

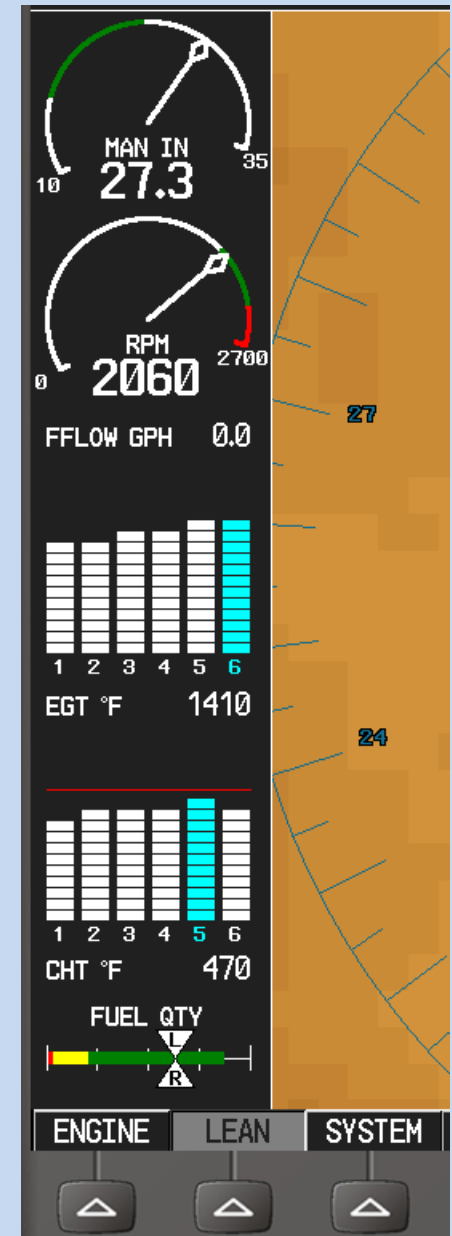
Using the Engine CHT/EGT Display for Diagnosing Problems

Ted Spitzmiller

From an article in *Light Plane Maintenance*
October 2008

Diagnostic Interpretation

- Multi-probe CHT/EGT can provide in-flight diagnostic capability
 - Pilot must know and understand system
- Serves as "early warning" device
 - pinpoints location and nature of engine problems sometimes before they show in other ways.
- Requires experience and knowledge of principles of exhaust analysis





EGT Fundamentals

- EGT probe is located in each exhaust
 - typically 4-6” from cylinder head.
 - Measures temp of exhaust gas exiting cylinder.
- Exhaust temp varies w/ power, altitude, OAT
- Also by engine mechanical conditions
 - Ignition timing & cylinder leakage (compression)
 - Dynamic instrument w/ lots of diagnostic potential.

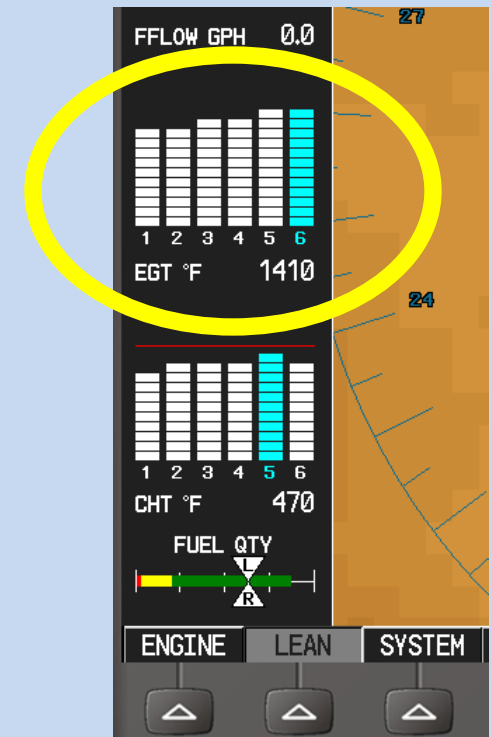


More EGT Information

- Temp varies from “combustion event” to “combustion event” as the engine is running.
 - Thermocouple registers a moving average:
 - Exhaust gases jet past probe in a pulsing manner, as exhaust valve opens and closes.

