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Author: MSgt Clifton Yelverton
363rd Training Squadron
82nd Training Group (AETC)
363 TRS/TRR
520 Missile Road
Sheppard Air Force Base, Texas 76311−2261
DSN: 736−2146
E-mail address: clifton.yelverton@us.af.mil or
363TRSCDCWriters@us.af.mil

Instructional Systems Specialist: Dr. Beverly D. Hill

Editor: Catherine Parker

Air Force Career Development Academy (AFCDA)
Air University (AETC)
Maxwell AFB, Gunter Annex, Alabama 36114−3107

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NOW THAT YOU have completed volumes 1, 2, and 3 of this career development course, you are well on your way to becoming a fully qualified Maintenance Management Analyst. This is your last volume, and it ties in all the previous areas that you have studied. In the preceding volumes you have learned about different agencies, responsibilities, and job functions. You have also learned how to use and manage the Integrated Maintenance Data System (IMDS) to support the maintenance complex. You went through some fundamental concepts of statistics to enable you to methodically measure and validate data.

This volume begins with the maintenance and inspection process in unit 1 that covers the aircraft and equipment maintenance system, the maintenance inspection system, and the planning cycle for flying and maintenance. Unit 2 teaches the fundamentals of maintenance metrics including computing maintenance and operations, as well as mission performance indicators for aircraft and communication-electronics equipment. You will also learn how to analyze key maintenance metric indicators. Unit 3 covers cyber and space communication systems reporting. Specifically, it includes the cyber and space communication systems performance indicators and the Air Force command level reporting. Unit 4 covers maintenance data analysis, including the analyst tools and responsibilities. You will also learn principles in gathering and analyzing data with statistical and data analysis processes and tools. In addition, we cover guidelines for preparing and presenting special studies. You may apply these principles in maintenance information systems other than IMDS that apply to maintenance management.

A glossary is included for your use.

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This volume is valued at 18 hours and 6 points.

NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then complete the unit review exercises.

Page

Please read the menu for Unit 1 and begin ➔

Unit 1. Maintenance and Inspection Process

THE KEY TO mission success is the sustained ability to provide mission-ready equipment at the time and place it is needed. With this requirement in mind, the Air Force developed maintenance, inspection, and planning systems. Your job, as a maintenance analyst, is to provide maintenance managers with accurate and timely information that is needed to improve the maintenance operation and the reliability and maintainability of assigned weapon systems and equipment. This unit will familiarize you with how the Air Force intends to provide mission-ready equipment where and when it is needed. In this unit, you will study maintenance, inspection, and planning systems.

1–1. Aircraft and Equipment Maintenance System

As a maintenance analyst, you are a key source for maintenance information about the organization's aerospace vehicles and equipment. Therefore, it is important that you gain a full understanding of how the Air Force developed several of the maintenance and inspection concepts that aid you in keeping aerospace vehicles and equipment fully operational and reliable at all times. In this section, you will study the maintenance concepts you need to know to effectively provide maintenance managers with the appropriate information.

601. Maintenance concepts

As you learned from your study of the maintenance complex, the Air Force maintenance concept revolves around the complexity and nature of a repair and the ability of an operating location to perform necessary maintenance. To give you a logical starting point for this section, we will review these concepts.

Levels of maintenance

Three levels of maintenance are critical to daily maintenance operations: organizational, intermediate, and depot. Depending on the scope of required maintenance, the appropriate level is used.

Organizational

This is the first level of maintenance and it is performed *on-equipment*. This includes working directly on aerospace vehicles, such as aircraft or support equipment on the flight line. Maintenance at this level consists of making minor repairs, inspecting, testing, or calibrating and is normally performed using the resources of an operating command at an operating location.

Intermediate

The second level of maintenance is performed *off-equipment*. Parts or components are removed from an end-item when they cannot be worked *on-equipment,* and are sent to a back shop to be tested, repaired, or replaced. Intermediate maintenance is usually conducted using the resources of the operating command at an operating location or at a centralized intermediate repair facility.

Depot

This third and highest level of maintenance is performed *on-* or *off-equipment* at a major repair facility. These repairs are complex and require highly specialized skills, shop equipment, or facilities usually located at another base, and may include commercial facilities. Maintenance performed at a depot may also include organizational or intermediate level maintenance.

Maintenance approaches

Maintenance is approached as, and is comprised of, two-level maintenance (2LM) and three-level maintenance (3LM). The 2LM approach uses two of the three levels of maintenance to support weapons systems and *modifies or eliminates the intermediate (off-equipment) function where possible*, consolidating specific repair functions at the depot or "regional" level. This is commonly practiced by overseas bases where intermediate maintenance is performed at a regional facility.

The 3LM approach employs organizational, intermediate, and depot levels of maintenance in one location. This is commonly practiced at continental United States (CONUS) bases where there are more skilled personnel and resources. However, depot repairs are normally performed at selected depot facilities known as Air Logistics Centers (ALC).

602. Types and categories of maintenance

Maintenance is divided into two basic types as follows:

- *On-equipment* is work performed on an aircraft or piece of support equipment.
- *Off-equipment* is work typically performed in a repair shop on components removed during on-equipment maintenance.

These two types of maintenance are performed at both operating locations and ALCs.

The USAF maintenance community is made up of mission-oriented units that are organized as detachments or squadrons within the operating commands. These units are supported by ALCs normally operated by the Air Force Materiel Command (AFMC). The assignment of tasks and resources are negotiated between the operating command and AFMC. The negotiation varies by command, equipment, and mission. AFMC balances peacetime economy, readiness, and responsiveness with wartime effectiveness, flexibility, survivability, and ease of sustainment.

An individual's duty is determined by the degree of specialization, the complexity of support equipment or the repair process, and the requirement for specialized facilities. However, wartime consideration may require that the operating commands be authorized to do repairs normally done by AFMC during peacetime. Air Force maintenance is further divided into the following categories:

Organization	On-Equipment	Off-Equipment
Operating Command	The on-equipment, operating command maintenance consists of the following: • Servicing. • Loading. • Launching. • Recovering. • Removing and replacing repair actions. • Scheduling inspections.	This category of maintenance consists of those tasks that *cannot* be accomplished on the end-item but are within the capability of the skills and equipment possessed by a unit. The tasks include repair of components by removing and replacing subassemblies. When a unit's wartime mission is to deploy or disperse, the tasks in this category should be limited to tasks independent of support equipment such as test stands or stations, and independent of special facilities.

Organization	On-Equipment	Off-Equipment
	• Accomplishing time compliance technical order (TCTO). • Making other modifications that can be done with the skills and equipment possessed by a unit.	For units that will stay in-place, the capability should be more highly developed and may have some workload shared by AFMC.
AFMC	This category includes those tasks that require specialized equipment such as jigs or rigs, or highly specialized skills or industrialized facilities, such as wing reskinning.	This includes any tasks that require highly specialized skills or sophisticated shop equipment not available in the operating command. Normally these tasks are assigned to AFMC because of the high cost of equipment, the excessive training required, and the low frequency of the tasks. (An example would be engine turbine maintenance, such as rotor blade replacement and balancing).

603. Maintenance classification

Maintenance, whether on- or off-equipment, is further classified into two kinds as follows:

- Scheduled (preventive).
- Unscheduled (corrective).

Scheduled maintenance is easily controlled through normal maintenance planning procedures and upkeep. Scheduled maintenance ensures equipment is ready and available at the time of need. *Unscheduled maintenance* is generated during the process of using equipment. It cannot be foreseen; therefore, it is difficult to manage.

Scheduled maintenance

Scheduled maintenance is known, or predictable, maintenance requirements that can be planned or programmed on a short- or long-range schedule. Such maintenance includes accomplishing recurring scheduled maintenance inspections and servicing, complying with TCTOs (excluding immediate actions), accomplishing scheduled time change item replacements, and correcting delayed or deferred discrepancies. It also includes modification and renovation projects that are programmed for depot to accomplish.

Preventive maintenance is a form of scheduled maintenance. Preventive maintenance is the normal upkeep and preservation of equipment through inspection, detection, and correction of discrepancies to prevent failures, to verify serviceability, or to restore complete serviceability of equipment that has been subject to usage, wear and tear, or corrosion. An example of a preventive maintenance type of inspection is corrosion control, which is performed on equipment on a scheduled basis.

Unscheduled maintenance

This category covers those unpredictable maintenance requirements that have not been previously planned or programmed, but require prompt attention and must be added to, integrated with, or substituted for previously scheduled workloads. This type of maintenance includes complying with immediate action TCTOs, correcting discrepancies discovered during flight or operation of equipment, and performing repairs as a result of accidents or incidents. Work that requires special depot scheduling is also classed as unscheduled maintenance.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

601. Maintenance concepts

1. What are the three levels of maintenance?

2. Which level of maintenance is performed on-equipment?

3. Which level of maintenance uses highly specialized skills and special facilities?

4. Which maintenance approach modifies or eliminates the intermediate function where possible?

5. Which maintenance approach is commonly practiced at CONUS bases?

602. Types and categories of maintenance

1. What are the two basic types of maintenance?

2. Which major command operates ALCs?

3. Which maintenance categories are used by the Air Force?

603. Maintenance classification

1. Which type of maintenance is predictable?

2. Which type of maintenance is unplanned?

3. This type of maintenance requires special depot scheduling.

1–2. Maintenance Inspection System

Inspections of assigned aerospace vehicles and equipment are a must to have a combat-ready force at all times. To keep equipment maintenance costs as low as possible while maintaining a mission-ready fleet, the Air Force instituted the preventive maintenance program using the inspection system. Preventive maintenance allows for identifying and correcting equipment discrepancies early before they cause major problems. This section explains the different maintenance inspection concepts and methods.

604. Inspection concepts and methods

When possible, maintenance is accomplished on a preplanned, scheduled basis. This planning provides the most effective and efficient use of people, facilities, and equipment. It also reduces unscheduled maintenance and allows for progressive actions toward maintaining and returning aircraft and equipment to safe operating condition.

Inspections on weapon systems, support systems, or equipment are accomplished using various concepts and methods.

Concepts

The five inspection concepts used by the Air Force are as follows:

1. Periodic.
2. Phased.
3. Isochronal.
4. Programmed depot maintenance (PDM).
5. Airline/manufacturer.

These concepts follow applicable –6 technical orders (TO), also known as the scheduled inspection and maintenance requirement manuals or inspection workcards. For example, 1C–130B–6WC–1 is an inspection workcard manual for the C–130B cargo aircraft. The local commander establishes the necessary controls to assure periodic, phased, or isochronal inspections are accomplished at or near their scheduled due time. The system program manager schedules the PDM inspection in coordination with the using agency before the scheduled due time.

Periodic concept

The periodic concept is based on the accrual of a specified number of flying hours, operating hours, or at the expiration of a calendar period. The following table lists the various inspections, with an explanation of each, that make up this concept.

Periodic Concept	
Types of Inspections	Description
Preflight (PR)	Primarily required before the first flight of a specified flying period. This inspection includes visually examining the aircraft and operationally checking certain systems and components to ensure that there are no serious defects or malfunctions.
End-of-runway (EOR)	Final visual and/or operational check of a designated aircraft's systems and components. It is performed immediately before take-off at a designated location, usually near the end of the runway. The inspection may include items such as checking tires for cuts, fluid systems for leaks, ensure panels and doors are closed and fastened, or down locks, and that covers and pins are removed.

