GAS TEMPERATURE INDICATOR

Exhaust gas temperature (EGT), turbine inlet temperature, (TIT), turbine gas temperature (TGT), interstage turbine temperature (ITT), and turbine outlet temperature (TOT) are all relative:

- temperatures used to monitor the temperature of the exhaust gases entering the first stage turbine inlet guide vanes

Even though these temperatures are taken at different locations on the engine:

- (each engine having one location),
- they are all relative to the temperature of the gases entering the first stage turbine inlet guide vanes.

Temperature is an:

- engine operating limit

used to :

- monitor the mechanical integrity of the turbines, as well as to check engine operating conditions

Actually, the temperature of the gases entering the first stage turbine inlet guide vanes is the:

- important consideration, since it is the most critical of all the engine variables

However, it is impractical to measure:

- turbine inlet temperature in most engines, especially large engines

Consequently, temperature thermocouples are:

- inserted at the turbine discharge,
- where the temperature provides a relative indication of that at the inlet

Although the temperature at this point is:

- much lower than at the inlet,
- it provides surveil lance over the engine's internal operating conditions.

Several thermocouples are usually:

- used, that are spaced at intervals around the perimeter of the engine exhaust duct near the turbine exit

EXHAUST GAS TEMPERATURE INDICATOR

The EGT indicator in the flight deck shows the:
- average temperature measured by the individual thermocouples

Several thermocouples are used to measure:
- EGT, TIT
- or any of the other temperature parameters mentioned.

They are spaced at intervals around the:
- perimeter of the engine turbine casing or exhaust duct

The tiny thermocouple voltages are typically:
- amplified and used to energize a servomotor that drives the indicator pointer.

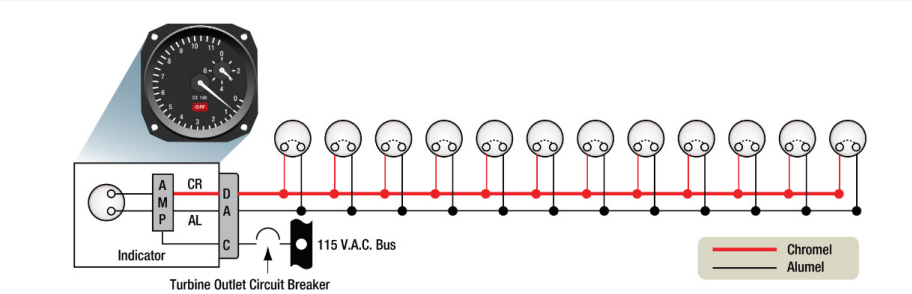

Figure 14-1. A typical exhaust gas temperature thermocouple system.

The EGT indicator shown is a:
- hermetically sealed unit

The instrument's scale ranges from:
- 0°C to 1 200°C
- with a vernier dial in the upper right hand corner
- a power off warning flag located in the lower portion of the dial

TURBINE INLET TEMPERATURE INDICATOR

A TIT indicating system provides a:
- visual indication at the instrument panel of the temperature of gases entering the turbine.

Numerous thermocouples:
- can be used with the average voltage representing the TIT

Dual thermocouples exist containing:
- two electrically independent junctions
- within a single probe

One set of these thermocouples is:
- paralleled to transmit signals to the cockpit indicator

The other set of parallel thermocouples provides:
- temperature signals to engine monitoring and control systems

Each circuit is:
- electrically independent,
- providing dual system reliability.

turbine inlet temperature system for one engine of a four engine turbine aircraft

