

TFE / ATF / TPE Reliability Reporting Definitions

1.0 Engine Systems Definitions:

1.1 Component

Any self-contained part, combinations of parts, subassemblies, or units which perform a distinctive function in the operation of the engine system.

1.2 Control and Accessory (C&A) Component

Any component which constitutes the fuel, oil, electrical, or pneumatic subsystems or the associated linkages and riggings of an engine system.

1.3 Line Replacement Unit (LRU)

A C&A component which can be readily changed on an aircraft during line maintenance operations.

1.4 Engine Section

A combination of components which perform one or more distinctive functions in the operation of the engine system.

1.5 TPE331 Engine Core

The engine core for the TPE331 turboprop engine series is defined as the combination of components comprising the compressor, combustion, turbine sections, and 'not otherwise classified' (NOC) power section components (i.e., main shaft, torsion shaft, aft curvic coupling, etc.).

1.6 TFE731 Engine Core

The engine core for the TFE731 turbofan engine series is defined as the combination of components comprising the low-pressure (LP) and high-pressure (HP) compressor sections.

1.7 ATF3 Engine Core

The engine core for the ATF3 turbofan engine series is defined as the combination of components comprising the low pressure (LP) compressor, crossover duct/number 3 sump, fan turbine and low-pressure (LP) turbine sections.

1.8 Basic Engine (TFE & ATF)

Those units and components which are used to convert fuel/air mixture into thrust/power; to transmit power to the fan and accessory drives; and to supplement the function of other defined systems external to the engine. Control and accessory line replacement units (LRU's) are excluded.

1.9 Engine System

The basic engine assembly plus its control and accessory components, including LRU's, as supplied by the engine manufacturer.

2.0 Engine Operating Definitions**2.1 Operating Engine Cycle**

As defined in the Engine Service Life service bulletins for each model series.

2.2 Operating Engine Hours

The engine operating hours accrued anytime the engine is operated in flight (liftoff to touchdown).

2.3 Engine Utilization Rate

The number of hours or cycles expended for one in -service engine or a fleet of engines during a stated interval of calendar time.

2.4 Cycles Since New (CSN)

Cycles since new are the total operating cycles accrued since Production Assembly.

2.5 Cycles Since Overhaul (CSO)

Cycles since overhaul are the total operating cycles accrued since last overhaul of engine.

2.6 Cycles Since Core (CSC)

Cycles since core are the total operating cycles accrued since Core Zone Inspection.

2.7 Cycles Since Repair (CSR)

Cycles since repair are the total operating cycles accrued since last repair/maintenance action requiring entry into the basic engine.

2.8 Time Since New (TSN)

Time since new is the total operating hours accrued since Production Assembly.

2.9 Time Since Overhaul (TSO)

Time since overhaul is the total operating hours accrued since last overhaul of engine.

2.10 Time Since Core (TSC)

Time since core is the total operating hours accrued since last Core Zone Inspection.

2.11 Time Since Repair (TSR)

Time since repair is the total operating hours accrued since last repair/maintenance action requiring entry into the basic engine.

3.0 Malfunction Definitions**3.1 Failure**

The inability of a component to perform its intended function or to satisfy acceptance criteria, as defined in the engine maintenance manuals or service bulletins, when operated within specified limits.

3.2 Primary Failure

Failure of a component which causes engine operations symptoms, and is the principal reason for an unscheduled maintenance action. There can be, at most, one primary failure per maintenance action. Failures resulting from maintenance errors, operational error, foreign object damage, handling damage, or secondary failures are not considered primary failures.

3.3 Subsidiary Failure

Failure of a component which does not cause operational symptoms and is not the principal reason for an unscheduled maintenance action. Includes failures detected at scheduled maintenance actions and during inspections for other causes. Failures resulting from maintenance errors, operator errors, environmental hazards, handling damage, or secondary failures are not considered as subsidiary failures.

3.4 Secondary Failure

Failure of a component which is caused by the primary or subsidiary failure of another component.

3.5 Handling Damage

Removal of a component due to damage resulting from maintenance errors, assembly errors, operator errors, and transportation damage. Includes removals due to operation of the engine beyond defined specifications and operating conditions, time cycle limitations, or with fuels or lubricants not conforming to the applicable specifications.

3.6 Foreign Object Damage (FOD)

Removal of a component due to damage resulting from lightning/bird/prop strikes, foreign object ingestion, weather, or similar hazards present in the engine operating environment.

3.7 Cumulative Performance Deterioration (EPD)

Engine performance below a specified minimum resulting from simultaneous deterioration of more than one component, none of which alone would cause performance to be below the specified minimum. Excluded are the events classified as handling or foreign object damage, primary, subsidiary, or secondary failures.