Periodic Concept	
Types of Inspections	Description
Thruflight (TH)	The TH is a between-flights inspection and is accomplished after each flight when a turnaround sortie or continuation flight is scheduled and a basic postflight is not required. This inspection consists of checking the aircraft for flight continuance, done by visual examination, or performing operational checks to ensure that no defects exist that would be detrimental to further flight.
Basic postflight (BPO)	Done after the last flight of a specified flying period. The BPO is a visual or operational check to assure that no defects exist that would be detrimental to flight. There is no obligation for maintenance to perform this inspection until operations releases the aircraft. The BPO is more thorough than a preflight or thruflight.
Hourly postflight (HPO)	Done after a specified number of flying hours are accrued. HPOs are done at equally spaced intervals. The due time for an HPO is determined at the completion of each periodic/phased inspection. Early or late accomplishment of an HPO does not normally change the scheduled times.
Periodic (PE)	Due upon accrual of a specified number of flying hours, operating hours, or the expiration of a calendar period. The PE is more extensive in scope than the HPO or BPO. It is a thorough and searching inspection of the entire weapon system or support system.

Phased concept

The phased concept involves consolidating the BPO, HPO, and PE requirements into small packages having approximately the same work content and clock hours for accomplishment. The primary objective of the phased inspection is to minimize the length of time an aircraft is out of commission for any given scheduled inspection. The number of phase packages varies by aircraft type. Through the application of this concept, a portion of the total recurring inspection requirements is accomplished at each phase and the cycle is repeated after the completion of the last package.

Phased inspections are scheduled at equal intervals throughout the total inspection cycle regardless of when the inspections are actually performed. PR, EOR, and TH inspections are accomplished the same as under the PE concept.

Isochronal concept

The isochronal concept is designed to translate flying hour utilization rates into calendar periods, usually expressed in days. This concept includes not only the PR, EOR, TH, and BPO, but also the home station check (HSC), minor inspection (MIN), and major inspection (MAJ), whose elements are described in the table below:

Isochronal Concept Elements	
Element	**Description**
Home station check	The HSC consists of inspection requirements arranged and designed for accomplishment when an aircraft returns from a long-range mission or upon the expiration of a specified short-term calendar interval. The due date of the inspection is computed from the completion of the last HSC/isochronal inspection. The inspection is done in conjunction with minor and major inspections.
Minor inspection	The MIN is due upon accrual of a specified number of calendar days. It consists of checking certain components, areas, or aircraft systems to determine if conditions exist, which if uncorrected, could result in failure or malfunction of a component before the next scheduled inspection.

Isochronal Concept Elements	
Element	**Description**
Major inspection	The MAJ is due upon the accrual of the number of calendar days established. The MAJ is very much like a PE in that it is a thorough and searching inspection of the entire aircraft. This inspection consists of checking certain components, areas, or systems that due to their function, require less frequent inspection than that required by other inspections. Remember, the purpose is to determine if there are any conditions that, if not corrected, would result in failure of a component or system before the next scheduled inspection. The PR, EOR, TH, and BPO are accomplished the same as under the PE concept.

Figure 1–1 is a simple chart that can help you recognize the different inspections that are common and unique to the concepts discussed so far.

Inspection	Concept
• Preflight. • End-of-runway. • Thruflight. • Basic postflight.	• Periodic. • Phase. • Isochronal.
• Hourly postflight.	• Periodic. • Phase.
• Home station check. • Minor Inspection. • Major Inspection.	• Isochronal

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Figure 1–1. Inspections and concepts.

PDM concept

PDM is an inspection requiring skills, equipment, or facilities not normally possessed by the operating location. Individual areas, components, and systems are inspected to a degree beyond the –6 inspection requirements. Operating location tasks may be accomplished during the PDM if it is economically feasible. PDM is accomplished at an established interval; the interval is measured from the output to input date. When an aircraft exceeds the PDM cycle, a red dash is annotated on the applicable forms. When 90 days have elapsed without a PDM input, the red dash is upgraded to a red X unless an extension is granted.

Airline/manufacturer maintenance concept

This scheduled maintenance follows the inspection schedule requirements of the aircraft manufacturer. This concept consists of letter checks A thru D. The A and B checks are considered *minor* inspections comparable to the Air Force flight preparedness inspections and are usually performed at home station. C and D checks are considered *major* inspections comparable to the isochronal requirements and are usually performed at a heavy maintenance or depot facility.

The letter check concept is specified in either flying hours or calendar days. The time frame intervals will be defined in the applicable –6 scheduled inspection and maintenance manual or the maintenance planning document (MPD). The inspection coordinator, called the single manager (SM), ensures the inspection period is properly established to meet maintenance and engineering requirements. Major commands (MAJCOM), with SM concurrence, approve deviations to schedules if letter check inspections cannot be met.

Methods

There are two methods of inspection: in-place and dock.

In-place method

This method of inspection is used when maintenance or operational requirements are such that the inspection or maintenance must be performed at the equipment (aircraft) location. This means the inspection can be performed on the equipment regardless of the equipment's location. If the equipment is located on the flight line, then the inspection is performed on the flight line. If the equipment is located in the hangar, then the inspection is performed there.

Dock method

The dock method is employed when the inspection or operational requirements are such that the equipment must be moved to a fixed location, usually a hangar dock, for the inspection and maintenance. Usually, maintenance crews are permanently assigned to the site. Each dock is equipped with the necessary tools and equipment needed to accomplish the required inspection or maintenance.

605. Calendar inspections

There are two calendar inspections required for aircraft, no matter which inspection concept the aircraft is under. These are the 30- and 90-day calendar inspections.

30–day inspection

This inspection is required when an aircraft has not flown or has been out of commission for more than 30 consecutive days. The inspection consists of a basic/hourly postflight or HSC, depending on the inspection concept. The 30-day inspection is required before the aircraft can be returned to operational status. These are the minimum inspection requirements; the local commander determines whether additional inspections or maintenance is required.

90–day inspection

This inspection is required when an aircraft has not flown for more than 90 consecutive days. The minimum requirements consist of performing a basic/hourly postflight, performing an operational check of all functional aircraft systems, and accomplishing all periodic or minor lubrication requirements. For aircraft under the phase or periodic inspection concept, the recurring inspection items required at each inspection are also considered as minimum requirements. Again, the local commander determines if any additional requirements are necessary.

Accomplishing either the 30- or 90-day inspection affects only the BPO or HSC inspection status. Flying time accrued toward a phase or periodic inspection remains charged against the aircraft for the next inspection. For aircraft under the isochronal concept, storage time accrued over15 calendar days is not charged against the calendar time for the next scheduled HSC, minor, or major inspection. However, the calendar days that have elapsed between the inspections and the date on which the aircraft was placed in storage is charged against the aircraft and used to adjust the due dates for the next inspections when the aircraft is removed from storage.

Aircraft in the PDM do not require the minimum requirements previously mentioned if the items were completed and documented as part of the PDM package and 90 days have not elapsed since they were accomplished.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

604. Inspection concepts and methods

1. Name the five inspection concepts.

2. Which type of inspection is conducted to prepare for flight?

3. Which type of inspection is required when a turnaround sortie or continuation flight is scheduled?

4. When would a MIN be required?

5. Define the in-place method of inspection.

6. Define the dock method.

605. Calendar inspections

1. When is a 30–day calendar inspection required?

2. When is a 90–day calendar inspection required?

3. Who determines if additional requirements need to be added to the calendar inspection?

4. Under what conditions do aircraft in PDM not require the 90–day inspection be performed?

1–3. Flying and Maintenance Planning Cycle

MAJCOMs are responsible for developing procedures to ensure the intent of the operational and maintenance planning cycles are met. The objective is to ensure the wing flying hour program execution is consistent with operational requirements and maintenance capabilities. These planning cycles ensure operations and maintenance resources are properly and effectively used. The process requires cooperation between maintenance and operations. Maintenance and operations schedulers work jointly to develop an annual flying plan that balances operational needs and maintenance capabilities. This wing flying plan includes an assessment of the wing's ability to execute the flying hour program.

The first step in this process is called "first look." In this section, we will discuss the "first look" process as well as the process of computing maintenance capabilities.

606. First look

Every year, on or about 15 March, the maintenance management production section tasks the maintenance management analysis section to accomplish a maintenance capabilities assessment to be completed by no later than the last workday of March, which is the "first look" request. This assessment takes into account personnel, facilities, and airframe capabilities for each aircraft maintenance organization.

Once complete, the maintenance management production section provides copies of the capability study to each operational squadron (OS) and maintenance scheduling section. The maintenance management production section further provides "first look" maintenance capability projections in a monthly format according to MAJCOM procedures to maintenance supervision, OS operations' officers, aircraft maintenance squadron commander (AMXS/CC), and the Maintenance Management Production Section. Projections include operational requirements, an assessment of maintenance's ability to support the monthly requirement, and an overall assessment of the unit's maintenance capability to meet the annual flying hour program.

The AMXS and OS coordinated responses are sent to the maintenance management production section and operations support squadron's (OSS) current operations flight scheduling, and are consolidated into a comprehensive package that includes a breakdown of sortie utilization (UTE) rates by month, sorties contracted/scheduled per day, monthly scheduled sorties, and inspection dock capability.

Once compiled, the package is presented to the Operations Group (OG) and Maintenance Group commanders (MXG CCs) before being presented to the Wing commander (WG/CC) for final approval. Final assessments of maintenance capabilities to support the operations' "first look" projections are sent to the MAJCOM as necessary.

607. Computing maintenance capabilities

Maintenance capability is composed of three parts: airframe capability, personnel capability, and facility capability. These are considered when determining the unit's capability to support the operational flying requirement for a specified month, quarter, or fiscal year. Below are each capability's considerations:

- Airframe capability determines if the unit's available aircraft can support the requirement.
- Personnel capability determines if the unit's workforce can support the requirement. If it can't, shortfalls are identified and recommended actions are made to enable personnel to meet the requirement or identify problems that are outside the unit's control (e.g., manning imbalances, skill level imbalances, etc.).
- Facility capability determines if a unit has the facilities (e.g., phase docks, fuel barns, etc.) to support the requirement.

Airframe capability

Airframe capability is used when determining the unit's capability to support the operational flying requirement for a specified month, quarter, or fiscal year. It is an assessment of various maintenance and operations factors based on historical data and assumptions. Airframe capability computations are a compilation of factors that determine if a unit's available aircraft can support any type of requirement in peacetime and wartime. When all factors are considered, the assessment is developed in terms of an airframe capability forecast. This is a tool for commanders to assess their peacetime or wartime capability.

Airframe capabilities vary with the airframe mission, base support, and unit mission requirements. For the purpose of this study, we use fighter base units with F–16s with a single operational mission. You'll look at the total F–16 sortie generation capability of all F–16 units.

The basic assumption starts with a scenario, whether the tasking is a peacetime or wartime capability. The assumption states its conditions and limitations, as directed by higher headquarters (HHQ). For example, the peacetime scenario includes a two-shift operation of nine hours each with a 40 work hour week. A third shift could incorporate training with essential personnel only.

Maintenance factors

Maintenance factors are all maintenance-related activities that can affect the availability of aircraft for sortie generation. These maintenance factors reduce airframe availability. If one aircraft is provided as a maintenance trainer, then that's one less aircraft for flying. Aircraft wash and scheduled maintenance actions are also included. These factors are assigned a numerical value for each unit (e.g., the maintenance factors for units are Base A – 2, Base B – 4, Base C – 1, etc.).

