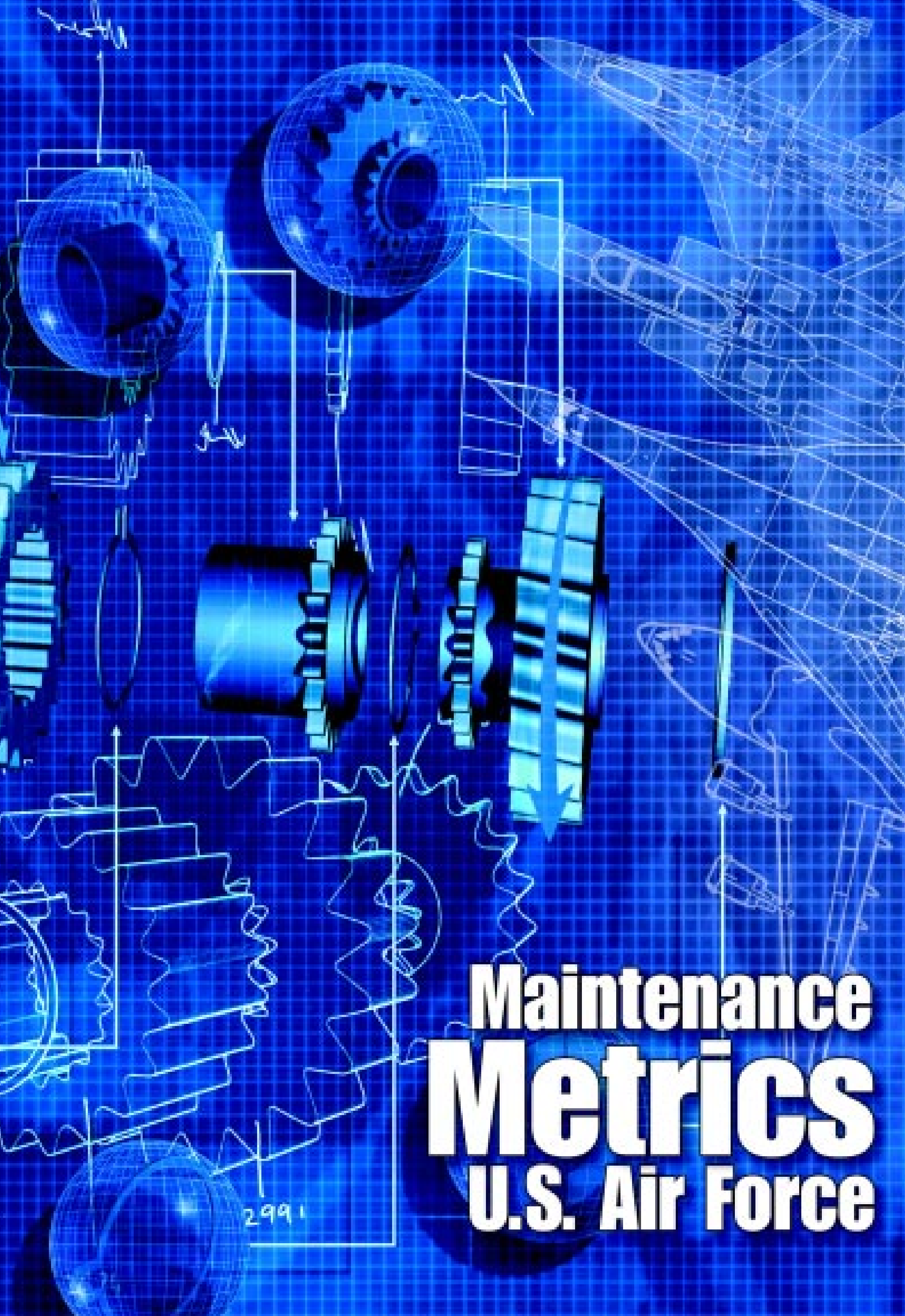

Maintenance Metrics U.S. Air Force

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The Editors, *Air Force Journal of Logistics*

James C. Rainey, Editor-in-Chief
Senior Master Sergeant Robert McGonagle, Associate Editor
Beth F. Scott, Editor
Lieutenant Colonel Gail Waller, Contributing Editor

Graphics and Layout

James C. Rainey
Beth F. Scott
Senior Master Sergeant Robert McGonagle
Lieutenant Colonel Mark R. McConnell
Chief Master Sergeant John G. Drew

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Air Force Logistics Management Agency
501 Ward Street
Maxwell AFB, Gunter Annex, Alabama 36114-3236
DSN: 596-4087/4088
Commercial: (334) 416-4087/4088
FAX: (334) 416-5890

Foreword

Aircraft maintenance metrics are important. Don't let anyone tell you differently! They are critical tools to be used by maintenance managers to gauge an organization's effectiveness and efficiency. In fact, they are roadmaps that let you determine where you've been, where you're going, and how (or if) you're going to get there. Use of metrics allows you to flick off your *organizational autopilot* and actually guide your unit. But they must be used correctly to be effective. Chasing metrics for metrics' sake is a bad thing and really proves nothing. A good maintenance manager will not strive to improve a metric but will use them to improve the performance of the organization. The intent of this handbook is to help reacquaint or introduce managers at all levels to these necessary tools of trade. I encourage each of you to read this handbook and keep it close at hand for future reference. Discuss the importance of metrics with others in the maintenance community. Today's Air Force has the best people, parts, and equipment in the world. My hope is that this handbook will help you capitalize on these strengths. As a maintenance leader, your task is to provide *good iron* to the operators when needed. It is your responsibility. Understanding metrics and their use in effectively and efficiently managing aircraft maintenance is key to your ability to uphold that responsibility. Good luck.

Terry L. Gabreski, Brigadier General, USAF
Director of Logistics
Air Force Materiel Command

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Introduction

The purpose of this handbook is to provide maintenance leaders at both the wing and major command (MAJCOM) level with a comprehensive guide to metrics associated with maintenance management.

This handbook is an encyclopedia of metrics and includes an overview to metrics, a brief description of things to consider when analyzing fleet statistics, an explanation of data that can be used to perform analysis, a detailed description of each metric, a formula to calculate the metric, and an explanation of the metric's importance and relationship to other metrics. The handbook also identifies which metrics are leading indicators (predictive) and which are lagging indicators (historical). It is also a guide for data investigation.

MAJCOM formulas may deviate slightly. For exact formulas, check with the MAJCOM logistics analysis division.

However, a word of caution is in order at this point. Overemphasis of a particular metric while ignoring the root cause of a problem may well lead to an improvement in the metric but worsening of the problem. Metrics are indicators and, as such, should be viewed in aggregate. The relationship between two metrics may be so intertwined as to make it impossible for the maintenance manager to separate the cause from the effect. Generally, metrics should be used to identify trends and not as pass or fail indicators. Individually, they are snapshots in time, and even the best organizations will occasionally dip below standards. Good metrics analysis, however, will focus the maintenance manager's attention on those areas where improvements can be realized.

MAJCOM formulas may deviate slightly. For exact formulas, check with the MAJCOM logistics analysis division.

Chapter 1
Maintenance Metrics Basics

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Metrics are nothing more than a barometer for *pain*. As leaders, our responsibility is to know where the *pain* is in order to alleviate it. Understanding the unit's maintenance metrics is only the first part of learning to manage the *pain*. Metrics are not just charts and numbers to be looked at. They are tools for fixing problems. If the tool does not generate questions, it is a waste of time. If a lot of time is spent looking at metrics that do not address daily problems affecting the unit, their value is questionable. When there is no applicable metric for driving unit performance, build one. Watch for filtering of the metrics that show the *pain*—they are the ones with the greatest value. If a metric rarely meets its prescribed standard, the standard is probably not realistic for one of two reasons—it was arbitrarily set too high, or significant issues need resolution. Either way, investigation into the circumstances is warranted.

The flying schedule sets the pace for the entire wing. It must be built on sound principles that are clearly articulated and vigorously defended by wing leadership. The flying schedule is an important document for consumption of Air Force resources, and the sortie is the focal point of consumption.

Foundations for Metrics

Scheduling. The flying schedule sets the pace for the entire wing. It must be built on sound principles that are clearly articulated and vigorously defended by wing leadership. The flying schedule is an important document for consumption of Air Force resources, and the sortie is the focal point of consumption. We focus on the sortie and all the events required for it to succeed. We establish a schedule to attempt a smooth flow of resource use that includes people, aircraft, and consumables. Without a schedule, all the moving parts certainly would not come together efficiently.

