K500 and K150 remote heat gun control system
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A control system was requested to allow customers in the K150 and K500 SEELine areas to remotely operate Leister MISTRAL-6 SYSTEM heat guns for the purpose of in-air heating of a component undergoing radiation testing. Previously the heat guns were restricted to local control only, meaning adjustments to the output of the heat guns would have to be made from inside the cave/vault.

General purpose remote operation controllers (Leister Model CSS) were ordered from Leister, the manufacturer of the heat gun. These controllers are designed for products throughout the Leister catalog, and therefore are not intended specifically for use with the MISTRAL-6 SYSTEM. As such, the units were adapted and reprogrammed in order to adequately control the heat gun. A single controller unit can control either the temperature output or the fan speed of the heat gun, but not both simultaneously. Therefore, two units are necessary for an individual heat gun. The controller units have 16 input/output ports on their rear face. Connections made between these ports can be considered as exposed circuitry, as such an enclosure is required. The enclosure manufacturing services of Protocase were selected for fabrication of two custom-designed enclosures for the control units (one enclosure box per SEE area). Pictured in Fig. 1 is the front face of the fully assembled enclosure. Communication between the controllers and the heat gun is made through a single RJ45 cable patched from the data room to the cave/vault.

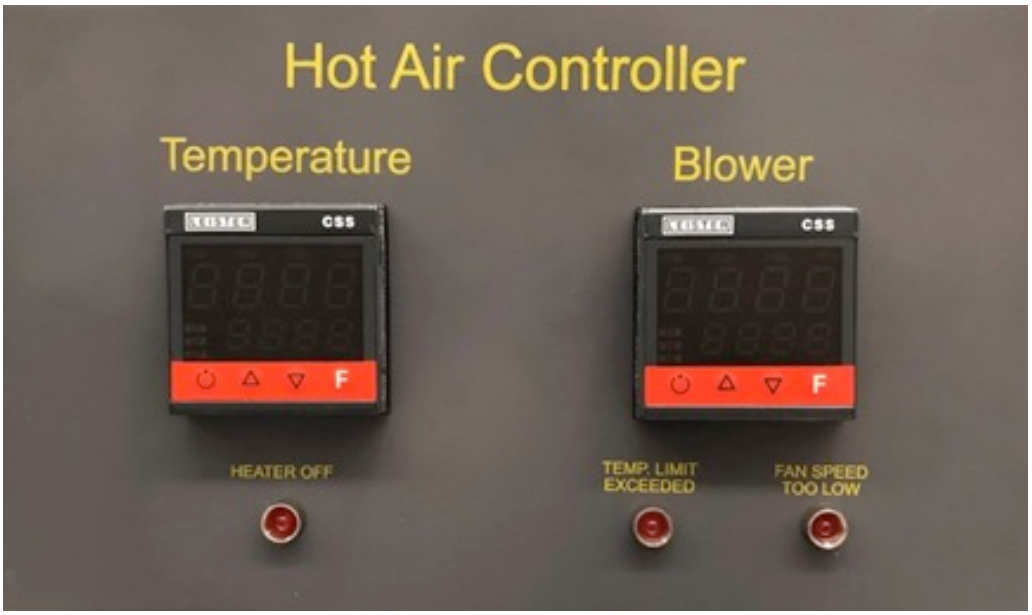

Fig. 1. Front face of a control box. Status LEDs are provided to indicate various fault states of the heat gun operation.

As the CSS controllers are PID (proportional, integral, derivative) units, they can monitor an external component's temperature via thermocouple signal and adjust heating power and fan speed of the

heat gun in real time to maintain a set temperature of the component being heated. Thermocouple patches from the cave/vault to data rooms were installed in the K500 SEE area (2x K-type, 1x T-type, 1x J-type). For the K150 SEE area, a thermocouple signal transmitter was installed to the K150 area heat gun. This transmitter takes a local thermocouple signal (K, T, J, E, R, S, B, N, or C-type) and sends a proportional output current signal to the controllers. This signal connection to the controllers has been incorporated to the already present RJ45 connection between the controllers and heat gun. The power supply for the thermocouple signal transmitter is also incorporated into the RJ45 wire, as the CSS controllers have a built-in 24V DC power supply that can power the transmitter.

Temperature testing to verify accurate thermocouple reading between the systems was performed. A test part was heated to four temperatures and comparisons were made between the readouts of a dedicated thermocouple reader (DTR), IR thermometer (IRT), the K500 box, and the K150 box. The results of the testing are shown in Table I. It should be noted that the temperature set point (SP) was set using the K150 box, which was actively controlling the heat gun that was heating the test part. As a result, the K150 box value should closely match the SP. The IR thermometer readings were taken by pointing an IR thermometer at a piece of painter's tape stuck in the same location that the thermocouples of the K150 box and the K500 box were attached. The results indicate adequate uniformity of the temperatures reported, showing that both boxes can read temperatures similarly despite their different means of signal transmittance. Additionally, the results show that the set points of the boxes are accurate (within 5%) to the real temperature of the test part ('real temperature' according to the dedicated thermocouple reader).

Table I. Temperature testing of the K150 and K500 boxes. All values in °C.

SP	K150 BOX	K500 BOX	IRT	DTR
65	65	64	63	65
80	81	78	78	80
95	95	92	92	94
110	111	107	105	107

Once basic functionality programming was completed, safety systems were then programmed into the control system. In order to protect the part being heated from overheating, an upper temperature limit can be set by the customer. When the thermocouple reports this temperature has been reached, the heating element of the heat gun is automatically disabled until the temperature falls below this upper limit. This system is unavailable in manual heat gun control, as manual control does not take any input signal from a thermocouple. The heating element requires constant blowing to protect itself from overheating and is protected by locking the user out of lowering the fan speed excessively. If the user attempts to lower the blower too far, the heating element is automatically disabled until the fan speed is raised above the minimum threshold. This system can be bypassed if necessary, should the customer request low temperature and low blower speed. In the event that the signal between the controllers and heat gun is disrupted, the heating element automatically disables until the signal is reestablished. If the thermocouple disconnects from the part being monitored, or if the thermocouple 'burns out,' there is either a fault signal (K500 box) or excessive temperature (K150 box) read by the controllers, and the

heating element is automatically shut off. The controller enclosure is fused and is grounded when plugged into 120VAC wall power.

Work is complete and the controller systems are currently active in the K500 and K150 areas for customer use.