine                                                   | 1800                           | 1900     |
| <b>Quartz</b><br>(Limited availability)                  | I                              | Very good                    | Generally good but reactive with sodium & at upper temperature limit with metals, carbonates & halides | 1100                           | 1100     |
| <b>APM**</b> (Advanced powder metallurgy - FeCrAl alloy) | I                              | Excellent                    | Resistant to Oxidation, carburization & sulphidation                                                   | 1300*                          | 1350     |

\* Short or supported tubes only as APM will bend at this temperature

\*\*Unsuitable for use in wirewound outer work tubes due to high electrical conductivity

‡ Resistance to thermal shock is partly dependent upon specific tube geometry

Recommendations are for guidance only and the suitability of a material for a specific application can only be confirmed when we know the complete details of the service conditions.

Carbolite wire wound tube furnaces may be used without an accessory worktube. If however a modified atmosphere or vacuum is required for the application then an accessory worktube is required. The accessory worktube needs to be longer for those applications when gas tight or vacuum tight end seals are required. The degree of extension depends upon the specific furnace, the temperature and the accessories to be fitted. Contact Carbolite or your local distributor for more information.

Some tube furnaces do not have the element directly wound onto the outer surface of the worktube and in these cases an accessory worktube is always required.

The intended application determines the best material to use on the basis of the tube's operating temperature range, porosity, chemical resistance and tolerance to thermal shock. Towards the upper limits of a worktube's temperature range the intended orientation is also important.

Extended tube lengths as well as the added weight of accessories fitted to worktube ends may cause them to flex under heating. Use of tube end supports and periodic rotation of the work tubes is recommended to prevent them bending.

Even where samples are only heated in air addition of end plugs greatly increases uniformity. This is particularly important for larger diameter tubes over 25mm and for vertical furnace configurations, where convection currents can have a significant effect on uniformity if end plugs are not used.

| Tube inner diam (mm) ▼ | Length (mm) ▶<br>▼ Tube outer diam (mm) | Standard Tube Sizes for Up to 1100°C |     |     |     |      |      |      |      |      |      |      |      |
|------------------------|-----------------------------------------|--------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
|                        |                                         | 450                                  | 600 | 750 | 900 | 1000 | 1050 | 1100 | 1200 | 1350 | 1500 | 1650 | 1800 |
| 19.5                   | 26                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 25                     | 32                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 28                     | 34                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 46                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 51                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 50                     | 60                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 53                     | 61                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 60                     | 70                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 64                     | 73                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 83                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 86                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 77                     | 87                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 78                     | 91                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 80                     | 95                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 100                    | 120                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 110                    | 125                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 117                    | 128                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 125                    | 140                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 134                    | 146                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 152                    | 164                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 150                    | 170                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |

| Tube inner diam (mm) ▼ | Length (mm) ▶<br>▼ Tube outer diam (mm) | Standard Tube Sizes for Up to 1300°C |     |     |     |      |      |      |      |      |      |      |      |
|------------------------|-----------------------------------------|--------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
|                        |                                         | 450                                  | 600 | 750 | 900 | 1000 | 1050 | 1100 | 1200 | 1350 | 1500 | 1650 | 1800 |
| 19.5                   | 26                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 25                     | 32                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 28                     | 34                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 46                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 51                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 50                     | 60                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 53                     | 61                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 60                     | 70                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 64                     | 73                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 83                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 86                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 77                     | 87                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 78                     | 91                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 80                     | 95                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 100                    | 120                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 110                    | 125                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 117                    | 128                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 125                    | 140                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 134                    | 146                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 152                    | 164                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 150                    | 170                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |

| Tube inner diam (mm) ▼ | Length (mm) ▶<br>▼ Tube outer diam (mm) | Standard Tube Sizes for Up to 1350°C |     |     |     |      |      |      |      |      |      |      |      |
|------------------------|-----------------------------------------|--------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
|                        |                                         | 450                                  | 600 | 750 | 900 | 1000 | 1050 | 1100 | 1200 | 1350 | 1500 | 1650 | 1800 |
| 19.5                   | 26                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 25                     | 32                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 28                     | 34                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 46                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 51                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 50                     | 60                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 53                     | 61                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 60                     | 70                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 64                     | 73                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 83                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 86                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 77                     | 87                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 78                     | 91                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 80                     | 95                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 100                    | 120                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 110                    | 125                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 117                    | 128                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 125                    | 140                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 134                    | 146                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 152                    | 164                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 150                    | 170                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |

# Work tubes - temperature compatibility

| Tube inner diam (mm) ▼ | Length (mm) ▶<br>▼ Tube outer diam (mm) | Standard Tube Sizes for Up to 1400°C |     |     |     |      |      |      |      |      |      |      |      |
|------------------------|-----------------------------------------|--------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
|                        |                                         | 450                                  | 600 | 750 | 900 | 1000 | 1050 | 1100 | 1200 | 1350 | 1500 | 1650 | 1800 |
| 19.5                   | 26                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 25                     | 32                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 28                     | 34                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 46                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 51                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 50                     | 60                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 53                     | 61                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 60                     | 70                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 64                     | 73                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 83                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 86                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 77                     | 87                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 78                     | 91                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 80                     | 95                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 100                    | 120                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 110                    | 125                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 117                    | 128                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 125                    | 140                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 134                    | 146                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 152                    | 164                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 150                    | 170                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |

| Tube inner diam (mm) ▼ | Length (mm) ▶<br>▼ Tube outer diam (mm) | Standard Tube Sizes for Up to 1500°C |     |     |     |      |      |      |      |      |      |      |      |
|------------------------|-----------------------------------------|--------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
|                        |                                         | 450                                  | 600 | 750 | 900 | 1000 | 1050 | 1100 | 1200 | 1350 | 1500 | 1650 | 1800 |
| 19.5                   | 26                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 25                     | 32                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 28                     | 34                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 46                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 51                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 50                     | 60                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 53                     | 61                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 60                     | 70                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 64                     | 73                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 83                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 86                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 77                     | 87                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 78                     | 91                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 80                     | 95                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 100                    | 120                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 110                    | 125                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 117                    | 128                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 125                    | 140                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 134                    | 146                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 152                    | 164                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 150                    | 170                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |

| Tube inner diam (mm) ▼ | Length (mm) ▶<br>▼ Tube outer diam (mm) | Standard Tube Sizes for Up to 1550°C |     |     |     |      |      |      |      |      |      |      |      |
|------------------------|-----------------------------------------|--------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
|                        |                                         | 450                                  | 600 | 750 | 900 | 1000 | 1050 | 1100 | 1200 | 1350 | 1500 | 1650 | 1800 |
| 19.5                   | 26                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 25                     | 32                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 28                     | 34                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 46                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 51                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 50                     | 60                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 53                     | 61                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 60                     | 70                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 64                     | 73                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 83                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 86                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 77                     | 87                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 78                     | 91                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 80                     | 95                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 100                    | 120                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 110                    | 125                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 117                    | 128                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 125                    | 140                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 134                    | 146                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 152                    | 164                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 150                    | 170                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |

| Tube inner diam (mm) ▼ | Length (mm) ▶<br>▼ Tube outer diam (mm) | Standard Tube Sizes for Up to 1600°C |     |     |     |      |      |      |      |      |      |      |      |
|------------------------|-----------------------------------------|--------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
|                        |                                         | 450                                  | 600 | 750 | 900 | 1000 | 1050 | 1100 | 1200 | 1350 | 1500 | 1650 | 1800 |
| 19.5                   | 26                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 25                     | 32                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 28                     | 34                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 46                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 51                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 50                     | 60                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 53                     | 61                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 60                     | 70                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 64                     | 73                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 83                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 86                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 77                     | 87                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 78                     | 91                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 80                     | 95                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 100                    | 120                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 110                    | 125                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 117                    | 128                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 125                    | 140                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 134                    | 146                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 152                    | 164                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 150                    | 170                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |

| Tube inner diam (mm) ▼ | Length (mm) ▶<br>▼ Tube outer diam (mm) | Standard Tube Sizes for Up to 1800°C |     |     |     |      |      |      |      |      |      |      |      |
|------------------------|-----------------------------------------|--------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
|                        |                                         | 450                                  | 600 | 750 | 900 | 1000 | 1050 | 1100 | 1200 | 1350 | 1500 | 1650 | 1800 |
| 19.5                   | 26                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 25                     | 32                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 28                     | 34                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 46                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 51                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 50                     | 60                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 53                     | 61                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 60                     | 70                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 64                     | 73                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 83                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 86                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 77                     | 87                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 78                     | 91                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 80                     | 95                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 100                    | 120                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 110                    | 125                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 117                    | 128                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 125                    | 140                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 134                    | 146                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 152                    | 164                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 150                    | 170                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |

| Tube inner diam (mm) ▼ | Length (mm) ▶<br>▼ Tube outer diam (mm) | Standard Tube Sizes for Up to 1900°C |     |     |     |      |      |      |      |      |      |      |      |
|------------------------|-----------------------------------------|--------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
|                        |                                         | 450                                  | 600 | 750 | 900 | 1000 | 1050 | 1100 | 1200 | 1350 | 1500 | 1650 | 1800 |
| 19.5                   | 26                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 25                     | 32                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 28                     | 34                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 46                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 38                     | 51                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 50                     | 60                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 53                     | 61                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 60                     | 70                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 64                     | 73                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 83                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 75                     | 86                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 77                     | 87                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 78                     | 91                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 80                     | 95                                      |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 100                    | 120                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 110                    | 125                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 117                    | 128                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 125                    | 140                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 134                    | 146                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 152                    | 164                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |
| 150                    | 170                                     |                                      |     |     |     |      |      |      |      |      |      |      |      |

Silimanite  
IAP  
Mullite  
RCA



Quartz  
APM (require support  
at this temp)



Requires support (s)  
Vertical configuration only (v)

## Work Tube Accessories

(◆ Please specify full tube dimensions, furnace model and operating temperature at time of order)

### Ceramic insulating plugs ◆

Ceramic fibre board plugs with a 6mm central tube are designed to reduce heat loss from tube ends and are particularly helpful for vertical tubes and tube diameters over 25mm. Two types (C & D) are supplied for use with standard and extended length work tubes respectively. Additional support mountings must be ordered for their installation into vertical worktubes.



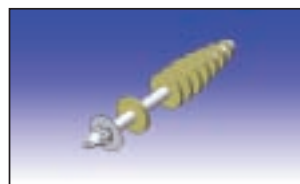
C type end plug



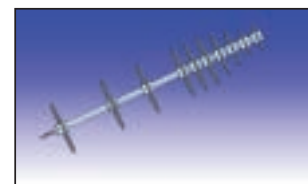
D type end plug

### Radiation shields ◆

Constructed from either ceramic or dust free metal discs on a central tube, these are used where the porous nature of ceramic plugs makes them unsuitable. Most often in vacuum applications or where a high purity atmosphere is required. Additional support mountings must be ordered for installation into vertical worktubes.



Ceramic radiation shields



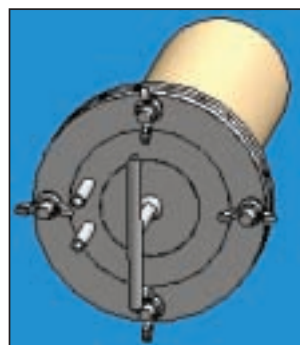
Metal radiation shields

### Gas tight end seals ◆

These comprise stainless steel discs which are equipped with a 6mm gas nozzle as standard or optionally with an NW16, NW25 or NW40 flange. Thermocouple glands to accept 1.5mm, 3mm and 10mm probes can also be added. Gas tight end seals can only be used on extended worktubes and are designed to be used in combination with insulation plugs or radiation shields (see above).