EGT Monitors Combustion

- Because it is so dynamic
 - Absolute numeric value of EGT at any given moment not important compared to moving average.
 - Relative value of EGT (to other cylinders and "normal" day-to-day performance)
 - And its response to changes in mixture are of primary interest.

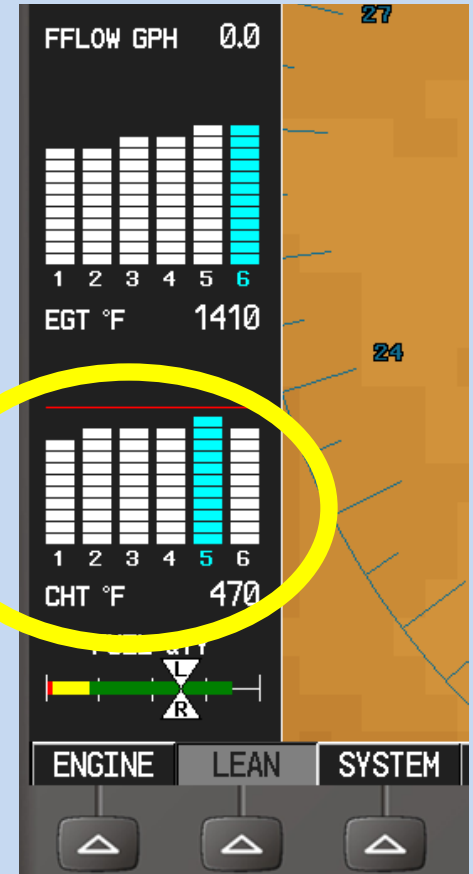


Absolute Values?

- Can provide additional information,
 - However, a barrage of varying digits can lead to sensory overload for the pilot.
- Think of EGT as being a "rectal thermometer"
- Single most fundamental piece of data any EGT system provides:
 - combustion is occurring!

CHT Fundamentals

- CHT is residual heat from combustion
- May provide similar diagnostic information as EGT
- CHT is slow to respond
- Measures temperature of one spot on cylinder head, and nowhere else
- *“Cylinders whose CHTs enter caution and warning range (>500° F) appear in yellow and red.”*



Some Differences EGT vs CHT

- EGT is quicker to change
 - Changes are larger in magnitude
 - Makes EGT more valuable tool for looking at irregularities in combustion process.
- EGT/CHT also have symbiotic relationship
 - They help to confirm each other.
- Individual CHTs or banks (1,3,5) can be dramatically affected by engine baffle issues/problems.

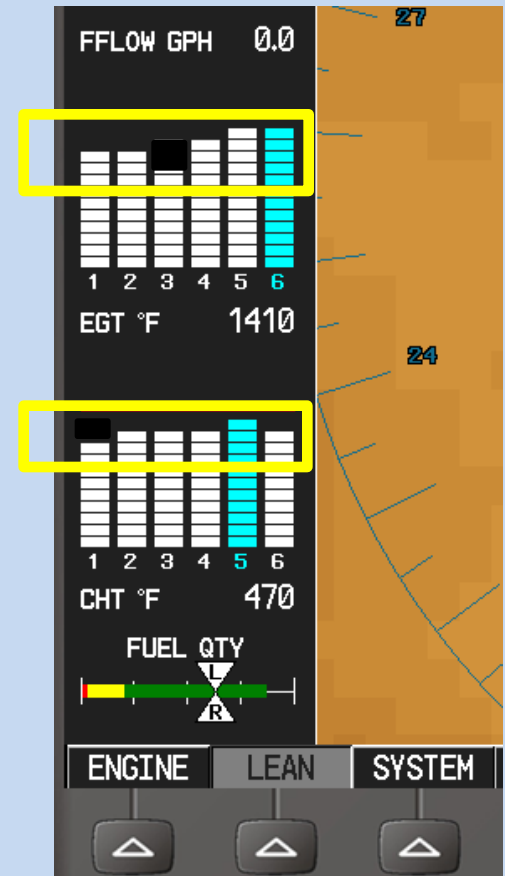


Diagnosis Quandary

- Cannot always tell what exactly is wrong
 - some malfunctions cause similar indications
 - could be multiple malfunctions
- Display can show something IS wrong
 - knowing which cylinder provides significant data over minimal instrumentation
 - Can establish trends to help with diagnosing issues

