الكروان لتجارة المواد العازنة ذ.م.م.
AL KARAWAN REFRACTORIES MAT. TR. L.L.C.
"Sharing Expertise & Experiences"
Specialist in the Design, Supply & Application of Refractory & Heat Insulation Systems

REFRACTORY INSTALLATION MANUAL

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com

INSTALLATION MANUAL		
N	**Document**	**Description**
1	0001 RF ENG DOC 001	General Refractory Installation Procedure
2	0001 RF ENG DOC 002	Formats for Reporting
3	0001 RF ENG DOC 003	Quality Assurance Plan
4	0001 RF ENG DOC 004	Refractory Dry Out

Rev	**GENERAL REFRACTORY INSTALLATION PROCEDURE**			
0	FIRST ISSUE			
0				
Rev	Prepared	Checked	Approved	Date

Content **Page No**

1. SCOPE

This document covers the installation sequence and modality for application of Insulating Castables, Dense Castable, Calcium silicate boards and Dense Bricks for various equipment. The document also describes the storage requirements of the materials and Quality Control requirements during installation

2. STORAGE OF VARIOUS REFRACTORY MATERIALS

2.1 Storage of Castable Materials

Refractory materials like Insulating castable, Dense Castable, and Mortars are sensitive to humidity. To protect these materials during storage, primary precautions against easy ingress of water or moisture from air are required. Especially castables and mortars are hydraulic setting refractory materials. Hence the castable bags, bricks, ceramic anchors and mortars shall be stored or stacked on wooden platform or pellets avoiding contact with floor in a clean, dry and covered shed or tarpaulin cover. Castable bags in torn or punctured condition shall be discarded. During installation the castable bags required for 1 to 2 days job should be shifted to site and stacked over wooden platforms and covered with plastic sheets or tarpaulins. The maximum stack height will be of 3 meter at site. In case of lump formation in any castable bag, the same should be broken down when lightly rubbed between the fingers. If not the whole bag shall be rejected. The following precautions should be taken during storage of castables and mortars:

- Material should be kept dry during storage.
- If the floor is not dry, it should be raised using timber boards standing on bricks.
- Bags of castables and gunning materials should be stacked away from the walls.
- In case it is absolutely necessary to store bags in open for short durations during construction operations the bags should be protected from water or moisture.
- Castables and gunning materials should be used in the same order in which they are delivered, so that their consumption can be on first-in first-out (FIFO) basis.
- In case they are stored for longer periods than recommended, it is preferable to get them tested before being put to use.

1. Stack away from the walls on wooden pallets.
2. First In First Out (FIFO) is must.
3. Must be used within shelf-life period.
4. Can be stored for longer life.

2.2. Storage of Ceramic Items

Ceramic Items has to be covered with polythene sheet to avoid absorption of moisture. The Box should be opened as on when required for site Installation works. All items issued for installation work must be fully consumed before using fresh material.

3. PREPARATION FOR WORKING

3.1 Documentation

Refractory Engineering Drawings with BOM.

Installation Procedure.

Standard formats for Refractory Installation.

Materials stock at site.

Space and storage condition for equipment & materials.

Working Records.

4. EQUIPMENT AND TOOLS & TACKLES

1. Electrical Pan Mixer
2. Brick Cutting Machine with Diamond Cutters
   (With required nos. of Diamond cutter blades)
3. Carpentry Tools
4. Masonry Tools
5. Shuttering Materials
6. Thermometer
7. Gammelas or bucket
8. Hand lamps (24volt) with Transformer
9. First aid box with necessary medicines
10. Water storage drums
11. Pulley and Rope
12. Lubricant
13. Welding Machine with accessories
14. All Safety tools and tackles

5. MARKING AND ANCHOR WELDING

5.1 Marking shall be done in the shell with thread and chalk (for exact location and spacing of anchoring / holding items) as per the pitch / dimension indicated in the respective drawings of the equipment.