Water cooled gas tight end seals are recommended where furnaces are to be operated at 1500°C or more. These assemblies can be used for medium vacuum applications down to  $10^{-3}$  mbar.

In order to accommodate the added weight of end seal assemblies tube end supports are recommended.



Gas tight end seal with water cooling

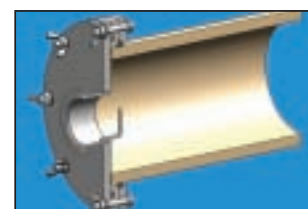
### High vacuum end seals ◆

These comprise stainless steel discs which are equipped with an industry standard vacuum flange. They can only be used on extended worktubes and are designed to be used in combination with radiation shields.

Water cooled high vacuum end seals are recommended where furnaces are to be operated at 1500°C or more. These assemblies can be used for medium vacuum applications down to  $10^{-5}$  mbar.



76-86 tube seal with NW25



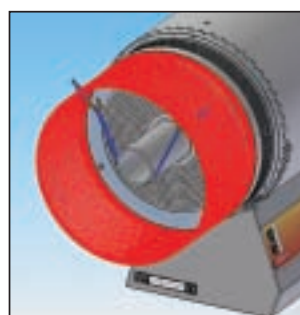
100-120 tube seal with NW40



19-25 tube seal with NW16

### Tube supports ◆

Designed to support extended worktubes and the additional weight of end seal assemblies, they reduce worktube stresses and can improve a tube's life expectancy.

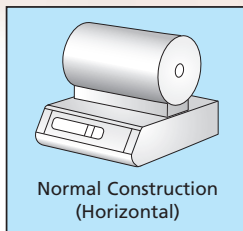


Optional accessory tube supports for STF series

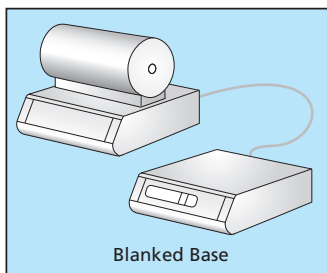


## Mounting Configurations

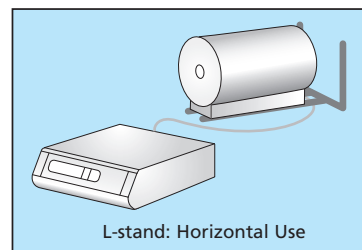
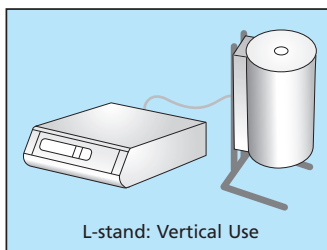
The normal configuration for horizontal tube furnaces in the MTF, CTF, STF and the three zone TZF furnaces is for the furnace body to be mounted directly onto a control module base unit.



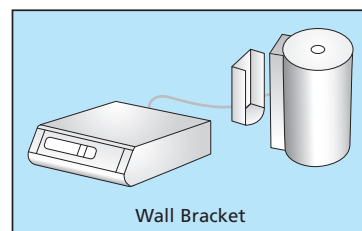
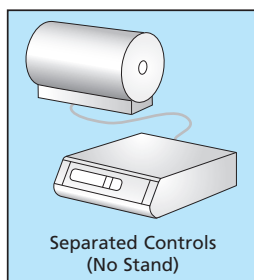
However several other options are available at time of order. The furnace body can be mounted on a 'blanked base' linked via either a 2 or 6 metre power conduit to a second control module containing all of the control electronics.



