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Guidance and Responsibilities

**AIR FORCE ENGINE TRENDING AND
DIAGNOSTICS PROGRAM**

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This instruction implements AFPD 21-1, Managing Aerospace Equipment Maintenance, for those engines covered in AFI 21-104, Selective Management of Selected Gas Turbine Engines and identified by Technical Order (TO) 00-25-254-1. It provides guidance and assigns responsibility for managing the Air Force Engine Trending and Diagnostics Program (ET&D). Technical Order 00-25-257 outlines the technical aspects of ET&D. Related policies include AFI 21-124, Oil Analysis Program. Major Commands (MAJCOMs) must coordinate any supplementing Command instructions with HQ USAF/ILM prior to publication. HQ USAF/ILM must approve any deviations from this instruction. This instruction applies to all Air Force and DOD contractor activities, including the Air National Guard and the Air Force Reserve.

1. Program Objectives.

1.1. Effective use of Engine Trending and Diagnostics (ET&D) can reduce engine flight safety risk, improve reliability, and significantly reduce life cycle costs. More specifically, ET&D is a logistics management process whose purpose is to:

1.1.1. Eliminate catastrophic engine failures by the prediction and detection of adverse trends towards known failure modes before they occur. This allows for pre-emptive corrective maintenance.

1.1.2. Reduce Engines Not Maintenance Capable Supply (ENMCS) rates and maintenance man-hours by forecasting time and material requirements days or weeks in advance.

1.1.3. Reduce average shop flow days and maintain a higher number of serviceable spare engines by preventing catastrophic failures, thereby minimizing the level of repairs.

1.1.4. Improve life measurement of critical components to reduce life cycle costs and improve reliability.

1.1.5. Increase mean time between engine removals by eliminating time-based removals within the limits of critical component life policy.

1.2. The primary goal of the ET&D program is to prevent or limit damage to turbine engines by prediction or early detection of performance degradation and/or failures. This is done by monitoring engine operating parameters, engine wear metal analysis, visual inspections, and comparison with other engine maintenance records data.

1.3. An equally important goal is to minimize the ET&D deployment footprint by standardizing ET&D hardware, software, test instrumentation, techniques and procedures, and consolidating base level tasks.

1.4. Secondary goals include achieving 100% on-board automated data collection and analysis with 100% accuracy of detection and prediction.

2. Program Guidance.

2.1. ET&D helps organizational and intermediate level technicians make informed preventive maintenance decisions based on engine operating conditions. The base level ET&D program should be designed to determine if maintenance needs to be performed before the next flight and/or before the scheduled engine removal.

2.2. ET&D includes maintenance activities performed by propulsion and Non Destructive Inspection (NDI) technicians to monitor and predict engine health, performance and structural integrity. Analysis tools include gas path analysis, variable geometry, operating parameters, test cell runs, vibration analysis, wear metal analysis, borescope analysis, oil analysis program, and maintenance records analysis.

2.3. Propulsion product management must develop and provide accurate limits for each engine type and provide this data promptly to all levels of engine management. These limits will provide the basis for interpreting and understanding the ET&D data.

2.4. Engine trending and diagnostics data can be taken manually or automatically. However, ET&D participants should maximize the use of automatic equipment and systems to increase the accuracy and timeliness of data and to facilitate the exchange of data and knowledge across the ET&D program.

3. HQ USAF Responsibilities. The Directorate of Maintenance (AF/ILM) will:

3.1. Provide Air Force ET&D policy.

3.2. Coordinate Air Force ET&D requirements within the Air Staff.

3.3. Ensure changes to maintenance policies affecting ET&D are coordinated with the Propulsion Product Group Manager (PPGM) and MAJCOMs.