3.8 System Malfunction, Lube (SYM)

Engine malfunctions specific to oil system malfunctions related to oil pressure fluctuations and the malfunction is identified as a result of a clogged oil filter, clogged oil regulator, or a non-working oil delta-P switch (specific to the TFE731-20/40/60 engines). SYM should also be used for any lube system problems where a primary failure cannot be identified.

3.8A System Malfunction, Controls (SYC)

Chargeable event where it is unclear which component in the engine control system is the primary failure. Often, multiple parts are removed during troubleshooting in the hope that the problem component is replaced. As it is usually difficult to track each removed item through the findings process, the engine finding code should be used in place of UTD. SYC should also be used for uncommanded acceleration events where the primary failure cannot be determined.

3.8B System Malfunction, Fuel (SYF)

Chargeable event where the problem is known to be related to the fuel system, but the primary failure is unclear. An example would be where both the fuel control and the fuel pump are removed during troubleshooting but it is uncertain which component caused the symptoms reported.

3.8C System Malfunction, Engine Flameout (SYO)

Chargeable event where an IFSD is caused by an engine flame-out due to LBO but attributing the primary failure to the DEEC or fuel control system is unclear.

3.9 Auto-Ignition Malfunction (ATO)

Engine experiences lean blowout on the ground (either at startup or auto-ignition test) or during flight due to a reduction in power lever angle which produces a reduction in fuel flow.

3.10 Non-Synchronous Vibration (NSV)

A noise or vibration frequency which is not synchronous (does not change) with any speed change of the rotating components within the engine.

3.11 Mean Time Between Failures (MTBF)

A reliability figure calculated by dividing the total component operating hours accrued in a period by the number of component primary failures that occurred during the same period.

$$\text{MTBF} = \frac{\text{total component operating hours in a period}}{\text{number of primary failures in the same period}}$$

3.12 Failure Rate

A reliability figure calculated by dividing the number of component primary failures by the total component operating hours accrued during the same period. Failure rate is the reciprocal of MTBF, and is expressed in ‘failures per 1000 engine operating hours’ (TPE) or ‘failures per 100,000 engine operating hours’ (TFE/ATF).

$$\text{Failure Rate} = \frac{1}{\text{MTBF}} \times 1000 \text{ or } 100,000$$

Unscheduled Component Removal

All removals other than those defined as scheduled below are considered unscheduled. Scheduled component removals are those removals due to reaching life limit, overhaul limit, or service bulletin compliance. In addition, for TPE331 only, parts removed during scheduled engine overhaul are considered scheduled engine component removals.

3.13 Mean Time Between Unscheduled Component Removals (MTBUCR)

A reliability figure calculated by dividing the total component operating hours accrued in a period by the number of unscheduled component removals that occurred during the same period.

NOTE: THIS APPLIES TO INDIVIDUAL COMPONENTS ONLY AND IS NOT USED TO COMPUTE ENGINE REMOVAL RELIABILITY

$$\text{MTBUCR} = \frac{\text{total component operating hours in a period}}{\text{number of unscheduled component removals}}$$

number of unscheduled component removals in the same period

3.14 **Unscheduled Component Removal Rate (UCRR)**

A reliability figure calculated by dividing the number of unscheduled component removals by the total component operating hours accrued during the same period. Unscheduled component removal rate is the reciprocal of MTBUCR, and is usually expressed in ‘removals per **1000** component operating hours’ (**TPE**) or ‘removals per **100,000** component operating hours’ (**TFE/ATF**).

$$\text{UCRR} = \frac{1}{\text{MTBUCR}} \cdot \text{x } 1000 \text{ or } 100,000$$

4.0 **Engine Shutdown Definitions**

4.1 **Uncommanded Ground Shutdown**

An uncommanded engine system shutdown which occurs at any time the aircraft is not airborne (wheels on the ground)

4.2 **In-Flight Shutdown (IFSD)**

An engine system shutdown which occurs at any time the aircraft is airborne (wheels off the ground)

4.3 **Commanded IFSD**

Any IFSD initiated by pilot intervention. Includes shutdowns within and outside of the flight manual recommendations and precautionary shutdowns.

4.4 **Uncommanded IFSD**

Any IFSD which is not commanded

4.5 **Chargeable IFSD**

Any IFSD occurrence, commanded or uncommanded, associated with a primary failure

4.6 **Mean Time Between In-Flight Shutdowns (MTBIFSD)**

A reliability figure calculated by dividing the total engine system operating hours accrued in a period by the number of chargeable in-flight shutdowns that occurred during the same period.

$$\text{MTBIFSD} = \frac{\text{total engine system operating hours in a period}}{\text{number of chargeable in-flight shutdowns}}$$

number of chargeable IFSD events in the same period

4.7 In-Flight Shutdown Rate

A reliability figure calculated by dividing the chargeable number of in-flight shutdowns by the total engine system operating hours accrued during the same period. In-flight shutdown rate is the reciprocal of MTBIFSD and is expressed as 'IFSD occurrences per 1000 engine operating hours' (TPE) or 'IFSD occurrences per 100,000 engine operating hours' (TFE/ATF).

$$\text{IFSD Rate} = \frac{1}{\text{MTBIFSD}} \times 1000 \text{ or } 100,000$$

5.0 Maintenance Definitions

5.1 Scheduled Maintenance

Planned maintenance performed at defined intervals to retain a components(s) in a serviceable condition.

