Furnace Tracker®

Slab Reheat System

USER MANUAL

Issue 3

MA3160A

DATAPAQ®

A Fluke Company

Furnace Tracker®
Slab Reheat System
User Manual

Issue 3

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.

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DATAPAQ PART NO. MA3160A

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.

Manual set in 10 pt Gill Sans.

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

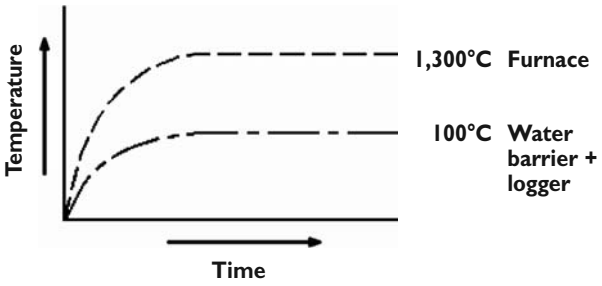
CONTENTS

Introduction

The object of monitoring the slab reheat process is to study the temperature profile of the slab throughout its thickness as it progresses through the furnace. Temperature data from the Furnace Tracker® Slab Reheat System is normally required to verify the slab temperature predictions of a mathematical model which controls the furnace.

Thermocouples, set at different levels within the thickness of the slab, send temperature information to a highly accurate data logger which travels through the furnace with the slab (see diagram, p. 10). This eliminates the need for trailing thermocouples, which is the traditional method of monitoring these type of furnaces. As the logger cannot operate directly in the fierce heat of the furnace – where temperatures can reach 1,300°C/2,370°F – it is protected by a thermal barrier system.

The logger's thermal protection consists of various layers of insulation which slow down the passage of heat and thus allow different temperature levels to exist within the system. The outermost insulation consists of a fiber blanket which can operate up to 1,600°C/2,912°F and protects an evaporative thermal barrier. The outer shell of this evaporative water barrier consists of high-grade ceramic insulation (limited to a temperature of 1,050°C/1,922°F) protected by a stainless steel casing. Inside, water slowly boils off and creates an environment where the temperature does not exceed 100°C/212°F. The logger, situated inside a further inner thermal barrier to protect it from condensation, is designed to operate at temperatures up to 110°C/230°F and will therefore function normally as the water boils off.



Relative temperature inside the system during its time in the furnace.

The relative proportions of the various insulating layers are carefully calculated to ensure optimum thermal performance during the processing time of the slab. The complete system is housed in a high-grade-alloy frame which holds the

outer insulation blanket in place and affords some mechanical protection if the slab discharges from the furnace on a ramp.

Hardware

The following hardware is required to set up and run trials with the Furnace Tracker Slab Reheat System. Some will be provided and prepared by the user, as detailed here.

Equipment Supplied by Datapaq

The equipment shown below is for a TB4272 standard Slab Reheat System. If the system is supplied for a shorter, longer or special process, then parts of the equipment will differ. Refer to your quotation for exact specification, and contact Datapaq for details.

- Insulation frame
- Evaporative water barrier
- Inner thermal barrier
- Insulation set – generally, fitted-blanket insulation (see specification below) plus spare
- Insulation templates
- Stainless steel wire (to secure insulation), 250 m/820 ft
- Tpaq21 data logger (2 loggers for 20-channel system)
- *Tpaq21 Data Logger User Manual*
- Set of 4 high-temperature lithium batteries
- Communications cable
- Thermocouples (see specification below)
- Insight Furnace Tracker software
- *Furnace Tracker Slab Reheat User Manual*
- Hand-held thermometer (to test thermocouples when assembling)
- Carrying case for accessories

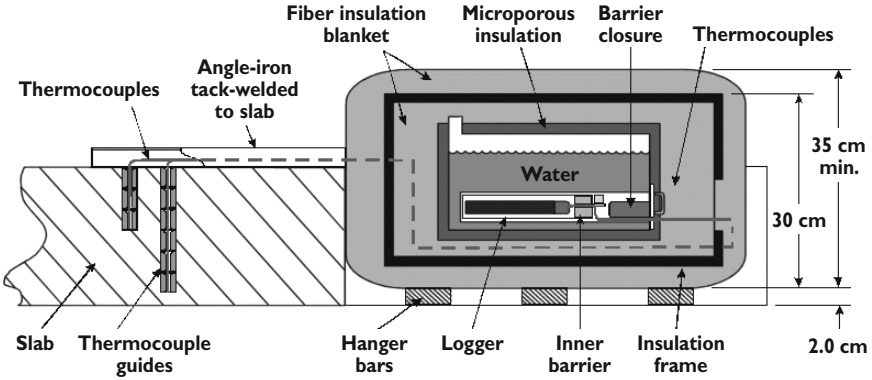
Equipment Supplied by User

- Aluminized heat-protection suit: jacket and trousers with foot protection, gauntlets (gloves), gold visor, head protection
- Safety glasses
- Protective gloves for handling insulation
- Good-quality approved dust mask or respirator
- Long-blade knife to cut insulation
- Electrical-wire cutters

Limitations of the System

Do not expose the system to water at any time, e.g. as a coolant, in a quench or de-scaler, or by hosing it down after use.

Exposure of the barrier surface to water may cause severe and permanent damage.