Work Force Management. Key to any maintenance activity is the availability of personnel. A schedule allows the work force needed to support the required task to be identified, manipulated, and managed. The schedule becomes a contract that identifies requirements (number of sorties and configurations) and provides a measure of stability and security for the work effort, as well as a gauge for performance. *Plan what you fly, and fly what you plan.*

The schedule becomes a contract that identifies requirements (number of sorties and configurations) and provides a measure of stability and security for the work effort, as well as a gauge for performance.

Agree on the basics and write them down: standard flying window, rules of engagement (ROE) for surges, night flying, cross country (XC) sorties; weekend duty; quiet hours; training days; standard configurations; minimum/ standard turn times; approval authority for Form 2407, Weekly/Daily Flying Coordination; scheduling changes (if it is too easy to change the schedule, it won't be built right the first time); XC ROE; crew ready/step minimums; and so forth.

Aircraft should rarely be added. If you are adding aircraft because maintenance can't provide front lines, something else is wrong. There is a domino effect—how many more aircraft will you add to the broke pile before you call *knock it off*? Not all aircraft are prepared to fly every day. Some aircraft are selected for ground training, cannibalization (CANN), spares, or nonflyers for time management. For the combat air forces (CAF), time management is critical to a smooth phase inspection flow. It sounds obvious, but adding an aircraft means it is not doing what was originally planned for it.

Aircraft should rarely be added. If you are adding aircraft because maintenance can't provide front lines, something else is wrong.

The flying window drives shift scheduling, and operations and maintenance are not the only agencies involved in sortie generation. Fuels management, air traffic control, the weather squadron, and many others are also involved. Supervision must cover the entire flying window—and then some. The length of the flying window determines effectiveness of the maintenance fix shift. Turbulence in the flying window creates stress on the flight line—keep the schedule consistent throughout the week. A late start on one day affects the next day's early start. Turn times must be negotiated between operations and maintenance and should be published. When building the schedule, early takeoffs and late landings should never cause a minimum turn time to be violated. For mobility air force (MAF) units, operational requirements flow from the Joint Chiefs of Staff, Air Staff, or other customer requirements through the Air Mobility Command (AMC) Tanker/Airlift Control Center (TACC) to the units. Most MAF operational requirements are short notice, requiring maximum flexibility. MAF units develop plans and schedules based on known requirements. However, unforeseen higher headquarters (HHQ) taskings cause units to refine their schedules daily. MAF units do not have a flying-hour window. Instead, the daily flying schedule determines the work shifts and personnel requirements.

Constant communication between the sortie generation and the plans and scheduling elements is vital to the isochronal inspection concept. This communication ensures aircraft are available for their scheduled dock input and available to meet mission requirements. The smooth flow of aircraft—through dash 6 inspection, time change, and time compliance technical order requirements—maximizes aircraft availability and reduces excessive maintenance down time. The result is capable aircraft available to accomplish the mission.

Known maintenance requirements should be included in both short- and long-range maintenance plans. Scheduling flexibility is the key to success in the MAF, along with adherence to sound maintenance management policy. Don't reconfigure aircraft during the day shift without an overwhelming, urgent need. Work with operations and fly the same configuration for the entire week. Unnecessary aircraft configuration drains manpower from troubleshooting, repairing, inspecting, servicing, launching, and recovering.

For the CAF, weekend duty should not be routine. Weekend duty should be based on rules, and aircraft should not be worked unless there is no other option but to work or replace a Monday flyer. XCs should rarely, if ever, return on a weekend.

Maintenance leaders must review sortie production and maintenance health constantly and be knowledgeable about maintenance indicators that will highlight trends before they become a problem.

Problems occur when:

- The lead operations scheduler changes week to week.
- Forms 2407 are approved by whoever is around.
- Late landings or early takeoffs are the norm.
- You're reconfiguring instead of servicing in the turn.
- Ground abort and CANN rates are on the rise.
- A squadron regularly flies more hours off its fleet than the phase dock can regenerate.
- Day shift is not fixing any aircraft.
- Major changes occur to next week's flying schedule.
- All scheduled maintenance is saved for phase.
- The maintenance schedule does not receive the same attention as the flying schedule.
- Maintenance scheduling effectiveness (MSE) is 100 percent, but there are many overdue items in the planning requirements report.
- Weekend duty is the norm.
- Technicians do not know what time they're coming to work tomorrow.

Sortie Generation. Maintenance leaders must review sortie production and maintenance health constantly and be knowledgeable about maintenance indicators that will highlight trends before they become a problem. You should be familiar with the daily production. Remember, sortie generation includes maintenance support, supply, airfield management, fire department, weather, safety, and civil engineers.

Maintenance Performance. Maintenance leaders' primary concerns are how well the unit is meeting mission requirements and how to improve equipment performance,

Maintenance leaders' primary concerns are how well the unit is meeting mission requirements and how to improve equipment performance, identifying emerging support problems, and projecting current trends. Maintenance performance is assessed using standards, goals, and maintenance plans.

identifying emerging support problems, and projecting current trends. Maintenance performance is assessed using standards, goals, and maintenance plans. When operational requirements are not achieved, maintenance analysis can determine root causes. Some areas for serious consideration include:

- Are operational requirements realistically based on availability of equipment?
- What are causes for flying schedule deviations (cancellations, aborts, additions, and early or late takeoffs)?

- Are specific aircraft, equipment, systems, or subsystems contributing to a disproportionate share of deviations and turbulence?
- Does specific equipment fail to perform as scheduled? Does this equipment require more or less maintenance than normal?
- Are there enough people to meet mission needs? Do certain work centers document significant overtime or show consistently high utilization rates?
- Is there a good balance of skills within Air Force specialty codes (AFSC) and between the units?
- Do higher rates of repeat/recur (R/R) discrepancies indicate training or experience shortfalls?
- Is there sufficient time to schedule and work maintenance problems?
- Are trends significant? Are the trends short term (6 months or less) or long term? Where are the units likely to be in 6-12 months?
- Are there seasonal or cyclical variations? Are current variations outside the norm?
- Does the rate look too good to be true? If it does, it probably should be challenged in the same way a bad rate would be challenged. If it stands the scrutiny, then a better process may have been found that should be shared with other units.

Understanding Metrics

Equipment/Mission Analysis. When negative trends are identified, further investigation may be necessary to gather facts. Quality assurance (QA), maintenance analysis leaders, and work-center technicians may be contacted for assistance. Consider the following questions when reviewing negative trends:

Which systems are creating a high not mission capable (NMC) rate? Are these the systems that normally create high NMC rates? If so, are the rates higher than normal? What are the high-rate driving components, and what is being done (or could be done) to address the problems?

- What factors are causing an increase or decrease in NMC hours?
- Are units' deployments affecting the rates? If so, to what extent?
- Are specific aircraft or equipment causing trend distortions?
- What systems are having high cannot duplicate (CND) or R/R malfunctions?
- What parts or components are causing not mission capable for supply (NMCS) conditions? Are these normal, or is a new problem possibly emerging?
- Are the items repaired on station? Are they two-level maintenance components? Could they be repaired locally?
- Is supply support sufficient and responsive? If not, why not? Are stocks adequate?
- Is the lack of training, technical data, or tools and equipment affecting certain systems or AFSCs?

Most of the key metrics fall into two categories—leading and lagging indicators. Leading indicators are those that directly impact maintenance's capability to provide resources to execute the mission. Lagging indicators show firmly established trends. The leading indicators will show a problem first, and the lagging indicators will follow.

Most of the key metrics fall into two categories—leading and lagging indicators. The theory of leading and lagging indicators is one of cause and effect. Leading indicators are those that directly impact maintenance's capability to provide resources to execute the mission. Lagging indicators show firmly established trends. In other words, the leading indicators will show a problem first, and the lagging indicators will follow. There are two cornerstones of maintenance metrics: fleet availability as measured by the mission capable (MC) rate and program execution as measured by the utilization (UTE) rate. For the MAF, movement of fuel, cargo, and people, as measured by departure and arrival reliability, replaces program execution (UTE) as a cornerstone.

Fleet Availability. These indicators measure the ability of logistics to provide sufficient aircraft to accomplish mission requirements. A set percentage of the fleet is

A set percentage of the fleet is necessary and must be available on any given day in order to execute the flying program. This is expressed as the MC rate and is the overall indicator of a fleet's health.

necessary and must be available on any given day in order to execute the flying program. This is expressed as the MC rate and is the overall indicator of a fleet's health.