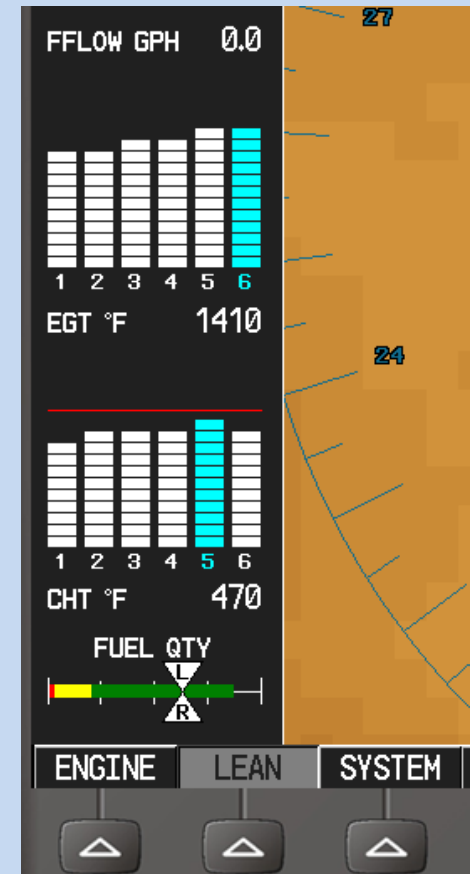
Temp Differentials

- EGT is commonly 3 or 4 bars (75-100° F) hottest to coolest in a fuel-injected engine.
 - Difference in fuel flow between richest and leanest cylinders.
- CHT differential is 1 or 2 bars among cylinders with proper baffles.
 - Lycoming notes differentials of 100 degrees F



Important Note

- Inter-cylinder EGT differential is not a constant.
 - Varies w/ mixture & power settings (among other factors).
 - At cruise, narrowest differentials for an engine will be at full throttle
 - most efficient
 - assuming proper mixture management.



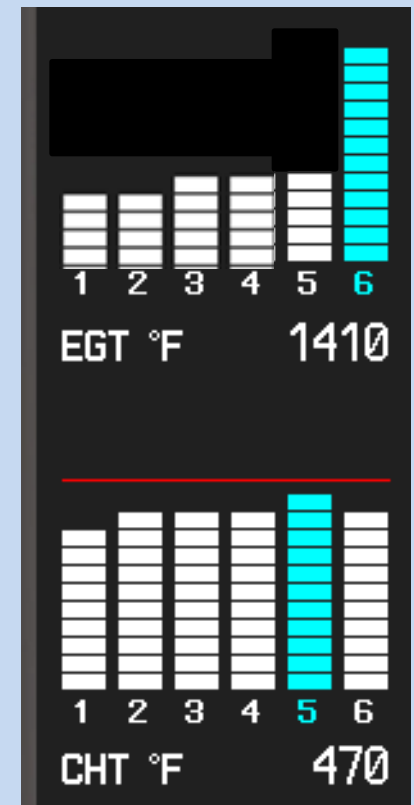


Aviation Fuel Injection Systems

- Fuel is constantly sprayed at the back of the valve
 - not pulsed based on demand and timing
 - no feedback electronics
 - pilot has to be knowledgeable to get the best available mixture from system by proper leaning