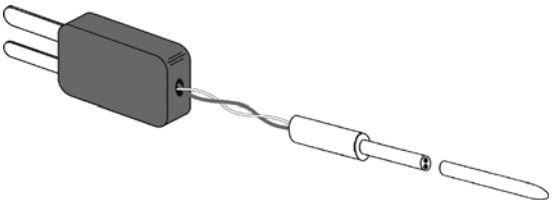


A Slab Reheat System, showing the thermal barrier assembly, in vertical cross-section, in position in the slab. In this case, the system is supported in the slab by hanger bars and uses angle-iron to protect the thermocouples (see text).

Thermocouples

Thermocouples for the system are specified as type K mineral-insulated, Nicrobel sheath, 3-mm/0.125-in. diameter, insulated hot junction, to ANSI MC 96.1 (special limits of error). 40 mm/1.6 in. of flexible PTFE-insulated 'tail' is fitted at the pot seal, terminated with a sub-miniature type K high-temperature plastic plug; plug and pot-seal are filled with non-corrosive silicone rubber.

Thermocouples must be purchased in specific lengths to suit your measuring positions.



A slab reheat thermocouple, as supplied, showing (from left) type K plug, PTFE-insulated tail, pot-seal, and sheathed thermocouple (see text).

Thermal Barriers

Components and specifications of two typical systems are as follows.

	TB4272	**TB4051**
Channels	10 or 20	10 or 20
Components Water barrier Insulation frame Insulation set Insulation templates Inner barrier	 TB4133 TB4031 CS2064 × 1 CS2094 TB4132	 TB3028 TB4031 CS2064 × 2 CS2022 –
No. of **insulation panels**	2 at each side, 2 at top and bottom	4 at each side, 3 at top and bottom
Duration at 1,200°C/2,192°F*	9 hours (see below for other temperatures)	7 hours
Dimensions Height Width Length	 300 mm/11.8 in. 575 mm/22.6 in. 687 mm/27.0 in.	 295 mm/11.6 in. 575 mm/22.6 in. 687 mm/27.0 in.
Weight Empty Full	 66.0 kg/145 lb 90.0 kg/198 lb	 41 kg/90 lb 55 kg/121 lb
Water capacity	24.0 litre/ 6.3 US gal.	14 litre/ 3.7 US gal.

* Durations given here assume use of no external insulation, i.e. with insulation inside the insulation frame only. For conditions exceeding these limits, contact Datapaq. For maximum temperature ratings with and without external insulation, see p. 12.

Duration in the Furnace

The maximum permitted time which the system can spend in the furnace without incurring damage depends on the temperature of the furnace. For the **TB4272 system only**, this time can be determined from the table below (data are for Altra 72, Altra 80 or Saffil insulation, used only inside the insulation frame; see below).

600°C/ 1,112°F	700°C/ 1,292°F	800°C/ 1,472°F	900°C/ 1,652°F	1,000°C/ 1,832°F	1,100°C/ 2,012°F	1,200°C/ 2,192°F	1,250°C/ 2,282°F
28.0 hrs	21.2 hrs	17.0 hrs	13.0 hrs	11.0 hrs	10.0 hrs	9.0 hrs	8.5 hrs

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 or to the user notes supplied. 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. 9 hours at 1,200°C/2,192°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 data logger used may contain non-rechargeable lithium batteries, which – if exposed to temperatures above 250°C/482°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.*

Adding Additional Insulation

The maximum temperature rating of the thermal barrier assembly with no external insulation (i.e. with insulation only inside the insulation frame) is 1,250°C/2,282°F. With one external layer of blanket added over and under the barrier assembly (see p. 21), this rises to 1,300°C/2,372°F. With two external layers of blanket over and under the barrier assembly, the rating is 1,350°C/2,462°F.

If external insulation is used, clearances in the furnace should be carefully checked.

Insulation Specification

Thermal insulation panels are cut from fiber blanket, which can be supplied by Datapaq in rolls 610 mm × 7.3 m/24.0 in. × 24 ft, if purchased locally the insulation must conform to the following specification:

Density	At least 100 kg/m^3 or 6.2 pcf Preferably 128 kg/m^3 or 8.0 pcf
Maximum operating temperature	At least 1,400°C/2,552°F Preferably 1,600°C/2,912°F
Thickness	25 mm or 1.0 in.
Maximum thermal conductivity at average 1,200°C/2,192°F	0.3 W/m-K or 2.1 BTU-in./hr-ft^2-°F

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

Health and Safety Information for Insulation Material

There are several different types of blanket insulation available including Refractory Ceramic Fiber (RCF) which may require specific health and safety precautions to comply with local legislation. Most blanket insulation supplied by Datapaq will be Altra 72, Altra 80 or Saffil thermal insulation, complying with EC Directive 97/69/EC. For other types of insulation you should contact the manufacturer (or Datapaq, if supplied by Datapaq) to obtain a Material Safety Data Sheet.