Leading and lagging indicators associated with fleet availability are:

- **Leading**
  - Ground abort rate
  - Air abort rate
  - MAF total air abort rate (home station air aborts + *J* diverts)
  - Code 3 break rate
  - 8-/12-hour fix rate
  - Repeat rate
  - Recur rate
  - Logistics departure reliability
  - Average deferred/delayed discrepancies per aircraft
  - Discrepancies awaiting maintenance (AWM) or awaiting parts (AWP)
  - MSE rate
  - Functional check flight (FCF) release rate

  - CANN rate
  - Issue effectiveness rate
  - Stockage effectiveness rate
  - Bench-stockage effectiveness rate
  - Mission capability (MICAP) aircraft part rate
  - Average repair cycle days
  - Phase flow—a phase time distribution interval (TDI)
- **Lagging**
  - MC–mission capable rate
  - FMC–fully mission capable rate
  - PMC–partially mission capable rate
  - PMCS–PMC for supply rate
  - PMCM–PMC for maintenance rate
  - PMCB–partially MC both maintenance and supply rate
  - NMCM (U/S)–not MC for maintenance, unscheduled or scheduled rate
  - NMCS–not MC for supply rate
  - NMCB (U/S)–not MC for maintenance and supply, unscheduled or scheduled rate
  - TNMCM–total not MC for maintenance (NMCM + NMCB) rate
  - TNMCS–total not MC for supply (NMCS + NMCB) rate

A set flying schedule is planned, then carried out in the prescribed manner in order to execute the flying program requirements and ensure adequate time to perform fleet health functions (scheduled maintenance).

Program Execution. These indicators show a unit's ability to fly a given schedule to accomplish the mission. A set flying schedule is planned, then carried out in the prescribed manner in order to execute the flying program requirements and ensure adequate time to perform fleet health functions (scheduled maintenance). The UTE rate is the overall indicator for a flying program or mission. Leading and lagging indicators associated with program execution are:

- **Leading**
  - Primary aircraft inventory (PAI) versus possessed aircraft rate
  - Programmed UTE versus actual UTE rates
  - Programmed average sortie duration (ASD) versus actual ASD
  - Flying-hour execution
  - Flying-scheduling effectiveness (FSE) rate
  - Chargeable deviation rate:

Operations add*	Operations delete
Operations nondelivery	Logistics nondelivery**
Maintenance nondelivery	Supply nondelivery

- Nonchargeable deviations rates:

Ferry/FCF add***	Weather add
Other add****	Weather delete
Sympathy delete*****	Other delete
HHQ/TACC delete	HHQ/TACC add

*An add is an aircraft added to the flying schedule after that schedule goes into execution.
**A nondelivery is interchangeable with cancellation or a scheduled sortie that did not fly.
***Ferry refers to a cross-country ferry, where the aircraft is en route from one location to another. FCF refers to a functional check flight, normally required after heavy or specialized maintenance to ensure airworthiness of an aircraft, and is not part of the normal flying schedule.
****Other stands for reasons not attributed to otherwise defined categories of deviations.
***** Sympathy refers to sorties that depend on other aircraft or facilities to be effective (for example, a tanker aircraft cancels it mission due to the abort of aircraft planned to receive its fuel).

Note: Not all MAJCOMs distinguish between chargeable and nonchargeable deviations.

- **Lagging**
  - UTE rate—sortie (the average number of sorties flown per assigned aircraft per month) or hourly (the average number of hours flown per assigned aircraft per month).
  - Logistics departure reliability measures the ability of logistics to ensure aircraft depart within 14 minutes of the scheduled departure time. Indicators associated with departure reliability are:
    - Home station
    - En route (second or subsequent leg of a mission)
    - Worldwide
    - First station after home station

Training must be planned and executed in the prescribed manner so properly trained technicians can do their part to accomplish the maintenance and flying programs.

Maintenance Training. These indicators measure the ability of a unit to train and prepare individuals to perform their assigned tasks. Training must be planned and executed in the prescribed manner so properly trained technicians can do their part to accomplish the maintenance and flying programs. Indicators associated with maintenance training are:

- Upgrade training (UGT) status
- Career development course (CDC) pass rate
- Training overdues (total number)
- Training no-shows (total number)
- 8-/12-hour fix rate
- Repeat rate
- Recur rate

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The maintenance analysis section is the key to providing data analyses and graphical presentations that illustrate how well mission requirements are being met. Its primary responsibility is to show where the *pain* is. Maintenance analysts are trained statisticians and investigators. Their core job is to analyze raw data, identify significant trends and problem areas, and present that information to the people who can correct the deficiencies. Most important, they can identify impending problems that require action. Astute leaders charge analysis with investigating problems suspected of driving unit effectiveness.

Maintenance analysts are trained statisticians and investigators. Their core job is to analyze raw data, identify significant trends and problem areas, and present that information to the people who can correct the deficiencies.

Maintenance Analysts

The analysts are the focal point for the management information systems (MIS) in the maintenance complex, providing assistance with information availability and data retrieval. Maintenance analysts are experts on the capabilities and limitations of the MIS used to collect raw data from across the maintenance complex (including debriefing, maintenance operations center, and production work centers). The analysts turn raw data into information (HHQ reports, special studies, and maintenance analysis referrals) used to evaluate the effectiveness and efficiency of a unit's maintenance effort. While some of these products are devised and used only at the unit level, others are monitored at higher headquarters. The maintenance analysis superintendent can provide an in-depth briefing on the specific measurements used.

Gauging the Unit

One way to gauge a unit's performance is to compare its rates to those of other units Air Force-wide with the same type aircraft and fleet size. When a unit's rates are very different from like units, it may indicate problems. Comparing present performance to past performance and current trends to past trends may also reveal insights into the relative health of a unit.

Table 1 identifies some key metrics, provides a brief description of that metric with the desired trend, and presents some things to consider when a unit's performance is not meeting the desired trend.

Metric	Description	Things to Look For
MC Rate	The percentage of possessed hours for aircraft that can fly at least one assigned mission. Desired Trend ↑	Workers putting off repairs to other shifts, inexperienced workers, lack of parts from supply, poor in-shop scheduling, high cannibalization rates, training deficiencies—formal or OJT. High commitment rates may also contribute to a lower MC rate.
NMCM Rate	The percentage of possessed hours for aircraft that cannot fly any assigned mission due to maintenance. Desired Trend ↓	Workers putting off repairs to other shifts, inexperienced workers, lack of manpower, lack of tools, lack of support equipment, training issues, environmental factors. Look at the impact of scheduled versus unscheduled maintenance.
NMCS Rate	The percentage of possessed hours for aircraft that cannot fly any assigned mission due to lack of parts. Desired Trend ↓	Backshops slow turning out parts, lack of in-shop technical repair data, lack of shop replaceable units and bits and pieces, stock level problems, transportation issues affecting delivery of parts.
FSE Rate	The percentage of sorties scheduled minus deviations. Desired Trend ↑	Last minute aircraft being added to the schedule, frequent configuration changes, frequent changes to the flying schedule, lack of discipline on who is authorized to change the flying schedule.
CANN Rate	The number of cannibalizations that occur per sortie (per 100 sorties for MAF) or for supply kit deployment. Desired Trend ↓	Reliability of parts, problems at shop or depot repair facility, lack of discipline or supervision, poor sense of urgency, supply problems, kit fill rates, parts that never had to be CANNed before (old airplanes breaking for new reasons, insufficient stockage levels on base, having to manage parts for deployments). Analyze the cause codes of CANNs. Are the parts being CANNed authorized to be on hand?

Table 1. Maintenance Analysis

Metric	Description	Things to Look For
Abort Rate	The number of air aborts plus ground aborts occurring per total number of sorties. Desired Trend ↓	Quality of maintenance decreasing, especially if aborts caused by R/R write-ups or aircrews not proficient on newer systems (leading to erroneous write-ups), reliability problems, or issues.
Break Rate	The number of aircraft landing with a grounding write-up per total number of sorties. Desired Trend ↓	Reliability of parts, training deficiency, poor technical data, test equipment, or insufficient tools.
Fix Rate	The number of grounding write-ups repaired per the total number of grounding write-ups that occurred. Desired Trend ↑	Training, lack of experienced technicians, poor technical data, lack of tools, or lack of test equipment.
R/R Rate	The number of R/R write-ups per the total number of write-ups. Desired Trend ↓	Component reliability, maintenance practices, or experience of maintenance technicians.
Maintenance Scheduling Effectiveness Rate	The number of maintenance actions started as scheduled per total number of maintenance actions scheduled. Desired Trend ↑	If either the unit or individual tail number rates decrease, look for: 1. Shortages in equipment or personnel, 2. Problems with a particular type of maintenance action being accomplished later than scheduled, and 3. Resources being over committed.
Deferred Discrepancies	Depicts how well your unit is keeping up with required minor repairs. Desired Trend ↓	The total number increasing or one tail number with a great deal more than the others, look for: 1. Actions being deferred for convenience or 2. Crew chiefs follow-up on AWP and shop chief awareness of backlogs.

