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|  | <b>OGI Process Equipment<br/>White Paper</b> |                 | Doc No:            | WP: 2201         |
|  |  |                 | Initial Issue Date | <b>9/21/2022</b> |
|  |  |                 | Revision Date:     | 10/26/2022       |
| <b>Bath High Temperature Shutdown – Pneumatic Control</b>                        |  |                 | Revision No.       | Rev – 1          |
|  |  |                 | Approved:          | <b>JMP</b>       |
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## Introduction:


The purpose of this study was to review the application of Burner Pilot shutdown with Bath High Temperature Shutdown for all TERI Natural Draft Water Bath Heaters.

## Background:

OGI has been manufacturing TERI Brand heaters with pneumatic controls specific to Customer needs for many years. OGI typically complies with Customer-proposed variations to these controls if the final control configuration is safe, if it protects the heater’s components and if it complies with referenced control standards; at minimum ASME CSD-1 as a reference.

Heater safety and control logic is broken up into three segments, Common Heater Shutdowns, Burner Specific Shutdowns, and Temperature Control.

- Common Heater Shutdown logic permits the burners pilot to be lit when these conditions are confirmed to be OK. These shutdowns are typically associated with heater bath operating conditions. For Pneumatic System, Common Heater shutdowns are installed in the pneumatic supply to the Pilot Safeguard (BASO). When OK, the Pilot is allowed to be lit and, when confirmed, will supply pneumatic pressure to the rest of the heater’s safety and control logic. IF any Common Heater Shutdown occurs, all burners and pilots will be shut down.
- Burner Specific Shutdown logic permits the Main Burner to operate when conditions are confirmed to be OK. The burner-specific conditions will include the Burner Pilot Lit status and may include High and Low Gas Pressure OK and High Stack Temperature OK depending on Main Burner Input. For Pneumatic Systems, burner-specific Shutdowns occur after the Pilot Guard (BASO) and will open the Burner Safety Valve when all conditions are proven to be OK. If a burner-specific shutdown occurs, only that burner will be shut down; for multi-burner heaters, the remainder of the burner(s) will be allowed to operate. Note that the Burner Specific Shutdown Logic incorporates the Common Heater Shutdown logic through the Pilot Safeguard Status.
- Temperature Control logic defines when a burner will operate based on the bath or process temperature controller set point. The Temperature Control logic incorporates the Common and Burner Specific shutdown logic, requiring the shutdown logic to be proven to be OK before the burner is allowed to operate.

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Pneumatic control system designs typically install Common Heater Shutdowns, like the Bath Low Level Shutdown (LLSD), in the main pneumatic control supply tubing to the Burner’s Pilot fuel gas supply and all remaining heater controls. The location of the Bath High Temperature Shutdown (HTSD) varies based on customer preference. Some customers have the HTSD installed as a Burner-Specific Shutdown downstream of the Pilot Safeguard (BASO) to shut down only the main burner if the HTSD set point is exceeded, Configuration 1. Other Customers have the HTSD installed as a Common Heater Shutdown in series with the Bath Low Level Shutdown to shut down the pilot and main burner if the bath temperature overheated, Configuration 2.

**Configuration 1:** Single Burner, Pneumatic Control Systems: (Illustrated on Page 3 of 6)

Common Heater Shutdown (Ahead of BASO)

- Bath Low Level Shutdown (LLSD)

Burner Specific Shutdowns (After BASO)

- Pilot Safeguard BASO confirms Pilot
- Bath High Temperature Shutdown (HTSD)
- High Stack Temperature<sup>1</sup>
- High and Low Burner Pressure<sup>1</sup>

Temperature Control (Burner Specific)

- Process Outlet Temperature Controller (Field Installed)

**Configuration 2:** Alternate Single Burner, Pneumatic Control Systems: (Illustrated on Page 4 of 6)

Common Heater Shutdown (Ahead of BASO)

- Bath Low Level Shutdown (LLSD)
- Bath High Temperature Shutdown (HTSD)

Burner Specific Shutdowns (After BASO)

- Pilot Safeguard BASO confirms Pilot
- High Stack Temperature<sup>1</sup>
- High and Low Burner Pressure<sup>1</sup>

Temperature Control (Burner Specific)


- Bath Temperature Controller
- Process Outlet Temperature Controller (Field Installed)

For single burner/fire tube heaters, OGI’s original standard design installed the HTSD downstream of the Pilot Safeguard (BASO) control output, Configuration 1, above.

