EXECUTIVE BRIEF · OPERATIONAL THERMODYNAMICS INTELLIGENCE

HEAT RATE DRIFT

Why Thermal Performance Deteriorates
While The Unit Appears Stable

YBGGlobal.com · ControlAlign™

EXECUTIVE SUMMARY

Operational drift in plain view

In many thermal power environments, units continue operating within apparently normal ranges while thermal efficiency progressively deteriorates.

Generation remains stable. Steam conditions remain acceptable. Dispatch targets are met.

Yet over time:

- fuel consumption increases,
- heat rate worsens,
- emissions intensity rises,
- and operating margin declines.

This phenomenon is commonly treated as routine operational variation. However, in many cases, it reflects the gradual evolution of the unit's thermodynamic transfer environment.

> **Thermal drift often develops silently beneath otherwise stable operational conditions — visible in outcomes long after it has begun in the transfer environment.**

Historically, operators monitor variables such as:

- excess O_2,
- combustion stability,
- temperature,
- emissions,
- and air–fuel balance.

These are all critical operational parameters.

But they do not necessarily provide direct visibility into:

- thermal coupling effectiveness,
- radiative heat-transfer behaviour,
- furnace-state stability,
- or the efficiency with which released thermal energy is transferred to the working fluid.

As a result, thermal performance may deteriorate progressively without immediately presenting as an operational abnormality.

HEAT RATE IS AN OUTCOME

> *Heat rate is typically defined as: "The amount of fuel energy required to produce one unit of electrical output."*

Lower heat rate generally indicates:

- lower fuel intensity,
- lower operating cost,
- and improved thermal efficiency.

> **Heat rate itself is not directly controlled. It is an operational outcome produced by the combined thermodynamic state of the unit over time.**

This distinction matters. Two operating periods may:

- produce the same electrical output,
- operate within acceptable combustion ranges,
- and satisfy dispatch conditions,

while exhibiting materially different heat-rate performance.

WHY DRIFT OCCURS

The furnace is not a static thermodynamic environment. Its operating state continuously evolves due to interacting operational variables including:

- excess O_2 variation
- air–fuel imbalance
- pulverizer variation
- burner-condition drift
- flame-shape instability
- slagging and fouling accumulation
- air ingress
- fuel-quality variability
- sootblower effects
- thermal absorption imbalance
- radiative coupling changes
- load-transition instability

Over time, these interacting conditions influence:

- flame behaviour,
- heat-transfer effectiveness,
- thermal-state stability,
- and the efficiency with which thermal energy reaches the working fluid.

> **Importantly: the unit may still appear operationally stable. This is operational thermal drift.**

THE VISIBILITY PROBLEM

One of the primary operational challenges is that thermal-performance drift is influenced by many interacting variables simultaneously. Viewed independently, these signals can become operationally overwhelming.

Historically, much of this complexity becomes compressed into a small number of observable KPIs:

- heat rate,
- fuel flow,
- emissions,
- and output.

The KPI reveals the result. But not necessarily:

- why the drift occurred,
- how thermal-state conditions evolved,
- or which operational conditions correlate with superior performance.

AN EMERGING OPERATIONAL QUESTION

As industrial environments become increasingly data-rich, an emerging question is beginning to develop across thermal operations:

> *"Could the next evolution in heat-rate management involve improving visibility into the thermodynamic transfer environment operating between fuel input and electrical output?"*

This includes improving interpretation of:

- thermal-state behaviour,
- radiative coupling effectiveness,
- operational drift development,
- and fuel-to-steam conversion stability.

HISTORIAN-DERIVED OPERATIONAL INTELLIGENCE

At YBGGlobal.com, part of the current focus involves historian-derived reconstruction of thermal-state behaviour using existing plant operational data.

The objective is not replacing:

- existing DCS environments,
- APC systems,
- combustion controls,
- or plant operators.

The objective is improving visibility into:

- operational drift,
- thermal transfer effectiveness,
- and the operating conditions associated with superior historical thermal performance.

> **This approach is intended to help transform large operational historian environments into more interpretable thermodynamic intelligence.**

CLOSING OBSERVATION

Thermal plants do not always lose performance through sudden failure.

In many cases: performance deteriorates gradually through operational drift.

The unit continues operating. The KPIs remain acceptable. The plant appears stable.

Yet progressively more fuel becomes required to sustain the same electrical output.

> **The operational challenge may therefore not only involve controlling combustion — but improving visibility into the thermodynamic transfer environment itself.**

YBGGlobal.com · Operational Thermodynamics Intelligence