- **Altra 72 and Altra 80** thermal insulation, manufactured by Rath (Deutschland) GmbH, is an alumina fiber blanket. The material is a mild mechanical irritant to eyes and skin. It may release fibrous dust, and mild mechanical irritation to the upper respiratory system may result from exposure. Reduce dust exposure as far as technically possible. Wear suitable protective clothing, gloves and eye protection. After handling, rinse exposed skin with water. The fiber is not classified as 'carcinogenic substance according to category 2 and irritant acc. to EC directive 97/69/EG'. Refer to the product's Material Safety Data Sheet (available from the manufacturer or from Datapaq) for recommended first-aid measures, work practices and other product safety information.
- **Saffil** thermal insulation, manufactured by Saffil Ltd., is an alumina fiber blanket densified by stitching with organic polymer. It contains no hazardous ingredients in accordance with EC Directive 93/112/EEC, and is of low toxicity. It may cause transient irritation of skin, nose and throat. Atmospheric concentrations should be kept as low as reasonably practicable. Wear suitable protective clothing, gloves and eye/face protection. After handling, rinse exposed skin with water. The polymer in the material is a combustible solid and, in the presence of excessive heat or flame, can melt and burn. Burning polymer is accompanied by melting and dripping which may ignite adjacent combustible material. Molten polymer will adhere to the skin causing deep thermal burns. Refer to the product's Material Safety Data Sheet (available at www.saffil.com) for recommended first-aid measures, work practices and other product safety information.

Preparation of the Slab

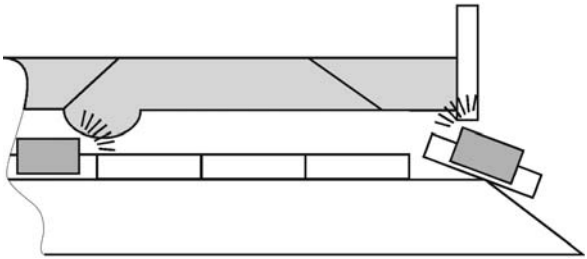
The slab is prepared by the user as described here. Machining of the slab will take some time and should be started two or three weeks before taking delivery of the Furnace Tracker system.

The overall height of the thermal-barrier assembly (the insulation frame surrounded by one layer of external insulation blanket) is 355 mm/14.0 in. In a small number of furnaces, the clearances within the furnace and at its entrance and exit will be sufficient to allow the barrier assembly to be placed on top of the slab and still enter and pass through the furnace without problem. In the great majority of furnaces, however, clearances will not permit this, and the assembly must be placed in a cut-out in the slab (p. 15) to reduce the overall height and avoid fouling.

Checking Clearances

Clearances within the furnace should be checked not only when planning the use of the Furnace Tracker system, but again when the slab has been prepared. Note that the overall height of a standard TB4272 Slab Reheat System in the slab is minimum 37 cm/14.75 in. In most furnaces the doors will open sufficiently to allow this through, but in the following situations take extra care:

- In a pusher furnace with a discharge ramp at the exit (see diagram below).
- When there is a 'knuckle' (baffle) inside the furnace (see diagram below).
- If the walking beam lifts the slab just at the entrance or exit.
- When the slab has to travel through a de-scaler at the exit of the furnace. (It is preferable that the slab does not travel through a de-scaler, but, if this is unavoidable, make sure the water spray is off and that clearance is adequate.)



Vertical section through a typical furnace, with exit door (right) open. Note extra clearance required by thermal barrier assembly (shaded) near a baffle (left) and when clearing the door and tipping onto the exit ramp (right).

With a non-standard Slab Reheat System, the overall height when in the slab can be calculated by adding 65–75 mm/2.6–3.0 in to the height of the insulation frame; this allows for one layer of external insulation blanket surrounding the insulation frame, and for the thickness of the hanger bars or plate used to support the barrier assembly in the slab (see below). For two external layers around the insulation frame (used when the furnace temperature reaches 1,350°C/2,462°F, see above), the overall height is found by adding 115–125 mm/ 4.5–4.9 in. to the height of the insulation frame.

Making a Cut-out in the Slab

In most cases a section of the slab will need to be removed to allow the thermal barrier assembly to be fitted within it and thereby reduce the overall profile and ensure adequate clearance in the furnace (see above).

When the cut-out section of the slab has been removed, a support must be provided within it on which the barrier assembly can rest as it travels through the furnace. There are two alternative types, as follows.