For multi-burner/fire tube heaters, OGI’s standard installed the HTSD in series with the LLSD to supply each burners Pilot Safeguard (BASO) with a COMMON pneumatic shutdown signal, Configuration 2, above. If the Common Shutdown signal is lost, all heater burners and pilots will shut down

<sup>1</sup> For heaters with single burner inputs greater than 2.5MMBtuh



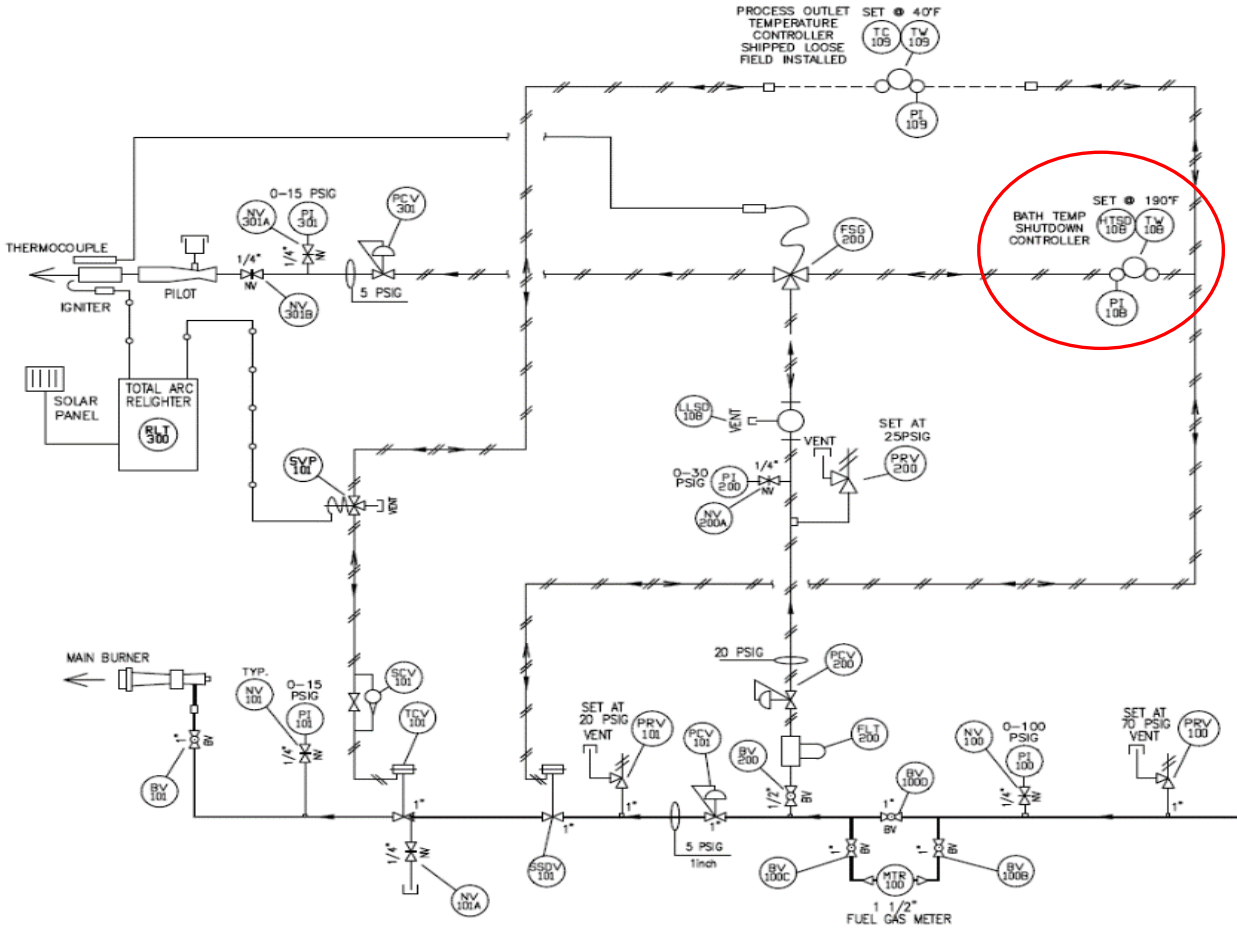
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**Discussion:**