Table 1. Maintenance Analysis (Continued)

Chapter 2 Notes

Assessing the Health of the Fleet

Chapter 3
The Metrics

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Maintenance Metrics Formula Index

Flying Related

Maintenance Related

Supply Related

Shop Related

Air Mobility Command-Only Related

Maintenance Status/FSE. The daily status summary should focus on yesterday, today, and tomorrow. What the unit did yesterday (flying schedule summary, including number of planned sorties versus number of flown sorties and chargeable deviations), today's schedule and current aircraft status, and what's planned for tomorrow. Remember, daily statistics are a snapshot. It may be difficult to see trends by looking only at daily performance once a week. Performance indicators may improve just by virtue of being watched. What gets attention, gets fixed.

Plan what you fly and fly what you plan.

Flying-Related Metrics

FSE Rate (Leading). This indicator is a measure of how well the unit planned and executed the weekly flying schedule. *Plan what you fly and fly what you plan* is still valuable flying schedule-guidance. Sticking to the printed schedule reduces turmoil, which helps keep people focused, allows for a better maintenance product, eases personnel tension, and stabilizes morale. It also drives more thoughtful and careful planning.

A high FSE rate indicates the unit has planned well and executed the schedule. A low FSE rate may indicate needless turbulence; however, not all turbulence is bad. When intentionally introduced to avoid additional turbulence later, it is smart management. Otherwise, it is nothing but added *pain* for the unit. It is all too easy to get drawn into operations requirements versus maintenance capabilities when looking at causes of turbulence. The mission is priority number one all the time, but firm scheduling discipline is a must for effective operations.

A high FSE rate indicates the unit has planned well and executed the schedule. A low FSE rate may indicate needless turbulence. The FSE rate is a valuable indicator because it takes into account total unit performance.

When the rate is low, leaders must search for opportunities to plan more carefully or stick to the current plan. Review chargeable deviations (situations generally within a unit's control) because they cause FSE to decrease. Ground aborts are the primary driver. A high commitment rate may also be influencing FSE. Have HHQ/TACC taskings caused a surge period? The FSE rate is a valuable indicator because it takes into account total unit performance. Some of the factors affecting FSE rates are timely aircraft preparation and repair, quality of maintenance, sense of urgency, crew-show discipline, avoidance of early and late takeoffs, and flexibility when unplanned events arise.

$$\frac{\textit{Adjusted Sorties Scheduled} - \textit{Chargeable Deviations}}{\textit{Adjusted Sorties Scheduled}} \times 100$$

Formula 1. Flying Scheduling Effectiveness Rate

Flying Schedule Deviations. These are reasons why an aircraft didn't fly a sortie as scheduled and are recorded as chargeable or nonchargeable for activity causing deviation (operations, logistics, air traffic control, weather, higher headquarters, and so forth).

$$\textit{Maintenance Rate} = \frac{\textit{Maintenance Deviations}}{\textit{Total Sorties Scheduled}} \times 100$$

$$\textit{Operations Rate} = \frac{\textit{Operations Deviations}}{\textit{Total Sorties Scheduled}} \times 100$$

Formula 2. Flying Schedule Deviations

If an aircraft fails to release from an FCF and repeats for the same problem, the maintenance manager must take serious actions.

FCF Release Rate. This indicator is tied directly to completeness of troubleshooting and thoroughness of repair procedures. FCF is a closely managed program. Every effort should be made to ensure qualified technicians and supervisors do the work and work review on FCF aircraft. If an aircraft fails to release from an FCF and repeats for the same problem, the maintenance manager must take serious actions.

$$\frac{\textit{Number of FCFs Released}}{\textit{Number of FCFs Attempted}} \times 100$$

Formula 3. FCF Release Rate

ASD. This is the average time an aircraft stays airborne during an individual sortie. This number is normally computed monthly but can be done weekly. The computation is straightforward: total hours flown divided by total sorties flown.

PAI. This inventory shows the number of aircraft assigned to meet primary aircraft authorization. A low PAI possessed forces a higher real UTE rate on fewer aircraft, possibly compromising two key areas: scheduled maintenance and deferred discrepancies (DD). Look for higher R/R rates. Break rates may increase, and the fix rate may suffer as well.

$$\text{Average Number of Aircraft Possessed} = \frac{\text{Total Possessed Hours (Month to Date)}}{24 \times \text{\# of Days (Month to Date)}}$$

Formula 4. Average Number of Aircraft Possessed

If the unit isn't meeting the sortie UTE rate, it means the average number of sorties per aircraft (based on PAI, not on assigned aircraft) is lower than programmed. Just scheduling more sorties is not the answer.

Backup Aircraft Inventory. BAI shows the number of aircraft above the primary mission inventory that permit scheduled and unscheduled maintenance, modifications, inspections, and repair without reduction of aircraft available for operational missions.

Sortie UTE Rate (Lagging). This key indicator, particularly, for fighters serves as a yardstick for how well the maintenance organization supports the unit's mission. If the unit isn't meeting the sortie UTE rate, it means the average number of sorties per aircraft (based on PAI, not on assigned aircraft) is lower than programmed. Just scheduling more sorties is not the answer. The root cause of a low UTE rate may lie in maintenance scheduling practices that result in low aircraft availability, effectiveness of the production effort that repairs and prepares aircraft for the next sortie, or even availability of qualified and trained technicians. It may also mean that other factors, such as weather, have an effect on the operation.

$$\frac{\textit{Sorties Flown}}{\textit{Primary Aircraft Inventory}}$$

Formula 5. Sortie UTE Rate

Hourly UTE Rate (Lagging). Operations and maintenance share this indicator because it reflects their combined performance. Operations is not flying the programmed ASD if the unit does not meet the hourly UTE rate. When maintenance meets the sortie UTE rate and operations meets the hourly UTE rate, the squadron can successfully execute the annual flying-hour program.

A unit's abort rate can be an indicator of both aircraft reliability and quality of maintenance performed.

$$\frac{\textit{Hours Flown}}{\textit{Primary Aircraft Inventory}}$$

Formula 6. Hourly UTE Rate

Abort Rate (Leading). A unit's abort rate can be an indicator of both aircraft reliability and quality of maintenance performed. The MAF tracks materiel and nonmateriel aborts through the Global Decision Support System and AMC History System via diversion codes *J* and *K*. A *J* divert is an abort due to an aircraft system malfunction, while a *K* divert is for nonmaterial reasons.

Examine the abort rate in relation to system malfunctions. Look for trends, root causes, and lasting corrective actions. The focus should be on preventing as many aborts as possible. Adding a preventable or not preventable indicator on the chargeable deviations slide focuses attention on prevention. A high abort rate will drive the FSE rate down. An air abort is really an operations call. Not all airborne malfunctions, however, result in an air abort. If an alternate mission is flown, then it's not an air abort. If there are a lot of air aborts, talk with operations—it may simply be a misunderstanding of the rules.

The break rate is the percentage of sorties that land in a Code 3 status. It's an indicator of aircraft system reliability and, sometimes, a measure of the quality of aircraft maintenance performed. The break rate is also an excellent predictor of parts demand.

$$\frac{\text{Air Aborts (J-Diverts)} + \text{Local training aborts} + \text{Ground Aborts}}{\text{Total Sorties Attempted}} \times 100$$

$$\text{Total Sorties Attempted} = \text{Sorties Flown} + \text{Ground Aborts}$$

Formula 7. Total Abort Rate

Code 3 Break Rate (Leading). The break rate is the percentage of sorties that land in a Code 3 status. It's an indicator of aircraft system reliability and, sometimes, a measure of the quality of aircraft maintenance performed. The break rate is also an excellent predictor of parts demand. Several indicators that follow break rate are MC, TNMCS, CANN, and R/R.

$$\frac{\text{\# of Sorties that Land Code 3}}{\text{Sorties Flown}} \times 100$$

Formula 8. Code 3 Break Rate

Maintenance-Related Metrics

The MC rate is perhaps the best-known yardstick for measuring a unit's performance. This rate is very much a composite metric. That is, it is a broad indicator of many processes and metrics.