Sortie generation factors

The maintenance factor is included as one of the factors for sortie generation. The others include the following:

1. Number of operations and maintenance days per year.
2. Total possessed aircraft.
3. Historical mission capability (MC) rate.
4. Turn factor (hours).
5. Average sortie duration (hours).
6. Flying envelope (hours).
7. Crew preflight time (hours).
8. Maintenance preparation time (hours).
9. Attrition rate.

You have learned about some of these topics in our previous lessons, so we will not cover them in any detail. Instead, we'll treat them as available data you are given.

Computations

In our computations, we look for maximum capability. Given some factors that can reduce our F–16's capability, we determine how much we can "deliver." With all these factors considered, we look for the following:

1. Sortie capability (initial and maximum).
2. Sortie losses (projected).
3. Flying hour capability (maximum).
4. Sortie UTE rate (maximum).

NOTE: In the following formulae, notice we use primary aircraft inventory (PAI) and possessed aircraft. You are to use the lower of the two at the time you are making the computations. Also, the number of operation and maintenance (O&M) days per year is based on 4.5 workdays per week, and does not include training, safety, or goal days. The formula used in computing airframe capability is as follows:

Initial Sortie Capability = (PAI or Possessed Aircraft-Maintenance Factors) × MC Rate × O&M Days per Year

First Turn Aircraft Available = (PAI or Possessed Aircraft) – Maintenance Factors

First Turn Sortie Capability = First Turn Aircraft Available × MC Rate × O&M Days per year

Sortie Capability = Initial Sortie Capability + First Turn Sortie Capability

Projected Sortie Losses = Sortie Capability × Attrition Rate

Maximum Sortie Capability = Sortie Capability – Projected Sortie Losses

Maximum Flying Hour Capability = Maximum Sortie Capability × Average Sortie Duration

$$\text{Maximum Sortie UTE Rate} = \frac{\text{Maximum Sortie Capability}}{\text{(PAI or Possessed Aircraft)}} \div 12$$

Personnel capability

Personnel capability is measured in terms of maintenance personnel per operational unit (MP/U). MP/U measures the total number of direct maintenance personnel needed for each specified operational unit to perform direct on- and off-equipment work. You use this measurement in developing manpower projections to support specified operating and maintenance concepts. This is only an estimated manpower projection. You take into consideration basing, deployment, and operational scenarios.

MP/U calculations include direct on- and off-equipment maintenance personnel and specialties related to direct on- and off-equipment support (e.g., structural repair [including sheet metal and composites] and non-destructive inspection [NDI]). When analyzing manpower requirements, MAJCOMs consider and use projected MC, partial mission capable (PMC), mean repair time (MRT), and mean time between maintenance (MTBM) rates, along with aircraft battle damage repair analyses to determine overall manpower needs.

MP/U calculations exclude maintenance staff agencies, logistics command section operations and support personnel, powered support equipment (SE) personnel, and munitions supply and missile maintenance personnel.

Computations

Personnel capability is expressed in several ways, depending on unit requirements. It is expressed as a ratio, with factors such as flying hours, sorties, work center, man-hours, crew, inspections (hourly postflight [HPO] and PE), number of personnel, and workday month (WDM). To meet operational requirements, it may be expressed as the number of sorties or flying hours a work center can support. Some of the formulas that can be used are:

Flying Hours Non-supported = Flying Hour Requirement-Work Center Flying Hour Capability

Total Man-Hours Required = Flying Hours Required x Man-Hour per Flying Hour Factor

$$\text{Number of Personnel Required} = \frac{\text{Total Man-Hours Required}}{\text{Number of Available Man-Hours for One Person In WDM}}$$

$$\text{Number of HPOs Per Crew Per Month} = \frac{\text{WDM}}{\text{HPO Days}}$$

Number of HPOs per Month = Number of HPO per Crew per Month x Number of HPO Crews Available

$$\text{Number of HPOs Per PE Cycle} = \frac{\text{HPO Inspections Cycle}}{\text{PE Inspections Cycle}}$$

$$\text{Man-Hours Per Flying Hour Factor} = \frac{\text{JDD Direct Man-Hours Expended}}{\text{Flying Hours Flown}}$$

$$\text{Aircraft Work Ration} = \frac{\text{Man-Hours By Standard Reporting Designator (SRD)}}{\text{Total Aircraft Man-Hours}}$$

$$\text{Supportable Flying Hours} = \frac{\text{Available Man-Hours}}{\text{Man-Hours Per Flying Hour Factor}}$$

$$\text{Supportable Sorties} = \frac{\text{Supportable Flying Hours}}{\text{Average Sortie Duration}}$$

Facility capability

When the term facility is used, it refers to space requirements (e.g., for a dock to be considered a complete operational unit, it must include the facility and the necessary personnel). In this instance, facility capability is computed to determine how many flying hours or sorties the inspection docks can support. These are determined for each type of aircraft. You must be able to calculate how many docks are required to support the flying schedule.

Computations

Facility capability may be expressed in docks and crews. Even though only one dock may be required, it may consist of three crews or shifts. To determine the number of flying hours or sorties your facilities can support, you need the following information: inspection cycle, average sortie length, WDM, in-dock time, and the number of docks available. To determine the dock requirements, use the following formulas:

$$\text{Number of Inspections Required} = \frac{\text{Flying Hours Scheduled}}{\text{Inspection Cycle}}$$

$$\text{Dock Days Required} = \text{Number of Inspections Required} \times \text{Average Dock Days Per Inspection}$$

$$\text{Number of Docks Required} = \frac{\text{Dock Days Required}}{\text{Work Days Per Month}}$$

To determine flying hours and sortie capability, use these formulas:

$$\text{Number of Inspections Per Dock} = \frac{\text{WDM}}{\text{Average Dock Days}}$$

$$\text{Number of Inspections Per Month} = \text{Number of Inspections Per Month} \times \text{Number of Docks Available.}$$

$$\text{Dock Flying Hour Capability} = \text{Number of Inspections Per Month} \times \text{Inspection Cycle}$$

$$\text{Dock Sortie Capability} = \frac{\text{Dock Flying Hour Capability}}{\text{Average Sortie Length}}$$

There are different algorithms for maintenance capabilities, which are airframe, personnel, and facility, developed by the MAJCOMs that meet their fleet and geographical requirements. You must follow the formulas prescribed by the MAJCOM to which you are assigned in order to meet their requirements.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

606. First look

1. What is included in the “first look” maintenance capability assessment?

2. Who is the final approval authority for a completed “first look” package?

607. Computing maintenance capabilities

1. What are the three parts of maintenance capability?

2. When is airframe capability used?

3. What are the four *main* computations to determine maximum capability?

4. What does the MP/U measure?

5. The term “facility” refers to?

6. Why is facility capability computed?

Answers to Self-Test Questions

601

1. Organizational, intermediate, and depot.
2. Organizational.
3. Depot.
4. 2LM.
5. 3LM.

602

1. On-equipment and off-equipment.
2. AFMC.
3. Operating command and AFMC on-equipment and off-equipment.

603

1. Scheduled.
2. Unscheduled.
3. Unscheduled.

604

1. (1) Periodic, (2) Phased, (3) Isochronal (4) Programmed depot maintenance, and (5) Airline/Manufacturer.
2. Preflight.
3. Thruflight.
4. After the accrual of a specific number of calendar days.
5. When maintenance or operational requirements mean that the inspection or maintenance must be performed on the equipment at its location.
6. When the inspection or maintenance requirements are such that the equipment must be moved to a fixed location.

605

1. When an aircraft has not flown or has been out-of-commission for more than 30 consecutive days.
2. When an aircraft has not flown for more than 90 consecutive days.
3. Local commander.
4. If the items were accomplished and documented as part of the PDM package and 90 days have not elapsed since they were accomplished.

606

1. Personnel, facilities, and airframe capabilities for each aircraft maintenance organization.
2. WG/CC.

607

1. Airframe capability, personnel capability, and facility capability.
2. To determine the unit's capability to support the operational flying requirement for a specified month, quarter, or fiscal year.
3. Sortie capability (initial and maximum), sortie losses (projected), flying hour capability (maximum), and sortie UTE rate (maximum).
4. The total number of direct maintenance personnel needed for each specified operational unit to perform direct on- and off-equipment work.
5. Space requirements including needed personnel.
6. To determine how many flying hours or sorties the facilities can support.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

1. (601) This is *not* a level of maintenance.
   a. Base.
   b. Depot.
   c. Intermediate.
   d. Organizational.

2. (601) The two-level maintenance (2LM) approach seeks to modify or eliminate which level of maintenance?
   a. Base.
   b. Depot.
   c. Intermediate.
   d. Organizational.

3. (602) Which maintenance category consists of those tasks that *cannot* be done on the end-item, but are within the capability of the skills and equipment possessed by a unit?
   a. Air Force Materiel Command (AFMC), on-equipment.
   b. AFMC, off-equipment.
   c. Operating command, on-equipment.
   d. Operating command, off-equipment.

4. (603) This is an example of a type of preventive maintenance inspection.
   a. Time compliance technical order (TCTO) compliance.
   b. Aircraft acceptance inspection.
   c. Systematic inspection.
   d. Corrosion control.

5. (603) Which maintenance category includes correcting discrepancies discovered during flight?
   a. Unscheduled.
   b. Preventive.
   c. Debriefing.
   d. Scheduled.

6. (604) The *primary* objective of *minimizing* the length of time an aircraft is out of commission due to a scheduled inspection describes this inspection concept.
   a. Isochronal.
   b. Periodic.
   c. Phased.
   d. Depot.

7. (604) Which inspection *method* is used when maintenance or operational requirements call for the inspection to be performed at the equipment location?
   a. Preventive.
   b. In-place.
   c. Delayed.
   d. In-dock.

8. (605) How many *calendar inspections* are *all* aircraft required to have, no matter which inspection concept applies?
   a. One.
   b. Two.
   c. Three.
   d. Four.

9. (605) Which inspection status is affected by the 30- or 90-day inspection?
   a. Preflight.
   b. Thruflight.
   c. Hourly postflight.
   d. Home station check.

10. (606) The maintenance management section tasked with accomplishing a maintenance capabilities assessment, known as “first look,” is maintenance
    a. management production.
    b. management analysis.
    c. operations center.
    d. supply liaison.

11. (607) The three parts that make up the maintenance capability are airframe, personnel, and
    a. facility.
    b. security.
    c. readiness.
    d. deployment.

12. (607) This *factor* reduces aircraft availability when computing for airframe capability.
    a. Mission capability rate.
    b. Attrition rate.
    c. Maintenance.
    d. Turn.

13. (607) When determining airframe capability, which computation includes *attrition rate* as one of the factors?
    a. Sortie capability.
    b. Projected sortie losses.
    c. Initial sortie capability.
    d. First turn aircraft available.

14. (607) When computing maintenance capabilities, personnel capability is measured in terms of
    a. base personnel per operational unit.
    b. civilian personnel per operational unit.
    c. military personnel per operational unit.
    d. maintenance personnel per operational unit.

Please read the unit menu for unit 2 and continue ➔

Student Notes

Unit 2. Maintenance Metrics

METRICS ARE NOTHING more than a barometer for problems. Understanding the unit's maintenance metrics is only the first part of learning to analyze these problems. 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, we develop one.

