Furnace Tracker®

Low-height Quench System

USER MANUAL

Issue 2a

MA3220A

DATAPAQ®

A Fluke Company

Furnace Tracker®
Low-height Quench System
User Manual

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Datapaq® is the world's leading manufacturer of process temperature-monitoring instrumentation. The company maintains this leadership by continual development of its advanced, easy-to-use Tracker systems.

Europe & Asia
Datapaq Ltd.
Lothbury House, Cambridge Technopark
Newmarket Road
Cambridge CB5 8PB
United Kingdom
Tel. +44-(0)1223-652400
Fax +44-(0)1223-652401
sales@datapaq.co.uk
www.datapaq.com

North & South America
Datapaq, Inc.
3 Corporate Park Dr., Unit 1
Derry
NH 03038
USA
Tel. +1-603-537-2680
Fax +1-603-537-2685
sales@datapaq.com
www.datapaq.com

DATAPAQ PART NO. MA3220A

European Community Directives

The following product types

TPaq21 Thermocouple Data Logger

manufactured by Datapaq Ltd.
Lothbury House, Cambridge CB5 8PB, UK

comply with the requirements of European Community directives as follows.

Council Directive 2004/108/EC Electromagnetic Compatibility (EMC)
Standards Applied
EN61326-1: 2006 – Group 1, Class B equipment (emissions section only), and Industrial Location Immunity (immunity section only).
CFR47: 2007 Class A – Code of Federal Regulations: Part 15 Subpart B, Radio Frequency Devices, Unintentional Radiators.

Council Directive 99/5/EC Radio and Telecommunication Terminal Equipment (RTTE)
Standard Applied EN300 220-1:2000

RoHS Compliance Datapaq temperature monitoring equipment is exempt from EU Directive 2002/95/EC (restriction of the use of certain hazardous substances in electrical and electronic equipment) under category 9 Monitoring and Control Instruments. This Datapaq product nevertheless uses RoHS-compliant components and manufacturing processes.

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Manual set in 10 pt Gill Sans.

User manuals are available in other languages; contact Datapaq for details.

SAFETY WARNINGS

For safe use of Datapaq equipment, always:

- Take care to follow its supplied instructions.
- Observe any warning signs shown on the equipment itself.

Indicates **potential hazard**.

On Datapaq equipment this normally warns of high temperature, but where you see the symbol you should consult the manual for further explanation.

Warns of **high temperatures**.

Where this symbol appears on Datapaq equipment, the surface of the equipment may be excessively hot (or excessively cold) and may thus cause skin burns.

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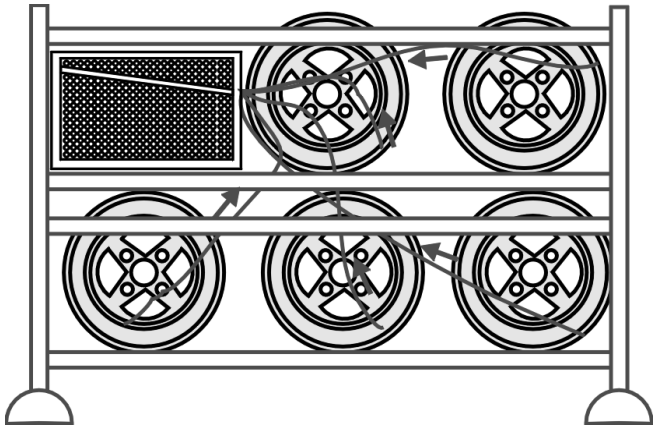
Introduction

The Datapaq® Furnace Tracker® Low-height Quench System is generally used to monitor the solution-treatment and age-hardening process in aluminum foundries. Systems based on this principle can also be used for monitoring higher-temperature heat-treatment processes in the steel industry where a water-spray quench follows the furnace stage.

The object of monitoring is to:

- Ensure all products within the load are meeting the relevant heat-treatment specification.
- Survey the furnace on a regular basis.
- Establish possible causes of problems occurring in the heat-treatment furnace.
- Ensure that process conditions are optimum.
- Examine effects of any changes made to furnace settings.

Thermocouples, set at different positions within the load, send temperature information to a highly accurate data logger which travels through the process with the product. This eliminates the need for trailing thermocouples, which is the traditional method of monitoring in these furnaces.



Product basket, showing Low-height Quench System in place (top left) and positions of thermocouples (arrowed).