5.2 Welding of anchoring items shall be done by qualified welder only.

5.3 Clean the position on the shell with wire brush where the anchoring items is to be welded.

5.4 Anchoring items shall be welded on that specified position.

5.5 Welding of these anchors is to be done with the approved brand of electrodes.

5.6 Anchors shall be kept in right angle during the welding.

5.7 After welding, anchors shall be hammer tested to ensure they are properly welded to the shell

6. PREPARATION FOR INSTALLATION

6.1 Surface Preparation

6.1.1. Clean the shell, before application of refractory. The surface must be free from grease, oil, dust and any other foreign material.

6.1.2. Wrap the tip of anchor with insulation tape or provide plastic cap or shall be coated with bituminous paint prior to lining with castables.

6.2. Shuttering Preparation

6.2.1 Make a plan for casting as per site condition (shuttering details, panel length, from which area casting has to be started and etc.)

6.2.2 Prepare shuttering as per casting plan.

6.2.3. Decide the panel size as per site condition.

6.2.4. Plan staggered panels as far as possible to ensure staggered joints with respect to hot face and backup layer.

6.2.5. Shuttering materials can be either wooden or metal. But ensure shuttering has to be strong enough to bear the load of material, vibration, ramming and etc., if required give further supports. Ensure shuttering material is having holes for making vent holes at an interval of 300-400mm.

6.2.6. Ensure orientation of shuttering forecasting suitability.

6.2.7. Apply Grease/ oil at shuttering surface for easy removal and prevention of water absorption.

6.2.8. Ensure number of shuttering available at site to avoid delay for want of shuttering required during casting.

6.2.9. The shuttering shall be supported rigidly with wooden pieces or steel to keep the shuttering in position and shape.

6.2.10. Instrument sleeves or other sleeves in lining shall have openings, which shall be plugged with oiled / greased wooden inserts with proper chamfer as indicated in the fabrication drawing. These wooden inserts shall be removed after the setting of castables.

6.2.11. Any metallic sleeves exposed to refractory surfaces are to be wrapped with Ceramic Paper before application of castable.

6.2.12. All Man way shall be fitted with wooden forms as per the dimensions indicated in the respective drawings. Forms shall be fitted smoothly in to the openings. Forms shall be coated with grease or oil prior to fixing so that it can be easily removed after lining has fully set.

6.2.13. For better compaction in vertical direction, shuttering height shall not be more than 750mm

6.3. Fixing of Water Percentage for Castables

6.3.4. Take 100 kg of one batch of material in a pan mixer.
6.3.5. Dry mix for 1 minute.
6.3.6. Add water as per specification data sheet.
6.3.7. Mix for 3 - 5minutes for conventional castables and mix for 5-7 minutes for Low cement castables.
6.3.8. Check for workability by 'ball in hand' consistency method.
6.3.9. If required increase water percentage step by step till satisfactory mix is obtained.
6.3.10. The exact amount of water to be added will be decided by Site Engineer during application as per the working consistency, since the same varies for different castables and for different sites depending on the climatic condition.
6.3.11. The mixing water should not have more than 200ppm of chloride whereas its temperature shall be allowed between 15-22°C.

6.4. Mixing time for Castable

6.4.4. Charge known quantities of castable in the mixer.

6.4.5. Start the mixer and mix dry for about one minute.

6.4.6. Add water slowly as per requirement fixed in 4.4 slowly without stopping mixer.

6.4.7. Continue mixing for 3 - 5 minutes for conventional castable and 5-7 minutes for low cement castable.

6.4.8. Check the workability/ consistency by 'ball in hand' method.

6.4.9. This can be studied time to time during installation of castable at site by the Engineer and decide about the method of mixing to achieve better quality of material.

6. Back-up Layer Fixing and Inspection

7.1. Calcium silicate Board

7.1.1. Check Dimensions of the board
7.1.2. Cut the board according to the anchor pitch
7.1.3. In places of anchor circular section must be cut for proper insertion
7.1.4. Fill the cut portion with loose boards for complete insulation
7.1.5. Repeat same for entire lining

8. Shuttering Fixing Details

8.1. For Dense and Insulating Castable

8.1.1. Ensure the proper shuttering available at site as per the casting plan with required tools & tackles and supports for fixing the supports.

