ENGINE INDICATING SYSTEMS

ENGINE PARAMETERS

PURPOSE

Engine instrumentation displayed in the cockpit (flight deck) can be categorized into two areas:

- Engine Operation;
- Engine Monitoring.

Where each specific engine instrument fits into these categories can vary, depending on engine and aircraft manufactures requirements and their recommendations in determining the order of data, or parameters, that are to be displayed. However there are common accepted standards for the layout or order of engine instruments.

The engine operation (sometimes referred as the operating or primary parameters) instruments represent engine performance.

Different engine types will display varied combinations of operating instruments; e.g. EPR, N1, EGT and N2; or e.g. N1, EGT and N2.

These instruments are essential for the flight crew to determine the power operating data of an engine.

The following example shows four instruments in this category:

The first is the thrust or engine power instrument.

The engine monitoring (sometimes referred to as the control parameters) instruments assist the crew to ensure proper control of the engine is maintained.

Common examples of these instruments are: oil pressure, temperature and quantity; fuel pressure, temperature and quantity; and nacelle temperature.

Two typical monitoring instruments are show here in Figure 2-1.

All engine instrumentation must be reliable, as they are the interface between the engine and the crew who rely on them completely to evaluate engine performance, operation and control.

They must also be accurate within the tolerances given for each instrument. An out of tolerance reading can sometimes result in a more damaging situation than no reading at all.

Engine instrumentation must be displayed instantaneously. A slow display time or a lag between the change in values of data or parameters, and the reading displayed in the cockpit can have serious consequences.
**Example:** When the pilot is monitoring a rising EGT (exhaust gas temperature), a lag in the reading could be interpreted that the maximum EGT has not been reached, whereby in reality, the engine is already overheating.

**POSITION**

Engine instrumentation is always in the center of the instrument panel, or if is slightly off center, favoring the Captains side. This enables reading for both the Pilot in Command and the First Officer (FO). *(Figure 2-2)*

Engine operating instrumentation is shown at the top of the panel, with the engine monitoring instrumentation below.

Thrust is the most important operating instrument; so the EPR or N1 indicator is found at the very top. This standard layout position always applies, no matter what type of indicator is used, whether an old dial and pointer display, or new electronic display (Cathode Ray Tube - CRT and Liquid Crystal Display - LCD). *(Figure 2-3)*

**Note:** Certain aircraft having an Electronic Flight Information System (EFIS or EIS), have a “backup” display for engine operating instruments on an additional indicator (standby indicator). An example is the Boeing 767.

Aircraft having a Flight Engineer (FE) station, have repetition of all engine monitoring instruments and some operating instruments on the FE instrument panel. These are direct duplication of respective instruments situated on the main cockpit instrument panel.

**DESCRIPTION**

Engine instrumentation data can be displayed on analog or digital indicators.

The displays can have pointers or numerical characters; some instruments have a mixture, or combination, of both.

An analog indicator (gauge) has a pointer, or needle, which moves to indicate a value, graduated around the edge of the dial.

Numerical displays use a dial indicator; small drums, graduated from 0 to 9 around their edges turn on themselves to form a legible number in one window of the dial. The same analog signals which drives the needle or the pointer of an analog gauge indicator, also drives the numerical display drums of a dial indicator.

Analog and numerical displays can also be produced using electronic indicators – the displayed data being produced by digital circuits rather than conventional mechanical means. *(Figure 2-4)*

These electronic indicators, used for instrumentation, can be either Cathode Ray Tubes (CRT) or Liquid Crystal Displays (LCD).

Electronic instrumentation is widely used on modern aircraft, being more reliable and accurate than the conventional mechanical gauges. The electronic indicators receive video signals and can replace several
conventional indicators with a single instrument. However, electronic displays require air cooling, which is not necessary for conventional instruments.