Obviously, it would be impossible for the logger to operate in the fierce heat of the furnace, so it has to be protected as it travels through the process. There

are two problems to overcome when monitoring the solution-treatment and age-hardening process:

- Protecting the logger from the heat of the furnace.
- Protecting the logger against the water quench which directly follows the solution-treatment process.

The Low-height Quench System consists primarily of a Tpaq21 data logger protected by two separate thermal barriers: a watertight inner one to protect the logger against the quench, and an outer evaporative water barrier with surrounding insulation to protect against heat in the furnace.

Hardware

The following hardware is required to set up and run trials with the Furnace Tracker Low Height Quench System.

Equipment Supplied by Datapaq

The equipment shown below is for medium-duration aluminum solution treatment and age hardening processes. If the system is supplied for shorter, longer or special process, then parts of the equipment will differ. Refer to your quotation for exact specification, and contact Datapaq for details.

TB4101 Thermal Protection System

1	TB4100	Insulation frame
1	TB4071	Evaporative water barrier
1	TB5810	Inner thermal barrier
2	CS2010	Insulation set
1	CS2024	Insulation templates
1	TP2116A	Tpaq21 data logger
1	MA5500A	*Tpaq21 Data Logger User Manual*, English
1	BP0021	Set of 4 spare high-temperature lithium batteries
1	CI1033	Communications cable
10	PA0712	Thermocouples 3.0 m long (or alternative lengths to suit)
1	SW5030	Insight™ Furnace Tracker software, English
1	MA3220A	*Furnace Tracker Low-height Quench System User Manual*, English
1	MA5070A	*Furnace Tracker General System User Manual*, English
1	CS1001	Hand-held thermometer
1	CC0044	Aluminum carrying case for accessories
1	–	CD: video demonstration of setting up hardware and running a profile

Spares Kit

10	TB1278	Silicone-rubber plug seals
2	SC1143	O-ring seals for TB5810 thermal barrier
10	PA1013	Dowel pins
1	SC0105	Thermocouple-plug rod
10	SC0106	Rod dome cap
1	TB9669	Securing screw for TB5810 thermal barrier
1	CS2016	Tube of silicone grease

Equipment Supplied by User

1 Pair high-temperature gauntlets (gloves)
1 Pair safety glasses
1 Pair protective gloves (for handling insulation)
1 Good-quality disposable approved dust mask or respirator
1 Long-blade knife (to cut insulation)
1 Pair long-blade scissors (to cut insulation)
1 Pair long-nose pliers
1 Plastic funnel (to pour water into evaporative barrier)

Limitations of the System

A standard system using a TB4101 thermal barrier will operate at a steady temperature of 550°C/1,022°F for a period of 10 hours in the solution-treatment furnace. After a quench into water for 3–5 minutes the evaporative water barrier will be replenished and will operate for up to 10 hours in the age-hardening furnace at a steady temperature of 200°C/392°F.

Datapaq must be consulted before using the system in any other process, which may be of longer duration, or where conditions in the furnace (or quench) may be different from those specified above.

The system may vent steam into the atmosphere of the solution treatment furnace as it travels through. If this in any way causes process problems then the use of a conventional phase-change thermal barrier and quench shield must be considered.

WARNING

This system must not under any circumstances be used in a heat-treatment process which results in an oil quench. This may cause a serious fire risk.

Thermocouples

Thermocouples for the system are specified as type K mineral-insulated, Nicrobel sheath, 1.5 mm diameter, insulated hot junction, to ANSI MC 96.1 (special limits of error). They must be purchased in specific lengths to suit your measuring positions.

Thermal Barriers

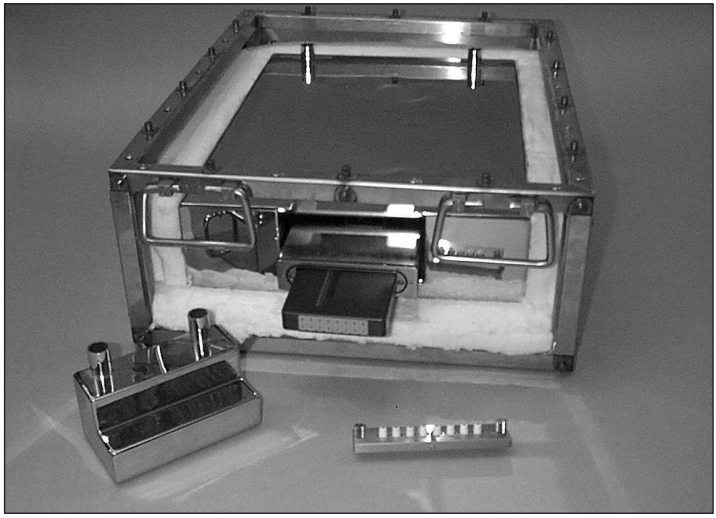
The inner thermal barrier (TB5810) is a watertight unit that offers no real protection against heat, but keeps the logger dry when the system is in the water quench.

