In reply, please refer to our Proposal No. TPS24-95429-R1

February 8, 2024

[redacted]

TPS Thermal Product Solutions continues to utilize our expertise, experience and resources to support and serve our customers. We look forward to providing you with quality equipment to meet your requirements. TPS product brands include:

Tenney:	Environmental Test Chambers/Rooms
Blue M:	Industrial/Laboratory Ovens
Gruenberg:	Industrial Ovens, Sterilizers, Dryers
Lindberg/MPH:	Heat Treat Furnaces
Wisconsin Oven:	Custom and Standard Industrial Ovens

Thermal Product Solutions is a global engineering-designer, manufacturer, and service provider of standard and custom thermal-processing equipment serving the defense, aerospace, electronics, biotech, medical, pharmaceutical, lab-animal science, energy, transportation, communications, and materials-processing industries. With our distinct brands of industrial and laboratory ovens and furnaces and environmental-temperature-cycling and stability-test chambers, our product lines accommodate a comprehensive range of applications and configurations to meet virtually every thermal-processing need

Please contact me, your local sales representative, as soon as we can be of further assistance.

Best regards,

[redacted]

We are pleased to submit the following quotation. Please carefully review the technical details of this proposal. We have done our best to match the appropriate unit to the requirements of your process, as we understand them. However, we would be happy to revise the proposal if there is a need to change the approach.

Quote Valid for 30 Days

Blue M Mechanical Convection, Horizontal Airflow Oven with Microprocessor Based Controller.	
Model DCI-966-G-F4T UNIT PRICE	[redacted]
INCLUDED ACCESSORIES (see below)	[redacted]
TOTAL	[redacted]
QUANTITY	1
TOTAL PRICE	[redacted]

Item	Description
A	**Model Number:** DCI-966-G-F4T **Temperature Range:** 15°C above ambient to 316°C **Interior Dimensions:** 48" wide x 48" deep x 72" high **Exterior Dimensions:** 102" wide x 66" deep x 105" high **Voltage:** 480V 3 Phase 60 Hz. **Amp Draw:** 43 amps **Heater Rating:** 32 kW **Air Flow:** Horizontal **Cabinet Type:** Inert Atmosphere Floor Model Single Door Left Hinged **Approx. Weight:** 2738-Lbs **Approx. Crate Dim:** 115" wide x 78" deep x 115" high **Instructional Manuals:** Digital Manual on a USB Drive **APPLICATION:** It is the understanding of TPS that the quoted unit will be used for non-hazardous applications. Drying moisture at 150C from water-based polymer part measuring 150 x 400 MM long, 3 lbs. each, in an inert atmosphere with an O2 level of below 50 ppm. **INTERIOR CABINET CONSTRUCTION:** All-Welded heavy gauge, reinforced type 304 stainless steel for maximum heat and corrosion resistance. All seams and entrance ports are welded gas tight to minimize inert gas leakage and maintain an oxygen free atmosphere with minimum gas flow. The cabinet is equipped with a gas flow meter valve to regulate inert gas flow rate and a tap water cooling system to provide rapid cool down from elevated temperatures **EXTERIOR CABINET CONSTRUCTION:** All-Welded heavy gauge reinforced cold-rolled steel finished with a durable textured white powder paint finish. The oven door is manufactured of cold -rolled steel exterior and stainless-steel interior. The door utilizes ball-bearing hinges and industrial type latching to provide positive door seal and minimize fume leakage.

[redacted]

[redacted]

CONTROL SYSTEM:
The **Watlow F4T** temperature process controller combines the flexibility of a modular I/O controller with best-in-class ease of use. Features a **4.3-inch, color touch panel** with high-resolution, graphical user-interface. 1 to 4 control loops with TRU-TUNE+ adaptive control algorithm for superior controllability. **40 ramp and soak profiles** with real-time clock and battery backup. Ethernet Modbus® TCP connectivity. High-speed USB host port. Modular design, which offers numerous types of field pluggable modules for maximum flexibility and easiest compatibility. **E-mail and text alerts** – notify users of an event that has occurred such as a specific profile or step within a profile, alarm condition, limit condition or analog input error. **USB and Ethernet ports are located on the front control panel**

OVER TEMPERATURE PROTECTION IS STANDARD, provided by an FM-approved limit control with independent sensor and power contactor.

HEATING AND AIR DELIVERY SYSTEM:
A direct drive ball bearing motor with a balanced stainless-steel multi-bladed blower wheel. Elements utilize Nichrome wire strung through high temperature, high dielectric strength refractory disks.
An airflow switch is provided to shut off the heating elements in the event of a blower system failure. This safety system also ensures that your power is connected with the proper phase rotation.

