

# Technical Specification For a Fully Automated Gas Fired Car Tunnel Kiln

Written by Steve Mortensen

## 1.0 Project Requirements

- 1.1 Process Description:      Glost firing of ceramic tile  
  Glost firing of garden pottery
- 1.2 Process Parameters:      Kiln designed for 7-12 hour cycle times  
  Cycle time depends on ware and furniture  
  Incoming moisture content <2% by weight  
  Average load specific heat is 0.2 BTU/lb/°F  
  Maximum temperature is 2000°F
- 1.3 Load Data:
- Ceramic Tile**
- |                            |                   |
|----------------------------|-------------------|
| Setter size                | 15"W x 2"H x 14"L |
| Setter arrangement         | 4 W x 13 H x 2 L  |
| Setters per car            | 104 setters       |
| One setter with four tiles | 14.5 lbs.         |
| Total load per car         | 1,508 lbs.        |
| Tile size                  | 6 x 6 in.         |
| Tiles per setter           | 4 tiles           |
| Tiles per car              | 416 tiles         |
| Tile sq. ft. per car       | 104 sq. ft.       |
- Garden Pottery**
- Specific sizes not known  
Specific setting arrangement not known  
27 inch tall kiln setting height  
33 cubic feet of working volume per car
- 1.4 Operating Schedule:      Single eight (8) hour shift per day  
  Kiln firing 24 hours per day
- 1.5 Production Capacity:
- Ceramic Tile**
- 7 hour cycle = 12,480 square feet per day  
12 hour cycle = 7,280 square feet per day
- Garden Pottery**
- 7 hour cycle = 3,960 cubic feet per day  
12 hour cycle = 2,310 cubic feet per day

## 2.0 Equipment Description

- 2.1 Model Number: TCF 66 27 (720-8) (540-1) 2000
- 2.2 Description: Fully automated 105-foot long gas-fired, fiber insulated car tunnel kiln with multi-zone temperature control, pressure control, transfer car, return track and car storage systems.
- 2.3 Reference Drawings: 9428-9433 and 9435
- 2.4 Car Dimensions: 66 in. wide x 27 in. high x 36 in. long  
Loading dimensions are 66"W x 27"H x 32"L
- 2.5 Kiln Length:
- |                |   |
|----------------|---|
| 30 ft.         | Preheat section                         |
| 30 ft.         | Main-heat section                       |
| <u>45</u> ft.  | Cooling section                         |
| <b>105 ft.</b> | <b>Kiln length door to door</b>         |
| 3 ft.          | Car transfer at entrance end            |
| 7 ft.          | Entrance / Pusher section               |
| 7 ft.          | Exit end section                        |
| <u>3</u> ft.   | Car transfer at exit end                |
| <b>125 ft.</b> | <b>Overall kiln installation length</b> |

All dimensions are subject to minor change

- 2.6 Cars & Track Needed:
- Single Product Production**  
**One 8 hr. shift, 24 hr. operation, 12 hr. cycle**  
92 cars minimum  
One (1) return, load/unload track  
One (1) "Smart" storage track
- One 8 hr. shift, 24 hr. operation, 7 hr. cycle**  
124 cars minimum  
One (1) return, load/unload track  
Two (2) "Smart" storage tracks
- Three 8 hr. shifts, 24 hr. operation, 12 hr. cycle**  
46 cars minimum  
One (1) return, load/unload track
- Dual Product Production**  
**One 8 hr. shift, 24 hr. operation, 12 hr. cycle**  
92 cars minimum  
One (1) return, load/unload track  
Two (2) "Smart" storage tracks

### **3.0 Kiln Structure & Insulation System**

- 3.1 Steel Shell: Heavy-duty steel frame and plate fabrication  
Sealed construction to prevent corrosion  
Modular design for ease of transport  
Kiln modules are 7.5 feet long
- 3.2 Insulation System: Insulating firebrick and ceramic fiber lined  
Properly rated for application  
Durable refractory used for wear-prone areas  
Energy efficient ceramic fiber walls and roof  
Long-life stack bonded construction
- 3.3 Kiln Cars: See paragraph 2.6 for quantity required  
Heavy gauge steel frame  
Four (4) flanged steel wheels with roller bearings  
Durable refractory perimeter  
Low-mass refractory insulation system  
Baffles underneath the load to minimize draft  
Blade and sand trough car seal  
Car top will have provision for six (6) support posts  
\*No posts, beams, furniture, or setters included

### **4.0 Transport Systems**

- 4.1 Main Pusher: Hydraulic main car pusher mechanism  
Adjustable speed control from 7-14 hours  
Mounted at the entrance end
- 4.2 Transfer Cars: Two (2) supplied with the kiln  
Automatic and semi-automatic operation  
Heavy-duty steel construction  
Electro-mechanical car pusher / puller systems
- 4.3 Return & Storage Tracks: See Paragraph 2.6 for quantity required  
For car return, loading, unloading, and storage  
Holds up to 39 cars per track  
30# steel rail, splice bars, and bolts  
Chain driven transport system  
"Smart" storage track is bi-directional

### **5.0 Heating & Cooling Sections**

- 5.1 Heating System Design: Zoned to meet temperature curve  
Designed to allow good range of adjustment  
Burner layout for optimum temperature control

