Attachment A: Inert Gas High Temperature Convection Oven Specifications

Metallic and ceramic-metal components and electron tube devices manufactured on-site in the Electronics Science and Technology Division code 6840 will require a high temperature bake-out (heat treating) procedure to be performed. This process must take place within a oven that can provide an oxygen free inert gas environment during the heating processes. The oxygen free zone is created by a positive pressure of inert gas that prevents corrosive oxidation to the outer surfaces of the components and electron tube devices being heat treated. The following list of specifications for the requested inert gas oven is critical for the successful fabrication of our components and devices.

We require an inert gas high temperature convection oven meeting or exceeding the following specifications:

1. The oven must be of multiple-wall construction, having at a minimum: (A) an interior hot chamber to contain the customer parts being heat-treated while maintaining and inert gas environment that prevents oxidation of the customer parts; (B) a refractory thermal insulation layer with ancillary air cooling that surrounds the outside of the interior hot chamber and all elevated temperature components associated with the inner chamber, including heater coils, inert gas convection blowers, heated inert gas plenums, etc., and (C) an outer (exterior) housing that surrounds the insulation layer and associated heating and forced convection components and their controls.
2. The interior hot chamber must be constructed of 304 stainless steel that is TIG (heli-arc) welded to render it gas tight, with all welds passivated. The exterior housing must be constructed of welded heavy gauge steel, reinforced as needed to maintain structural integrity, and coated on the exterior with high temperature paint or enamel that withstands the outside surface temperatures. The insulation layer must be of refractory mineral wool, refractory ceramic wool, refractory mono-block, high temperature fiberglass, or a combination thereof.
3. The interior hot chamber must have inside dimensions of not less than 38 inches wide by 20 inches deep by 25 inches high. The interior hot chamber must have a volume of not less than 11 cubic feet.
4. The oven shall have a door to allow access to the interior chamber for the loading and unloading of customer parts before and after the process cycle. The door shall be double-walled and insulated, with the inner wall, insulation, and outer wall of the same materials and construction as the overall oven. A double door (inner and outer door) arrangement with equivalent performance and functionality is also acceptable.
5. The oven door (or double door combination) must make a hermetic seal to maintain the purity of the inert gas environment of the interior hot chamber and thus prevent oxidation of the customer parts being heat-treated. The door assembly shall have a pivoting hinge and latch design for proper security and safety during bake-out process and for ease in opening and closing.

6. The door system must have a double seal or double gasket design to maintain the highest level of inert gas seal integrity, and inert gas purity, at the temperature rating of the oven. The seals may be water cooled as needed to maintain mechanical and hermetic sealing integrity.
7. The door assembly must a have a safety switch built in for immediate shut down if inadvertently opened during operation.
8. The oven will require at least two stainless steel adjustable height shelves within the heating chamber. These shelves must be removable.
9. The oven must capable to heat the customer parts in the oven during heat-treatment to an operating temperature of at least 450 degrees Celsius, with a heater and insulation design margin to at least 500 degrees Celsius.
10. The heating elements shall be of the nichrome type, with a recirculating high temperature inert gas blower for forced convection of the inert process gas within the interior hot chamber to maintain temperature uniformity. The direction of inert gas forced convective flow shall be horizontal. The inert gas forced convection system, including heaters, blower, and inert gas plenums, must maintain the hermetic nature and purity of the inert gas to prevent oxidation of the customer parts being heat-treated in the interior hot chamber of the oven.
11. The oven must include a built in profiling electronic controller for the oven heating elements that can control the inner chamber temperature as required during the various stages of heat increase, holding temperature at desired set point(s) , and then an incremental decrease of temperature to room levels. The controller must be able to support multiple programs and operate with profiles having as many as 250 segments of ramps and dwells. The temperature controller must be able to maintain a process temperature within the inner heated chamber to plus/minus 5 degrees Celsius at any desired temperature between 50 degrees Celsius to the maximum operating temperature of the oven (at least 450 degrees Celsius). A communication link via a RS-232 connection is preferred.
12. The oven must be equipped with an over-temperature protection circuit.
13. The oven must come equipped with thermocouples to measure the inner chamber temperature and communicate to the temperature controller and the over-temperature protection circuit.
14. The oven shall be capable of operating with inert process gases of nitrogen, argon, helium, carbon dioxide, as well as non-flammable forming gas, in the heated interior chamber. The selected gas will be customer-supplied from a tank and regulator. Note: The forming gas can consist of a maximum of 4% hydrogen, with the remainder made up of nitrogen.
15. The oven must include flowmeters, gas flow throttling valves, and a pressure gauge to control and measure inert gas flow.
16. The inert gas process control system of the oven must have a timer and electronically activated valves built-in to control the inert gas flow during the sequences of the heating process. These steps will include: initial inert gas purge to clear the inner heated chamber and associated inert gas blower and plenums of air to ensure an oxidation-free inert gas environment, maintenance of inert gas positive pressure and flow during stepped or ramped

increases in heat and during temperature dwells, and maintenance of positive inert gas pressure during cool down.

17. The oven must have a pressure relief valve to vent the inert gas that maintains a positive pressure in the interior hot chamber at approximately 0.5 PSIG.

18. There is a requirement for a lead-in port from the outside of the oven that enters uninterrupted via a hollow tube into the interior hot chamber. The port and tube inner diameter shall be at least 2.5 inches. The outside termination should have an ANSI ASA smooth face flange or equivalent. The axis of the lead-in port tube and associated aperture / flange shall be positioned to enter at the center of the rear wall of the interior heated chamber. The port and tube shall be of the same materials and welded construction as that of the inner hot chamber, so that the inert gas purity is maintained. The oven shall be supplied with a blank ANSI ASA flange or equivalent with O-ring seal mating with and bolted to the outside terminating flange of the lead-in-port. (Note: Ultimately, the lead-in port will be used by the customer as a feed-through for additional customer-supplied hermetic instrumentation sensors that contact the parts being heat-treated, or to supply the interior volumes of hollow customer parts being heat-treated with separate inert gas or vacuum pumping via customer-supplied tubulation that passes though the lead-in port and seals to an appropriate mating flange.)

19. The oven shall include a forced air cooling system, working in conjunction with the insulation, between the heating chamber and outer walls, in order to ensure suitably low temperatures on the exterior oven surfaces and the control electronics, and to facilitate cool-down. The design will require a cooling air exhaust port that includes an adjustable port damper. The system will require a differential air pressure switch to ensure proper cooling air movement to protect the equipment.

20. The exterior surfaces of the oven shall not exceed 50 degrees Celsius during operation, with the exception of the air cooling system exhaust port which can be hotter.

21. The oven system shall be powered by 208 VAC 3 phase electrical source, and shall come equipped with a fused disconnect switch at the rated source voltage and amperage.