8.1.2. Ensure the required numbers of shuttering and stopper plate at site to avoid stoppage of work due to want of shuttering/ stopper plate.

8.1.3. Ensure separate manpower for fixing the shuttering, while many fronts are available for casting.

8.1.4. Apply a coat of grease / oil over the form – work. Check it before placement.

8.1.5. Fix the shuttering as per required thickness. This can be maintained by fixing a small stopper/ wedge at the top of the shuttering.

9. Installation Procedure of Brick Lining

9.1 Mortar Preparation

9.1.1. Transfer known quantities of mortar to clean drum.

9.1.2. Add specified quantity of water/ binder.

9.1.3. Mix it uniformly.

9.2 Brick Lining Method

9.2.1. Refractory Lining must be always be laid as per drawing.

9.2.2. First layer (course) must be installed with extreme care.

9.2.3. The mortar has to be applied uniformly on the surface of the brick and should be covered the entire surface of the bricks. Brick lay with a "collar" or with non-uniformity in mortar leads to the hollow space formation in the mortar joints.

9.2.4. At any case, the mortar thickness should not be more than 2mm.

9.2.5. In the case of usage of any cutting brick, then the cut brick size should be more 60%ofthe original length.

9.2.6. Use one or two key bricks per ring. Cut the key bricks from the standard arch bricks of same brick combinations. Use brick cutting machine & diamond cutters for cutting bricks.

9.2.7. Provide expansion joints as per drawing. Expansion joints must never contain any contamination. Fix ceramic paper by applying a thin coat of mortar with bricks.

9.2.8. For Brick alignment, use wooden hammer for insulation brick and metal hammer for dense brick. Don't apply too much of force for aligning the brick, it will damage the surface of the brick.

9.2.9. "Pointing" has to be carried out after brick lining is completed.

Inspection

9.3.1. Check for uniformity of lining.

9.3.2. Make inspection report and final protocol.

10. Installation of Insulating Castables

10.1. Mixing of Castables

10.1.1 Clean the mixer thoroughly. Charge known quantity of castable in the mixer.

10.1.2. Mix dry for about one minute.

10.1.3. Add specified quantity of water.

10.1.4. Mix as per predetermined schedule.

10.1.5. Discharge the mixed material from the pan mixer.

10.1.6. Insulating castable can also be mixed manually in case quantity is small

10.2. Casting

10.2.1 The mixed castable should be cast as early as possible.

10.2.2 Fill the mixed castable in the shuttering and tamp the material thoroughly.

10.2.3 Fill the material uniformly in the shuttering and castable leveling should be uniform throughout the panel after tamping. In any case, settling of material at one place / corner should be avoided.

10.2.4. At a time pouring should not be more than 50-70 mm height to avoid air pocket / void. Ensure proper filling of material in the shuttering.

10.2.5. Joint of adjacent panel shall be a construction joint with steps.

10.2.6. The adjacent panel shall be screed properly before doing construction joints. Excessive smoothening or toweling shall be avoided.

10.2.7. Alternative panels shall be casted at a time and construction joints shall be staggered.

10.2.8. All old joints shall be wetted before casting of new panels.

10.3. Interruption in Application

10.3.1 During casting any sort of interruption due to any reasons the castable shall be removed in green state from the shell plate and clean the surface.

10.3.2. In some cases the consolidation is over for more than % of the panel the loose materials shall be removed and finish the compacted surface from top. The balance portion may be cast later to form as a separate small panel.

10.4. Removal of Shuttering

10.4.1. Check and ensure proper setting of castable.

10.4.2. Remove all the supports provided for fixing the shuttering / stopper plate One by one.

10.4.3. Don't apply heavy force for removing the supports. If heavy force is applied for removing the supports it will disturb the castables.