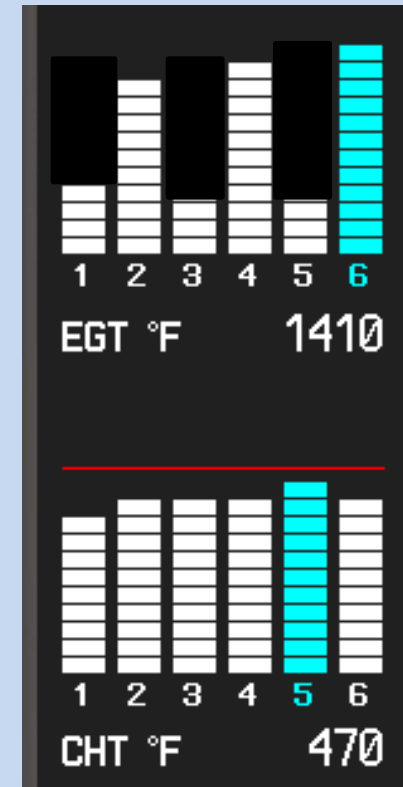
Example 1

- Problem: High EGT on cylinder #6;
- CHT is normal on all cylinders.
- Possible cause:
 - one spark plug stopped working in #6
 - If EGT intermittently high, spark plug firing is intermittent
 - Spark plug fouling is common
 - Partially obstructed fuel injector nozzle
- *View single-plug high EGT effect when switching to one mag at run-up and watch EGTs jump*



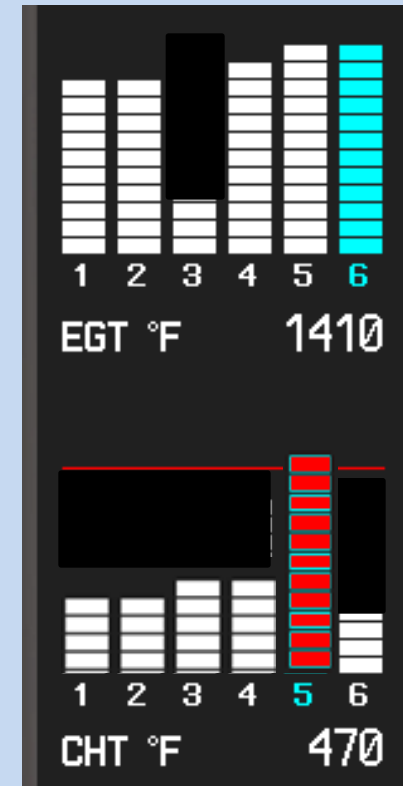
Example 2

- Problem: Possible EGT bank-specific imbalance
- CHT indications are uniform
- Likely Problem:
 - If fuel-injected, staggered EGTs with 7 bar spread of 175° shown could need injector cleaning
- Bank-specific nature could be meaningful
 - More investigation should be made for bank-specific EGT imbalance to check for induction leaks/other causes.



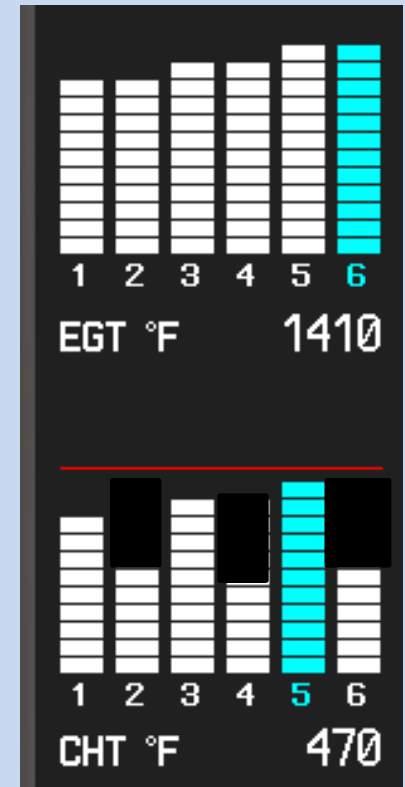
Example 3

- Problem: CHT on #5 cylinder is grossly high.
 - Very abnormal combustion process in the cylinder (pre-ignition?), or
 - High friction in the cylinder, or
 - Probe is subjected to unusual heat
- If low EGT on #3 (adjacent cylinder)
 - Exhaust leak at #3 exhaust gasket may be blow-torching CHT probe on #5
 - Precautionary airport landing