We watch for the filtering of metrics that show the problem because they may be 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, an investigation into the circumstances is warranted. You will study methods to measure the effectiveness of maintenance, operations, and mission performance indicators. The term *logistics* is also synonymous with maintenance while the term *operations* is synonymous with mission. One section focuses on key metrics and their impact to the Air Force mission. This unit also covers cyber space communication system performance metrics and measures.

2–1. Computing Maintenance and Operations Performance Indicators

Maintenance managers are primarily concerned with how well the unit is meeting mission requirements, how to improve equipment performance, and identifying support problems that surface. Managers compare the unit's logistics performance with their own, as well as with the MAJCOM's standards and goals. They also develop their own maintenance plans and measure how well they are able to execute and achieve their objectives.

As an analyst, you make monthly comparisons of actual maintenance performed versus what was scheduled. You also compare maintenance performance with established standards. When you make these comparisons, you are required to identify significant deviations from what was planned or from established standards.

There are a large number of performance items you will compare either to "plans" or to "standards" while on the job. In this section's lessons, you will learn how to compute the most common maintenance performance indicators.

608. Computing system reliability and capability rates

System reliability and capability rates are indications of a unit's ability to keep equipment in a ready status. A maintenance analyst looks closely at equipment performance and identifies trends that might require further investigation, such as referrals or special studies.

As an analyst, you compute system reliability and capability rates that are presented at daily meetings and could be included in the monthly maintenance summary. If computed inaccurately, these rates could hurt the credibility of your maintenance unit and duty section. Therefore, it is advantageous for everyone to ensure that the rates are computed with accuracy.

Status coding

Each system and aircraft is coded in either the Integrated Maintenance Data System (IMDS) or another maintenance documentation database that your base uses. These codes represent how each system or aircraft performed during a sortie. Normally two types of status codes are used: system and aircraft.

System status codes

System status codes reflect, by system, any malfunction or failure that occurred during the aircraft sortie. These are also known as *system capability (cap) codes* that indicate the status of each system/subsystem at the end of the sortie. System status codes not only indicate how the individual system performed on the aircraft, but also indicate if the system was in operation during the sortie. System status codes are shown in figure 2–1.

CODE	DESCRIPTION
0	System flown with a known discrepancy, no additional discrepancies noted. System can be used.
1	System used and performed satisfactory.
2	System used and performed satisfactory, minor malfunction exists. System is capable of further missions.
3	System performed unsatisfactory. This system did not cause an abort.
4	System performed unsatisfactory. This system did cause an abort.
5	System out of commission prior to takeoff.
6	System installed but not used.
7	System not installed.
8	Aircraft or system has suspected or known radiological/biological contamination.

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Figure 2–1. System status codes.

Aircraft status codes

Aircraft status codes, also called *landing status codes*, reflect how the overall aircraft performed. These status codes do *not* consider whether each system was used, they just reflect the overall condition of the aircraft upon landing after the sortie. By using these codes, described in the following table, flying squadron managers can better supervise their aircraft.

Aircraft Status Codes	
Code	**Description**
1	The aircraft landed with no discrepancies (malfunctions or failures).
2	The aircraft or system has minor discrepancies, but is capable of further mission assignments within normal turnaround times. A malfunction occurred but the aircraft/system is still partially functional.

Aircraft Status Codes	
Code	**Description**
3	The aircraft or system has major discrepancies in mission essential equipment that may require extensive repair or replacement before further mission assignment (a system on the aircraft failed completely). **NOTE:** Short of the aircraft crashing, this code is the least favored to be attached to an aircraft.

System reliability rate

System reliability is expressed as a percentage. The rate provides you with an indicator of how long a selected system performs without a *malfunction* (write-up). Malfunction includes cap codes 2, 3, and 4. You obtain the data required to calculate capability rates from either the Transaction Identifier Code (TRIC) Aircraft System Reliability/Capability Report (TRIC: ASR) or the Performance Report (TRIC: PER). System reliability can be calculated for a single aircraft or for the entire fleet. The formula for the calculation is shown below:

$$\text{System Reliability} = \left(\frac{\text{Total number of sorties flown Cap Code 1}}{\text{Number of system uses (Cap Codes 0,1,2,3,4, and 8}} \right) \times 100$$

To make your calculation, select the appropriate formula. Next, obtain the required data that is to be entered in the formula.

For this example, 185 sorties were flown, of these none (0) were flown without the use of the environmental control system, and there were 5 system malfunctions (cap code 2). Therefore, your data is:

Sorties flown = 185

System not used = 0

Sorties without malfunctions = 180.

The next step is to enter the data in the appropriate section of the formula:

$$\text{System Reliability} = \left(\frac{180}{185} \right) \times 100$$

Complete the math: 180 divided by 185 equals 0.973. Multiply this by 100 (0.973 × 100) to get the system reliability. In this example, system reliability is 97.3%.

Interpreting this calculation shows that the system did *not* malfunction 97.3 percent of the time it was used

System capability rate

System capability rates provide you with an indicator of how much of the time a selected system performs without a *failure* (major malfunction/unsatisfactory performance write-up). You obtain the data required to calculate capability rates from either the Aircraft System Reliability/Capability Report (TRIC: ASR), Performance Report (TRIC: PER). Like the reliability rate, you can calculate system capability for a single aircraft or for an entire aircraft wing As you look at the capability rate formula shown below, note that it differs from the system reliability because it reflects **only system failures** (cap codes 3 and 4)—*not malfunctions*.

$$\text{System Capability} = \left(\frac{\text{Total number of sorties flown Cap Codes 0,1,2, and 8}}{\text{Number of system uses (Cap Codes 0,1,2,3,4, and 8}} \right) \times 100$$

To begin, select the appropriate formula for the statistic you are calculating. In this case, use the preceding System Capability formula. Next, obtain the data required for your calculation. For this example, 180 sorties were flown. Of these, none (0) were flown without the use of the radio, and there were 3 system failures (cap code 3). Therefore, the data to enter in the formula is as follows:

Sorties flown = 180

System not used = 0

Sorties without failures = 177.

Now, substitute your data into the appropriate portions of the formula:

$$\text{System Capability} = \left(\frac{177}{180}\right) \times 100$$

To determine the System Capability, complete the math operations. First, divide 177 by 180. Enter the result (0.983) in the formula. Then complete the multiplication: 0.983 × 100. The result is a 98.3 percent system capability.

This result indicates the radio system did *not* fail 98.3 percent of the time it was used

System capability is a valuable tool to use when selecting aircraft for certain types of missions. *The higher the capability the less likely a system failure will occur.* Since system capability uses only failures, it is always *equal to or higher than the system reliability*, which includes failures and malfunctions.

609. Computing base repair capability rates

Base repair capability rates are management indicators that evaluate work center repair capability. Your duty section, Maintenance Management Analysis (MMA), is responsible for analyzing the base's repair capability and providing maintenance managers with information regarding adverse trends.

Purpose

The purpose of any base repair capability program is to return base-generated reparable items, authorized for base-level repair, to a serviceable condition at base-level. In simpler terms, a base repair capability program is designed to repair parts at base-level, if the repair is authorized by the USAF. If certain repair actions are not authorized at base level, supply must forward non-repairable items to contract maintenance or the AFMC depot for repair. Local maintenance managers use the results of these rates to track the effectiveness of the total repair capability. MAJCOM managers use the information in evaluating programs to increase repair capability across an entire weapon system, and an aircraft is considered a weapon system.

Procedure

While most commands have an established standard for base repair, a unit should strive for a rate of 100 percent. You must keep managers informed on how well they are doing with this program. Certain action-taken codes are used in computing a base repair rate. Use six of the repair codes and all the "not reparable this station" (NRTS) codes to calculate the rate. Figure 2–2 is an extract from IMDS screen 127, once you click the option "Action Taken Codes." You can find a detailed description of these codes in TO 00–20–2, *Maintenance Data Documentation*, or TO 00–20–3, *Maintenance Processing of Reparable Property and Repair Cycle Asset Control System*.

0 = BENCH CHECKED—NRTS, WARRANTY	H = EQUIPMENT CHECKED, NO REPAIR R
1 = BENCH CHECKED—NRTS, REPAIR NO	J = CALIBRATION, NO ADJUSTMENT REQ
2 = BENCH CHECK--NRTS, LACK OF TOO	K = CALIBRATION, ADJUSTMENT WAS RE
3 = BENCH CHECK--NRTS, LACK OF TEC	L = ADJUSTMENT FOR SAFETY, PROPER
4 = BENCH CHECKED—NRTS, LACK OF P	M = DISASSEMBLE, OFF-EQUIPMENT, MU
5 = BENCH CHECKED—NRTS, SHOP BACK	N = ASSEMBLE AFTER OTHER ACTIONS W
6 = BENCH CHECKED—NRTS, LACK OF T	P = REMOVED, WHEN ONLY THIS ACTION
7 = NRTS, TOOLS, PARTS, DATA, ETC.	Q = INSTALLED WHEN ONLY THIS ACTIO
8 = NRTS, DEPOT OR MANAGEMENT DIRE	R = REMOVE AND REPLACE A LIKE ITEM
9 = BENCH CHECKED—CONDEMNED, NOT	S = REMOVE AND REINSTALL THE SAME
A = BENCH CHECKED AND REPAIRED IN	T = REMOVE FOR CANNIBALIZATION (HO
B = CHECKED AND FOUND SERVICEABLE	U = REPLACED AFTER CANNIBALIZATION
C = CHECKED, REPAIR DEFERRED	V = CLEANING WHEN NOT PART OF REPA
D = BENCH CHECKED, TRANSFERRED TO	W = NON-DESTRUCT INSPECTIONS
E = INITIAL INSTALLATION, NO REMOV	X = TEST, INSPECTION, SERVICE, NO
F = REPAIR, NOT FOR ON-EQUIPMENT I	Y = TROUBLE SHOOT, REPORT TIME SPE
G = REPAIRS AND/OR REPLACEMENT OF	Z = CORROSION REPAIR/TREATMENT, IN

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Figure 2–2. Action Taken Codes listing.

The first thing to do before you compute the rate is to obtain the necessary data. You could extract the appropriate data from job data documentation (JDD) reports, the background report, IMDS screen 386, Base Repair Capability Program, TRIC QBS, or another extraction method such as a query language processor (QLP). Regardless of the method you choose, select the number of units produced for action-taken codes A, F, G, K, L, Z, and NRTS codes 0–9.

Once you have the necessary data, the next step is to compute the base repair rate. The formula is:

$$\text{Base Repair Capability Rate} = \frac{\text{Total repairs (A, F, G, K, L, Z)}}{\text{Total repairs + NRTS 0 - 9}} \times 100$$

For this example, the maintenance organization had 688 repair actions and 16 NRTS actions. Using this data, you compute the base repair capability rate by substituting in the formula as follows:

$$\text{Base Repair Capability Rate} = \frac{688}{688 + 16} \times 100 = 97.7\%$$

This rate is acceptable when compared to the standard of 95 percent that most units use.

If you have a request to itemize the rate further, you would do the same computations by work center. This lets work center supervisors know how well their shops are doing in the base repair capability program. These computations are used to determine to what extent reparable items are repaired at base-level.