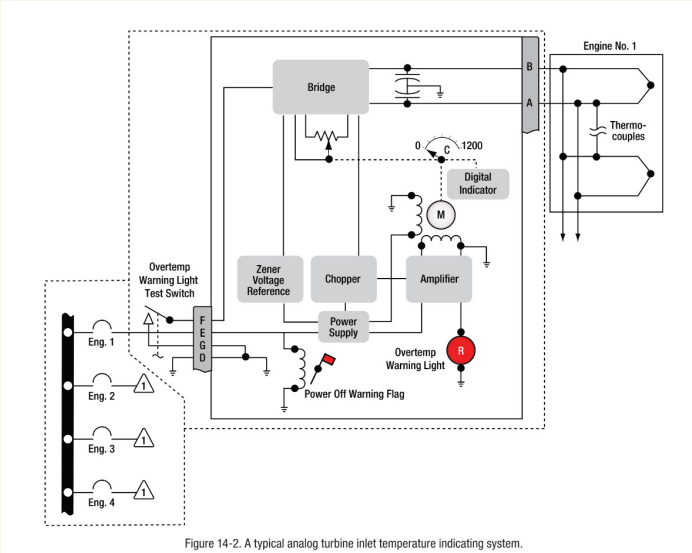

Figure 14-2. A typical analog turbine inlet temperature indicating system.

The indicator contains a:

- circuit,
- chopper circuit.
- phase motor to drive the pointer.
- feedback potentiometer.
- voltage reference circuit
- amplifier
- power off flag
- power supply
- over temperature warning light

Output of the amplifier:

- energizes the variable field of the two phase motor that positions the indicator main pointer and a digital indicator

The motor also:

- drives the feedback potentiometer

to provide a :

- humming signal to stop the drive motor when the correct pointer position
- relative to the temperature signal, has been reached

The voltage reference circuit provides a:

- closely regulated reference voltage in the bridge circuit
- to preclude error from input voltage variation to the indicator power supply.

An over temperature warning light in the indicator illuminates when:

- the TIT reaches a predetermined limit.

An external test switch is usually installed so that:

- over temperature warning lights for all the engines can be tested at the same time

When the test switch is operated:

- an over temperature signal is simulated in each indicator temperature control bridge circuit

Digital cockpit instrumentation systems need not employ:

- resistance type indicators and adjusted servo driven thermocouple gauges

to provide the pilot with:

- temperature information

Sensor resistance and voltage values are:

- input to the appropriate computer

where they are:

- adjusted.
- processed.
- monitored
- output for display on cockpit display panels

They are also sent for use by :

- other computers requiring temperature information for the control and monitoring of various integrated systems.

ENGINE PRESSURE RATIO (EPR)

The thrust of an engine is:
- limited to what the engine can safely tolerate
- yet must be adequate for the safe operation of the aircraft.

Turbine engines have a:
- pressure indicator that relates the power being developed by the engine

It is called the:
- engine pressure ratio (EPR) indicator or EPR gauge

This gauge compares the:
- engine turbine discharge pressure to the pressure of the ram air at the inlet of the engine

This is considered a measure of the:
- thrust being developed.

With adjustments for temperature:
1, altitude
2, and other factors,
3, the EPR gauge
- presents an indication of the thrust being developed by the engine

Since the EPR gauge compares two pressures:
- it is a differential pressure gauge

It is a remote sensing instrument:
- that receives its input from an engine pressure ratio transmitter

or
- in digital instrument systems displays, from a computer

The pressure ratio transmitter contains:
- compares the two pressures
- and converts the ratio into an electric signal used by the gauge for indication

EPR is used to set power for:
- takeoff on many types of aircraft

It is instrumented by:
- total pressure pickups in the engine inlet (Pt2) and in the turbine exhaust (Pt7)

OIL PRESSURE AND TEMPERATURE

1, OIL PRESSURE INDICATOR

To guard against engine failure resulting from:
- inadequate lubrication and cooling of the various engine parts

the oil supply to critical areas must be:
- monitored

The oil pressure indicator usually shows:
- the engine oil pump discharge pressure

With a differential oil pressure system a:
- direct indication is taken from the oil pressure downstream of the oil pump outlet
- and a second reading at the inlet of the oil scavenge pump.