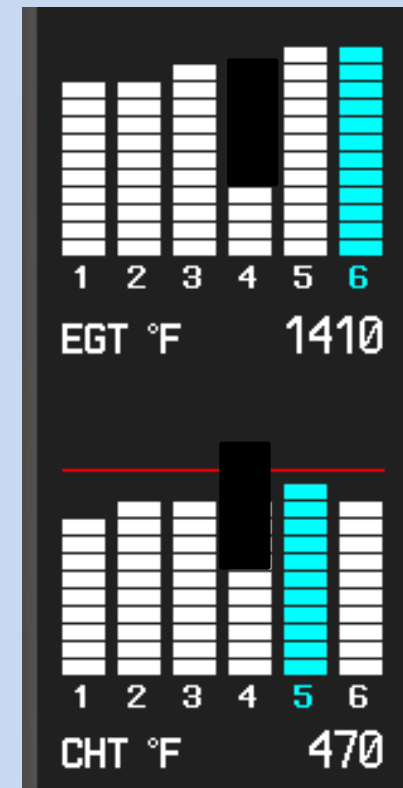
Example 4

- Problem: Staggered CHT pattern.
 - One bank of cylinders is running colder
- Possible cause:
 - Check cowl and engine compartment for cooling irregularities affecting one side of engine.
 - Checking cowl flaps with two separate segments as one inch of cowl flap misalignment can cause a 50-degree F difference in CHT.
 - On fuel-injection, such an EGT spread is excessive (and still bank specific). Consider nozzle and spark-plug cleaning.



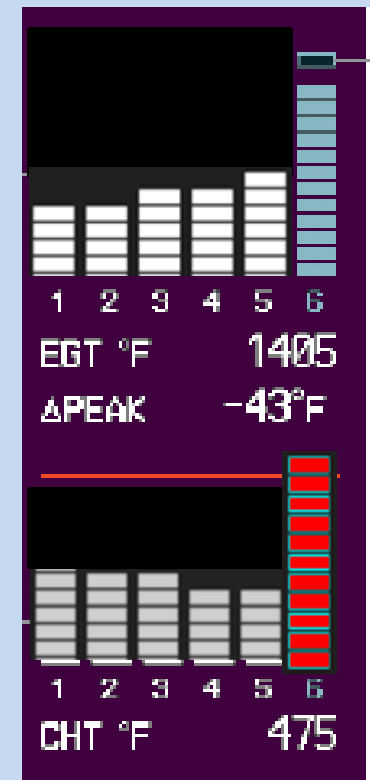
Example 5

- EGT is low on #4 cylinder, as is CHT resulting in a "cold cylinder".
- Either compression is low, or fuel flow to cylinder is restricted