610. Maintenance scheduling effectiveness rates

The maintenance scheduling effectiveness rate is used as a local management feedback tool to measure adherence to scheduled maintenance plans and actions. Maintenance scheduling effectiveness is a management indicator that measures how well the maintenance schedule was accomplished. You will find that managers are always interested in the timely accomplishment of the maintenance requirements scheduled in the monthly maintenance plan. One maintenance requirement you will analyze is the number of inspections completed compared to the number of inspections scheduled.

You can get the number of scheduled inspections from the monthly maintenance plan. The following list contains the *minimum* information for a monthly maintenance plan, your organization's monthly maintenance plan may contain additional information:

- Aircraft operational hours and total sorties' requirement for each type of equipment by squadron, group, or wing.
- Workload requirements, time compliance technical orders (TCTO), engine changes, time changes, contract or depot maintenance, washes, corrosion control, and inspection requirements.
- Estimated specialist support requirements, projected in bulk hours by work center. (**NOTE:** This data is normally supplied by MMA.)
- Quality assurance scheduled inspections listed by type.
- Special activities, such as unit commander calls, group temporary duty (TDY), and unit formations.
- Training requirements.
- Support requirements: fuel; oil, lubricants and servicing; supply; food services; security; fire department; base civil engineer; and base operations.

Get your information and completed inspections from plans and scheduling if you are actually doing a comparison of scheduled inspections versus completed inspections.

While all maintenance actions are important, the relative importance of accomplishing one type of maintenance action versus another is determined by local maintenance managers or higher headquarters. You must know which tasks are more important and have the greatest impact on mission accomplishment. A weighted value by degree of importance is assigned to each scheduled maintenance action or task.

Maintenance scheduling effectiveness rates can be calculated for any scheduled maintenance action. Refer to figure 2–3 as we calculate the actual maintenance scheduling effectiveness for a given wing.

A	B	C	D	E	F
SCHEDULED EVENT	WEIGHTED POINTS	NUMBER OF EVENTS SCHEDULED	POSSIBLE POINTS	COMPLETED AS SCHEDULED	POINTS EARNED
Alert Prep	25	5	125	4	100
Phases	20	3	60	3	60
Washes	15	13	195	8	120
BPOs	10	27	270	20	200
TCTOs	10	50	500	25	250
Engine Changes	5	0	0	0	0
TOTAL	---	---	**1150**	---	**730**

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Figure 2–3. Maintenance scheduling chart example.

You may obtain data for columns A, B, C, and E from plans and scheduling (fig. 2–3). Perform your calculations as follows:

Calculating Maintenance Scheduling Effectiveness Rate	
Step	**Action**
1	List all scheduled maintenance events to be monitored in column A.
2	List the weighted points for each maintenance event in column B.
3	List the number of events scheduled for that month in column C.
4	Multiply the weighted points in column B by the number of events scheduled in column C to get the possible points. ***Example***: 25 × 5 = 125. Enter your product in column D.
5	Enter the number of events completed as scheduled in column E.
6	Multiply the weighted points for each event in column B times the number of events completed in column E. **Example:** 25 × 4 = 100. Enter the product in column F.
7	Get the total from columns D and F after you have computed for each event.
8	Divide the total of points earned in column F by the total possible points in column D. Multiply the quotient by 100 to get the rate.

The formula used in the preceding steps is shown below:

$$\text{Maintenance Scheduling Effectiveness Rate} = \frac{\text{Total points earned}}{\text{Total points possible}} \times 100$$

Use the data from the example in figure 2–3 and substitute in the formula:

$$\text{Maintenance Scheduling Effectiveness Rate} = \frac{730}{1150} \times 100 = 63.5\%$$

You have just computed the wing's maintenance scheduling effectiveness rate. Now, compare 63.5 percent to the established standard. For this example, we use 95 percent, but as we stated, standards vary among MAJCOMs. As you can see, 63.5 percent is below the standard, so an investigation should be performed to determine the cause of unaccomplished events. These procedures may be applied to any category of scheduled data when computing maintenance scheduling effectiveness.

611. Computing delayed discrepancy rates

The deferred, or delayed, discrepancy (DD) rate (DDR) is a leading indicator that should be closely evaluated in comparison to other metrics. This rate represents the average deferred discrepancies across a unit's average possessed aircraft fleet.

Purpose

Deferred discrepancies are maintenance actions that need to be accomplished but are deferred to a later date when they are discovered. For a delay to be considered a DD, the job is either deferred to a later date, scheduled with a start date greater than 5 calendar days after the discovery date, or deferred for awaiting parts (AWP) not available through the local supply system. Parts on order must have a valid off base requisition. Delayed discrepancies are referred to as awaiting maintenance (AWM), AWPs, or a combination of AWM and AWP.

Although minor maintenance actions must sometimes be deferred or delayed to a more appropriate time, maintenance work centers try to keep this rate as low as possible. If DDs can't be scheduled or combined with a more extensive maintenance action, maintenance schedulers should routinely schedule their aircraft to work these delays.

DD rates

The *total number* of DDs is based on snapshots of how many DDs there are on a given date and are necessary because the number of discrepancies is *not* constant. The number of DDs fluctuates as jobs are worked and parts issued. To compute DD rates you will need the following:

- Total (snapshot) of AWM and/or AWP discrepancies, obtained from the Event Listing (TRIC: EVL). Snapshots are typically done once a week for each week in a month (command or local policy may differ).
- Average possessed aircraft for the reporting period. Obtain the possessed hours from the Aerospace Vehicle Status report (TRIC: AVS) and calculate using the following formula:

$$\text{Average Possessed Aircraft} = \frac{\text{Possessed Hours}}{\text{Days in Reporting Period} \times 24 \text{ hrs.}}$$

The following is an example using the formula to compute average possessed aircraft for a wing that has 21,318 possessed hours and a 31 day reporting period:

$$\text{Average Possessed Aircraft} = \frac{21{,}318}{31 \times 24}$$

$$= \frac{21{,}318}{744}$$

$$= 28.7$$

To calculate the total, AWM and AWP DD rates in the following examples, we will use these values:

Average Possessed Aircraft	=	28.7
Total (Snapshot) AWM discrepancies	=	120
Total (Snapshot) AWP discrepancies	=	43

Computing DD Rates

Rate	Computation
Total DD rate	$\text{Total DDR} = \frac{\text{Total (Snapshot) AWM + AWP discrepancies}}{\text{Average Possessed Aircraft}}$ $\text{Total DDR} = \frac{120 + 43}{28.7} = \frac{163}{28.7} = 5.7$
AWM DD rate	$\text{AWM DDR} = \frac{\text{Total (Snapshot) AWM discrepancies}}{\text{Average Possessed Aircraft}}$ $\text{AWM DDR} = \frac{120}{28.7} = 4.2$
AWP DD rate	$\text{AWP DDR} = \frac{\text{Total (Snapshot) AWP discrepancies}}{\text{Average Possessed Aircraft}}$ $\text{AWP DDR} = \frac{43}{28.7} = 1.5$

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

608. Computing system reliability and capability rates

1. What indications of a unit's ability do system reliability and capability rates provide?

2. What is a system reliability rate?

3. What is a system capability rate?

609. Computing base repair capability rates

1. What is the purpose of the base repair capability program?

2. Name two agencies that repair parts that are *not repairable* at base level.

3. Units should strive for this base repair capability rate.

610. Maintenance scheduling effectiveness rates

1. What does the maintenance scheduling effectiveness rate measure when it is used as a local management feedback tool?

2. Which document is referenced to get the number of scheduled inspections?

3. What are some examples of support requirements?

4. What should you do if the computed rate is *lower* than the MAJCOM standard?

611. Computing delayed discrepancy rates

1. What does the DD rate represent?

2. What are deferred discrepancies?

3. What criteria must be met for a job to be considered a DD?

2–2. Mission Performance Indicators

A primary reason for you to analyze maintenance data is to maintain a constant awareness of the various weapon systems and support equipment capabilities. Such capabilities depend on all assets available and necessary to support them. These assets include time, manpower, money, facilities, and equipment. If maintenance planning and programming are to be effective, the organization's productive capability must be developed in realistic terms.

These realistic terms, computed from past performance, are based on the organization's effectiveness. With the month's commitment (the mission for the month), management must know whether the commitment is compatible with the resources available as they are being used. A maintenance organization must be flexible so that additional crews can be formed and additional shifts can be set. To do so, organizations must improve the utilization and effectiveness of available manpower and equipment to increase capability. The mobility requirements of modern warfare demands that you know your maximum capabilities—we must know how much, how many, how fast, and how effectively we can mobilize when necessary.

To provide inputs for improving or increasing maintenance capabilities, you must have a complete understanding of what the capabilities are and how they are computed. This section provides techniques for computing various mission performance indicators. Also, we present examples for computing mission capability factors and for improving such factors. Additionally, you will learn about the flying performance rates you will be computing and analyzing monthly, and how all the flying indicators discussed are used.

612. Computing aircraft status rates

Aircraft status computations specifically identify potential problem areas for maintenance managers. MC is calculated from past data that indicates the percentage of time each type of aircraft, missile, trainer, and so forth, was actually capable of performing its assigned mission(s). This data is available from the Equipment Status Report (ESR) and AVS report.

Purpose

The MC rate represents the percentage of all possessed aircraft that are capable of fulfilling at least one of their wartime missions. It quantifies the number of aircraft that can go to war.

Total not mission capable maintenance (TNMCM)/total not mission capable supply (TNMCS) rates are used in conjunction with the MC rate to identify the problems that cause lower MC rates. Both of these rates reflect the total aircraft not mission capable (NMC) limitations—either for maintenance, represented by "M," or supply, represented by "S." TNMCM is the sum of not mission capable maintenance (NMCM) and not mission capable both (NMCB), while TNMCS is the sum of not mission capable supply (NMCS) and NMCB.

As a maintenance management analyst, you use the data for several different activities, such as informing maintenance managers about the status of assigned equipment, as well as preparing analyses, briefings, and the monthly maintenance summary. The data is used to portray the total supply and maintenance limitations. This information is reported via IMDS directly to the Reliability and Maintainability Information System (REMIS) and is available to all REMIS users.

Maintenance and supply statuses

Maintenance status codes are used to describe the assigned aerospace vehicles and equipment capability to perform their unit assigned missions. Units that are assigned missions are defined as a unit's specifically assigned wartime, training, or test missions. For example, a fully mission capable (FMC) aircraft can fly all peacetime and wartime missions; if an aircraft is not FMC, it is reported in the maintenance status codes as either NMC or partial mission capable (PMC). PMC aircraft can fly at least one, but not all missions. On the other hand, NMC aircraft cannot fly any assigned missions.

The reason an aircraft is assigned a specific status code is indicated by the addition of a letter to the basic PMC or NMC maintenance status condition code. The additional letters are "M" for maintenance or PMCM; "S" for supply or PMCS; or "B" for both maintenance and supply or PMCB. Aircraft in codes NMCM and NMCB use an additional code to show if needed maintenance is scheduled ("S") or unscheduled ("U"); when added after NMCM, it becomes NMCM scheduled (NMCMS) or NMCM unscheduled (NMCMU). If the reason is NMCB, it results in NMCB scheduled (NMCBS) or NMCB unscheduled (NMCBU).

For overall logistics support assessment, an NMCB code is considered equally as important as NMCS and NMCM. The table in figure 2–4 is designed to help familiarize you with these commonly used terms and their acronyms.