The outer thermal barrier protects the logger against heat in the furnace. It has three components:

- An evaporative water barrier, comprising a main tank surrounding the inner barrier and a small tank closing off the main tank's entrance.
- Replaceable thermal insulation panels surrounding the water barrier.
- An insulation frame housing the water barrier and insulation.

The system operates on the following principal. A thermal insulation layer which can operate in temperatures up to 1,200°C/2,192°F (Superwool fiber blanket) slows down the passage of heat and allows different temperature levels to exist within the system.

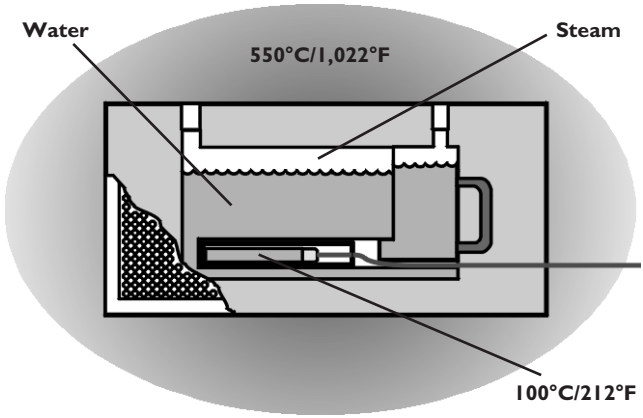
Datapaq recommends use of Superwool fiber blanket, as ceramic fiber blanket has been reclassified as class 2 carcinogenic under European legislation. The customer can of course use ceramic fiber blanket as substitute insulation, but this is at the customer's own risk. Superwool and ceramic fiber have the same thermal properties.



Insulation frame and water barrier, showing the water barrier's small front tank removed (front left), inner barrier containing the Tpaq21 data logger (center), and the inner barrier's end-plate (front right).

Protected by the insulation, the water inside the evaporative barrier slowly heats up and then boils off creating an environment where the temperature does not exceed 100°C/212°F. The logger, situated inside the evaporative thermal barrier, is designed to operate at temperatures up to 110°C/230°F and will therefore operate safely while there is water in the system. The Low-height Quench System will have a water capacity adequate for the process for which it is designed.

Datapaq must be consulted before using the system in any process which may be of longer duration than that originally specified, or where conditions in the furnace or quench may be different from those specified.



Temperatures inside and outside the system while it is in the furnace.

The Superwool blanket insulation and evaporative water barrier are housed in a high-grade alloy insulation frame that is designed to allow free passage of water during the quench, and to drain freely afterwards. This is essential when using the system in aluminum solution-treatment and age-hardening processes, as it allows water (from immersion in the quench tank) to replenish the system for operation in the age-hardening furnace.

The thickness of the insulating layers is calculated to ensure optimum thermal performance during the processing time in the furnace.

	Thermal Protection System			
	TB4065 Long duration	**TB4080 Long duration, 2 loggers**	**TB4101 Medium duration**	**TB4072 Short duration**
Components Water barrier Insulation frame Insulation set Insulation templates Inner barrier	 TB4061 TB4060 KL1437 TB9281 TB5810	 TB4108 TB4060 KL1437 TB9281 TB4109	 TB4071 TB4100 CS2010 × 2 CS2024 TB5810	 TB4071 TB4070 CS2010 CS2012 TB5810
No. of **insulation panels** at each side and at top and bottom	3	3	2	1
Duration* at 550°C/1022°F (solution) and 200°C/392°F (age)	20 hours solution + quench + 10 hrs age	19 hours solution + quench + 10 hrs age	10 hours solution + quench + 10 hrs age	5 hours solution + quench + 5 hrs age
Dimensions Height Width Length	 321 mm/12.6 in. 514 mm/20.3 in. 657 mm/25.9 in.	 321 mm/12.6 in. 514 mm/20.3 in. 657 mm/25.9 in.	 210 mm/8.25 in. 450 mm/17.75 in. 610 mm/24 in.	 160 mm/6.3 in. 400 mm/15.75 in. 560 mm/22 in.
Weight Empty Full	 39 kg/86 lb 59 kg/130 lb	 39 kg/86 lb 59 kg/130 lb	 31 kg/68.4 lb 43 kg/95 lb	 26 kg/57.5 lb 38 kg/83.8 lb
Water capacity	21 litre/ 5.5 US gal.	20 litre/ 5.3 US gal.	12 litre/ 3.2 US gal.	12 litre/ 3.2 US gal.