Hanger Bars

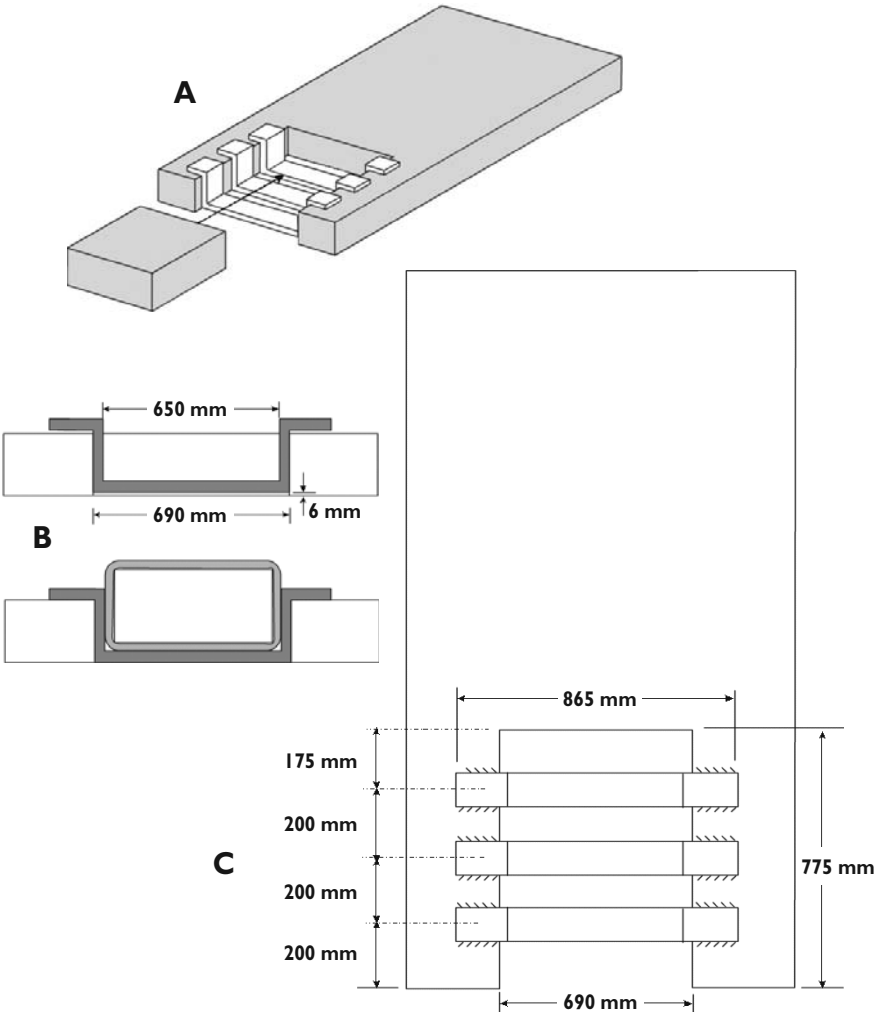
This is the preferred method, though it requires some forging capability. Three bars, of the same material as the slab, are forged (not welded) into shape and then welded to the top face of the slab.

See diagram (p. 16) for details of manufacture and fitting.

Welded Steel Plate

A steel plate on which the system will rest during the trial is welded into the cut-out in the slab at both the top and bottom edges of the plate. A 12.5-mm-wide slot should be cut into the plate (see diagram, p. 17) to ensure it does not distort due to expansion. This method is less desirable than using hanger bars (above), as the welded joints fixing the plate in position can be vulnerable at high temperature.

See diagram (p. 17) for details of manufacture and fitting.

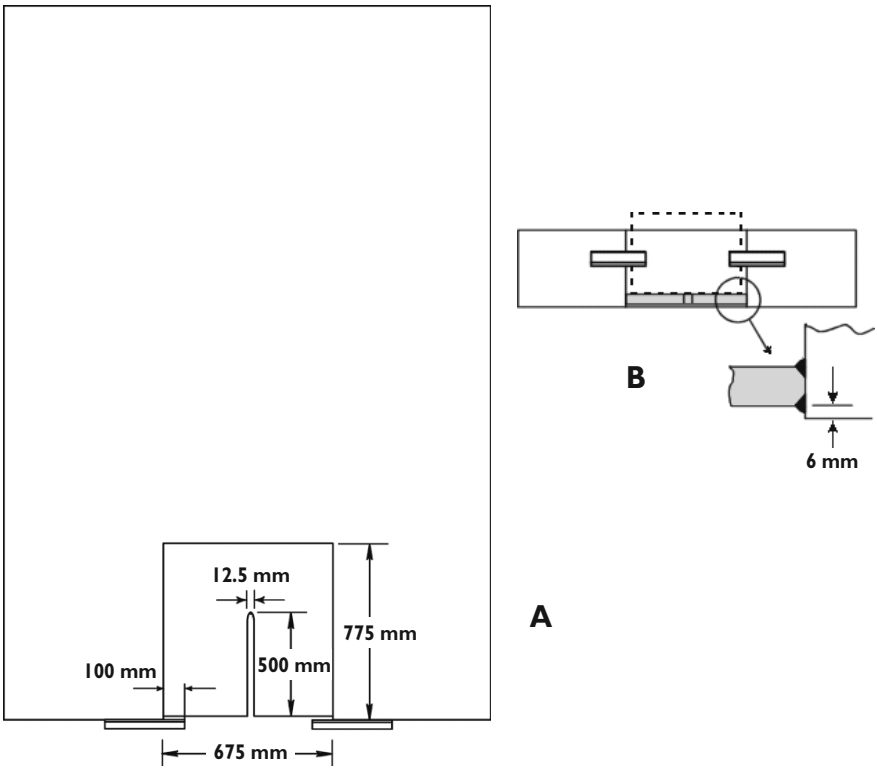


Hanger bars *for supporting the thermal barrier assembly in the slab's cut-out.*

A: General view, showing hanger bars in place, ready to receive the barrier assembly.

B: Vertical cross-section through the slab's cut-out. Lower figure shows the barrier assembly in place, surrounded by one layer of fiber blanket.