A differential pressure system compensates for the:
- bearing chamber air pressures

High chamber air pressures will:
- reduce the oil flow through the jets

while very low chamber pressures will
- increase the oil flow through the jets

The choice of indication will vary by:
- manufacturer from one engine to another

2, OIL TEMPERATURE INDICATOR

The ability of the engine oil to lubricate and cool depends on the:
- temperature of the oil

as well as the:
- amount of oil supplied to the critical areas

An oil inlet temperature indicator frequently is provided to show the:
- temperature of the oil as it enters the oil pressure pump

Oil inlet temperature is also an indication of:
- proper operation of the engine oil cooler.

As the total oil content in a gas turbine engine circulates through the system three or four times a minute
- the position at which the oil temperature should be taken is not of great importance

Sensing is achieved using a:
- bulb

that consists of a:
- closed tube containing a spiral of nickel or platinum wire of known electrical resistance

The wire is supplied with:
- 28V DC electrical power

The resistance of the wire varies in relation to its :
- temperature

FUEL PRESSURE AND FLOW

The methods for sensing and displaying fuel pressure are similar to that:
- used for oil pressure

1, On most engines, there is a:
- low pressure sensor positioned after the outlet from the low pressure filter

Low fuel pressure can:
- originate from cavitation caused by high fuel pump demand.

2, differential pressure sensor:
- is also fitted across the fuel filter

These sensors will give warning of an :
- impending filter blockage and the risk of cavitation

Warning of low fuel pressure is displayed either as a:
- warning lamp

or
- an EICAS status message

FUEL FLOW INDICATOR

Fuel flow instruments indicate the fuel flow in:
- pounds per hour (lbs/hr) from the engine fuel control

Fuel flow in turbine aircraft is measured in:
- lbs/hr instead of gallons,

because the fuel weight is a:
- major factor in the aerodynamics of large turbine aircraft

Fuel flow is of interest in monitoring :
- fuel consumption and checking engine performance.

In most turbine aircraft installations, the fuel flow indicating system consists of a:
1, transmitter
2, indicator for each engine

The fuel flow transmitter is mounted in the:
- engine's accessory section and measures the fuel flow between the engine driven fuel pump and the fuel control device

The transmitter is an:
- electrical device that contains a turbine that turns faster as the flow increases
- which increases the electrical signal to the indicator.

The fuel flow transmitter is connected electrically to the indicator:
- located on the aircraft flight deck, or on the test cell operator's panel

There have been a number of flow meter types used

The types that are common today:
1, The synchronous mass flow
2, the motorless mass flow

1, Synchronous Mass Flow Meter

With this meter type:
- fuel passes through an impeller that is being driven at a constant RPM by an electric motor.

This creates a:
- swirling motion in the fuel that is proportional to the mass of fuel passing through the impeller.

The fuel then passes through a:
- turbine which straightens it and creates a torque force against a restraining spring.

The deflection of the turbine wheel is used to move a :
- potentiometer which provides a measurement to an indicator.

2, Motorless Mass Flow Meter

The motorless flow meter generates:
- electromagnetic pulses as a function of flow

Fuel enters the transmitter:
- which drives a rotor that incorporates a magnet fixed to its rim

A rotor shaft carries a:
- second magnet

A pick-off coil is positioned on the flow meter casing and an encircling coil is positioned with the:

- rotor drum

The fuel flow drives the:

- rotor at a speed that is proportional to the flow.

Each time the rotor magnet passes the pick-up coil its magnetic field induces a:

- pulse of current in the coil.

The frequency of the pulses denotes the RPM of the rotor which is converted into:

- digital signals for use by the flight management computer and displayed on EICAS.

ENGINE SPEED

Gas turbine engine speeds are measured by:

- engine rpm

The rpm of each rotating spool:

- (compressor section/ turbine combination) is measured

Most turbofan engines have two or more spools that turn independently at different speeds.

Tachometers are usually calibrated in percent rpm so that:

- various types of engines can be operated on the same basis of comparison

Turbine speeds are generally:

- very high and the large numbers of rpm would make it confusing