* Duration shown above is based on the average temperature (not the maximum temperature) in the furnace throughout the process.

Thermal barriers for the Datapaq Low-height Quench System offer many benefits:

- Thermal barriers in three sizes to suit the longest thermal process, or the lowest clearance at the furnace entrance.
- High thermal capacity (up to 20 hours in the solution-treatment furnace alone) to suit the longest heat-treatment processes.
- Will monitor all processes including water quench.
- Can be re-used instantly after a trial (insulation panels must be replaced).
- Easy to assemble and use.
- Made of rugged high-grade stainless steel to resist high temperatures.
- Up to 20 thermocouples for maximum data-gathering.
- Ensures product achieves solution-treatment and age-hardening specifications (time at temperature).

- Ensures all areas of the product (even to the center of the casting) meet time and temperature specification during quench.
- All areas of product basket can be surveyed ensuring correct furnace balance.
- Hot and cold spots in furnace identified before problems occur.
- ISO 9000 reports generated for your records and to satisfy your customer's requirements.

These thermal protection systems can only be used for water quenches and must ***never*** *be used in oil quenches.*

WARNING

Never exceed the specified duration for your thermal barrier. This is shown on the barrier data sheet; if it is a special thermal barrier with no data sheet, refer to your original quotation. In case of any doubt about the thermal duration of your barrier, contact Datapaq.

The time component of the thermal duration is a cold-to-cold time (e.g. 6 hours at 500°C/932°F etc.): from the logger entering the furnace to its removal at the end of the process. It is important to adhere to the specified barrier duration as the logger used may contain non-rechargeable lithium batteries, which – if exposed to temperatures above 185°C/365°F – are at serious risk of bursting explosively. If the thermal duration of the barrier is exceeded, and the cooling water runs dry, the logger will quickly exceed this critical temperature. Should this happen, the thermal barrier may contain the explosion but the logger and the interior of the thermal barrier will be irreparably damaged.

Insulation Specification

Panels are cut from Superwool 612 blanket (or equivalent), 128 kg per m^3/8.0 lb per ft^3 density, 25 mm/0.98 in. thick, which can be supplied in rolls 610 mm × 7.23 m/24.0 in. × 23.7 ft (Datapaq part no. CS2010). Locally purchased insulation can be used, but it must conform to this specification.

Superwool is not a refractory ceramic fiber.
Discard the insulation panels after one use; they should not be reused.

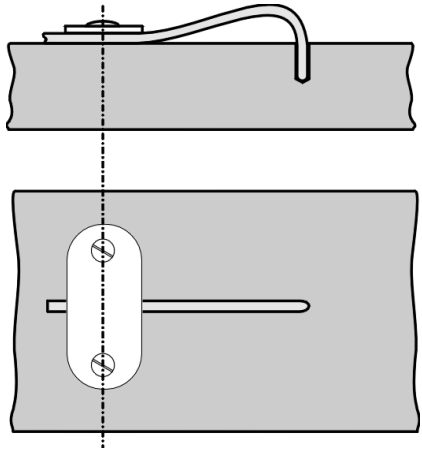
Running a Temperature Profile

Refer to the *Tpaq21 Data Logger User Manual* for details of using the logger with Insight software, i.e. to set up communications, to reset the logger to receive fresh data, and to download the data after the run.

Preparation of the Test Piece

If it is necessary to monitor the temperature of the casting during the heat-treatment process, a reject casting should be prepared. Use a 1.5-mm-diameter drill to make a hole for the thermocouple. The depth of the hole depends on the required measuring point, which may be at the inner or outer surface of the casting or at the center of the thickest section. The thermocouple can be secured by a clamp, or tied to the casting using high-temperature nickel or Inconel wire.