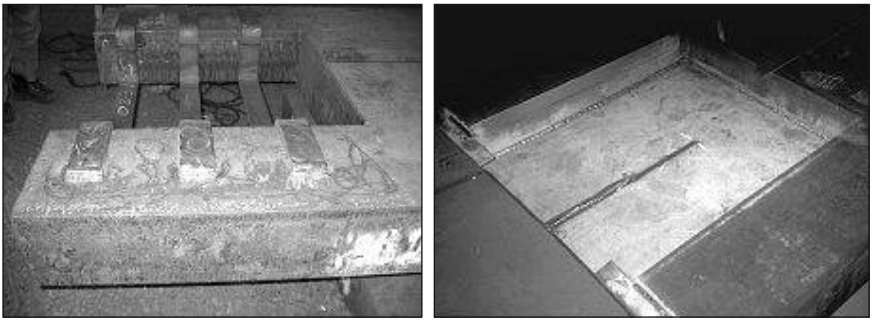
C: Plan view of the slab, showing dimensions and positioning of hanger bars (dimensions shown suit the TB4272 standard Slab Reheat System, see p. 11; for other systems, dimensions must be adapted to suit). Bars are forged from 100 × 20-mm-/4 × 0.8-in.-section steel, welded to the slab at the top only. Also weld two short pieces of steel to the end of the slab, one across each side of the cut-out, to hold the barrier assembly in place (as shown on p. 17).



Welded steel plate *for supporting the thermal barrier assembly in the slab's cut-out.*

A: Plan view of the slab, showing dimensions and positioning of steel plate (dimensions shown suit the TB4272 standard Slab Reheat System, see p. 11; for other systems, dimensions must be adapted to suit). Lengths of 50 × 50-mm/2 × 2-in. angle-iron are welded to the end of the cut-out, as shown, to hold the barrier assembly in place.

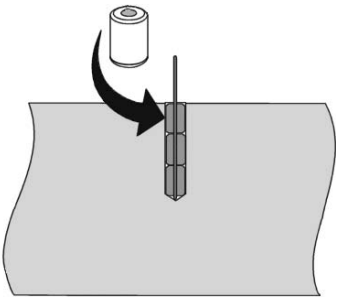
B: End-elevation view of the slab's cut-out, showing 12-mm/0.5-in. steel plate (shaded), angle-iron supports and position of barrier assembly (dotted line). The steel plate must be welded top and bottom, all around (i.e. not stitch-welded).



Slabs fitted with hanger bars (left) and a welded steel plate (right) to support the thermal barrier assembly in the cut-out.

Drilling Holes for Thermocouples in the Slab

The thermocouples recommended for the Slab Reheat System are 3 mm/0.12 in. in diameter. As it is not possible to drill such a small-diameter hole deep enough to reach the base or center of the slab, as required for slab-reheat measurements, it is recommended instead to drill a larger-diameter hole (12.5–20 mm/0.5–0.8 in.) to the correct depth and then fill the hole with machined steel bushes 25–30 mm/c. 1 in. long that are a sliding fit in the hole. The internal diameter of these steel bushes should be a sliding fit for the thermocouples. Bushes should be of the same or similar material to the slab, and with 1.5 mm edges (bore and exterior) chamfered to 45° (see diagram).



Thermocouple and steel bushes in place in the slab (vertical section). Note chamfering on edges of bush.

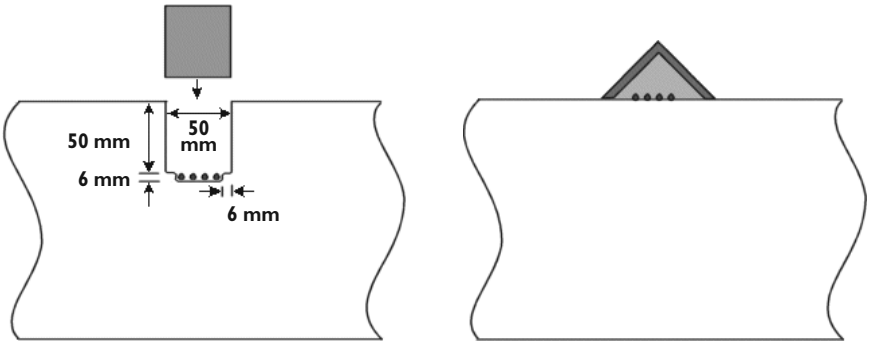
Some users place the thermocouples in the large-diameter holes and simply fill in around them with fibre insulation or ceramic paste, but the steel-bush method (above), although requiring a little machining, gives more accuracy.

Protecting the Thermocouples

The body of the thermocouple – from the system's thermal barrier to the entry point in the slab – should be protected a) from mechanical disturbance by the

seals at the base of the furnace door that brush across the top of the slab, and b) from any turbulence created by the burners. There are two ways to achieve this:

- Machine a long channel in the slab and cover the thermocouples with steel blocks, tack-welded in place (most expensive method, but gives the most accurate data).
- Cover the thermocouples along its length with 1400-grade fiber blanket, held in place with a length of inverted angle-iron, c. 60 × 60 × 6 mm/ 2.5 × 2.5 × 0.25 in. (less expensive, but, at temperatures over 1,100°C/2,012°F, may give inaccurate data due to the body of the thermocouple being at a higher temperature than the hot junction).



Vertical section through the slab, showing thermocouples protected by steel blocks within a channel in the slab (left) and by angle-iron and fiber blanket on the surface of the slab (right).

Storing the Slab

After the slab (and the blocks to cover the thermocouples, if used) have been machined, **oil the machined surfaces** and store the slab where it will not be exposed to moisture. Corrosion of the machined surfaces will affect the fit of the blocks in the slot.