The impact of the Bath High Temperature Shutdown (HTSD) location in pneumatic control systems was reviewed for Single Burner heaters, main and pilot shutdown. The current design has the HTSD located after the Pilot Safeguard (BASO) creating a possibility for the bath to overheat when operating on the pilot alone under low or no natural gas flow through the process coil. This overtemperature issue is more likely to occur during summer month operation when natural gas flow through a heater is at its lowest and ambient temperatures are high.

If the HTSD only shuts down the main burner, the pilot will continue to operate, and the bath temperature will continue to rise and potentially boil off the bath media until the bath Low-Level shutdown trips the pilot off, at which point, the heater is shut down, and the customer is left with an inoperable heater due to inadequate bath level.

The possibility of bath over-tempering is predominant with smaller heaters where the bath volume is smaller relative to the energy input available from the pilot.



**Configuration 1: Original High Temperature Shutdown Controller Location for Single Burner Heaters**

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## Bath High Temperature Shutdown – Pneumatic Control

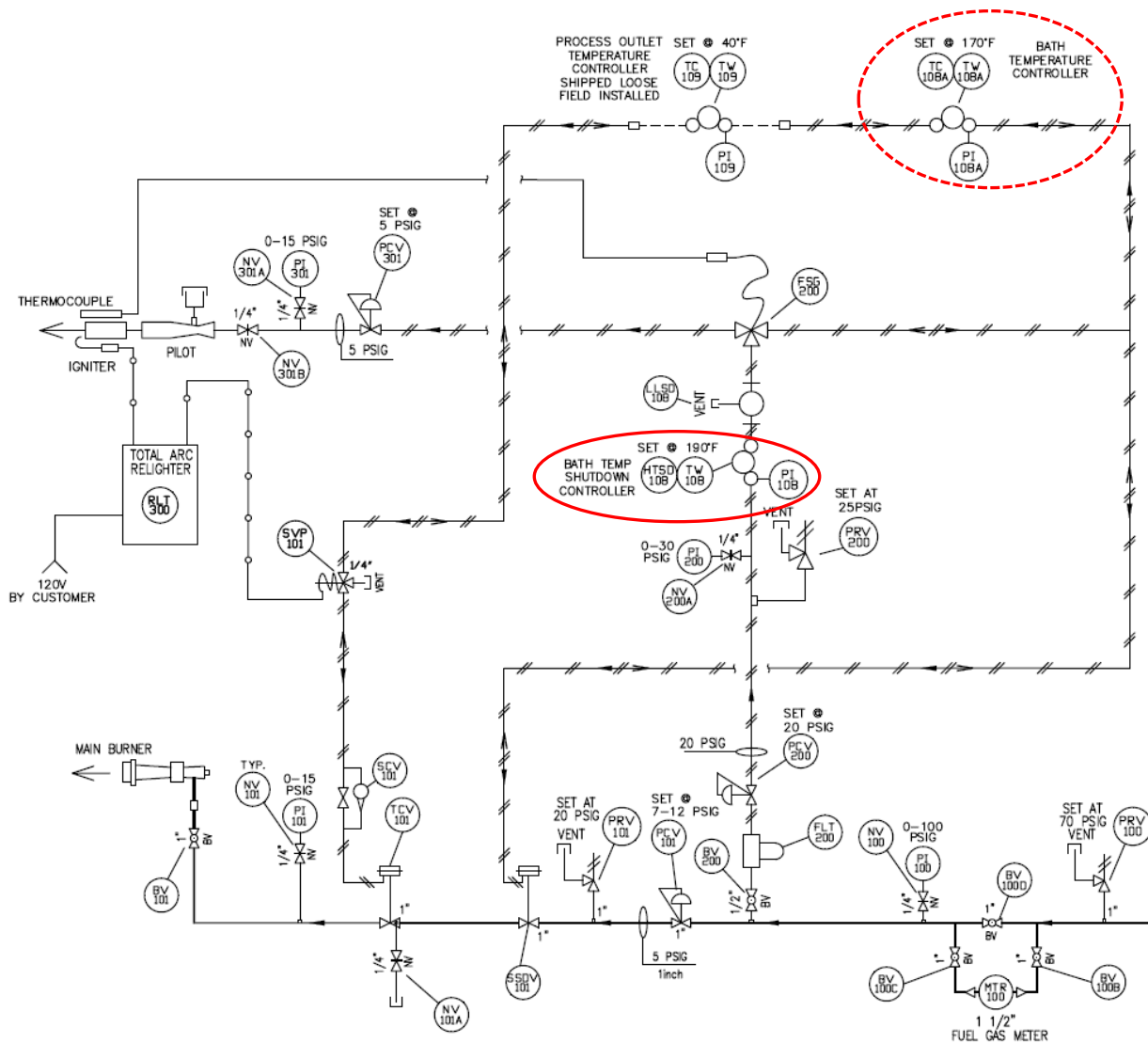
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Issuing Dept:


R&D Engineering

If the HTSD is moved in series with and ahead of the Low-Level Shutdown, in the supply tubing to the Pilot Guard (BASO) valve, both the pilot and main burner would trip off when the bath temperature climbs above the HTSD Set point. Here the heater bath temperature never reaches a point where bath media is lost (no boiloff) and the heater would be available to be restarted for operation.

Experience has shown that during a cold heater startup, when downstream piping, valves and instrumentation must be warmed up. This additional heat load will momentarily increase the duty on the heater and may cause the heater's bath to exceed the set point of the HTSD. To avoid this, OGI will add a Bath Temperature Controller to be installed in series, upstream of the Reg NG Temp Controller, set slightly above the calculated bath temperature for this heater design. When installed, the main burner will shut down at a point where the HTSD set point will not trip the pilot and the heater will remain online.



**Configuration 2: New High Temperature Shutdown Controller Location  
with Added Bath Temperature Controller**

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Note that during periods when a high temperature shutdown could occur, it is the time of year when the gas usage is low and most heater's pilot and burner could be turned off. This becomes an operational decision by the customer on a heater-by-heater application.

There were concerns noted about the inaccuracy of the pneumatic temperature controllers. Typically, when properly adjusted, these controllers will have a ~10°F or lower dead band. The key is that these controllers take time to adjust, and because they are a bi-metal, expansion-style controller, the temperature set point needs to be adjusted and tuned gradually, allowing the controller-sensing elements to soak to the new temperature. This will require that this controller be evaluated occasionally to ensure accuracy. It will be important to consult the pneumatic temperature control maintenance manual for guidance on proper adjustment of this controller.

With the revised location of the pneumatic temperature controller, OGI would recommend that the set point for this high temperature shutdown be 190°F. This would allow the temperature in the bath to reach up to ~200°F before the pilot shuts down.

## Conclusion:

Though the recommended pneumatic control feature is not typical for all Customers' pneumatic design, OGI sees real benefit in making this change part of OGI's standard pneumatic control design for all heaters, as well as incorporating this into all customer pneumatic control designs moving forward.

Revising the location of the Bath High Temperature Shutdown to the Pilot and Pneumatic control supply tubing and adding a Bath Temperature Controller for all heaters will:

- avoid uncontrolled overheating of the heaters bath media during low or no-flow conditions during higher ambient temperature operation;
- allow the heater to ramp up without tripping the HTSD during initial cold startups;
- avoid loss of water/glycol media, keeping the heater available and operational after the HTSD trip.