If the air temperature in the immediate vicinity of the casting is to be measured, then the thermocouple can be secured to the casting or the sides of the product basket as described above.



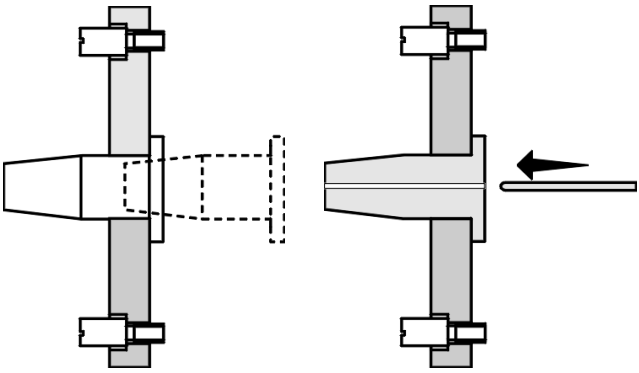
Thermocouple secured to the test piece by bracket and screws – seen in section (above) and in plan view (below).

Assembling the Logger, Thermocouples and Inner Barrier

After the test piece has been prepared and the Datapaq equipment unpacked and checked, the first operation is to set the thermocouples into the end-plate of the TB5810 inner thermal barrier.

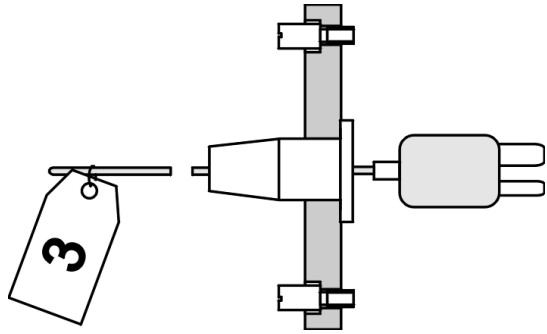
The lengths should be marked on labels to be attached to the ends of each thermocouple and will be specific to the points being measured. They must not be mixed up. Prior to fitting, test each thermocouple by connecting it to the hand-held thermometer (supplied) and gently heating the tip. The thermometer should show an increase in temperature; if it does not, or shows signs of being open circuit, replace the thermocouple.

After testing, straighten each thermocouple, then fit the silicone-rubber plug seals into the inner barrier's end-plate. Lightly lubricate the tip and body of the thermocouple with silicone grease and push it through the silicone-rubber seal.



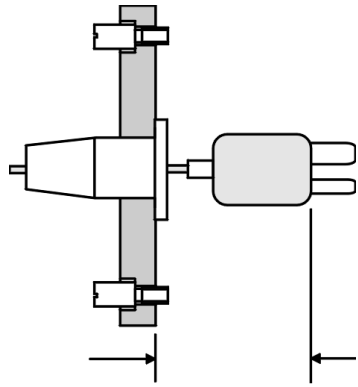
Thermal barrier's end-plate in section, showing fitting of plug seal (left) and thermocouple (right).

At this stage it is necessary to ensure the thermocouples are in the correct sequence and orientation to fit correctly into the logger. Each thermocouple plug will need to correspond to its specific channel in the logger (channel numbers are marked on the logger). Keep a written note of which thermocouple has been connected to which channel. Each thermocouple plug has a wide pin (-), and a narrow pin (+). These plugs will fit into the logger only if the wide pin is uppermost.



Correct orientation and numbering of a thermocouple: wide pin(+) to the top, narrow pin (-) below.

Ensure also that the distance between the end of the thermocouple plug and the inner face of the end-plate is correct. If this is not set correctly, the inner barrier will not close and water will enter during the quench.



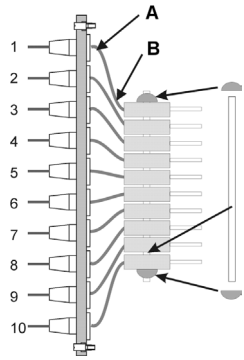
Setting the distance (maximum 40 mm) between the end of the thermocouple plug and the inner face of the end-plate.

Start by fitting thermocouples 5 and 6 first and set the correct distance on these. Then fit thermocouples 4 and 7. It may be necessary to bend the thermocouple body slightly to ensure the plugs are close enough together to fit into the logger; this is because the spacing of the thermocouples on the barrier end-plate is wider than the spacing on the logger. Repeat this for thermocouples 3 and 8, then 2 and 9, and finally 1 and 10. Use a pair of long-nose pliers to carefully bend the thermocouple, ensuring that the bend radius is not less than 6 mm.