FMC Rate (Lagging) Compare the FMC rate with the monthly MC rate. A significant difference between the two indicates aircraft are flying with key systems partially inoperative and cannot perform all the designed operational capability statement missions. A low FMC rate may indicate a persistent parts-supportability problem.

$$\frac{\text{FMC Hours}}{\text{Possessed Hours}} \times 100$$

Formula 9. Fully Mission Capable Rate

PMC Rate. An aircraft may be partially mission capable for either parts or maintenance, and the status indicates the aircraft cannot perform all assigned missions. Good maintenance practice dictates all malfunctions be fixed as soon as possible whether or not it’s convenient.

$$\frac{\text{PMCB Hours + PMCM Hours + PMCS Hours}}{\text{Possessed Hours}} \times 100$$

Formula 10. Partially Mission Capable Rate

MC Rate (Lagging). The MC rate is perhaps the best-known yardstick for measuring a unit's performance. This rate is very much a composite metric. That is, it is a broad indicator of many processes and metrics. A low MC rate may indicate a unit is experiencing many hard (long fix) breaks that don’t allow them to turn an aircraft for many hours or several days. It may also indicate serious parts supportability issues, poor job prioritization, lack of qualified technicians, or poor sense of urgency. The key here is to focus on the negative trends and top system problems that lower the MC rate. Examining the 8-hour (fighter) or 12-hour (all other aircraft) fix rates may provide clues to a low MC rate, but be careful here—the message units should hear from leadership is, fixing aircraft well is more important than fixing aircraft fast. Positive trends for a well-managed fix rate will indicate good management. Fixes on some systems predictably take longer than 8 or 12 hours. Exceeding this mark is not necessarily indicative of poor maintenance. However, a unit with poor production problems may consistently exceed 8-/12-hour fixes in a wide variety of systems.

Maintenance is responsible for keeping the TNMCM rate under control by fixing aircraft quickly and accurately.

$$\frac{\text{FMC Hours} + \text{PMCB Hours} + \text{PMCM Hours} + \text{PMCS Hours}}{\text{Possessed Hours}} \times 100$$

Formula 11. Mission Capable Rate

TNMCM Rate (Lagging). Maintenance is responsible for keeping the TNMCM rate under control by fixing aircraft quickly and accurately. Prioritization of jobs, good workload distribution, adequate facilities, and robust coordination between the maintenance operations center, flight line, and back shops are crucial to minimizing downtime. Look for a relationship between the R/R, break, and fix rates to NMCM. A strong correlation could indicate heavy workloads (people are overtasked), poor management, training problems, or poor maintenance practices. Usually, if the TNMCM rate is too high, these other rates also indicate problems. The key is to be alert. When one is bad, automatically look at the others.

$$\frac{\textit{NMCM Hours} + \textit{NMCB Hours}}{\textit{Possessed Hours}} \times 100$$

Formula 12. TNMCM Rate

TNMCS Rate (Lagging). TNMCS is driven principally by spare parts availability. However, maintenance can keep the rate lower by consolidating feasible CANNs to as few aircraft as practical. TNMCS is based on the number of airframes out for parts, instead of the number of parts that are MICAP. It does not take long to see the link between the CANN rate and TNMCS rate. The best situation is for both rates to be as low as possible. Another word of caution here—TNMCS should not be held low at the expense of increased CANN actions. Maintenance should not be driven to make undesirable CANNs (those that may be labor intensive or risk damaging the good part) just to keep the TNMCS rate low. Maintainers will let leaders know what they think if pressed to CANN a part that's not feasible just to consolidate all MICAPs on one aircraft. An easy mistake is just looking at the few components eating up huge chunks of time. Usually these are hard-to-obtain items across the Air Force or involve heavy maintenance. They are obvious, but little can be done about them. Try focusing on the items getting a lot of hits. They may be easy to get, but why are so many being ordered? Is the base-stockage level high enough? Is there a trend or reason why so many need to be ordered in the first place? Another facet is the amount of time lost due to parts in transit. Are the parts easy to procure but sitting on pallets at some port? Are the folks on base getting the old parts turned in? Could the part be fixed on base, even though the current guidance says send it back to the depot; can the status quo be challenged?

Maintainers will let leaders know what they think if pressed to CANN a part that's not feasible just to consolidate all MICAPs on one aircraft. An easy mistake is just looking at the few components eating up huge chunks of time. Usually these are hard-to-obtain items across the Air Force or involve heavy maintenance.

$$\frac{\textit{NMCS Hours + NMCB Hours}}{\textit{Possessed Hours}} \; x\ 100$$

Formula 13. TNMCS Rate

R/R Rate (Leading). R/R is perhaps the most important and accurate measure of the quality of maintenance performed in a unit. A repeat discrepancy is one occurring on the same system or subsystem on the first sortie or sortie attempt after originally reported. A recurring discrepancy occurs on the second through fourth sortie or attempted sortie after the original occurrence. A unit's goal should be no R/Rs. A high R/R rate may indicate lack of thorough troubleshooting; inordinate pressure to commit aircraft to the flying schedule for subsequent sorties; or a lack of experienced, qualified, or trained technicians. Examine each R/R discrepancy and seek root causes and lasting fixes.

$$\frac{\textit{Totals Repeats + Total Recurs}}{\textit{Total Pilot Reported Discrepancies}} \; x\ 100$$

Formula 14. R/R Rate

Eight- and Twelve-Hour Fix Rates (Leading). This indicator shows how well the repair process is being managed. Occasionally, some repairs, just by their nature, exceed the standard timeframe. However, all repairs exceeding the standard time should be reviewed.

Eight-Hour Fix Rate. The cumulative percentage of Code 3 aircraft breaks recovered within 8 hours of landing. This interval is used for fighter aircraft.

Twelve-Hour Fix Rate. The cumulative percentage of aircraft breaks recovered within 12 hours of landing. This interval is reported for all aircraft other than fighter aircraft.

$$\frac{\begin{array}{c}\textit{\# of Code 3 Breaks Fixed within}\\ \textit{8 or 12 Hours After Landing}\end{array}}{\textit{Total Code 3 Breaks}} \; x\ 100$$

Formula 15. Eight-Hour (Fighter) or 12-Hour (other Aircraft) Fix Rate

A unit should schedule maintenance first and then support the flying schedule with the remaining aircraft available. Too often, units do it the other way around—schedule maintenance with airframes left over after schedulers fill the flying schedule.

MSE Rate (Leading). MSE is a measure of maintenance's ability to plan and complete inspections and periodic maintenance. A low MSE rate may indicate a unit is experiencing turbulence. It's a leadership issue if the turbulence could be avoided with careful planning. When maintenance misses a scheduled action because an aircraft is broken off station, that's a reasonable occurrence. When maintenance misses a scheduled action because the aircraft is pulled to support the flying program, beware. A unit should schedule maintenance first and then support the flying schedule with the remaining aircraft available. Too often, units do it the other way around—schedule maintenance with airframes left over after schedulers fill the flying schedule.

$$\text{Maintenance Scheduling Effectiveness} = \frac{\text{Number of Completed Scheduled Maintenance Actions}}{\text{Number of Maintenance Actions Scheduled}} \times 100$$

Formula 16. MSE Rate

DD Rate (Leading). Sometimes minor maintenance actions must be deferred to a more opportune time. DDs fall into two categories—AWM and AWP. Many deferred actions appropriately wait until a scheduled event like phase. Supply should maintain an aggressive follow-up program to keep visibility on those parts ordered for AWP deferred discrepancies. Maintenance should try to keep the AWM rate as low as possible. If a discrepancy doesn't need to be scheduled with a more extensive maintenance action, maintenance schedulers can schedule an aircraft down for a day to work deferred discrepancies.