DOOR SWITCH - INDUSTRIAL GRADE:
The oven blower system and heating elements will automatically shut off when the door is opened. This will enable the operator to load the oven without hot air blowing on them. Upon activation of the door switch, the Purge cycle is restarted (see below) to remove oxygen that have entered into the work chamber when the door is opened.

INERT GAS OPERATION:
The oven is equipped with a gas flow meter valve to regulate gas flow rate and a tap water cooling system to provide rapid cool down from elevated temperatures. An inert gas system is used to maintain an inert atmosphere in the oven at a slight positive pressure during the entire process cycle. Inert gas is injected into the chamber through the circulation blower's shaft seal. Inert gas flow and chamber pressure are monitored and regulated with various instruments on the gas control panel

Initial High Chamber Purge Cycle:
Before the process cycle is allowed to begin, a chamber purge cycle is initiated which lasts for a set amount of time dependent on oven size and purge rate. The purge cycle is designed to purge the chamber of existing atmospheric air in the chamber and replace it with an inert gas. All oxygen, water vapor, airborne contaminants, etc., are removed. A volume of inert gas of at least 5 to 10 times the volume of the work chamber be forced through the oven is recommended. **Purge flow rate is factory set at 1100-SCFH with a purge time of 60-minutes.**

Run (Heat Process) Cycle:
After the purge cycle has been completed, the purge timer output will open to de-energize and close the (High) Purge solenoid valve. The inert gas supply will now flow into the chamber through the Run Flow Adjustment valve on the gas control panel. This Run flow maintains a slightly positive pressure in the chamber during the heat process cycle. **Run Flow rate is factory set at 800-SCFH.**

Cool-Down Cycle:
Upon completion of the heat process cycle, the heating system will be disabled. During the Cool-Down Cycle, the inert gas atmosphere must be maintained until the workload is below the temperature at which oxidation will occur. 125° C is considered the highest safe temperature for most workloads. The Cool-Down Flow Rate is the same as the Run Flow Rate.

COOLING COIL OPERATION:
As applicable, cooling of the oven is achieved by circulating chamber air through a stainless-steel water-cooled coil mounted in the conditioning plenum downstream of the heaters. More than one coil can be utilized. The coil is shrouded with stainless steel heat transfer fins over its entire width and length.

Cooling control is achieved by energizing and opening a water-cooling solenoid valve, which permits cooling water to flow to the cooling coil. The solenoid valve may be energized either by a cooling switch mounted on the main control panel or by an event output of the main controller.

Operation at or below 100°C requires the oven to be connected to a water facility utilizing the cooling coil during operation. Otherwise, heat generated from the circulation blower will prevent these temperatures from being maintained.

Considerations:

- **The water supply (no Glycol) should be rated 30 to 40 PSIG, 10 GPM at temperatures up to 75° F maximum.**
- **Water-In and Water-Out connections are located at the rear of the unit.**
- **Water Inlet Connection: The water inlet connection is made to the Cooling Coil solenoid valve and is a Type 3/4" FPT. Make sure your connection is secure.**
- **Water Outlet Connection: The water outlet / drain connection is made to a 3/4" MPT stainless steel pipe. Your connection should be made with a clamped hose that runs to an open drain, which assumes there is no significant resistance to the flow of water, i.e., zero (0) PSIG "back pressure"**
- **Chilled water system (if utilized) must be an "open loop" type system, which should allow the cooling coil to drain via gravity while not in use.**
- **At the start of cooling, steam will be generated by the introduction of chilled water to the coil. Steam will exit the coil to the return piping of the chiller system; piping and sump apparatus must be able to handle such condition and should not build up pressure.**
- **Expected Chilled water Temperature Delta to be worst case 33 degrees F**

UNIFORMITY PACKAGE For Model DCI-966-G-F4T	
ITEM	DESCRIPTION
B	**Install semi-pierce walls and variable frequency drive (VFD)** on the blower motor to enable tuning of airflow across the oven work space
C	**Oven air temperature uniformity test.** TPS will heat the oven to a set point of 150C and allowed to stabilize. TPS will tune the chamber uniformity at this set point by adjusting the semi-pierce walls and the variable frequency drive (above). **At 150C, the oven uniformity must be within +/- 2% (+/- 3C) as measured with nine (9) calibrated thermocouples in an empty, stabilized oven.** One (1) thermocouple will be placed in each of the eight (8) corners of the oven chamber approximately 3-inches from each wall surface and the ninth thermocouple is positioned in the geometric center of the chamber. Uniformity test duration shall be no more than 1-hour at set point in a stabilized oven. There will be a 30 to 45-minute stabilization time for all 9-points to be within the uniformity spec. There may be a temperature overshoot of more than 10-degrees reading in two or more of the 9 thermocouples during the first few minutes when the oven profile transitions from ramp to soak. A TPS technician will perform the uniformity test using TPS equipment at the TPS facility. Test documentation will be standard TPS documentation which will include the 9-point temperature uniformity survey performed on this unit (usually in Excel or PDF format). This is saved in the USB manual that is provided with the unit when it ships.