Before bending, ensure the pins on the thermocouple plugs are the right way up.

If not all of the 10 thermocouple channels are used, or if the 11th hole for the antenna is not required, fit the dowel pins provided with the system into the silicone-rubber plug seals to seal the holes.

When all the thermocouples are in position and fitted into the logger, slide the rod provided through the holes in the plugs and fit the dome catches.



Bend the thermocouples at points marked (A, B). Slide the rod through the thermocouple plugs and fit its dome catches.

At this stage fit the numbered identification labels to the tips of the thermocouples so these can easily be identified at a later stage. Make sure that the number on the label corresponds to its channel number on the logger.

The logger must now be reset; refer to the *Tpaq21 Data Logger User Manual* for details.

After resetting, slide the logger and assembled thermocouples into the body of the TB5810 barrier and tighten the securing screws enough to ensure a good seal. Do not overtighten these screws or they will shear.

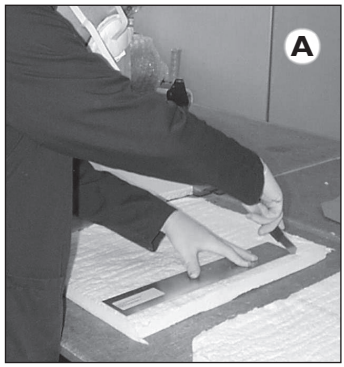
Before sealing, clean the faces of the end-plate and the flange of the inner barrier, and ensure the O-ring gasket is in place and in good condition.

Fitting the Inner Barrier into the Water Barrier

If space allows, carry out this operation near the furnace, as it saves carrying a heavy barrier to the product basket.

Cut to shape the insulation panels which will surround the water barrier, using the set of templates supplied with your system (see A). The thickness of insulation (i.e. the number of panels) varies between systems, and a label on

each template shows how many panels of each size to cut (see also p. 13, or contact Datapaq if your system is not listed there); note that, for systems using more than one panel on each face of the frame, the outermost panel must be cut slightly smaller to allow for the thickness of the frame's structure. Panels are cut from a roll of Superwool or other insulation material (see specification on p. 14). Cut holes in the upper panels to accommodate the tank filler spouts; these allow the steam to escape and permit water from the quench to refill the water barrier.



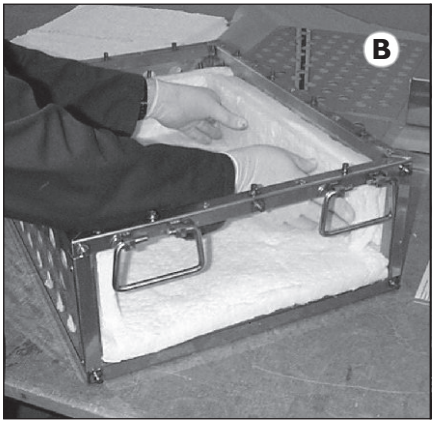
When working with Superwool insulation, protective clothing such as gloves, overalls, approved dust mask and goggles should be worn to prevent skin irritation.

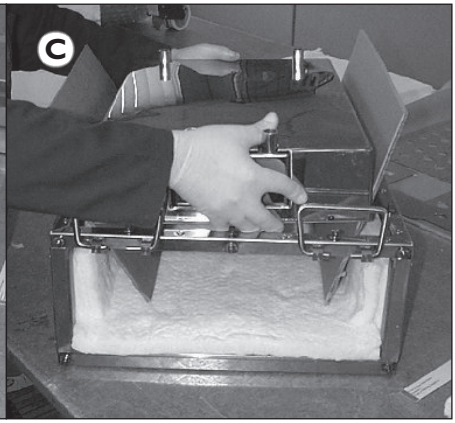
Position first the insulation panel(s) at the base of the insulation frame, and then those at the sides and rear (see B).