Monthly Rates: Each Monday morning, analysts take a snapshot of each reportable MDS, of the total number of deferred discrepancies, for both maintenance and supply, for the previous workweek. The following calculations are applied to the "snapshot" information.

$$\text{AWM} = \frac{\text{Total AWM (Snapshot) Discrepancies}}{\text{Average Aircraft Possessed}}$$

$$\text{AWP} = \frac{\text{Total AWP (Snapshot) Discrepancies}}{\text{Average Aircraft Possessed}}$$

Units use the following formulas to determine the cumulative monthly rates. At least four weekly rates must be used to calculate the cumulative monthly rate.

$$\text{Monthly AWM Rate} = \frac{\text{AWM (Week 1)} + \text{AWM (Week 2)} + \text{AWM (Week 3)} + \text{AWM (Week 4)}}{\text{Number of Samples}}$$

Formula 17. DD Rate

$$\text{Monthly AWP Rate} = \frac{\text{AWP (Week 1) + AWP (Week 2) + AWP (Week 3) + AWP (Week 4)}}{\text{Number of Samples}}$$

Formula 17. DD Rate (Continued)

A perfect phase flow portrays a fleet's evenly paced progression into phase (a nearly perfect diagonal line). Average phase time remaining on a fleet should be approximately half the inspection interval.

Phase Flow. A phase time-distribution interval is a product that shows hours remaining until the next phase on a flying squadron's fleet. It is common practice to convert the TDI to a scatter diagram, facilitating ease of tracking. A perfect phase flow portrays a fleet's evenly paced progression into phase (a nearly perfect diagonal line). Average phase time remaining on a fleet should be approximately half the inspection interval. However, a unit may have good reasons to manage its phase flow so the data points define a pattern other than a diagonal line. For example, in preparation for a long-distance overseas deployment, a unit may need to build up the average phase time remaining on its fleet, because phase capability may be limited for a short time. Beware of gaps or groupings, especially on aircraft with less than half the time remaining to phase.

CANN Rate (Lagging). The CANN rate is the average number of CANN actions per 100 sorties flown. A CANN action is the removal of a serviceable part from an aircraft or engine to replace an unserviceable part on another aircraft or engine, or removal of a serviceable part to put into a readiness spares package for deployments. This rate includes all aircraft-to-aircraft and engine-to-aircraft CANN actions. The measurement is used in conjunction with the supply issue effectiveness rate. In most cases, a CANN action takes place when base supply cannot deliver the part when needed and mission requirements demand the aircraft be returned to an MC status. Since supply relies on the depot for replenishment, this indicator can also be used, in part, to indicate depot support.

Issue effectiveness is usually lower than stockage effectiveness, but it is more representative of a supply customer's view of supply support. The significant difference between issue and stockage effectiveness is that stockage effectiveness uses only those back orders for items supply is authorized to stock.

$$\text{CANN Rate} = \frac{(\text{Number of Aircraft-to-Aircraft CANNs}) + (\text{Number of Engine-to-Aircraft CANNs})}{\text{Total Sorties Flown}} \times 100$$

Formula 18. CANN Rate

Supply-Related Metrics

Issue Effectiveness Rate. This is the percentage of customer requests that were filled by items in the inventory. Issue effectiveness is based on filling any request, not just requests for items supply is authorized to stock. It is used to measure how well the logistics customer is supported by supply. Issue effectiveness is usually lower than stockage effectiveness, but it is more representative of a supply customer's view of supply support.

$$\text{Issue Effectiveness Rate} = \frac{\text{Issues}}{\text{Issues} + \text{All Back Orders}} \times 100$$

Formula 19. Issue Effectiveness Rate

Stockage Effectiveness Rate. This is the percentage of customer requests filled by items supply is authorized to stock. The significant difference between issue and stockage effectiveness is that stockage effectiveness uses only those back orders for items supply is authorized to stock. It measures how well the logistics customer is supported by base supply and depot replenishment. This is especially important since supply cannot possibly stock every possible part. It is funded to stock only the most used or critical parts. A high stockage-effectiveness rate means success in anticipation of customer needs.

$$\text{Stockage Effectiveness Rate} = \frac{\text{Issues}}{\text{Issues + All Back Orders} - \text{4W Back Orders}} \times 100$$

Formula 20. Stockage Effectiveness Rate

Total repair cycle time is for aircraft only. It does not include engines or support equipment.

Total Repair Cycle Time. This is the average time, in days, an unserviceable asset spends in the repair cycle at a unit. This indicator is for aircraft only. It does not include engines or support equipment. The clock begins when maintenance orders a repair cycle asset from supply and ends when a like asset (serviceable or unserviceable) is turned in to supply. The time the item is awaiting parts in the repair shop is not included. This indicator is primarily a local management tool. To improve the process of repairing parts, the different steps in that process must be measured. This indicator and its components provide this capability.

$$\text{Repair Cycle Time} = \frac{\text{Pre-maintenance Days + Repair Days + Post-maintenance Days} - \text{AWP Days}}{\text{Number of Items Turned In}}$$

Formula 21. Total Repair Cycle Time

Average Repair Cycle Time by Segments (Buckets of Time). This is a more detailed look at the total repair cycle days. The total repair cycle is broken into three segments:

- Pre—the time a serviceable part is issued from supply until the broken part is received by the backshop for repair.
- Repair—the time a part remains in the shop until repaired, minus time spent AWP.
- Post—the time it takes for the repaired part to be turned back to supply.

The sum of the three steps above equals the total repair cycle time. It measures the efficiency of the three major steps in a unit's repair cycle.

$$\textit{Pre-Maintenance Time} = \frac{\textit{Total Number of Days in Pre-Maintenance}}{\textit{Total Number of Items Repaired}}$$

$$\textit{Repair Time} = \frac{\textit{Total Number of Days in Repair–AWP days}}{\textit{Total Number of Items Repaired}}$$

$$\textit{Post-Maintenance Time} = \frac{\textit{Total Number of Days in Post Maintenance}}{\textit{Total Number of Items Repaired}}$$

Total Repair Cycle Time = Pre-Maintenance Days + Repair days + Post-Maintenance Days

Formula 22. Average Repair Cycle Time

Shop-Related Metrics

Electronic Warfare (EW) Pod MC Rate. An MC EW pod is one that can meet its wartime missions. Therefore, this rate represents the percentage of all possessed EW pods capable of fulfilling their wartime requirements.

$$MC\ Rate = \frac{\#\ of\ Serviceable}{\#\ of\ Possessed\ Pods}\ x\ 100$$

Formula 23. EW Pod MC Rate

The EW Pod MC Rate represents the percentage of all possessed EW pods capable of fulfilling their wartime requirements.

EW Pods AWP Rate. Measures deferred discrepancies for EW pods requiring parts. Weekly AWP rate is a snapshot taken each Monday morning and covers the previous work week (Monday-Friday).

$$Weekly\ AWP\ Rate = \frac{Total\ AWP\ (Snapshot)\ Discrepancies}{Average\ Possessed\ EW\ Pods}\ x\ 100$$

Formula 24. EW Pods Weekly AWP Rate

Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) MC Rate. An MC LANTIRN pod is one that can meet its wartime missions. Therefore, this rate represents the percentage of all possessed LANTIRN pods capable of fulfilling wartime missions.

$$MC\ Rate = \frac{\#\ of\ Serviceable}{\#\ of\ Possessed\ Pods}\ x\ 100$$

Formula 25. LANTIRN MC Rate

LANTIRN Test Station MC Status. LANTIRN test station capability is computed by calculating the ability of the shelter test equipment to bench check the 16 testable line-replaceable units, including LANTIRN intermediate automatic test equipment (LIATE), radio frequency automatic and electro-optical test set, power supply test set (PSTS), and the environmental control unit test set (ECUTS). The condition of the external support equipment (cooling and servicing unit, 400Hz frequency converter, and fluid-conditioning unit) is also tracked.

In terms of spare engine status, beware of snapshots in time on this indicator. A low daily snapshot is not necessarily an indicator of difficulty. The shop may have just issued engines to the line or for a deployment.

- **LANTIRN LIATE—**ten-unit test capability
  Example: 40 percent MC = 4/10 units testable
- **Power PSTS—**four-unit test capability
  Example: 75 percent MC = 3/4 units testable
- **ECUTS—**two-unit test capability
  Example: 50 percent =1/2 units testable

Spare Engine Status. The status shows the raw number of FMC spare engines available in the engine shop. Compare the number to the base stockage level to get an idea of the capability to replace engines or support deployments at a given time. Beware of snapshots in time on this indicator.

A low daily snapshot is not necessarily an indicator of difficulty. The shop may have just issued engines to the line or for a deployment. The engine shop should show the annual trend line with war-reserve engine levels by month for the previous year. A particular month's data point not shown in association with the previous year's trend is not useful. Engines NMCS and engines NMCM are objective measures rating the health of engine parts supportability and the engine repair line.

Training-Related Metrics

Several indicators are useful to show the health of the maintenance training process. The following key indicators are available in a monthly status-of-training presentation the maintenance training organization develops and the logistics group (LG) and operations group (OG) review.

