ESTIMATING EXHAUST "SWIRL"

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2013 Frame 6 Users Conference

TRACING EXHAUST TEMPERATURE SPREADS
Steps For Trouble Shooting

The source of a high temperature spread can often be traced back to a specific location in the combustion chamber locations.

There are three basic steps to be followed:

1. Identify the high and low spots in the exhaust temperature profile.
2. Back-trace the exhaust temperature anomaly through the gas **swirl angle** to chamber location.
3. Identify the hardware which is capable of producing a variation in the combustion pattern.

TRACING EXHAUST TEMPERATURE SPREADS
What Is The Swirl Angle?

- The **Swirl Angle** is the angle between the measured representative exhaust gas temperature, at varying loads, and the known combustor source-location.
- However, the swirl angle is not a rigidly controlled parameter and could be expected to vary between units - it should be treated only as a tool.
- Troubleshooting via exhaust temperature spreads has been very helpful in identifying the location of malfunctioning combustion hardware.

TRACING EXHAUST TEMPERATURE SPREADS.
Using The Map & Graph

- Locate the cold region by looking at the exhaust temperature data.
- Select the cold thermocouple and its corresponding location on the map.
- Using the graph, find the swirl angle which corresponds to the load at which the data was taken.
- From the location of the low thermocouple, back-trace (clockwise on the map) the amount of the swirl angle to identify the location of the probable cause.

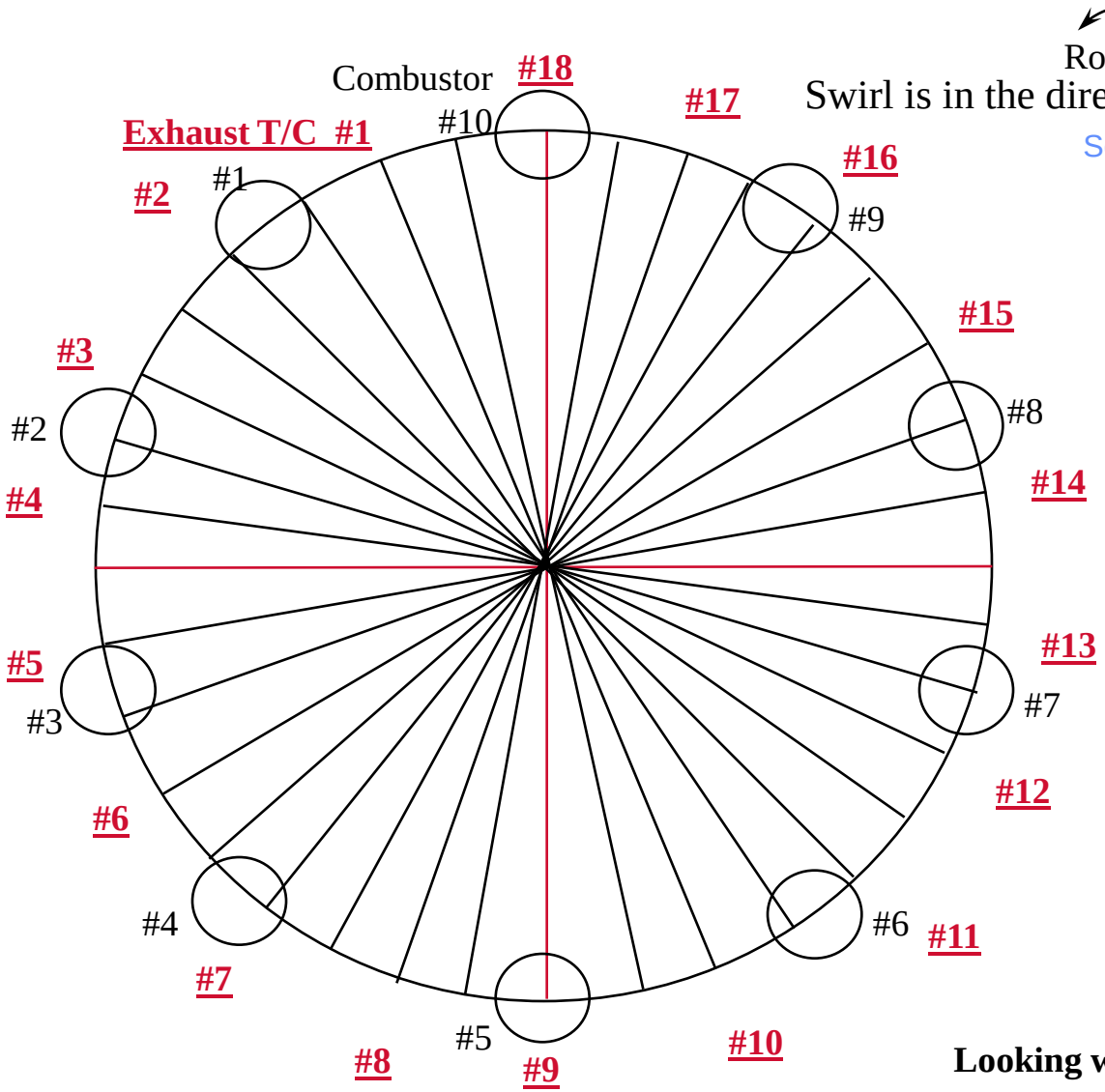
TRACING EXHAUST TEMPERATURE SPREADS.

Trouble Shooting Hints

- **HOT STREAK** (signifies excess fuel/not enough air)
  - Inspect Liners for plugged holes
  - Check Fuel nozzle assembly

- **COLD STREAK** (signifies excess air/not enough fuel)
  - Inspect fuel nozzles for plugged orifices
  - Inspect check valves for proper operation
  - Inspect cross-fire tubes for leaks
  - Inspect transition piece seals for proper installation and leaks

MS 6001B EXHAUST T/C MAP --MK IV w 18T/C's



MS 6001B EXHAUST TEMPERATURE SWIRL PATTERN

MS 6001B EXHAUST TEMPERATURE SWIRL PATTERN

EQUATION TO CALCULATE SWIRL ANGLE

At 40 MW, swirl angle = 0 degrees

At 25 MW, swirl angle = 100 degrees

Delta Swirl / Delta MW = (0 – 100) / (40 – 25) = -100 / 15 = -6.667^{o} /MW

Line can be represented by the following equation ($25 \geq MW \geq 40$) :

Swirl Angle = (40 – MW) * 6.667

GO TO EXCEL EXAMPLES

EXHAUST TEMPERATURE SPREADS

- The exhaust spread algorithm is part of the combustion monitoring program, an equipment protective device.

- The exhaust temperature spread is a measure of the variance in exhaust temperature readings.

- The spread checks are in place to ensure even heat distribution within the gas turbine combustion and exhaust ends. An uneven temperature distribution could indicate abnormal combustion patterns or combustion gas bypass conditions are present.

EXHAUST TEMPERATURE SPREADS

Spread1 = Highest minus the Lowest reading

Spread2 = Highest minus the 2nd Lowest reading

Spread3 = Highest minus the 3rd Lowest reading

Allowable Spread = variable value which represents the maximum allowable spread based on exhaust temperature and CPD. At base load, typically between 105 – 125 F.

QUESTIONS?