FMC - Fully Mission Capable	The aircraft is capable of performing all of its assigned missions.
PMC - Partial Mission Capable	PMC is a grouping of all PMC statuses (PMCB, PMCM, PMCS). The aircraft can perform at least one, but not all, of its assigned missions due to maintenance or supply reasons.
NMC - Not Mission Capable	NMC indicates the aircraft cannot perform any of its assigned missions due to maintenance and/or supply reasons. NMC is a grouping of all statuses (NMCS, NMCM, NMCB).
TNMCM - Total Not Mission Capable Maintenance	This is the sum of Not Mission Capable Maintenance (NMCM) and Not Mission Capable Both (NMCB) and reflects total NMC aircraft limitations due to maintenance.
TNMCS - Total Not Mission Capable Supply.	This is the sum of NMCS and NMCB and reflects total NMC aircraft limitations due to supply.

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Figure 2–4. Mission capable terms and descriptions.

Airworthiness

The maintenance status codes describe an aircraft's ability to perform a unit-assigned mission. Hence, if it cannot perform its mission, it is in either a PMC or NMC status. When an aircraft is in an NMC status, it may still be able to fly, but not perform its assigned mission. An NMC aircraft can be considered flyable or nonflyable. The mission essential systems list (MESL) specifies which system, subsystem, or component on an aircraft is mission-essential.

A flyable NMC aircraft can fly although it has an inoperative system, subsystem, or component that is listed on the MESL. For example, an autopilot system may be mission essential for long flights but not for short distances. So an aircraft with an inoperative autopilot system can be considered "NMC flyable." On the other hand, when flight safety is of concern, such as with a leaking hydraulic system, the aircraft is “NMC nonflyable.” The code “A” for airworthiness is added to the NMC code. For example, “not mission capable maintenance airworthy” is indicated as NMCMA.

Work unit codes

Units report the work unit codes (WUC) for the *most serious* mission-limiting condition on aircraft that are in PMC and NMC status. The WUC for the maintenance condition is used when reporting PMCB or NMCB. The WUC for supply conditions should agree with the WUC reported in the supply system.

Aircraft status rates

All raw data used to compute aircraft status rates come from the AVS report. The AVS report displays possessed hours. For the following example, you have been tasked to compute MC rates for the 123rd Wing, which has 500 possessed hours for their F–15s. The 500 possessed hours are broken down as follows (use this data to compute the following rates):

Data for Computing Mission Capability Rates	
Data	**Hours**
FMC	300
NMCS	100
NMCM	50
NMCB	25
PMCM	15
PMCS	5
PMCB	5
Total	**500**

Here are the computations for the MC rates.

Mission Capability Rate Computations	
Rate	**Computation**
MC	The formula for computing mission capability rate is: $\text{MC Rate} = \frac{\text{FMC hours} + \text{PMC hours}}{\text{Possessed hours}} \times 100$ $\text{MC Rate} = \frac{300 + 25}{500} \times 100 = 65\%$
PMC	To calculate the PMC rate, you must first compute PMC hours using this formula: PMC hours = PMCS hours + PMCM hours + PMCB. Then compute the PMC rate using this formula: $\text{PMC Rate} = \frac{\text{PMC hours}}{\text{Possessed hours}} \times 100$ $\text{PMC Rate} = \frac{25}{500} \times 100 = 5\%$

Mission Capability Rate Computations	
Rate	**Computation**
NMC	The NMC rate is divided between NMCS, NMCM, and NMCB. The formulas for computing the different NMC rates are shown below.
NMCB	$\text{NMCB Rate} = \frac{\text{NMCB hours}}{\text{Possessed hours}} \times 100$ $\text{NMCB Rate} = \frac{25}{500} \times 100 = 5\%$
NMCM	$\text{NMCM Rate} = \frac{\text{NMCM hours}}{\text{Possessed hours}} \times 100$ $\text{NMCM Rate} = \frac{50}{500} \times 100 = 10\%$
NMCS	$\text{NMCS Rate} = \frac{\text{NMCS hours}}{\text{Possessed hours}} \times 100$ $\text{NMCS Rate} = \frac{100}{500} \times 100 = 20\%$
TNMC	To calculate the TNMC rate, you must first compute TNMC hours using this formula: TNMC hours = NMCS hours + NMCM hours + NMCB. The formulas for computing TNMC rate is as follows: $\text{TNMC Rate} = \frac{\text{TNMCM hours}}{\text{Possessed hours}} \times 100$ $\text{TNMC Rate} = \frac{175}{500} \times 100 = 35\%$
TNMCM	$\text{TNMCM Rate} = \frac{\text{NMCM hours} + \text{NMCB hours}}{\text{Possessed hours}} \times 100$ $\text{TNMCM Rate} = \frac{50 + 25}{500} \times 100 = 15\%$
TNMCS	$\text{TNMCS Rate} = \frac{\text{NMCS hours} + \text{NMCB hours}}{\text{Possessed hours}} \times 100$ $\text{TNMCS Rate} = \frac{100 + 25}{500} \times 100 = 25\%$

613. Measuring flying schedule planning and execution

In this lesson, we discuss the different mission performance indicators that are used to determine how well a unit is planning and executing its flying schedule. There are three main areas that contribute to making this determination: the mission schedule deviation rate, the flying scheduling effectiveness rate, and the departure reliability rate. We will take a look at each of these in the following paragraphs.

Mission schedule deviation rate

Mission schedule deviation rates are management indicators that show how well your unit is flying their scheduled missions. In this lesson, you will study the various deviation rates you will be computing and analyzing on a monthly basis: cancellation, early/late takeoff, ground, and air abort. First, you will learn about the terminology used with these rates and then you will study the actual procedures involved in computing each one.

Deviations

A *deviation* is an event that is different from what was planned/scheduled. A cancellation is a deviation; also, an early/late takeoff is a deviation.

Chargeable deviation

The two most common types of chargeable deviations are maintenance and supply. A *maintenance deviation* is caused by a maintenance malfunction, such as a component failing. A *supply deviation* is caused by a lack of parts. Chargeable deviations are controlled at MAJCOM level.

Nonchargeable deviation

A nonchargeable deviation is a deviation caused by reasons other than maintenance or supply, such as a late crew arrival, weather, or similar events.

NOTE: Command directives provide more specific definitions of chargeable and nonchargeable deviation categories. However, for the purpose of this course, you need only know that *maintenance and supply deviations are chargeable* and *all other categories are nonchargeable*.

Cancellation

A cancellation is a scheduled flight that, for some reason, could not fly at its scheduled time and date, nor could it fly within the cancellation grace period. This cancellation grace period may differ among MAJCOMs. For example, one command may use ±3 hours from the scheduled takeoff time. If an aircraft's scheduled takeoff time was 0800 and the grace period is 3 hours, but the aircraft actually took off earlier than 0500, later than 1100, or not at all, then the originally scheduled sortie would be considered a cancellation.

NOTE: If an aircraft does fly, but the originally scheduled sortie was cancelled, then the flight would be considered an addition to the schedule.

Cancellation rate

Now that you know what a cancellation is, let's learn how to determine a cancellation rate. You will need the following information:

- The number of sorties scheduled, obtained from either the Accomplishment Utilization Report (AUR) or a locally established mean.
- The number of chargeable cancellations, obtained from either the AUR or a locally established mean.

The formula you use to determine the cancellation rate is:

$$\text{Cancellation rate} = \frac{\text{Number of chargeable cancellations}}{\text{Number of scheduled sorties}} \times 100$$

Example: Determine the cancellation rates from the following data:

Sorties scheduled	Cancellations	
210	Operations	4
	Maintenance	7
	Supply	3
	Higher headquarters	6

Step 1: Obtain the number of scheduled sorties: 210.

Step 2: Obtain the number of chargeable cancellations. Remember to count only maintenance and supply cancellations. You will find that there were 7 maintenance cancellations and 3 supply cancellations for a total of 10 chargeable cancellations.

Step 3: Substitute the data in the formula and perform the calculation.

After substitution, here is the cancellation rate:

$$\text{Cancellation rate} = \frac{10}{210} \times 100 = 4.8\%$$

This calculation shows that 4.8 percent of the cancelled scheduled sorties were chargeable deviations. Because chargeable cancellations should be controllable, whenever you have a high cancellation rate you most likely have a problem. A high cancellation rate always warrants a detailed investigation. Most MAJCOMs set standards for chargeable deviations; therefore, whenever the cancellation rate exceeds the standard, you must investigate to determine the cause.

Early takeoff

An early takeoff is a scheduled flight that actually flies earlier than the originally scheduled time. Normally, an early takeoff is based on a standard period versus the scheduled time. This early takeoff "grace period" differs depending on the type of aircraft and the MAJCOM. One type of aircraft may have an early takeoff grace period of 5 minutes. As an example, based on a 5-minute grace period, an aircraft would be considered an early takeoff if it launched earlier than 5 minutes before its scheduled time. Conversely, an aircraft scheduled for a 0900 takeoff that actually takes off at 0855 is considered an on-time takeoff (OTTO) based on the 5 minute "grace period." Consider the following two examples:

Example 1. An aircraft is scheduled for a 0900 takeoff, but actually took off at 0745. It is considered an early takeoff based on a 5 minute early takeoff grace period and a 3-hour cancellation grace period.

Example 2. An aircraft is scheduled for a 0900 takeoff, but actually took off at 0545. It is considered a cancellation and an addition based on a 3-hour cancellation grace period.

Late takeoff

A late takeoff is a scheduled flight that actually flies later than its originally scheduled time. Normally, there is a late takeoff "grace period" based on a standard period versus the scheduled time. This late takeoff "grace period" differs depending on type of aircraft and MAJCOM. One type of aircraft may have a late takeoff "grace period" of 10 minutes, and another 5 minutes. As an example, based on a 10-minute "grace period," an aircraft is considered as taking off late if it takes off more than 10 minutes beyond its scheduled time.

Example 1. An aircraft is scheduled for a 0900 takeoff, but actually departs at 0911. It is a late takeoff based on a 10-minute "grace period," (0911 versus 0910).

Example 2. An aircraft scheduled for takeoff at 0900 actually took off at 0908. It is an on-time takeoff based on a 10-minute "grace period," (0908 versus 0910).

The aircraft must not take off any later than the cancellation "grace period" or it is considered a cancellation and an addition instead of a late takeoff.

Example 1. An aircraft scheduled for takeoff at 0900 actually took off at 1100. It is a late takeoff based on a 10-minute "grace period" and a 3-hour cancellation "grace period."

Example 2. An aircraft scheduled for takeoff at 0900 actually took off at 1215. It is a cancellation and an addition based on a 3-hour cancellation "grace period."

Late takeoff rate

Now that you know what a late takeoff is, you must learn how to determine the rate. You will need the following information:

- Number of sorties scheduled; obtained from either the AUR or a locally established mean.
- Number of chargeable late takeoffs; obtained from either the AUR or a locally established mean.
- Total number of cancellations; obtained from either the AUR or a locally established mean.

The formula you would use to determine the late takeoff rate is:

$$\text{Late Takeoff Rate} = \frac{\text{Number of chargeable late takeoffs}}{\text{Number of scheduled sorties - number of cancellations}} \times 100$$

***Example*:** Determine the late takeoff rate for the following data:

Sorties scheduled	Aircraft status:	Total
210	Operations late	1
	Operations early	1
	Maintenance late	16
	Maintenance cancelled	6
	Supply late	2
	Supply cancelled	14
	Higher headquarters late	4

Step 1: Determine the number of scheduled sorties.