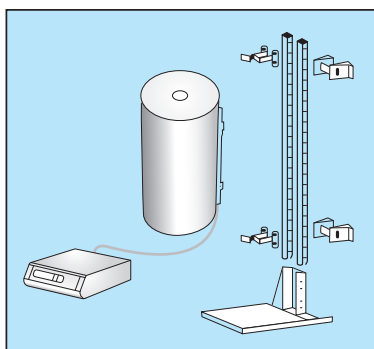
Alternatively the furnace body can be supplied mounted on a separate 'L' style stand which allows it to be freely positioned separately from the control module in either a horizontal or vertical position. (Note that different work tube mounting accessories may be required to change from horizontal to vertical operation, or vice versa).



The furnace body may optionally be supplied separately from the base and either completely without a stand or with a wall mounting bracket.

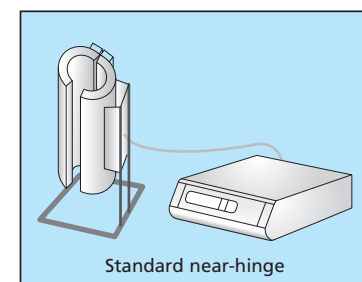
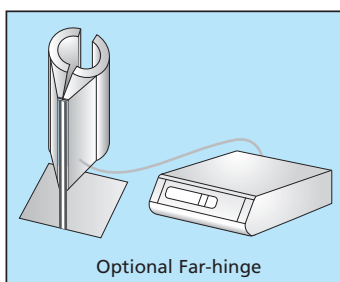


G range tube furnaces are available with a complete 'G' pattern stand or optionally with just support rail portion of the stand (without the foot) with or without a wall mounting bracket.



Split tube furnaces from the HST and HZS ranges are optionally available for dual vertical and horizontal use mounted upon an 'L' style stand. They are also available completely without stands and in a so called 'farhinge' configuration which enables the split furnace to open wide than the conventional hinge.

VST and TVS range vertical split tube furnaces are similarly available without stands and in 'farhinge' designs as an alternative to the standard 'nearhinge' configuration. The far hinge configuration opens wider to give easier access when using large or awkwardly positioned worktube or test pieces.



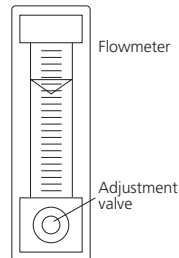
## Modified Atmosphere

(★ Specify at the time of order)

There are a number of methods of working in Carbolite furnaces using a modified, usually inert atmosphere or with vacuum. A range of worktube accessories are listed on page 56 to enable this.

### Gas Flow-meters ★

The walls of chamber furnaces are frequently permeable so gas flow-meters with a standard length of 100mm and 3% accuracy can be added.



### Inert Gas Inlet ★

A 6mm hose connection that is usually placed on the furnace side and connected to the chamber via a ceramic tube. Suitable for the introduction of inert gas or oxygen.

**NOTE** The introduction of gases may alter heating characteristics and /or performance characteristics of furnace elements, please contact Carbolite for advice.

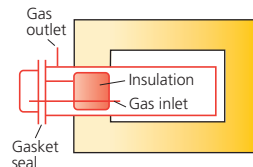
### Solenoid Valves ★

Electrically operated valves, activated by a panel mounted switch or using a 3216 or 3508 controller to start or stop gas flows.

### Atmosphere Retorts (1100°C) ★

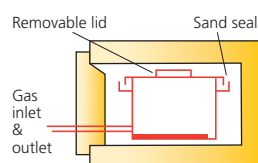
#### Type A105

A range of inconel enclosures sealed by front opening insulated door plugs, gas inlet and outlet connections are easily accessible towards the front. These should be specified at time of order so that the door interlock mechanism is modified.



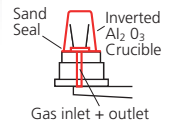
#### Type A107 ★

A range of deep Inconel retorts similar to a pack carburising box, they have a shallow removable lid on top which is seated into a sand seal. Front mounted gas inlets / outlet connections extend through slots in the modified furnace door.



### Inverted Crucible ★

For bottom loaded, raised hearth furnaces gas may be introduced through a modified hearth and retained by an inverted metal bell jar or ceramic crucible.