4. Air Force Materiel Command (AFMC) Responsibilities.

4.1. Propulsion Product Group Manager (PPGM).

4.1.1. Responsible for recommending policy to AF/ILM and implementation of ET&D.

4.1.2. Provides ET&D software tools to the Air Force.

- 4.1.3. Co-chairs the Air Force ET&D steering group.
 - 4.1.4. Ensures coordination of ET&D policy and guidance with HQ USAF/ILM, MAJCOMs, and other agencies as necessary.
 - 4.1.5. Ensures AFMC personnel are trained in ET&D objectives, policies, procedures and practices.
 - 4.1.6. Ensures ET&D future development requirements are stated.
 - 4.1.7. Works with AFRL to assess existing/potential ET&D technologies.
 - 4.1.8. Works with the Air Force Safety Agency to ensure ET&D analysis is integrated into mishap analysis and corresponding recommendations are assessed and incorporated into appropriate policy and guidance.
 - 4.1.9. Establishes and manages a computer based data system to evaluate Air Force ET&D participation and effectiveness, and provide engine program offices with historical data on ET&D analysis results.
- 4.2. Air Logistics Center Propulsion Directors.
- 4.2.1. Provide an equipment specialist and engineer for ET&D issues on each engine.
 - 4.2.2. Provide engine specific technical orders and updates.
 - 4.2.3. Provide membership to the ET&D steering group.
 - 4.2.4. Provide participation in major ET&D conferences, meetings, and committees to identify and discuss operational issues and policies.
 - 4.2.5. Ensure assigned personnel are trained and have established procedures to review ET&D limits and diagnostics.
 - 4.2.6. Establish and maintain diagnostic criteria based on a periodic review of data from equipment tear down and overhaul findings.
 - 4.2.7. Support Component Improvement Program, Research, Development, Test and Evaluation (RDT&E) to improve current ET&D processes and techniques.
 - 4.2.8. Support Maintenance Planning Working Group (MPWG) requests for performance improvements to ET&D algorithms, software, hardware, technical data, metrics, logistics supportability, fleet trend analysis, diagnostics procedures, performance limits, and error reduction.
 - 4.2.9. Support engine life management plans with ET&D descriptions, potential upgrade information, and funding requirements of the ET&D program and future upgrades.
- 4.3. Automatic Test Systems PGM.
- 4.3.1. Provide a program manager, equipment specialist, and engineer for ET&D support equipment program issues.
 - 4.3.2. Provide ET&D support equipment technical orders and updates.
 - 4.3.3. Ensure there is adequate interface control between ET&D programs and applicable support equipment programs.

- 4.3.4. Provide membership to the ET&D steering group and the Propulsion Support Equipment Advisory Group (PSEAG).
- 4.3.5. Provide participation in major ET&D conferences, meetings and committees to identify and discuss operational issues and policies.
- 4.3.6. Ensure assigned personnel are trained and understand ET&D objectives.
- 4.3.7. Support RDT&E to improve current ET&D support equipment processes and hardware.
- 4.3.8. Support MPWG requests for performance improvements to ET&D support equipment hardware, technical data, test cells, logistics supportability, performance, and error reduction.

4.4. Air Force Research Laboratory.

- 4.4.1. Participate in major ET&D conferences, meetings, and committees to identify and discuss ET&D and RDT&E technologies, policy, issues and practices.
- 4.4.2. Accomplish RDT&E of ET&D technologies.
- 4.4.3. Evaluate cost effectiveness of developing ET&D technologies.
- 4.4.4. Establish proof of concept test programs where needed.
- 4.4.5. Develop ET&D technology and methods for a proof of concept engine validation test.
- 4.4.6. Act as the focal point for all ET&D and RDT&E activities, and coordinate RDT&E activities with the PPGM and the MAJCOMs.

4.5. Headquarters Air Force Materiel Command, Directorate of Engineering and Technical Management.

- 4.5.1. Establish an OPR for command-wide policy and procedures for execution of the ET&D program.
- 4.5.2. Ensure ET&D policy and procedures are implemented in a timely manner as an integral part of the total life-cycle aircraft weapon system engineering process.

5. Air Education and Training Command (AETC) Responsibilities. Provide initial and follow-on training. AETC coordinates course material changes with the MAJCOM OPRs and the PPGM.

5.1. Appoint lead-training group and Training Manager. Responsibilities will include:

- 5.1.1. Participate in Training Planning Team (TPT), ET&D steering group, and related product teams.
- 5.1.2. Define specific training requirements by instructional system development analysis according to AFI 36-2201 and AF Handbook 36-2235 volumes 1 through 11.
- 5.1.3. Develop training to compliment maintenance management concepts, policies and proficiency requirements of MAJCOMs.
- 5.1.4. Provide formal training on selected engine TMS through Field Training Detachments, mobile training teams, or technical schools.
 - 5.1.4.1. Training will supplement other forms of training available through on the job training (OJT), Air Force Engineering Technical Service (AFETS) or Contract Engineering Technical

Service (CETS) Type 1 courses.