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.

Assembling the System

After preparation of the slab (p. 14), proceed as follows to assemble and fit the thermal barrier, thermocouples and logger.

1 Place External Insulation in Slab

The first operation is to cut a length of fiber blanket sufficiently long to surround the outside of the insulation frame, and lay it in the cut-out of the slab; the blanket width will be too narrow to cover the whole of the insulation frame, so cut an additional strip of equal length and lay that alongside the first. Cut a further smaller piece of blanket to sit vertically against the rear face of the cut-out, flush with the top of the slab, and put this in position (**A**).

2 Fit Water Barrier's Insulation

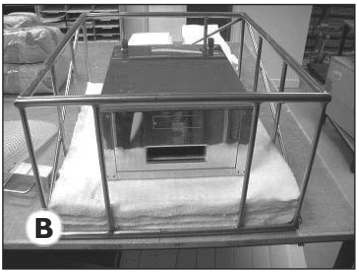
If possible, carry out this operation near the slab, to minimize the need to carry a heavy thermal barrier assembly.

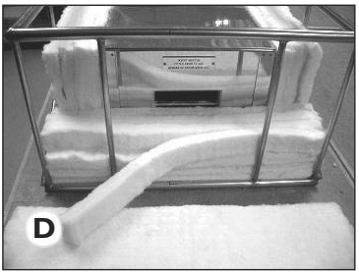
WARNING

Take appropriate safety precautions when working with the insulation material (see p. 13). Always wear a mask, goggles and gloves.

Cut to shape the insulation panels which will surround the water barrier, using the templates supplied with your system. Panels are cut from a roll of fiber blanket (see specification, p. 12).

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. 11, or contact Datapaq if your system is not listed there).





Position first the insulation panel(s) at the base of the insulation frame, and then place the evaporative water barrier on top of these. Ensure the open end of the water barrier faces the open end of the frame (**B**).

Cut and position the rear insulation panels behind the water barrier, and then the side insulation panels on either side of it (**C**).

Cut the lower front insulation panels so that their tops are level with the bottom of the water barrier's cavity (**D**).

3 Fill Water Barrier

Now use a funnel to fill the evaporative barrier with water to the top of the filling tubes. The TB4272 holds 24 litres/6.3 US gal., the TB4051 holds 14 litres/3.7 US gal. The fiber-blanket insulation must be kept dry, so, before filling, place polythene sheeting over the insulation to protect it from water spillage, and use adhesive tape to seal the sheeting in place around the filler and vent holes and prevent water seeping onto the top of the barrier (**E**). When the barrier is full, remove the sheeting.

To minimize accidental spillage before the assembly enters the furnace, put adhesive tape (e.g. masking tape) over the tops of the filling tubes and puncture this with a small hole to allow steam to escape.

WARNING

Failing to fill the water barrier will cause catastrophic destruction of the system.

4 Fit Thermocouples into Slab

New thermocouples are used for each run through the furnace. Remove each thermocouple from its plastic wrapping and test it by connecting it to the hand-held thermometer (supplied) and heating the tip with an open flame. If the thermometer shows no increase, or if the thermocouple shows signs of being open circuit, discard that thermocouple.

Thermocouple lengths will be marked on a label attached to each one and will be specific to the measurement holes in the slab. Use masking tape to label each thermocouple with the **thermocouple number** – at the probe end and at the pot seal at the logger end; at the logger end, you may instead write the number on the thermocouple plug. Use a marker pen to mark the corresponding number of rings around the tip of each thermocouple (e.g. five rings for thermocouple no. 5). Thermocouple numbers will correspond to the channel numbers marked on the logger and must not be mixed up. Keep a written record of the location of each numbered thermocouple in the slab.

Labelling of the thermocouples is essential to ensure that they are correctly connected to the logger – subsequent analysis of the data may otherwise be invalid.

Put the thermocouples in position one-by-one, starting with those furthest from the thermal-barrier assembly (see p. 18 for preparation of the thermocouple holes in the slab). Straighten each thermocouple enough to allow it to be pushed fully to the bottom of its hole in the slab.

Ensure that the bushes in the thermocouple holes (p. 18) are free of any swarf from the machining operation.

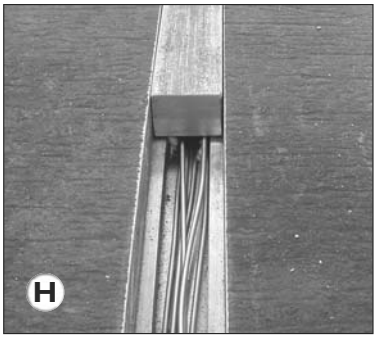
Remove the thermocouple from its hole in the slab, measure the depth of insertion to ensure it is correct, and then replace it. Gently bend the thermocouple through 90° where it exits the hole (ensuring that the bend radius is at least 10 mm), and carefully lead it back first directly towards the center-line of the slab, and then towards the slab cut-out (**F**): this will mean laying it within the machined channel (if it is to be protected by steel blocks) or in a straight line along the top of the slab (if angle-iron is to be used as protection); see p. 18 for details. Temporarily tie the thermocouples together along the slab's center-line with wire or masking tape.