UGT Status. This career-progression status reflects the percentage of five- and seven-level technicians in UGT. The goal should be to keep the combined total less than 40 percent, because the higher the number, the greater the training burden.

CDC Pass Rate. CDC pass rate is the percent of people who pass their end-of-course tests. The goal is 95 percent; first and second fail percentages are also available.

Training Overdues. This indicator tracks the percentage of overdue training actions. The goal is to maintain this indicator at less than 5 percent. Training overdues are frequently a measure of readiness, as this measure considers wartime skills, such as M-16 and chemical warfare defense-equipment training. Excessive overdues may indicate a force that feels they only have time for the day-to-day mission and don't have time to train.

Training No-Shows. This indicator tracks the number of scheduled training events versus the number of events actually attended. The desired number of no-shows is zero. Every effort should be made to ensure individuals receive training once they are scheduled.

Other Indicators. As mentioned earlier in the handbook, some aircraft indicators, such as 8- and 12-hour fix rates or R/R, may also indicate training problems.

AMC-Only Metrics

Logistics Departure Reliability. This provides the percent of departures that are delayed because of supply, saturation, or maintenance problems.[1] AMCI 10-202, Volume 6, *Mission Reliability Reporting System,* provides criteria for delay-code assignment. It also provides the commander with an objective measure of the health of the air mobility system and reflects the percentage of departures that are on time. On time refers to the standard for departures contained within the Air Mobility Master Plan—those within 14 minutes of the scheduled departure time. The main focus of departure reliability is to strengthen the air mobility system through accountability for process improvement.

Local training missions that do not support an external customer are excluded because there are no requirements for the units to report delays for organically planned and executed missions.

AMCI 10-202, Volume 6, Mission Reliability Reporting System, provides criteria for logistics delay-code assignment.

$$\frac{\#\ of\ Departures - \#\ of\ Logistics\ Delays}{\#\ of\ Departures} \times 100$$

AMC Formula 1. Logistics Departure Reliability

Worldwide Logistics Departure Reliability. Essentially this is the same as Logistics Departure Reliability. It provides the percent of total departures that are delayed for supply, saturation, or maintenance problems.[1]

$$\frac{\text{\# of Departures} - \text{\# of Logistics Delays}}{\text{\# of Departures}} \times 100$$

AMC Formula 2. Worldwide Logistics Departure Reliability

AMC Formulas 2 - 4 are all new. They will be incorporated into the new AMC supplement to AFI 21-101, Maintenance Management of Aircraft.

Home-Station Logistics Departure Reliability. This delineates down to only first-leg departures of unit-owned aircraft departing home station.[1]

$$\frac{\text{\# of Home-Station Departures*} - \text{\# of Home-Station* Logistics Delays**}}{\text{\# of Home-Station Departures*}} \times 100$$

*Home-station departure = Unit-Owned (first leg of mission) Departure.
**Home-station logistics delays that occur on the first leg of mission only.

AMC Formula 3. Home-Station Logistics Departure Reliability

En Route Logistics Departure Reliability. This is any second or subsequent leg departure of a mission.[1]

$$\frac{\text{\# of En Route Departures*} - \text{\# of En Route* Logistics Delays**}}{\text{\# En Route Departures*}} \times 100$$

*En route departure = second or subsequent leg of the mission.
**En route logistics delays that occur on the second or subsequent leg of the mission.

AMC Formula 4. En Route Logistics Departure Reliability

First Station After Home-Station Departure Reliability. This captures only second-leg departures when the second leg originates from a base other than the home station from which the first leg departed.[1]

$$\frac{\text{\# of First Station After Home-Station Departures*} - \text{\# of First Station After Home-Station* Logistics Delays**}}{\text{\# First Station After Home-Station Departures*}} \times 100$$

*First station after home-station departure = second leg of mission only.
**First station after home-station delays that occur on the second leg of the mission only.

AMC Formula 5. First Station After Home-Station Logistics Departure Reliability

AMC Notes

1. Local training missions that do not support an external customer are excluded because there are no requirements for the units to report delays for organically planned and executed missions.

Chapter 4
Helpful Hints for Data Investigation

Special Interest

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Analytical Process

The analytical process consists of identifying contributory factors, manipulating raw data into meaningful formats; computing management indicators; performing statistical measurements; and creating accurate, complete, and easy-to-understand presentations. An analytical process uses a number of methods—for example, visual observation dependent upon the observer's experience and knowledge and statistically or visually performed comparative analysis—and involves the comparison of two or more like operations or items to identify variations or differences. Statistical analysis and statistical investigation are the methodical study of data. These methods are used to reveal facts, relationships, and differences about data and data elements and are a useful adjunct to comparative and visual analysis. Analysts should use these tools and other methods to perform analytical studies to gain insight into unit performance and enhance process improvement.

AFSC 2R0X1 CDC is a good source of statistical and analytical techniques, and the maintenance data analysis section (MDAS) maintains a current copy of the five- and seven-level CDC for reference.

When leaders have a hunch or a specific agenda, it is almost always better that they spell out what they think is going on or what they would like to see, if it can be done. Asking analysis for specific information or data is perfectly legitimate but fails to recognize just how much more it can provide.

Management Contributions to the Analytical Process

Operations and logistics leaders have a significant impact on the usefulness of the MDAS. By challenging the MDAS with analyzing problems, they foster the in-depth training of the analysts and help the unit.

When leaders have a hunch or a specific agenda, it is almost always better that they spell out what they think is going on or what they would like to see, if it can be done. Asking analysis for specific information or data is perfectly legitimate but fails to recognize just how much more it can provide. If analysis knows what the agenda is, it is far better prepared to use all the tools at its disposal to uncover or present all the pertinent analyses.

Never let analysts just hand over raw data sheets; that is bean counting. Good analysts will always try, situation permitting, to provide a bottom-line narrative. The leader should not have to analyze the data; that is the analyst's job. It is easy to miscommunicate what is really wanted or how it is to be presented. The leader must be willing to go back to the well several times, because there are infinite ways to present information. There needs to be a dynamic relationship between leadership and analysts, where the latter feels free to probe for the real agenda. In the end, this saves a lot of time, and leaders get far better analyses and information.

Leaders should constantly review how information is being organized and presented. The lack of focus regarding use of data, improper arrangement of data for analysis, or unclear presentation of results can obscure meaningful information. Leaders should be familiar with how data are developed, interpreted, and presented to ensure accurate presentations for decision making. Studies and analyses specifically targeted for areas of concern are valuable in helping units isolate factors surrounding problem areas.

Analytical Studies. MDAS will provide work centers the results of investigations, analyses, or studies. Specific studies are provided to the requester, and a file copy is retained for future reference. Reproducing the study or including it in a monthly maintenance summary achieves widespread dissemination.

The study should state assumptions up front, summarized in plain English, and state how the significance is measured.

Most studies should begin with some sort of background information. Each study should include the data, research, investigation, and statistical findings, along with their respective sources. Conclusions relevant to the study should be drawn from this information. Finally, the study should include recommendations to address the conclusions relevant to the problem (other issues uncovered can be identified but should be kept separate). The most effective study is one that goes beyond

Most studies should begin with some sort of background information. Each study should include the data, research, investigation, and statistical findings, along with their respective sources. Conclusions relevant to the study should be drawn from this information. Finally, the study should include recommendations to address the conclusions relevant to the problem.

superficial conclusions and helps solve a problem relative to mission performance.

Maintenance Analysis Referrals

Referrals should not be determined by a quota system. They should be used only when necessary to effect a permanent solution to a problem that cannot be solved by other means.

Referrals are highly effective for making many agencies aware of a common problem. Referral reports are simply tools to aid in process improvement and should never be used to attach blame. A referral identifies, investigates, and proposes corrective actions for management problems.

Referral reports are used to start the referral procedure and document corrective actions for implementation and future reference. Given the amount of investigation and research needed to properly process referrals, they should be not used for problems that can be resolved more efficiently through verbal or other less formal communications.

Referrals should not be determined by a quota system. They should be used only when necessary to effect a permanent solution to a problem that cannot be solved by other means. Referral reports must be concise, accurate, and timely to provide operations and logistics leaders with information for making decisions. Anyone can initiate a referral, but MDAS is the office of primary responsibility and maintains a log of all referrals, assigning a referral number before processing begins. Referrals are routed through the affected agencies for comments, with the final addressee as the MDAS. The MDAS retains copies, indicates whether additional monitoring or follow-up action is necessary, and provides a completed study to the LG/OG quality assurance.