Step 2: Determine the number of chargeable late takeoffs. Remember to *count only maintenance and supply late takeoffs*. You may have noticed that there are 24 early/late takeoffs. You are only interested in late takeoffs for maintenance and supply. So, how can you tell which are early and which are late? Keep in mind, an aircraft will never take off early because of a maintenance or supply deviation. Therefore, if the deviation is for maintenance or supply reasons, you know that it is a late takeoff. Our data shows that there were 16 maintenance and 2 supply late takeoffs for a total of 18 chargeable late takeoffs.

Step 3: Determine the total number of cancellations. In our example, 20 sorties were canceled.

Step 4: Substitute the data in the formula and perform the calculation. After substitution:

$$\text{Late Takeoff Rate} = \frac{18}{210 - 20} \times 100 = 9.5\%$$

This calculation shows that 9.5 percent of the scheduled sorties were chargeable late takeoffs. As previously mentioned, whenever a very high late takeoff rate is reached, you must investigate to determine the cause since chargeable late takeoffs should be controlled. Most MAJCOMs set standards for chargeable late takeoffs, so exceeding the standard should warrant an investigation.

Flying scheduling effectiveness rate

The flying scheduling effectiveness (FSE) rate measures your organization's effectiveness in flying sorties as scheduled. The FSE rate provides commanders with a tool to measure their ability to plan and execute their flying requirements. A monthly and weekly flying schedule is prepared. The unit records events that are considered deviations (chargeable and nonchargeable) from the schedule.

Both chargeable and nonchargeable deviations are combined to get the total number for all deviations. The total deviations are then subtracted from the total number of scheduled sorties. The formula you would use to compute the FSE rates is:

$$\text{FSE Rate} = \frac{\text{Total number of scheduled sorties - total deviations}}{\text{Number of scheduled sorties}} \times 100$$

The data you use to compute the FSE rate is normally obtained from either the AUR or a locally established means and the following information is needed:

- The number of scheduled sorties.
- The number of additions.
- The total number of cancellations.

Example**:** Determine the FSE rate for T38As using the following data:

Sorties scheduled	Aircraft status	Total
210	Operations additions	10
	Operations cancellations	4
	Maintenance cancellations	10
	Maintenance additions	8
	Supply cancellations	6

Step 1: Determine the number of scheduled sorties. There were 210 sorties scheduled.

Step 2: Add all deviations (additions and cancellations). The total number of deviations is 38.

Step 3: Substitute the data in the formula and perform the calculation. After substitution:

$$\text{FSE Rate} = \frac{(210 - 38)}{210} \times 100 = 81.9\%$$

The FSE rate for T38As is 81.9 percent. As the number of deviations increases, the FSE rate goes down. Since deviations directly affect the FSE rate, whenever the rate goes below your command’s standard, an investigation should be performed to determine the cause.

Departure reliability rate

Departure is synonymous with takeoff; so are delayed departures and late takeoffs. The departure reliability is the percentage of total departures that did *not* have a delay. It is a measure of all departures affected by any kind of delay. The delay could be any deviation or a direction by higher headquarters that delays the mission. This rate is used by the Air Mobility Command (AMC) and applies to nonfighter aircraft such as cargo aircraft and tankers. The mission of large aircraft is the timely delivery of personnel, supplies, and equipment to any destination in the United States and worldwide. The main concern of logistics planners and managers is the reliability of certain types of aircraft and the bases that support launching them.

AMC Instruction (AMCI) 10–202, Volume 6, *Mission Management and Reliability Reporting System (MMRRS)*, 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. This allows each level of command to improve mission departure reliability performance.

For example, consider a squadron of United States-based fighter aircraft deploying to a base in the Middle East. One requirement is in-flight refueling midway through their flight. Air mobility planners look for bases along the flight route that can provide tanker support. In making their decisions for tanker support, they look at the reliability of the base and aircraft that can support the mission. The departure reliability rates are an important factor in this decision making.

There are two types of departure reliability rates: logistics and worldwide. The *logistics departure reliability* rate provides the percent of departures that are delayed because of supply, saturation, or maintenance problems. Logistics refers to maintenance, supply, transportation, delivery of fuel, and so forth. A departure delay for supply occurs when the aircraft delays for parts. A departure delay for saturation, or shortage, occurs when there is saturation, or shortage, of logistics facilities, personnel, or assigned support equipment. A departure delay due to maintenance problems includes improper maintenance, lack of maintenance equipment, or maintenance-related training at home station.

The logistics departure reliability rate equation is as follows:

$$\text{Logistics Departure Reliability Rate} = \frac{\text{Total departures} - \text{Logistic delays}}{\text{Total departures}} \times 100$$

The logistics departure reliability rate is usually focused on the unit that owns the aircraft, referred to as the *home station*, which originates the first leg of the mission. This is known as the *home station logistics departure reliability*. The *en route logistics departure reliability* rate is used to account for delays that occur *en route* during the second or subsequent legs of the mission. The applicable AMC instructions set the guidelines and definitions for applying the appropriate rate.

The *worldwide departure reliability* rate is the percentage of total departures, similar to the logistics departure reliability, where the delays are also due to supply, saturation, or maintenance problems. It is an overall rate because it takes into account everything that caused a delay.

For example, a flock of birds on the runway can delay a departure if personnel have to drive them off, resulting in the aircraft departing late. This action is required to avoid the engines ingesting the birds on takeoff. The formula for the *worldwide departure reliability* rate uses the same factors as the *logistics departure reliability* rate; however, all departures throughout its worldwide mission are included. The departure reliability rate can be computed for the type of aircraft (called the mission design series, e.g., C–141, C–5, and KC–10) or for the base.

614. Computing planning factors

In this lesson, we take a look at the different factors that provide input for planning different operations. We begin by looking at the utilization rate, followed by the aircraft availability and attrition rates. Then we turn our attention to the spare factors and conclude the lesson with a discussion of man-hours per flying hour.

Utilization rate

The utilization (UTE) rate is primarily used by operations in planning the unit's flying hour program. Maintenance uses this measurement to show assigned aircraft usage. Since they are used for planning, actual UTE rates are used to evaluate the unit's monthly and annual plan. The UTE rate can be used to plan equal utilization of possessed aircraft. It makes sense that one aircraft should not fly only 15 hours in a time period when another aircraft had to fly 100 hours. You can tell if your aircraft are being used equally by calculating each aircraft's UTE rate and applying the normal curve.

The two types of UTE rates are as follows:

Program UTE rate is the number of hours each possessed aircraft is programmed to fly to accomplish the unit's mission. Program UTE rates are normally computed for monthly and quarterly intervals.

Actual UTE rate is the number of hours that each possessed aircraft actually flew.

Calculating UTE rates for flying hour program

The most common use of an UTE rate is in the unit flying program. Each fiscal year, the MAJCOM allocates flying hours to the units based on their operational and maintenance capabilities. The command also provides a recommended annual UTE based on the unit's primary aircraft inventory (PAI). PAI is the number of aircraft assigned to the unit. This could be the same number as the total "authorized" for the unit. When the MAJCOM allows for variation in the computation of the UTE rate, they only consider a certain number of aircraft for inclusion in the formula. These are "chargeable" aircraft. This could happen in situations where some aircraft may be in programmed maintenance (PDM, depot, modification, etc.) or a unit may be undergoing conversion.

In support of the flying hour program, we define the UTE rate as the average number of sorties or hours flown per authorized or chargeable aircraft. There are two ways to compute the UTE rate—sortie and hourly. The *sortie* UTE rate is used for fighter aircraft and the *hourly* UTE rate is used for all other aircraft. The UTE rate is computed monthly. Under this program, as actual UTE rates are computed, the unit compares the monthly UTE rate with the monthly goal and the current cumulative rate for the fiscal year. The main goal is to meet the annual allocated flying hours. The following are the formulas to calculate the Sortie and Hourly UTE Rates.

$$\text{Sortie UTE Rate} = \frac{\text{Sorties flown}}{\text{Authorized or Chargeable aircraft}}$$

$$\text{Hourly UTE Rate} = \frac{\text{Hours flown}}{\text{Authorized or Chargeable aircraft}}$$

NOTE: Chargeable aircraft may be the same number as authorized aircraft.

Calculating Usage (USE) rates

The USE rate is similar to the UTE rate and is preferred in Mobility Air Forces' (MAF) units. It is the average number of flying hours or sorties per aircraft possessed for a given time period. The USE rate is expressed as hours or sorties per aircraft per day, month, or year. This rate is not easily controlled at the local level. A high USE rate compared to similar fleets may indicate the fleet is overtasked or a low USE rate may indicate that the fleet is underutilized. The ideal performance for USE rates should be flat, performing within margins set by the MAJCOM with little fluctuation. The USE rate formulas are as follows:

$$\text{Sortie USE Rate} = \frac{\text{Total sorties flown}}{\text{Average possessed aircraft}}$$

$$\text{Hourly USE Rate} = \frac{\text{Total hours flown}}{\text{Average possessed aircraft}}$$

Calculating UTE rate Z-score

To determine if aircraft are being over or underutilized, you can compute the UTE rate and apply the normal curve. Keep in mind that the aircraft configuration will play a part in this. Some aircraft may only be configured to fly local missions and their flying hours will be less than average; you may have aircraft that are configured to fly local and cross-country missions, and their flying hours will be more than average.

The *minimum* time period for data used in this calculation should be 6 months. You will need the following data to compute UTE rate Z-score:

- The average number of flying hours per possessed aircraft. This can be determined by dividing the total number of flying hours by the total number of possessed aircraft. The flying hours may be obtained from the AUR and the possessed aircraft is obtained from the AVS.
- A calculated standard deviation. For this example, we provide the standard deviation since you already know how to calculate it.
- A selected aircraft's total flying hours for the same time period where the average number of flying hours per possessed aircraft were based.
- The formula you use to compute UTE rate Z-score is: $Z = \frac{X - \overline{X}}{S}$

Where:

Z	=	The number of standard deviations.
X	=	The selected aircraft total flying hours.
$\overline{X}$	=	The average number of flying hours per possessed aircraft.
S	=	The value of one standard deviation.

For this example you need to determine if aircraft A4040 is being used effectively based on the following data:

6 months total flying hours:	2,700
6 months total possessed aircraft:	90
Standard deviation:	5
6 months flying hours of aircraft A4040:	50

Step 1: Determine the six-month average number of flying hours per possessed aircraft by dividing the total flying hours of 2,700 by the 90 total possessed aircraft.

$$\frac{2700}{90} = 30 \text{ average flying hours per possessed aircraft.}$$

Step 2: Substitute the numbers in the formula and perform the calculation. After substitution:

$$\frac{50 - 30}{5} = 4 \text{ standard deviations (Z).}$$

Step 3: At this point, you have to decide if the utilization is acceptable. Remember from our study of a normal curve (volume 3) that whenever the Z value exceeds 3, a problem most likely exists. As you can see, the Z value of 4 in our example exceeds 3; therefore, a problem most likely exists.

In this case, the *positive* Z value indicates that the aircraft was used more than the average. A *negative* Z value means the aircraft was used less than average. For this example, the utilization of aircraft A4040 was not good, since it was used significantly more than it should have been. You can state that *the scheduling of aircraft A4040 requires careful attention to avoid overflying it*.