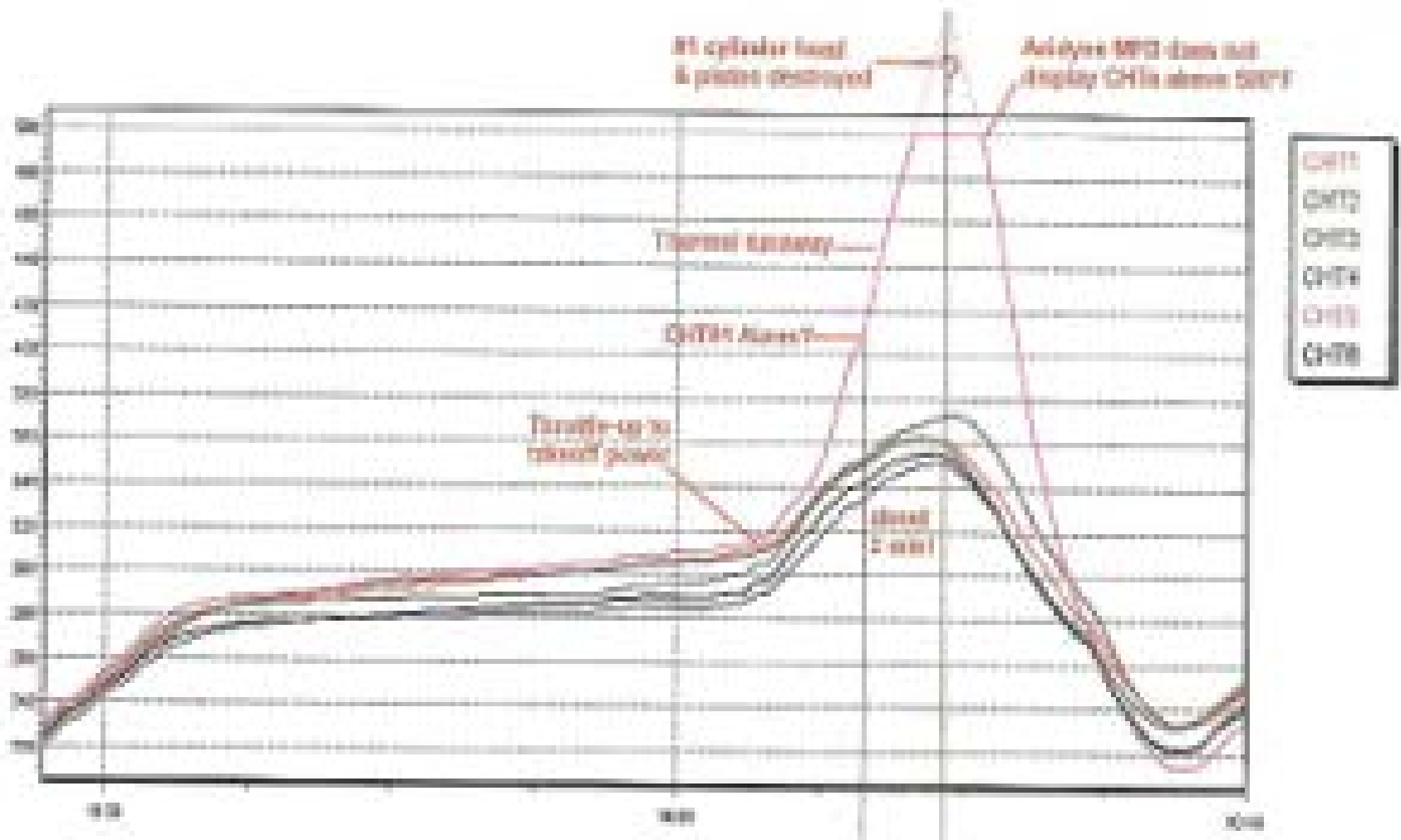


Example 6

- High EGT and CHT (#6) points to a combustion problem
 - May be a faulty spark plug
- If CHT exceeds red line (bars turn red)
 - Reduce power and full rich mixture
 - Observe if EGT lowers followed by CHT drop-off
- Precautionary landing
- Investigate any time such divergent readings occur.
 - Both spark plugs for #6 cylinder should be pulled and examined
 - Compression test and borescope
- A/C grounded—Cause MUST be found.