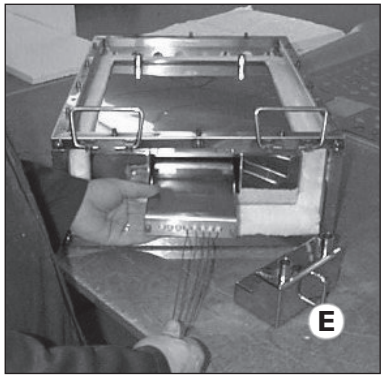
The water barrier can now be installed by placing some thin cardboard against the side insulation panels to make it easier to lower the barrier into place (see C); the cardboard must be removed after fitting the barrier. At this point fill both the water barrier's tanks with water using a funnel (see D); when water overflows from the second spout the tank is full.

WARNING

Forgetting to fill the tanks with water will result in disaster!

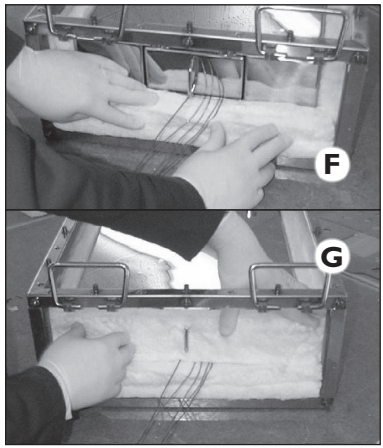




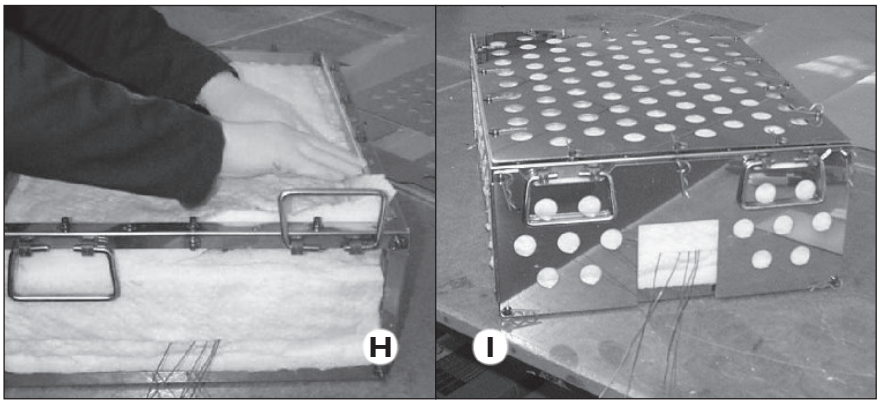


The inner barrier containing the logger and thermocouples can now be loaded into the water barrier: slide the logger assembly to the rear of the water barrier's main jacket, and carefully slide the small water jacket into position over the thermocouples (see E).

Fitting the front insulation panels requires the panels to be cut horizontally to allow the thermocouples to exit the insulation: mark each panel at the height of the thermocouples and cut right along its length; then fit the lower halves followed by the upper halves (see F–G). A small vertical slit may need to be cut in the innermost front panel to accommodate the handle of the small water jacket.



To complete the insulation, fit the top panels, ensuring the filler spouts line up with the holes in the insulation (see H).



When all insulation panels are in place, fit the front and the top of the insulation frame and secure with R-clips provided (see I).

Placing the System in the Product Basket

The thermocouples can now be placed into the test pieces in the product basket. Wherever possible keep the thermocouples within the confines of the product basket and secure them to the sides. Secure the whole system within the product basket by tying it to the basket framework with high-temperature nickel or Inconel wire.

Recovering the System

It is best to remove the logger as soon as the system is out of the ageing furnace. The product basket should be situated in an area where the system can be accessed easily. Removing the logger from the system is not difficult, but extreme caution should be taken, as the water still in the water barrier will be very hot. Heat-protective gloves and an approved dust mask (see 'Hardware') must be worn.

Dismantling the System

Remove the thermocouples from the test pieces and carefully wind them up into coils of diameter not less than 20 cm/8 in. for 1.5-mm/0.06-in.-diameter cables or 40 cm/16 in. for 3-mm/0.12-in.-diameter cables.

Remove the front of the insulation frame and carefully remove the insulation panels covering the small water jacket. Slowly remove the small water jacket and place it on the floor away from you.

Slowly pull out the thermocouples which will draw the inner barrier (containing the logger) out of the water barrier. Grasp the inner barrier to remove it fully.

Loosen the two retaining screws at the front of the inner barrier and remove the logger together with the barrier's end-plate and the thermocouples. Data from the logger can be now be downloaded to the PC as detailed in the *Tpaq21 Data Logger User Manual*.