5 Fit Barrier Assembly in Slab, Re-test Thermocouples and Fix Protection

Now that all the thermocouples have been positioned in the slab holes and laid on the slab surface, they should be **tested again** (see above) to make sure that none were damaged during fitting; this is unlikely, but worth checking.

The **protective blocks or angle-iron** should now be laid over the thermocouples along the slab's center-line, with additional lengths of angle-iron covering the thermocouples where they emerge from the slab: put a piece of blanket insulation under the angle-iron here to keep the thermocouple pressed into the bottom of its hole (**G**).

Tack-weld the protective blocks or angle-iron into place. It is sufficient to use short welds 12 mm/0.5 in. long on each side of the blocks or angle-iron, as they will be removed after the run so that the slab can be re-used if required (**H**–**I**).



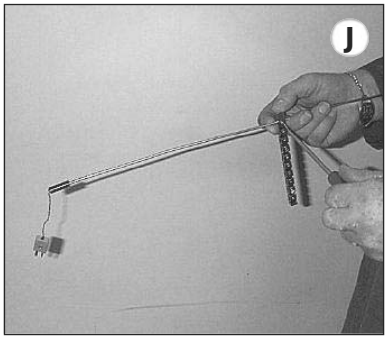
Position the thermal barrier assembly in the slab cut-out, placing it on top of the fiber blankets with the open end of the water barrier facing the end of the slab.

Where the thermocouples enter the slab cut-out, run them around each side of the barrier assembly, next to the insulation frame, keeping an equal number of thermocouples on each side.

6 Clamp the Thermocouples

If supplied (on older systems), use the thermocouple clamp to fix the thermocouples together at the logger end. They will be held temporarily in this clamp to control their springiness and thus make it far easier to connect them to the logger. Starting with thermocouple no. 1, straighten the last 500 mm of the main body of the thermocouple and position the outermost attachment point of the clamp 200 mm from the thermocouple's pot seal (**J**). Tighten the screw to lock the thermocouple in position. Repeat this

in sequence until all thermocouples are in the clamp (**K**).



7 Reset Logger and Fit into Inner Barrier

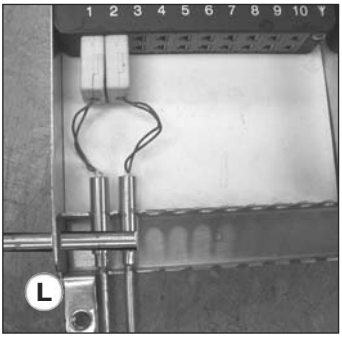
Reset the logger using the Insight software: see *Tpaq21 Data Logger User Manual* or Insight's Help system (on Insight's menu bar, select Help > Contents). Ensure that the sample interval you set allows enough total data-recording time for the process, and for any interruptions to production prior to the slab entering the furnace.

If using two loggers (a 20-channel system), trigger mode should be set to 'Date and Time' during reset, such that both loggers will start recording synchronized data at the same instant.

Open the inner (data logger) barrier and place the logger or loggers inside. (Illustrations show a TB4132 inner barrier.)

8 Connect Thermocouples

Push each thermocouple's pot-seal into the appropriate slot in the inner barrier, and, as each one is installed, slide the holding rod through the hole in the side of the barrier and across the pot-seal to hold it in place (**L**). When all thermocouples are in position, slide the holding rod fully across, engaging it at both sides of the barrier. Starting with thermocouple no. 1, plug the thermocouples into the logger, ensuring that their numbers correspond with the channel numbers on the logger.



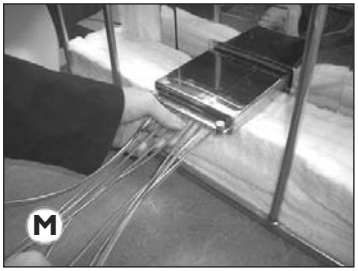
If required, install an additional small thermocouple attached to the logger's surface to measure its temperature profile.

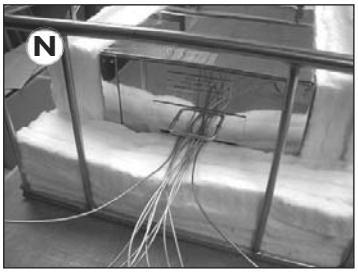
9 Install Inner Barrier

When all thermocouples are attached to the logger, close the inner barrier's lid and hand-tighten the two fixing screws. Remove the holding rod, and store this for use in preparing the next run (the inner barrier will not fit inside the water barrier with the holding rod in place).

Guide the inner barrier (containing the logger) and thermocouples into the water barrier's cavity, pushing it as far in as it will go (**M**). Try to avoid the thermocouples bunching together as they exit the water barrier's opening.

Fit the barrier closure into the opening above the thermocouples, ensuring it is fully home, and secure it with the catch at the top (**N**).





If a thermocouple clamp has been used to aid connection to the logger (see above) it must now be removed. It must not enter the furnace.

Carefully bend the thermocouples over the edge of the barrier and the lower insulation panels. Then loop together the excess thermocouple wire and push it back to the side of the insulation frame so that it will lie between the frame and the external fiber blanket.

10 Complete the Insulation

Fit the upper front insulation layers inside the insulation frame above the thermocouples (**O**), and then fit the top insulation layers above the water barrier.