- |     |                     |   |   |
|-----|---------------------|---|---|
| 5.2 | Preheat Length:     | Zone 1<br>Zone 2<br>Zone 3<br>Total preheat section length  | 12.0 ft.<br>12.0 ft.<br><u>6.0</u> ft.<br>30.0 ft.              |
| 5.3 | Preheat Burners:    | Two (2) recirculating fans for uniformity in Zone 1<br>Zone 1 heated by four (4) bottom burners<br>Zone 2 heated by four (4) bottom burners<br>Zone 3 heated by two (2) bottom burners<br>All burners are staggered on opposing sides<br>Burners positioned for optimum heating uniformity  |   |
| 5.4 | Main Heat Length:   | Zone 4<br>Zone 5<br>Zone 6<br>Zone 7<br>Zone 8<br>Total main heat section length  | 6.0 ft.<br>6.0 ft.<br>6.0 ft.<br>6.0 ft.<br>6.0 ft.<br>30.0 ft. |
| 5.5 | Main Heat Burners:  | Zone 4 heated by two (2) bottom burners<br>Zone 5 heated by two (2) top burners<br>Zone 5 also has two (2) bottom burners<br>Zone 6 heated by two (2) top burners<br>Zone 6 also has two (2) bottom burners<br>Zone 7 heated by two (2) top burners<br>Zone 7 also has two (2) bottom burners<br>All burners are staggered on opposing sides<br>Burners positioned for optimum heating uniformity |   |
| 5.6 | Heating Capacity:   | Maximum capacity of 7.1 M BTU/hr<br>Actual usage depends on load and heating cycle  |   |
| 5.7 | Controlled Cooling: | Overall cooling section length is 45 feet<br>Countercurrent airflow to prevent breakage<br>Cooling air supplied near the exit end of the kiln<br>Cooling air exhausted near main heat section<br>Cooling section is identified as Zone 8<br>Includes controlled cooling supply blower<br>Includes controlled cooling exhaust blower<br>Two (2) recirculating fans in final 12.0 feet              |   |

## 6.0 Exhaust, Pressure, & Gas Safety Systems

- |     |               |  |
|-----|---------------|--|
| 6.1 | Kiln Exhaust: | Products of combustion exhausted near entrance<br>Automatic pressure control system<br>All fans and blowers include shock mounts<br>Ducting beyond exhaust fans not provided |
|-----|---------------|--|

- 6.2 Gas Safety: Strict adherence to the latest safety standards  
NFPA / FM compliant gas safety system  
Individual burner ignition  
Flame supervision at each burner  
Double gas safety shut-off valves  
Valve proving system  
Pressure switches  
Pressure gauges

## 7.0 Temperature & Kiln Control Systems

- 7.1 Control System: Computer / PLC based control system  
Integrated control and monitoring of all functions  
3 control / monitoring screens (status, recipe, alarm)  
Mounted in a dust-tight NEMA enclosure  
Informative and easy-to-use operator interface  
Facilitates switching from tile to pottery recipes  
Modem connection for remote data access
- 7.2 High Limit Protection: Provided in three (3) high temperature kiln sections  
FM rated discrete temperature limit controllers  
Audible alarm and section shut off if not rectified
- 7.3 Thermocouples: Eight (8) type "K" for heating control  
One (1) type "K" for cooling control  
Six (6) type "K" for cooling section monitoring  
One (1) type "K" for cooling air exhaust monitoring  
Three (3) type "K" for high limit protection  
All mounted in protective sheaths

## 8.0 Utilities & Client Site Requirements

- 8.1 Natural Gas Service: Caloric content of gas not less than 1000 BTU/ft<sup>3</sup>  
Volume of 7,100 scfh minimum  
Pressure at gas inlet 5 PSIG minimum  
Service brought to connection point on kiln
- 8.2 Electrical Service: 480 Volt, 3 phase, 60 Hz  
Voltage fluctuations not to exceed +/- 10%  
120 Amperes (approx.) subject to verification  
Final data provided on completion of engineering  
Main power disconnect and fusing not provided  
Service brought to connection point on kiln
- 8.3 Concrete Foundation: Pit and layout per manufacturer's layout drawing  
Soil compaction testing and civil work, if required

- 8.4 Air Intake & Exhaust: Make-up building air, if required  
Exhaust ducting from kiln through roof  
Waste heat ducting to drier
- 8.5 Permits: All government mandated permits if required
- 8.6 Car Posts & Decking: Car refractory per manufacturer's layout drawing  
Tile setters and/or shelving in sufficient quantity
- 8.7 Tile & Garden Pottery Ware sufficient to fill kiln for performance testing

## **9.0 Technical Documentation**

- 9.1 Documentation: Two (2) Operating and Service Manuals (English)  
General kiln assembly drawings  
Electrical system drawings  
Foundation drawing (but no site engineering)  
Controller manuals  
Spare parts lists and other technical data

## **10.0 Performance & Acceptance Testing**

- 10.1 Testing & Performances +/-15°F uniformity on a 12 hr. cycle with full tile load  
Uniformity measured with pyrometric cones  
Automated car transport per this specification  
Functionality of computer / PLC control system  
Remote kiln monitoring from distant office