The thermocouples can remain connected to the logger and to the barrier end-plate while the logger is downloaded and reset. This speeds reassembly of the system.

Removing the Water Barrier from the Product Basket

Keep the insulation frame and water barrier level when removing, as there will be hot water inside that could spill. If the system is not to be reused immediately, allow it to cool before emptying the water.

Discard the insulation panels after one use; they should not be reused.

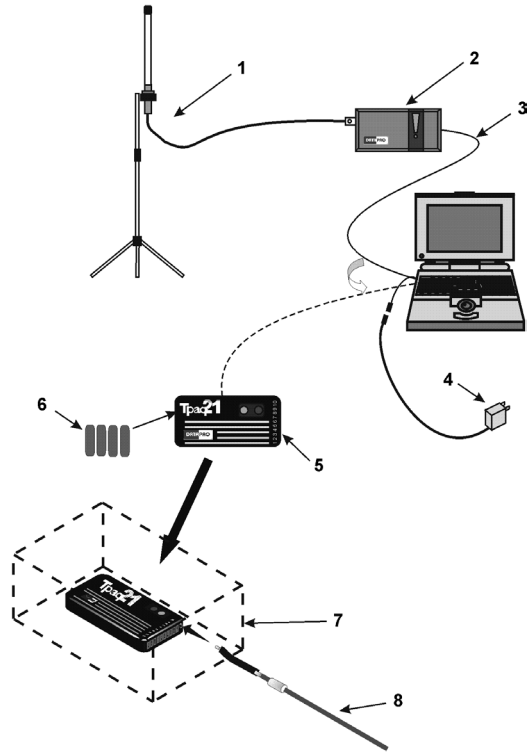
Preparation for Another Run

If a second profile run is to be carried out shortly after the first one, reset the logger, carefully empty the water barrier of hot water, refill both water jackets with cold water, cut and fit new insulation panels, and reassemble the system.

Using Telemetry

The Low-height Quench System can be fitted with radio telemetry, allowing data gathered inside the furnace to be seen in real time. This requires a Tpaq21 logger incorporating the factory-fitted transmitter module (TP2116TX), and a special high-temperature transmitting antenna (TX2051); the standard thermal barrier which holds the logger is already provided with an end-plate which will accept the antenna as well as the 10 thermocouple leads. A receiving antenna system is also required, as shown.

Radio reception is possible in the solution-treatment and age-hardening furnaces, but not while the system is in the quench.



Organization of components in a Low-height Quench telemetry system.

1. *Antenna kit RX0211 (Europe and Japan) or RX0212 (USA), comprising antenna, cable and stand. A dual-antenna kit is available for long furnaces.*

2. *Receiver RX1002A (Europe), RX1000A (USA), RX1003A (Japan).*
3. *Communications cable CI1030 (RS232).*
4. *Receiver Power Supply CH0058 (UK), CH0055 (USA), CH0057 (Europe), CH0056 (Japan).*
5. *Tpaq21 Telemetry Data Logger TP2116-TX.*
6. *4 × lithium batteries BP0021A.*
7. *Low-height quench thermal barrier, including TB5810 barrier with 11-hole faceplate for 10 thermocouples and transmitting antenna.*
8. *Transmitting antenna TX2051A for low-height quench thermal barrier.*

See the *Tpaq21 Data Logger User Manual* for:

- Specification and use of telemetry hardware.
- Resetting the logger for a profile run using the Insight software.
- Using the real-time display of results and data analysis.
- Ending data collection by the logger.

Troubleshooting

If you cannot resolve your problem, please contact the Service Department at Datapaq (see title page for contact details).

Europe & Asia
Datapaq Ltd
Lothbury House
Cambridge Technopark
Newmarket Road
Cambridge CB5 8PB
United Kingdom
Tel. +44-(0)1223-652400
Fax +44-(0)1223-652401
sales@datapaq.co.uk

North & South America
Datapaq, Inc.
3 Corporate Park Dr., Unit 1
Derry, NH 03038
USA
Tel. +1-603-537-2680
Fax +1-603-537-2685
sales@datapaq.com

China
Datapaq Ltd
3rd Floor, Lane 280-6
Linhong Road
Shanghai 200335
China
Tel. +86(0)21-6128-6200
Fax +86(0)21-6128-6221
Fax +86(0)21-6128-6222
sales@datapaq.com.cn

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A Fluke Company

www.datapaq.com