Functions of Deficiency Analysis

Deficiency analysts serve a dual role. They provide analytical support to the squadrons and maintenance leaders and also provide technical expertise for the MDAS. They use analytical data and technical knowledge to identify problems, work with the customer, and help find solutions. They should not limit themselves to pointing out general areas for investigation. They should identify deficiencies applicable to a work center, particular equipment end item, maintenance practice, or management action. Deficiency analysis responsibilities include:

- Review QA summaries for positive and negative trends.
- Review debriefing data and abort information daily to assist in the identification of problem aircraft or systems.
- As a minimum, perform monthly reviews of:
  - Deferred discrepancy lists for technical errors or negative trends.
  - R/R discrepancy lists for problems.
  - High CND rates and incidents for inadequate troubleshooting or technical data problems.
  - Aircraft scheduling deviations for negative maintenance practices and trends that impact work force and workload stability.
- Monitor and evaluate the maintenance portion of the base repair program and intermediate repair enhancement program.
- Analyze the performance of selected systems, subsystems, and line-replaceable units to help determine the source of problems affecting the mission.
- Attend the QA program and product improvement working group meetings, providing trend data as needed.

  Note: The function of the deficiency analyst is not to become the full-time, data-integrity team monitor.

The following are questions the assigned analysts have been trained to ask.

Building Narratives for Out-of-Standard Indicators

- **Weekly Reports**
  - What are the major contributing systems?
  - What are the common write-ups within the major contributing systems?
  - Are there aircraft with multiple write-ups in the major contributing systems or different systems?
  - Is MICAP information available on aircraft with high supply times?

- Are there any previously stated facts that apply?
- Are there any systems trends?
- Are there technical data limitations?
- Is there a lack of proper tools?
- Answer the questions: what is the problem, what is the unit doing to resolve the problem, and/or what does the headquarters staff need to know to resolve the problem?

- **Monthly Report**
  - What are the major contributing systems?
  - What are the common write-ups within the major contributing systems?
  - Are there aircraft with multiple write-ups in the major contributing systems or different systems?
  - Do pilot reported discrepancies (PRD) indicate a recent trend in system write-ups for major contributors?
  - Do PRDs indicate a recent trend in write-ups for a particular tail number within major contributing systems?
  - What type of corrective actions were taken? Do similar discrepancies still reappear?
  - Could CANNs have been a factor?
  - Did the aircraft/system cause problems with other maintenance indicators?
  - Is MICAP information available on aircraft with high supply times?
  - How has the aircraft/system performed since the last incident (PRD listing/Core Automated Maintenance System [CAMS] Screen 174)?
  - Are there any previously stated facts that apply (previous weeklies, studies, and so forth)?
  - Check repeat/recurs in an effort to identify actual component failures versus maintenance procedural, training, or skill-level problems. This will involve contacting the shop responsible for the repair.

- Are there any systems trends?
- Are there technical data limitations?
- Is there a lack of proper tools?
- What is the problem, what is the unit doing to resolve the problem, and/or what does the headquarters staff need to know to work resolution of the problem?

The following hints can be applied to all processes under investigation. (Breaks, Aborts, and CANNs are used only as examples.)

Technical Information. Always check with deficiency analysis for answers to technical questions. It's a good idea to review their summaries, also. Sometimes they've already gathered information on the same aircraft/systems. Make it a point to talk to the appropriate shops concerning problem aircraft and components.

Fix Rates and Write-Ups Exceeding the 4-/8-/12-Hour Requirement. Deficiency analysts or the shop responsible for repair may have the average time it takes to troubleshoot and repair some items.

Supply. The MICAP section of supply should have information on supply issues and actions affecting aircraft and components with high supply times.

Trends. There are various types of trends that should be investigated. Detailed analysis will depend on how much time is available and the type of data being researched.

Ask:

- Are the failures seasonal (more failures in hot or cold temperatures)?
- Are the components that are failing environmentally sensitive (that is, responding to temperature extremes, corroding)?
- Could the failures be operating-time related?
- Do corrective actions point toward lack of training or workarounds caused by lack of parts or proper tools?

After weekly reports and spreadsheets are updated, it's a good time to start looking at historical data for possible trends affecting current data.

Break Rates

Verify documentation of Code 3 aircraft:

- Are debriefing forms loaded correctly?
- Are landing times correct?
- Are the proper system break codes used?

Verify accuracy of aircraft status:

- Are start and stop times of NMC conditions correct?
- Do the work unit codes match the identified Code 3 systems on the debrief form?

Isolate the problem system:

- Once verification of Code 3 documentation and aircraft status is completed, what systems stand out?
- Past history?

Identify components within suspect systems:

- Does CAMS documentation seem reasonable?
- Do start and stop times for maintenance actions agree with aircraft status times?

Track problem items through the backshop:

- Can the failure be confirmed?
- Can the common repair actions in the shop be identified?

Check for R/R/CND actions:

- Were they good fixes?
- Is there a chance some Code 3 actions are self-inflicted?

Abort Rates

Verify documentation of aborted aircraft:

- Are debriefing forms loaded correctly?
- Do the data correlate with the daily flying schedule?

- Are the proper systems used?
- Are the proper *when discovered* codes used?
- Are the proper abort cause codes used?

Isolate the problem:

- What systems stand out?
- Past history?

Identify components within suspect systems:

- Does the CAMS documentation seem reasonable?
- Do start and stop times for maintenance actions agree with aircraft status times?

Track problem items through the backshop:

- Can the failure be confirmed?
- Can common repair actions in the shop be identified?

Check for R/R/CND actions:

- Were they good fixes?

CANN Rates

- If CANN logs are maintained, do they match what is documented in CAMS?
- Are there obvious gaps in the CANN log (missing or incomplete data)?
- Are there notes of CANN actions initiated but canceled?
- Does it appear parts have been sitting around?

Isolate the problem:

- What systems stand out?
- Past history?

Identify components within suspect systems:

- Does CAMS documentation seem reasonable, or is everything coded to the next higher assembly or subsystem level (that is, actual components not identified)?

- Was the CANN action faster than removing, repairing, or replacing the item?

Check for R/R/CND actions:

- Was the CANN action a good fix?
- Did the CANN action only provide a partial fix?

Take the list of problem or suspect subsystems and components to quality assurance and the technical representatives.

- Have the problems been identified previously?
- Have material deficiency reports, safety reports, and so forth been submitted?
- Are there pending modification programs?

Identify problem aircraft. Correlate findings with other areas. Is there a common thread with:

- Causes for NMC/PMC conditions?
- Overall system/component failures in the fleet?
- Problem items in the Base Self-Sufficiency Program?
- Overall pilot-reported discrepancies?
- Air and ground abort causes?
- Overall R/R/CND problems and rates?

In General:

- Are sufficient samples tracked to get an accurate picture?
- If updates to CAMS are backlogged or if CAMS has been down, was time allowed for data to be updated before taking samples?
- Was the sample or monthly average compared with past samples?
- Is there a large change in overall rates?
- Examine data by squadron, flight, and aircraft:

- Is there a large change in overall rates from one month to another or from one sample to another?
- Can a problem aircraft be identified as a CANN bird or one in an inspection or modification?
- Could the problem be tied to nonavailability of CAMS or other documentation problems?

If possible, compare data with other units that have like aircraft and missions:

- Are the numbers comparable?
- Are there similar trends?
- Are there common systems or component problems?

Document findings and distribute to the OG/LG and other appropriate maintenance activities.

Instructions

AFPD 21-1	*Managing Aerospace Equipment Maintenance*
AFI 21-101	*Maintenance Management of Aircraft*
AFI 21-103	*Equipment Inventory, Status, and Utilization Reporting*
AFI 21-105	*Aerospace Equipment Structural Maintenance*
AFI 21-118	*Improving Aerospace Equipment Reliability and Maintainability*
AFI 90-1102	*Performance Management*
AFCSM 21-556-V1 through 21-579-V2	Core Automated Maintenance System Manuals

Air Force Technical Orders

00-5-1	*Air Force Technical Order System*
00-20-1	*Aerospace Equipment Maintenance General Policy and Procedures (with RAC 1 incorporated)*
00-20-2	*Maintenance Data Documentation*
00-20-5	*Aerospace Vehicle Inspection and Documentation*
00-25-107	*Maintenance Assistance*
00-25-254-1	*Comprehensive Engine Management System Engine Configuration, Status, and TCTO Reporting Procedures*
00-35D-54	*USAF Deficiency Reporting and Investigating System*

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