10.4.4. Remove the shuttering slowly.

10.5 Inspection

10.5.1 Check for honeycomb, rat hole, segregation, lamination, etc. Mark the area to be repaired.

10.5.2. If repair area is very small, carryout necessary repair work by removing the loose material and filling it with new fresh material and compact with rodding.

10.5.3. If the repair area is larger, dismantle the repair area and recast. Make the casting installation details.

10.6 Natural Curing

10.6.1 Allow air drying for minimum 8 hours after casting.
10.6.2 Allow wet curing for 12 hours minimum.

10.7 Inspection Report

10.7.1. Complete the castable installation details report

10.7.2. Make a joint inspection along with client and any other third party.

11. Installation of Dense Castable

11.1. Mixing of Castables

11.1.1. Clean the mixer thoroughly. Charge known quantity of castable in the mixer.

11.1.2. Mix it dry for about one minute.

11.1.3. Add specified quantity of water.

11.1.4. Mix as per predetermined schedule.

11.1.5. Discharge the mixed material from the pan mixer

11.2. Casting

11.2.1 The mixed castable should be cast as early as possible.

11.2.2. Fill the mixed castable in the shuttering and vibrate thoroughly.

11.2.3. Fill the material uniformly in the shuttering and material leveling should be uniform throughout the panel after vibration. In any case, settling of material at one place/ comer should be avoided.

11.2.4 Draw back the needles lowly in running condition.

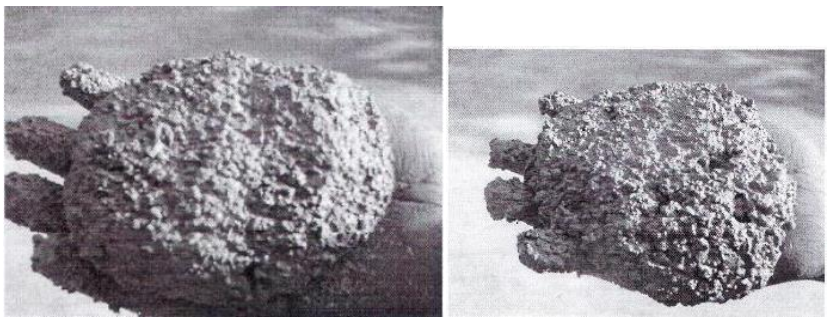
11.2.5. Ensure proper filling of material in the shuttering. At a time pouring should not be more than 100mmheightto avoid air pocket/ void.

11.2.6 Joint of adjacent panel shall be a construction joint with steps. The adjacent panel shall be screed properly before doing construction joints.

11.2.7. Excessive smoothening or trowelling shall be avoided.

11.2.8. Alternative panels shall be casted at a time and construction joints shall be staggered. All old joints shall be wetted before casting of new panels

11.2.9. Once casting is over, provide steps in the surface, this will avoid the straight joints between the two consecutive panels as mentioned in the drawing. This has to be done after 15- 30 minutes of casting.



Correct Percentage of water in mix - Shiny surface & no flowability in 'Ball in hand test'

11.3. Interruption in Application

11.3.1 During casting any sort of interruption due to any reasons the castable shall be removed in green state from the shell plate and the surface cleaned.

11.3.2. In some cases the consolidation is over for more than 50% of the panel the loose materials shall be removed and finish the compacted surface from top. The balance portion may be cast later to form as a separate small panel.

11.4. Removal of Shuttering

11.4.1. Check and ensure proper setting of castable.

11.4.2. Remove all the supports provided for fixing the shuttering one by one.

11.4.3. Don't apply heavy force for removing the supports. If heavy force is applied for removing the supports it will disturb the castables.

11.4.4. Remove the shuttering slowly.

11.5. Inspection

11.5.1. Check for honeycomb, rat hole, segregation, lamination, etc. Mark the area to be repaired.

11.5.2. If repair area is very less, carryout necessary repair work by removing the loose material and filling it with new fresh material and compact with rodding.