TRUCK AND TRANSFER CART For Model DCI-966-G-F4T	
ITEM	DESCRIPTION
D	**Stainless steel angles/guides on the oven's insulated floor are installed to accommodate a roll-in rack cart (below).** The floor is reinforced to hold the cart and products, total weight of up to 1000-Lbs consisting of 560-Lbs products (70-Lb each) distributed across eight (8) shelves and approx 430-Lbs cart with 8 shelves. **Truck and Transfer Cart:** **One (1) stainless steel roll in rack truck** designed to fit in the DCI-966 with insulated floor. This will include eight (8) shelves. Shelves are spaced 7-inches. **One (1) transfer cart** is provided to load/unload the truck into the oven chamber. A spring-loaded latch and truck guides keep the truck secure during transportation.
E	**A general arrangement (GA) drawing** will be issued for customer review and approval prior to oven build.

INCLUDED Accessories For Model DCI-966-G-F4T				
ITEM	DESCRIPTION	UNIT PRICE	QTY	TOTAL
F	**Light Tower with Horn:** Light tower with audible alarm will give a prominent visual and audible display of a running condition (green), an end of process condition (amber), and an alarm condition (red). The horn will only sound in the alarm condition.	[redacted]	1	[redacted]
G	**N2 Run Valve:** Install an N2 Run Solenoid Valve to turn OFF N2 flow when the oven is idle	[redacted]	1	[redacted]
H	**Low N2 Pressure Switch with Alarm:** A Nitrogen Low Pressure Alarm with audible and visual indicator and alarm silence switch is installed. An alarm will alert operator indicating low inlet pressure at the supply (below 40PSIG). The pressure switch will remove power to the oven heaters in the event of a loss of inlet pressure at the N2 supply line.	[redacted]	1	[redacted]
I	**Trace Oxygen Analyzer:** The **Alpha Omega Series 3510** Trace Oxygen Transmitter will use the second channel of the Watlow controller to read and display the oxygen level measured inside the chamber. This O2 measurement system will be configured to turn on the chamber's purge system and turn off the heating element once a high O2 PPM condition is detected. The Watlow controller will be configured to prevent the start of the heating process until the O2 PPM level reaches the desired set point level. An alarm silence switch will be provided for the high O2 alarm. The system includes O2 solenoid valves, which will close and disable the sampling pump when the door is opened; and remain off until the completion of the initial purge cycle is completed. The purge system is wired so that it does not turn ON the heating elements of the oven during the purge cycle. **The Series 3510 Trace Oxygen Transmitter has a single range of 0-500 PPM,** which includes two manual isolation valves, two AC powered solenoid valves (used to protect the oxygen sensor from exposure to air), high capacity in-line filter, and sample pump mounted on the side of the enclosure, and a flow meter.	[redacted]	1	[redacted]

[redacted]

INCLUDED Accessories For Model DCI-966-G-F4T				
ITEM	DESCRIPTION	UNIT PRICE	QTY	TOTAL
J	**Datalogging Capability for the F4T:** The controller will include the ability to log critical data such as channel PV, set point, controller alarms, PID output, analog inputs, and events. Datalogging can be enabled at any time to log real-time data of a list of user selected data points. Data logging can also be enabled/configured through Modbus. Log Interval can be set every 0.1-second to 60-minutes. User can determine if logged files will be moved automatically and/or manually. While data logging is enabled, the data log file is stored within either the internal memory or USB device memory. **File size limit is 20MB maximum when using internal memory, 1GB when using USB.** Once the file reaches a specified size (if set to transfer automatically), it will be sent directly to one of three other destinations (USB, TFTP server or a Samba server). The file transfer can also be initiated manually at any time. The file transfer process will **move all log files** from internal memory to the selected destination. Files are saved as comma-separated values (filename.csv). Datalogging is terminated when power is lost while the data log file is maintained (saved) where it was captured.	[redacted]	1	[redacted]
K	**Trend Chart for the Watlow F4T:** A Graphical **Trend Screen** is available. This screen plots real time data for any input connected to the controller if configured. The PV for each channel can be configured to display. The chart is scalable. Users can create up to four (4) trend screens and they have the ability to scroll through a matching color legend of parameters on the trend chart (6 color pens available per chart). The trend chart screen can be captured using the snapshot or screenshot feature where the image can be saved to a USB host port location for viewing, emailing or printing.	[redacted]	1	[redacted]
	TOTAL ACCESSORIES			[redacted]