### Atmosphere Control System ★

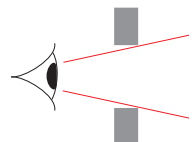
This system is suitable for use with either tube furnaces using gas tight end seal assemblies of chamber furnaces using Type A105 retorts. Housed in its own cabinet the system is recommended where hydrogen gas is required for processing. It provides greater safety and convenience in control of hydrogen and nitrogen purge gas. Provides protection when introducing hydrogen at low temperatures, provides a monitored burn-off pilot flame and senses failure of gas supplies and is equipped with hydrogen and nitrogen flow-meters, using a pressure system. For mass flow systems contact Carbolite.



## Entry Ports

### Access and Viewing Ports ★

A 25 mm diameter hole is placed through the furnace door in one of two optional formats; with either a pivoted stainless steel cover disc or a permanent quartz window.



### Thermocouple Calibration Port ★

An additional ceramic sheath is installed adjacent to the control thermocouple and accessible through the back of the furnace. This enables the insertion of a reference thermocouple (not supplied) in order to check the calibration of the existing controller/thermocouple system.



## Chamber Furnace Thermocouple Options

### Accessory Thermocouple ★

A semi-flexible metal sheathed mineral insulated thermocouple (type K for 1100°C max. and type N for 1200°C max.) with 2 metre compensating cable and connection plug. For use with the calibration port or insertion through chimney.

### Secondary Thermocouple ★

An additional thermocouple similar to the control thermocouple built-in and connected to an external socket. For use with chart recorders etc.

## Servicing, Maintenance & Parts



Carbolite works closely with its worldwide network of dealers to ensure that you have easy local access to service, preventative maintenance and replacement parts. To improve even further, a new dedicated aftermarket facility has been established at our factory in the UK.

This unit will not only provide a base from which our team of field service engineers can operate but will carry stocks of the most common spare parts.

### Preventative Maintenance

- ❖ To satisfy the requirements of quality management systems e.g. ISO 9001:2008, NADCAP, AMS 2750D
- ❖ To help ensure health & safety of operational personnel
- ❖ To monitor the condition of equipment so as to avoid costly, unexpected breakdowns
- ❖ To avoid wasted energy through heat loss
- ❖ To ensure the integrity of results and measurements obtained

### Custom Designed Plans

- ❖ Our maintenance plans are custom-made to meet your specific requirements, whether it is support for a single unit, an entire department or all units within an organisation.
- ❖ Each contract is discussed and agreed with the user to provide a core of functional and safety checks.

### Inspection

- ❖ Preventative maintenance
- ❖ Thermal surveying & calibration
- ❖ Condition monitoring
- ❖ Functional checks
- ❖ Provision of detailed reports
- ❖ Thermography

### Repair

- ❖ Advantageous response, charge rates and parts pricing for maintenance contract holders
- ❖ Factory trained, fully qualified, IEE 17th edition certified engineers
- ❖ All repair work warranted



### Calibration

- ❖ Of thermocouples
- ❖ Of temperature indicators
- ❖ Of temperature measurement systems
- ❖ Of uniformity
- ❖ To local, national or UKAS standard
- ❖ Provision of reports / certificates
- ❖ Automatic reminders to avoid non-compliances

**FOR UK COVER CONTACT**  
**the Carbolite Engineering Services helpdesk**  
**Tel: 01433 624242 Fax: 01433 624243**  
**Email: [service@carbolite.com](mailto:service@carbolite.com)**



[www.carbolite.com](http://www.carbolite.com)

**CARBOLITE®**  
Leading Heat Technology

**Carbolite**  
Parsons Lane, Hope, Hope Valley S33 6RB, United Kingdom  
Tel: +44 (0)1433 620011 Fax: +44 (0)1433 621198  
e-mail: [info@carbolite.com](mailto:info@carbolite.com) [www.carbolite.com](http://www.carbolite.com)

part of **VERDER**  
scientific