6. MAJCOM Responsibilities.

- 6.1. Establish a headquarters OPR for ET&D responsibilities.
- 6.2. Participate in major ET&D conferences, meetings, and committees to identify and discuss relevant ET&D issues and policies.
- 6.3. Supplement this AFI with Command Instructions as necessary to achieve objectives of the program and to provide guidance necessary to execute the ET&D program and ensure that subordinate organizations understand and properly execute their ET&D responsibilities.
- 6.4. Identify specific requirements to assist ET&D programs through available technology channels and processes.
- 6.5. Ensure Units operating ET&D programs have sufficient manning positions and appoint qualified, experienced persons as ET&D Program Managers at each operating base.
- 6.6. Ensure owning units submit accurate and timely quality deficiency reports to applicable engine program offices on equipment requiring any maintenance activity due to an ET&D recommendation, and on ET&D component failures where no ET&D maintenance was performed.
- 6.7. Ensure the timely gathering, reduction, and interpretation of ET&D data.
- 6.8. Ensure the timely repair of ET&D on board equipment (data recorders, sensors, etc.).
- 6.9. Ensure technicians attend training.
- 6.10. Ensure ET&D-assigned computers are not modified or used for non-ET&D applications without MAJCOM OPR approval.
- 6.11. Ensure applicable programming documents (budget, facilities, manpower, maintenance, etc.) include the need for Air Force ET&D support.

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Attachment 1**GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION*****References***

AFPD 21-1, *Managing Aerospace Equipment Maintenance*

AFI 21-104, *Selective Management of Selected Gas Turbine Engines*

TO 00-25-254-1, *Comprehensive Engine Management System Engine Configuration, Status and TCTO Reporting Procedures*

TO 00-25-257, *Engine Trending and Diagnostics System*

AFI 21-124, *Oil Analysis Program*

Abbreviations and Acronyms

AETC—Air Education and Training Command

AFETS—Air Force Engineering Technical Service

AFI—Air Force Instruction

AFMC—Air Force Material Command

AFPD—Air Force Publication Directive

CETS—Contract Engineering Technical Service

ENMCS—Engines Not Maintenance Capable Supply

ET&D—Engine Trending and Diagnostics

MAJCOM—Major Commands

MPWG—Maintenance Planning Working group

NDI—Non Destructive Inspection

OJT—On the Job Training

PPGM—Propulsion Product Group Manager

PSEAG—Propulsion Support Equipment Advisory Group

RDT&E—Research, Development, Test and Evaluation

TO—Technical Order

TPT—Training Planning Team

Terms

ET&D Steering Group— A team chartered by Air Staff to facilitate development and implementation of ET&D objectives, policies, training and practices. The steering group is co-chaired by the Propulsion PGM, HQ AMC, and HQ ACC and has membership from Air Staff, every operating command, the

depots, and AFRL.

ET&D support equipment— ET&D support equipment includes engine data collection hardware (onboard the aircraft) and software, data download hardware and software, data cables, and peripheral analysis hardware and software such as that used in test cells, automatic borescopes, and the AF Oil Analysis Program.

MPWG— Maintenance Planning Working Group is composed of users, MAJCOM, original equipment manufacturer, and depot personnel to resolve maintenance issues.

Oil Analysis— The process of analyzing wear metals found in oil and other fluids used to lubricate or operate mechanical equipment, evaluating the condition of the fluid or the equipment from which the fluid originated, and recommending maintenance actions to the equipment operating activity.

Performance trending— Predict and detect adverse trends before problems occur.

PSEAG— Propulsion Support Equipment Advisory Group is a team chartered by Air Staff to facilitate development and implementation of support equipment objectives, policies, training and practices. It is composed of MAJCOM and depot specialists in propulsion support equipment. The PSEAG is chaired by the Propulsion PGM and reports to the Engine Advisory Group. The scope of the PSEAG includes, but is not limited to, ET&D equipment