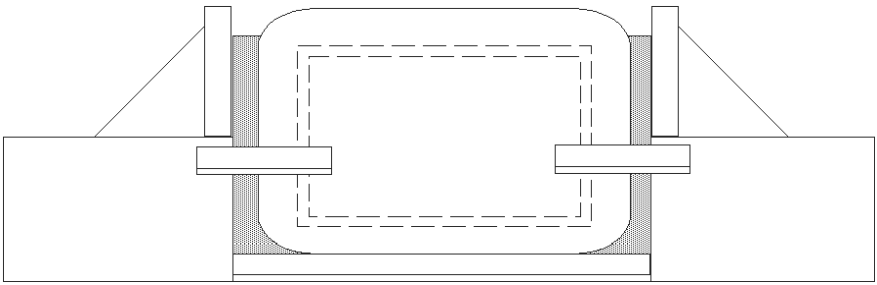
Fold the external fiber blanket around the sides and top of the barrier assembly, and cut a further piece of blanket to sit vertically against the front face of the insulation frame. The aim is to get as much fiber blanket insulation as possible all around the barrier assembly, and this may involve cutting small pieces to tuck inside the slab cut-out.

When the final external layers are in place, tie high-temperature wire around and over the barrier assembly to hold the insulation in place and prevent it being blown away by the burners.

Weld retainers to the end of the cut-out to hold the barrier assembly in place, as shown on p. 16 and p. 17.

If the insulation might be dislodged by the furnace-door seals, fit sheet metal over the system and secure this with angle-iron welded to the leading edge of the slab (**P**).

If the slab and system are to be discharged from the furnace down an inclined ramp, further protection may be required to prevent mechanical shock. This can be done by welding vertical plates to the slab to the height of the insulation frame.



Vertical cross-section through the slab's cut-out, showing 25-mm/1-in. vertical plates (and triangular bracing plates as supports) welded onto the slab to protect the barrier assembly. Extra fiber blanket (shaded) is inserted around the barrier assembly.

The Slab Reheat System is now ready to go into the furnace.

Always keep the slab level while it is being transported to the furnace.

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 or to the user notes supplied. 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. 9 hours at 1,200°C/2,192°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 data logger used may contain non-rechargeable lithium batteries, which – if exposed to temperatures above 250°C/482°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.*

Recovering the System

It is best to remove the logger from the system as soon as it has exited the furnace and is in an area where there is easy access.

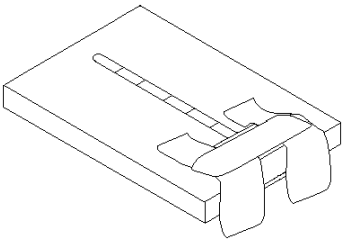
It is particularly important to remove the logger quickly, as the remaining water in the water barrier may otherwise boil off completely. The logger's temperature will then rise and the logger may be destroyed.

Removing the Logger

Removing the thermal barrier assembly from the slab is not difficult, but extreme caution should be taken as the slab will be at maximum temperature.

WARNING

Full heat-protective clothing and an approved dust mask must be worn. See p. 9.



After moving the slab to a safe area, cut three pieces of insulating fiber blanket about 2 m long and place these onto the slab and over the thermal barrier assembly, leaving access to the end of the slab (see diagram). This will cut down the heat output from the slab. (These pieces of blanket can be used for insulation in the barrier assembly on the next run.)

Use a knife to cut into the thermal barrier's insulation and remove the section covering the barrier closure. Slowly remove the barrier closure and place it on the floor away from the slab.

WARNING

Take care to avoid steam or boiling water which may escape from the filler spouts in the water barrier.

Slowly pull on the thermocouples, thus drawing the inner barrier (containing the logger) out of the water barrier. Then either:

- Undo the screws on the inner barrier, remove the logger and pull out the thermocouple plugs – *or* . . .

- Using a bolt-cutter, quickly cut through all the thermocouples (they cannot be used more than once) and carry the inner barrier away so that it can be opened, and the logger removed, at a safe distance from the hot slab.

When the logger is away from the hot slab, **download** data to the PC using the Insight software: see *Tpaq21 Data Logger User Manual* or Insight's Help system (on Insight's menu bar, select Help > Contents).

Removing the Thermal Barrier Assembly from the Slab

WARNING

Take appropriate safety precautions when working with the insulation material (see *p. 13*). *Always wear a mask, goggles and gloves.*

When the slab is cool, strip back the outer layers of fiber blanket from the insulation frame and remove the frame from its position in the slab cut-out. The remaining insulation should then be removed, placed in sealed polythene bags and disposed of in accord with local waste-disposal regulations.

Remove the water barrier from the insulation frame. There may be some distortion of the water barrier due to the heat, but this is normal and will not affect the performance of the system.

Grind off the tack-welds which hold in place the protective blocks or angle-iron on top of the slab; these can then be removed and re-used.

Discard the thermocouples: there is no guarantee that they will give accurate results during a second run.

Analysis – Using the Software

Full details on using the Insight software are contained entirely within its online Help system: access this by clicking Help, and then Contents, on Insight's main menu. Then, within Help, click on Contents headings and topics to expand and read them. You may also click the Help button in any dialog – or press the F1 key – to bring up help information relevant to the task being performed.

Troubleshooting

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

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