5.2 Unscheduled Maintenance

Any maintenance that is not scheduled.

5.3 Scheduled Engine Removal

An engine removal is classified as scheduled if the engine was removed for scheduled maintenance.

5.4 Unscheduled engine Removal (UER)

Any engine removal not classified as scheduled.

5.5 *Chargeable* Unscheduled Engine Removal (TFE/ATF ONLY)

An unscheduled engine removal is considered chargeable if:

- a) There is a primary failure; and engine removal is required* to access the failed component, or engine removal is required to access secondary failures resulting from the primary failure, or

b) The engine removal is due to cumulative engine performance deterioration, investigation in progress, unable to determine, quality related, facility reporting insufficient, system malfunction, non-synchronous vibration, or auto-ignition system.

Unscheduled Engine Removal (TPE)

a) There is a primary failure of an engine system component, or engine removal is due to cumulative engine performance deterioration, investigation in progress or unable to determine

* To determine chargeable **engine** removal requirements, the following components/engine sections are determined by the project engineering group (TPE, TFE & ATF) to have on-the-wing accessibility and deemed non-chargeable UER's. **Removal of these components/engine sections do not incur a chargeable UER and are so flagged in the database. The removal of any other components/engine sections may or may not incur a chargeable UER. Each of these components/engine sections are flagged appropriately in the data base to indicate engine removal requirements.**

Note: TPE331 fleet does not produce a reliability report for 'chargeable unscheduled engine removal' but the feature of engine removal requirement flag attached to each component exists for historical data retrieval purposes:

TFE731 Engines:

Fan, fan support housing, fan gearbox, accessory and transfer gearbox, and LRU's. (There may be modular components noted for individual fleets)

ATF3 Engines:

Fan, all components in the number 1 and 2 sumps (except for the number 2 sump housing) and LRU's.

TPE331 Pre-Century through TPE331-15 Engines:

Nose cone, diaphragm, all components in the gearbox (except the housing) and LRU's.

5.6 Mean Time Between Unscheduled Engine Removals (MTBUER) - TPE Fleet Only

A reliability figure calculated by dividing the total engine system operating hours accrued in a period by the number of unscheduled engine removals that occurred during the same period.

$$\text{MTBUER} = \frac{\text{total engine system operating hours in a period}}{\text{number of unscheduled engine removals in same period}}$$

5.7 Mean Time Between Unscheduled Chargeable Engine Removals (MTBCUER) - TFE/ATF Fleet Only

A reliability figure calculated by dividing the total engine system operating hours accrued in a period by the number of **chargeable** unscheduled engine removals that occurred during the same period. (Described in 5.5)

$$\text{MTBCUER} = \frac{\text{total engine system operating hours in a period}}{\text{number of chargeable unscheduled engine removals in same period}}$$

5.8 Unscheduled Engine Removal Rate (UERR) or Chargeable Unscheduled Engine Removal Rate CUERR)

A reliability figure calculated by dividing the number of unscheduled engine removals (chargeable unscheduled engine removals if CUERR is being calculated) by the total engine operating hours accrued during the same period. UERR (CUERR) is the reciprocal of MTBUER (MTBCUER) and is expressed as ‘unscheduled engine removals per **1000** engine hours’ (**TPE**) or ‘chargeable unscheduled engine removals per **100,000** engine hours’ (**TFE/ATF**).

$$\text{UERR or CUERR} = \frac{1}{\text{MTBUER or MTBCUER}} \cdot \text{x 1000 or 100,000}$$

5.9 TFE731 Unscheduled Core Entry at Scheduled Major Periodic Inspection (MPI)

An engine in for schedule MPI, with less than 4200 hour (1200 hour military applications) since last compressor zone inspection (CZI) that requires a core entry. If an engine is entered earlier for customer scheduling convenience, the event is not classified as unscheduled.

5.10 TFE731 Unscheduled Core Entry Rate at Schedule MPI (UCER)

A reliability figure calculated by dividing the chargeable number of unscheduled core entries at scheduled MPIs in a given period.

$$\text{UCER} = \frac{\text{number of chargeable core entries at scheduled MPIs in a period}}{\text{total number of scheduled MPIs in the same period}}$$