

## Turndown Fired Equipment

This document covers operational and integrity concerns for Fired Equipment during turndown operations. The topics covered in this document are not specific to any particular site but are intended to serve as a general guide.

It is important to consider the following High Risk, High Impact concerns when running below defined operating envelopes on minimum throughput. Unit adjustments require a more detailed, facilitated discussion with experts to ensure safe operation. Becht can assist with IR monitoring if needed to help validate operational modifications.

High Risk, High Impact Concerns	Symptom(s)	Consequence(s)
1. Poor combustion system management / process heat integration	<ul style="list-style-type: none"> <li>• Local hot or cold spots within equipment / poor flame stability</li> <li>• Poor flame pattern / burner performance</li> <li>• High draft / tramp oxygen biasing true excess oxygen at burners</li> <li>• Issues lighting burners / maintaining burners</li> <li>• Convection tube failure</li> </ul>	<ul style="list-style-type: none"> <li>• Fuel rich pockets resulting in uncontrolled combustion, equipment damage / fire</li> <li>• Low oxygen conditions at burners, flame blow out, uncontrolled combustion, equipment damage / fire</li> <li>• Afterburning, damage / fire</li> <li>• Burners unavailable needed</li> </ul>
2. Low tube velocity	<ul style="list-style-type: none"> <li>• Rapid internal coking of tubes</li> <li>• Unexpected locations of tube coking</li> <li>• Radiant/shock tube failure</li> </ul>	<ul style="list-style-type: none"> <li>• Exceedance of tube mechanical design, loss of containment / fire</li> <li>• Decreased cycle between spall / decoke, loss of operating flexibility</li> <li>• Unexpected loss of throughput when units return to high rates</li> </ul>
3. Operation near operating envelopes – SIS trips, min/max burner pressure, etc	<ul style="list-style-type: none"> <li>• Operating in or very near alarm(s)</li> <li>• Issues with flame stability</li> </ul>	<ul style="list-style-type: none"> <li>• Accidental heater trips, increased risk recovering from trips and operational upsets</li> </ul>
4. Corrosion in steam generators and air preheaters (APH)	<ul style="list-style-type: none"> <li>• Steam – unstable level/pressure</li> <li>• APH – operating at or past dew point</li> </ul>	<ul style="list-style-type: none"> <li>• Steam blanketing corrosion</li> <li>• Furnace trips via level instability</li> <li>• Damage/plugging to bundles</li> </ul>

1. It is critical to ensure stable flame pattern, optimized heat flux, and keeping equipment biased towards safe operating modes. Increase IR monitoring for high risk heaters: Becht maintains best in class Advanced IR technology to provide ultra-accurate data coupled with actionable engineering analysis with each monitoring report.
2. Low tube velocity can lead to exponentially faster coking rates or a change in location of coke formation. Ensure you have operating limits and monitoring processes, such as Infrared monitoring, in place.
3. Be aware and cautious of normalization of deviation, if running in or near alarm points confirm validity of the alarm points. Accidental trips can result in higher risk activities like lighting a heater or restarting a unit.

This guideline provides guidance on high risk, high impact concerns, symptoms, and consequences for unit turndown conditions. Additional risks should be taken into account before proceeding into a planned shutdown or mothball. For further guidance on these issues, we welcome you to reach out to your internal site team, corporate organization, or Becht. We are here to help you succeed during these challenging times.