Some engine instrumentation indicators can have colored zones. These specific zones allow the pilot to determine the state of the engine parameter, or data, at a glance. These colored zones can be found on both conventional analog indicators and modern electronic indicators, where data is displayed in an analog form. *(Figure 2-5)*

**Example:**
- The needle in the green zone means that the value of this parameter is in the normal range.
- The needle in the yellow zone means that the value of this parameter is in a range which requires careful monitoring by the crew.
- The needle in the red zone means that the value of this parameter has reached an unacceptable range, which is very irregular or hazardous, and requires immediate action by the crew.

### OPERATION

**OPERATING PARAMETERS**

**Engine Thrust Indication**

EPR (Engine Pressure Ratio). This parameter is the ratio of the total pressure in the engine air intake to the total pressure at the turbine outlet. Two sensors are used to detect the two respective pressures; this data is fed to a device for computation of the pressure ratio and fed to the EPR instrument. Pt is the designated “point” the inlet and outlet pressures are taken. An engine may have e.g., Pt7 and Pt2 as the pressure detect points. *(Figure 2-6)*

Examples of engines that use EPR instruments to indicate thrust are: P&W and RR turbojet engines.

N1 is the symbol for the rotation speed of the low pressure compressor turbine.

Examples of engines using N1 are GE and CFM turbojets to indicate thrust.

On a double flow turbojet, the N1 reading represents, as a percentage, the RPM of the fan. A speed sensor sends a signal to the parameter display system.

**Comparison of EPR and N1**

EPR is generally accepted to be the better indication of thrust in terms of accuracy, however it has small delay times, and is dependent on prevailing temperature. Also the pressure probes can be prone to damage and contamination.

N1 has relatively better response and thus is a more reliable and stable indication of thrust.

**EGT (Exhaust Gas Temperature)**

EGT represents the turbine temperature. This is a very important parameter, alerting the crew when
the temperature approaches the limits of mechanical integrity for the turbine and the combustion chamber.

Several temperature sensors are used, called thermocouples, usually made of chrome/nickel and nickel/aluminum, commonly trade named chromel and alumel, respectively; known as “K” Type thermocouples.

Thermocouples are located around the edge of the outlet pipe, close to the turbine outlet. These sensors, together with their interconnection leads, are of a specific high tolerance resistance.

The thermocouples and connecting wiring is usually made up of one assembled harness for ease of installation and reliability.

Average EGT indications of jet engines are determined by such factors as: operating conditions; the condition of the engine; type of engine (high or low bypass); and materials used.

The hot and cold junction principle of dissimilar metals producing a voltage, that is proportional to the temperature at the hot junction, is displayed on the EGT indicator, graduated in degrees Celsius.

Several temperature sensors, thermocouples generally made of chrome/nickel and nickel/aluminum, are located around the edge of the outlet pipe, close to the turbine outlet. These sensors transmit an average temperature to the EGT indicator on the instrument panel, graduated in degrees Celsius.

**N2**

N2, the rotational speed of the high pressure compressor rotor, is used by the pilot to check engine performance. N2 is expressed as a percentage of the nominal rpm. The transmitter is usually a tachometer generator driven by the accessory gearbox.

**Flowmeter (FF: Fuel Flow)**

This instrument provides the crew with important information on the performance and efficiency of the engine. It displays the instantaneous fuel flow rate (consumption) in kilo per hour (kph) or in pound per hour (pph). A fuel flow transmitter, usually located after the HP valve, measures the fuel flow rate and sends it to the indicator. This same information is used by the total fuel consumption indicator (Fuel Used Indicator)

**MONITORING PARAMETERS**

**LUBRICATION SYSTEM**

This system is very important to the operation of the turbojet (powerplant).

Certain parameters must be available on the instrument panel for close monitoring by the crew. *(Figure 2-7)*

![Fuel System Indication](Image)

**Lubrification System**
- Quantity
- Pressure
- Temperature

![Alarmes](Image)

- Oil filter clog
- Fuel filter clog

![Vibration Indication System](Image)

Figure 2-7. Nacelle Temperature indicator.