[redacted]

OPTIONAL Accessories For Model DCI-966-G-F4T				
ITEM	DESCRIPTION	UNIT PRICE	QTY	TOTAL
1	**Maintenance Kit:** This kit contains parts required to maintain your oven in like-new operating condition, or help keep the chamber functioning in an emergency. A typical kit contains door gasket, thermocouple, solid-state relay, fusing and all necessary instructions and documentation.	[redacted]	1	[redacted]
2	**NIST Certificate of Calibration:** The certificate of calibration provided by TPS for your records provides NIST Temperature traceability for the chamber as a system, at the specified set point.	[redacted]	1	[redacted]
3	**Circular Chart Recorder, Partlow 1- Pen:** A Partlow MRC5000 single pen, 10-inch diameter chart recorder will be provided to record the temperature. This includes one (1) box of chart paper in degrees C. If degrees F chart is desired, please specify on the order. **Recorders are mounted on the control panel.**	[redacted]		
4	**Chart paper - for Partlow recorder:** Box of chart paper for your recorder. Please specify °C or °F at the time of ordering.	[redacted]		
5	**Emergency Power OFF (EPO):** The Emergency Power Off Pushbutton will shut down the heating system and the circulation motor when pressed. The Emergency Power Off Pushbutton must be pulled out to reset the system with all faults cleared.	[redacted]	1	[redacted]
6	**UL Approved Control Panel:** The control panel will be provided with a UL Label for compliance to UL-508 guidelines. **This UL label will be applied to the instrument control panel.**	[redacted]	1	[redacted]
7	**Redundant Over-Temp Protection (OTP).** A Redundant High Limit Controller provides electronic limit control with independent thermocouple sensor, separate heat contactor, and buzzer. Power to air heaters is interrupted, and buzzer sounds when limit temperature is reached. **Note- This function as a secondary or backup OTP to the main OTP that comes standard with the unit. This is installed on the control panel.**	[redacted]	1	[redacted]
8	**End of Process Alarm:** Audible & Visual End-Of-Process alarm alerts the operator that the process cycle has been completed. A panel mounted light also indicates the end-of-process status. Additionally, an audible alarm silence button is provided on the panel to silence the audio alarm signal.	[redacted]		
9	**Door Lock- Electro-Mechanical:** An electro-mechanical door lock will be installed to prevent the door from being opened when the oven is processing. This protects product loads from being damaged due to accidental disruptions in the process occurring when someone opens the door.	[redacted]	1	[redacted]

[redacted]

OPTIONAL Accessories For Model DCI-966-G-F4T				
ITEM	DESCRIPTION	UNIT PRICE	QTY	TOTAL
10	**Door Lock – Pneumatic:** A pneumatic door lock will be installed to prevent the door from being opened when the oven is processing. This protects product loads from being damaged due to accidental disruptions in the process occurring when someone opens the door.	[redacted]		
11	**Maintenance Lockout System:** A lockable/taggable circuit breaker will be installed. This provides a method of locking the equipment out for maintenance.	[redacted]	1	[redacted]
12	**Heavy Duty Main Fused Disconnect Switch:** Protected by a steel enclosure, these switches withstand tougher factory conditions. A fused disconnect switch is a combination of a switch to disconnect the circuit and a fuse to shut off the circuit in the event of a problem. When installing or maintaining equipment on the circuit, or the circuit itself, the switch provides a method of manually turning off the power. These have a padlockable lockout to secure in the off position.	[redacted]	1	[redacted]
13	**ProcessView Data Acquisition Software.** Supports both Ethernet and RS-485 networks simultaneously. **Up to 50 controllers** embedded in an oven or chamber can be monitored and/or controlled on a **local Ethernet and/or RS-485 Network.** Control and check the status of each controller loaded profile. CSV or Encrypted formats are supported for Data Logging. Built-in Web Server allows for remote PC/Smart Phone access to read-only Profile Status and Process Data. **Bar/QR Scanner** is supported, which keeps Operators from making typing mistakes. Loading Profiles or adding Batch/Profile Run information is supported. All data and logged parameters can be uploaded to a Cloud Database service (such as Amazon AWS or Microsoft Azure) that enables anyone with secure access to access the data real-time. Profile Status can be accessed **via Cellular text messaging** from anywhere in the world. Password Security for different levels of users provides secure access.	[redacted]	1	[redacted]

Note 1: For any other available accessories, please add the price to the price on page 1. Accessories added may affect the quoted lead-time.

[redacted]