11.5.3. If the repair area is more, dismantle the repair area and recast.

11.5.4. Make the casting installation details.

11.6. Natural Curing

11.6.1. Allow 24 hours natural curing after casting. Wet curing has to be carried out, if the temperature of the casted panel is getting increased enormously. Wet curing has to be carried out by covering the refractory panel with wet. Gunny bag and sprinkling by spraying water on the surface of water for 16 hours. The wet curing has to be carried out in consultation with Site Engineer.

11.7. Inspection Report

11.7.1. Complete the castable installation details Report

11.7.2. Make a joint inspection along with client and any other third party

12. ACCEPTANCE CRITERIA

1. The shell surface and anchors shall be cleaned properly with wire brush to ensure that these shall be free from any loose material, rust or foreign materials etc.
2. The anchor welding shall be tested for spacing & welding. If spacing is found to varying more than 10%then it shall be re-welded, and the welded anchors shall be checked for strength as per the satisfaction of the client & site in charge as per normal procedure by hammer testing randomly.
3. Wherever shuttering is required, its strength and workability shall be good enough to bear the load and dimension shall be ensured as per the reference drawing. The water shall be mixed as per the recommendation in the Product Catalogue and for getting proper workability as per the site Engineer. Lower percentage water with no workability as well as higher percentage of water leading to slurry formation shall be avoided.
4. Normal drinking water at temp around 15 to 25°C shall be used.
5. After the removal of shuttering & 24 hrs of natural curing the surface shall be hammered test.
6. After initial drying if superficial surface hair line cracks is found then the same shall be acceptable while afterheat dry out, if any cracks of max. 5mm wide and more than half of castable thickness, shall be repaired by cutting full thickness and refilling with fresh castable.

13. PRECAUTIONS

1. Unnecessary extra load shall not be put over the lining before and after setting.
2. It shall be ensured that all equipment's and tools used for mixing are free of foreign material particularly Portland cement and lime.
3. The inner surface of wooden form shuttering shall be plain and smooth. Machine oil or grease etc shall be applied on the surface of wooden form to make it waterproof and easy to remove after installation
4. Ceramic Fibre Blanket type and grade

14. RECORD KEEPING

1. The following records shall be kept to maintain the quality work for refractory lining.
2. Date of manufacture of castable.
3. Quantity of material and quantity of water added.
4. Water temperature.
5. Mixing time.
6. Panel no. with date of casting
7. Curing start time.
8. Frequency of water sprinkle.
9. Shuttering removal time.
10. Air dry time.
11. Temperature record of heat drying.
12. Inspection and repair work record.
13. Water added to mortar for proper consistency.

Client			**Owner**	
Rev	**Formats for Reporting**			
0	FIRST ISSUE			
0				
Rev	Prepared	Checked	Approved	Date

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com

Sr No	DOCUMENTS ENCLOSED
1	DAILY REPORT
2	DAILY JOB PROGRESS REPORT
3	WELDING REPORT DETAILS
4	BACKUP LAYER FIXING DETAILS
5	BRICK LINING INSPECTION REPORT
6	CASTING INSTALLATION DETAILS / REPORT

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com

الكروان لتجارة المواد العازنة ذ.م.م.
AL KARAWAN REFRACTORIES MAT. TR. L.L.C.
"Sharing Expertise & Experiences"
Specialist in the Design, Supply & Application of Refractory & Heat Insulation Systems

WELDING REPORT DETAILS

Date:

Project:

Equipment:

Location:

Elevation:

Ref. Drawing No.:

Anchor Mark:

Anchor height:

Anchor Pitch:

1. At shell plate: Vertical Pitch:
   Horizontal Pitch:

2. At tip of anchor: Vertical Pitch:
   Horizontal Pitch:

Welding Quality :

Other Remarks :

Signature			
Name			

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com

الكـــروان لـــتـــجـــــارة المـــواد الـــعـــــازنـــــة ذ.م.م.
AL KARAWAN REFRACTORIES MAT. TR. L.L.C.
"Sharing Expertise & Experiences"
Specialist in the Design, Supply & Application of Refractory & Heat Insulation Systems