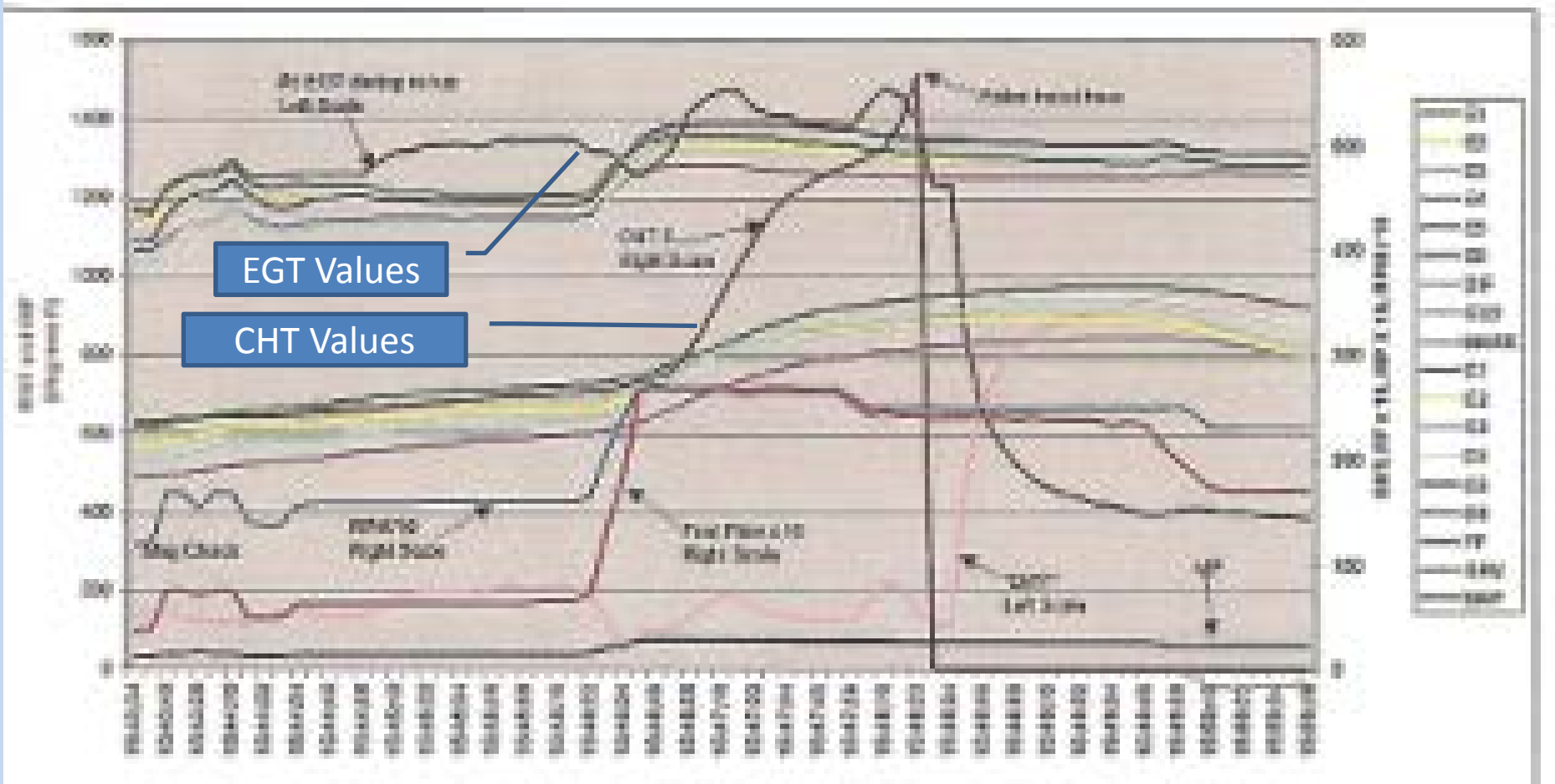
Actual Readouts from a Failed Engine



Damage to #1 From Detonation



Here is another

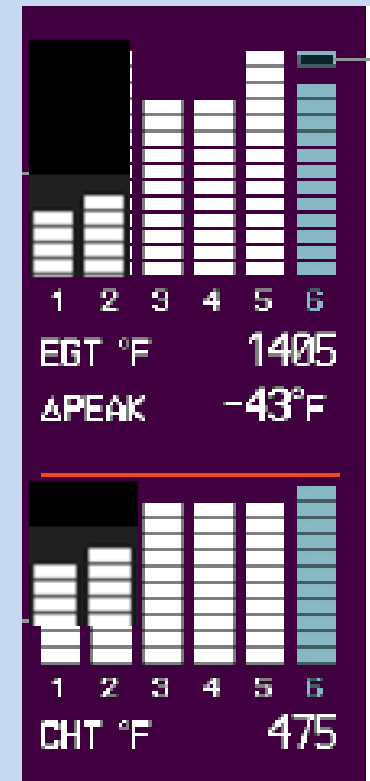


#5 Piston Head



Example 7

- Problem: Low EGT & CHT indications for #1 and #2 could be normal for this engine.
- Cause: Possibility bad intake lobe on cam.
 - Intake lobes (unlike exhaust lobes) do "double duty"
 - one lobe works intake lifters for both opposing cylinders (#1 & #2 (on opposite sides of engine) get intake-valve actuation from same cam lobe.
 - When this lobe begins to wear flat, reduced duration and lift on intake valve may show as reduced power and lower EGT, indicating an overly rich mixture. (Compression may be fine.)





G1000 Aspects

- EIS automatically reverts to The Engine page (from Lean or System) when abnormal parameters are sensed:
 - Fluctuation in engine RPM
 - Fuel quantity above certain levels