BACK-UP LAYER FIXING DETAILS

(For calcium silicate blocks/ ceramic blanket/ ceramic board / ceramic paper)

Date:

Project :

Equipment:

Location:

Elevation:

Ref. Drawing No.:

Refractory Material:

Joint Details:

Total Thickness (After fixing):

Joint filling Details:

Other Remarks:

Signature			
Name			

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com

BRICK LAYER DETAILS

Date:

Project :

Equipment:

Location:

Elevation:

Ref. Drawing No.:

Refractory Material:

Joint Details:

Total Thickness (After fixing):

Verticality Details:

Other Remarks:

Signature			
Name			

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com

الكروان لتجارة المواد العازنة ذ.م.م.
AL KARAWAN REFRACTORIES MAT. TR. L.L.C.
"Sharing Expertise & Experiences"
Specialist in the Design, Supply & Application of Refractory & Heat Insulation Systems

CASTABLE LAYER INSPECTION DETAILS
(For insulation and Dense layer)

Date:

Project:

Equipment:

Location:

Elevation:

Ref. Drawing No.:

Refractory Material:

Joint Details:

Total Thickness:
(After fixing)

Panel Thickness:

Date of Casting:

Verticality Details:

Other Remarks:

Signature			
Name			

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com

Client			**Owner**	
Rev	**Quality Assurance Plan**			
0	FIRST ISSUE			
0				
Rev	Prepared	Checked	Approved	Date

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com

No	Characteristic Check	Material	Activity	Acceptance Criteria
1.	Condition of the Material	All refractory Material	Visual Checking	As per refractory installation procedure
2.	Anchor Shape, size and quality	Anchor, studs etc.	Test certificate and random measurement	As per approved Drawing
3.	Welding of Anchoring Materials	Anchor	Pitch and Perpendicularity Electrodes Hammer and Bending test	As per relevant drawing
4.	Surface Preparation	Wire brush	Visual Checking	Free from any loose particle, mill scale or foreign material
5	Castable Lining	Material	a) Thickness b) Shuttering c) Panel Size d) Water Quality e) Water Temperature f) Water Percentage g) Mixing Time h) Pouring and compaction i) Shuttering Removal j) Curing k) Expansion joint l) Final Dimension m) Wall perpendicularity	• As per drawing • Wooden or metallic shuttering should be rigid • Should not exceed 750 x 750mm • Clean cold potable water • As per product catalogue 15-22°C • As per product catalogue (+/- 10 % Tolerance) • As per installation procedure • As per installation procedure • After castable becomes hard • As per application procedure • As preapproved drawing • As per drawings (Tolerance of +/- 6mm or 1.5% whichever is greater) • Plumb level +/- 10mm or 1.5% whichever is greater
6	Brick Lining	Material	a) Thickness b) Laying of mortar between bricks c) Expansion Joint d) Brick laying e) Wall Perpendicularity f) Final Dimensions	As per Drawing 1-2mm thick As per Drawing As per Drawing Plumb level +/- 10mm or 1.5% whichever is greater) As per drawing (Tolerance of +/- 6mm or 1.5% whichever is greater)
7	Final Dry out	Method	Dry out of refractory material	As per specification heat up schedule

Client			**Owner**	
Rev	**Refractory Dry Out**			
0	FIRST ISSUE			
0				
Rev	Prepared	Checked	Approved	Date

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com

Heating Schedule for Refractory Dry out

Heat curing will be done for castable lining to remove moisture. For prior to heating of working lining, pilot burner (Low duty burner) will be used with furnace oil or light diesel oil or natural gas.

Note: If any steaming is present even after holding at any temperature as per the specified time mentioned above, then soaking to be increased, till steaming stopped.

Note: Obtain Heat Schedule for appropriate Refractory Applied and Follow the Cycle.

P.O. Box : 26117, Shed# 4 Ind. Area 6, Sharjah, UAE
Tel : +971 6 5670 562, Fax: +971 6 5670 563
E-mail: acaravan@emirates.net.ae Web : www.caravangrp.com