Aircraft availability rate

In recent years, as you might expect, the number of aircraft available for both peacetime and wartime missions has become increasingly important. With few exceptions, diverse operational areas, expanding global missions, and day-to-day training takes a toll on every airframe. As a result, computing aircraft availability is even more critical for proper maintenance and mission planning.

Purpose

One of your maintenance analyst goals is to aid the preventive maintenance process. Our aircraft require regular maintenance and repair to ensure their optimum availability for mission taskings. Each aircraft has a maintenance concept tailored to its operational mission. The specific inspection and servicing requirements included in the maintenance concept form the basis of a preventive maintenance program. All Air Force (AF) units must implement and manage the scheduled program tasks for their assigned aircraft and associated SE. Following this program ensures that aircraft systems and components will operate with greater reliability over time and ensure maximum aircraft availability.

Maintenance scheduling, in conjunction with maintenance analysis, provides operations and maintenance managers with planning factors for aircraft availability and maintenance capability and informs them of deviations from maintenance schedules.

Computing

Aircraft availability is defined as the percentage of a fleet *not* in a depot-possessed or non-mission capable status. When computing aircraft availability you use the AVS report (TRIC: AVS) to find the MC rate and total possessed hours.

NOTE: There are only certain possession purpose codes that are selected for MC and total possessed hours. The list is too numerous to include in this text, so make sure that you review AFI 21–101, *Aircraft and Equipment Maintenance Management*, before computing this in your daily duties.

The following example assumes that you selected the correct hours based on possession codes:

MC hours = 16,854.8

Total possessed hours = 20,150.4

$$\text{Aircraft Availability Rate} = \frac{\text{MC hours}}{\text{Total possessed hours}} \times 100$$

$$\text{Aircraft Availability Rate} = \frac{16{,}854.8}{20{,}150.4} \times 100 = 83.6\%$$

Attrition rate

Attrition is the reduction or loss of sorties due to weather, aborts, operation cancellations, or a failure of maintenance to provide aircraft for scheduled sorties. In other words, attrition represents the historical percentage of sorties lost to causes beyond the unit’s control. The maintenance management production section schedules sorties to fulfill the mission commitment using what we call the attrition factor.

Attrition factors

An attrition factor is any factor that influences aircraft attrition. Attrition factors represent a historical percentage of scheduled sorties lost to causes outside of a unit’s control, such as maintenance, weather, and so forth. The total attrition factor is the total combination of all the attrition factors that applies to the unit.

NOTE: The total attrition factor is also referred to as an attrition rate.

The attrition factor enables the maintenance production manager to project additional scheduled sorties to meet the fiscal year requirements. To allow for attrition, the maintenance production manager overschedules committed sorties by an additional number of sorties based on the attrition factor.

Each MAJCOM determines the different categories for the attrition factor. For example, Air Combat Command (ACC) uses these factors when computing attrition: maintenance, operations, supply, higher headquarters (HHQ), weather, sympathy, air traffic control, and a separate category called "other." ACC defines these deviations distinctly.

We compute these factors based on the unit's historical data from previous flying months. Use enough data to ensure that you consider seasonal variations. We look for the total sorties lost in a particular category. The computations vary according to each unit's unique requirements and situation as agreed upon by operations and maintenance.

Here is an example of the computed attrition factors for an ACC unit:

ACC Unit Computed Attrition Factors	
Maintenance	.01
Operations	.01
Supply	.01
HHQ	.01
Weather	.02
Sympathy	.01
Air traffic	.01
Other	.03
Total Attrition factors	.11

When you add all the individual attrition factors for the unit in the preceding example, the total attrition factor is .11. This figure, converted to a percentage; is an example of an 11 percent attrition rate.

Applying the attrition factor

Given an 11 percent total attrition factor (attrition rate), the next step is to compute the number of sorties that are to be added to the schedule for the following month.

Sorties required = 200

Total attrition factor = .11

To account for the loss of scheduled sorties, you are required to divide the sorties by one, minus the attrition factor. In this case, we are using the total attrition factor, therefore the formula is as follows:

$$\text{Total sorties to schedule} = \frac{\text{Sorties required}}{(1 - \text{Total attrition factor})}$$

$$= \frac{200}{1 - .11}$$

$$= \frac{200}{.89}$$

$$= 224.72$$

We round this to 225 sorties

Total sorties to schedule next month = 225

Additional sorties to schedule = 225 – 200 = 25

To meet the 200 sortie requirement, there must be 225 sorties scheduled to account for the 11 percent sortie loss due to attrition. You can also apply each attrition factor separately to look for anticipated sortie losses in a specific category. For example, to look for projected sorties lost due to maintenance, use the maintenance attrition factor (.01) to compute the number of expected sorties lost due to maintenance. Using the requirement for 200 sorties, compute the projected sortie loss due to maintenance as follows:

$$\text{Sorties Lost Due to Maintenance} = \frac{\text{Sorties}}{(1 - \text{maintenance attrition factor})}$$

$$= \frac{200}{1 - .01}$$

$$= \frac{200}{.99}$$

$$= 202$$

Projected sorties lost due to maintenance attrition: 202 – 200 = 2

NOTE: The attrition factor is used to project sortie losses and compensate for the calculated loss.

Spare factors

The spare factor is another tool that you calculate and the maintenance production management section uses the factor to ensure the unit’s mission goals are met. Where attrition factors represent sorties lost to causes outside of a unit’s control, spare factors compensate for unit-controllable causes. Unit-controlled factors include maintenance cancellations, supply cancellations, and ground aborts. Maintenance management analysis computes spare aircraft requirements annually and provides this data to the maintenance production management section, which uses it to build the annual flying schedule. Daily spare aircraft requirements are shown for each unit in the weekly flying schedule.

Each MAJCOM has its own criteria for scheduling spare aircraft needed to meet the unit’s mission. Generally, spare requirements will *not exceed* 20 percent of the number of aircraft committed to the flying schedule, rounded up to the next whole aircraft number. Analysis uses historical *first sortie logistics losses* (maintenance and supply cancellations, and ground aborts) compared to the number of historical sorties scheduled to determine the spare factor. Use as much historical data as needed to ensure that seasonal variations are considered.

The spare factor is computed using this formula:

$$\text{Spare Factor} = \frac{\text{Historical 1st Sortie Cancellations}}{\text{Historical Sorties Scheduled}}$$

We will use the following maintenance production data sample for our calculation:

Historical Sorties Scheduled = 200

Number of 1st Sortie Maintenance Cancellations = 20

Number of 1st Sortie Supply Cancellations = 4

Number of 1st Sortie Ground Aborts = 10

Compute the spare factor for each category as follows:

$$\text{Maintenance} = \frac{\text{1st Sortie Maint Cancellations}}{\text{Historical Sorties Scheduled}} = \frac{20}{200} = .10$$

$$\text{Supply} = \frac{\text{1st Sortie Supply Cancellations}}{\text{Historical Sorties Scheduled}} = \frac{4}{200} = .02$$

$$\text{Ground Abort} = \frac{\text{1st Sortie Ground Aborts}}{\text{Historical Sorties Scheduled}} = \frac{10}{200} = .05$$

Once the spare factor is computed for each of the categories, add them together to find the total spare factor, as follows:

1st Sortie Maintenance Cancellations	=	.10
1st Sortie Supply Cancellations	=	.02
1st Sortie Ground Aborts	=	.05
Spare Factor	=	.17 or 17 %

Using a sample sortie requirement of 30 1st sorties, we can calculate the number of spare aircraft required for the schedule to compensate for sorties lost due to unit-controlled factors:

Spare Aircraft Required	=	1st Sorties Scheduled × Spare Factor
Spare Aircraft Required	=	30 × .17
	=	5.1

Rounded to the next higher whole aircraft, the number of spare aircraft required is 6. To meet the sortie requirement of 30, 6 spare aircraft will have to be scheduled.

Man-hours per flying hour

Man-hour cost factors are a must in determining a unit's maintenance capabilities. For example, the plans and scheduling section must know how many man-hours are required to support one flying hour, an inspection, an engine change, and other types of maintenance operations. However, even after you have established these cost factors, they must be evaluated and compared to find out if they are reliable and effective. If you use a cost factor derived from inefficient work or poorly controlled conditions, you cannot produce meaningful capability factors. Therefore, you must figure these man-hour cost factors for each maintenance shop, section, or activity.

How can you find the man-hour cost factor of a completed maintenance action? The easiest way to compute the man-hour cost factor is to multiply the number of people who do the job by the number of clock hours it takes them to do the job. For example, what would the man-hour cost be for a job that takes 6 people and 4 clock-hours to complete? The answer is 6 × 4 = 24 man-hours. This example is a simple mathematical problem and is not always the case when you compute all man-hour cost factors.

The two main factors to consider are man-hours and flying hours. The man-hour data obtained by the JDD from IMDS is broken out into three categories:

1. On-equipment.
2. Off-equipment.
3. Support general.

The MAJCOM determines the parameters of these two factors. The main source is the maintenance information system (MIS) used. You can extract man-hour data from an MIS, such as the IMDS. You obtain the flying hours from the plans and scheduling office. They oversee the flying hour program and compute the flying hours expended by each aircraft for the month. We will not go into the computations of the flying hours because the requirements vary by MAJCOM.

Note that the algorithms vary to correspond to requirement changes. Because of the variability of the algorithms/requirements, our discussion focuses on the *basic formulas* and examples of variations.

Man-hours/flying hours for on and off equipment

The man-hours expended for completed on-equipment and off-equipment work are combined to obtain the man-hours per flying hours. The formula is as follows:

$$\text{Man-hours/Flying Hour} = \frac{\text{Man-hours (On)} + \text{Man-hours (Off)}}{\text{Flying hours}}$$

The labor man-hours for both on- and off-equipment are only obtained from labor expended whose first position of the WUC is *not* equal to "0", and *not* equal to support general work unit codes, also referred to as support general logistics control numbers (LCN).

Man-hours/flying hours for on- and off- equipment and support general labor

When including general support actions in computing for the man-hours per flying hours, the data is added to the on- and off-equipment man-hours and the formula is modified to the following:

$$\text{Man-hours/Flying Hour} = \frac{\text{Man-hours (On)} + \text{Man-hours (Off)} + \text{Man-hours (Sup Gen)}}{\text{Flying hours}}$$

The labor man-hours for support general work are the man-hours for both on- and off-equipment obtained from labor expended on actions whose first position of the WUC is equal to "0." Support general work includes routine maintenance tasks such as parking, fueling, cleaning, documenting, unpacking, scheduled and unscheduled inspections, and so forth.

One example of a man-hour/flying hour variation is the formula used by ACC. They call it "Maintenance Man-hours per flying hour" and it is computed as follows:

$$\text{Maintenance Man-hours/Flying Hour} = \frac{\text{Total Direct JDD Man-hours Documented against Aircraft and Engines}}{\text{Hours flown}}$$

The ACC formula narrows the equipment focus to only aircraft and engines. The direct JDD man-hours also refer to on-equipment man-hours. ACC places restrictions as far as including only assigned aircraft and engines. This means that precision measurement equipment laboratory (PMEL), aerospace ground equipment (AGE), and SE transient maintenance hours are *not* included.

Sometimes you must consider more elements. Consider a case where a work center is responsible for only one type of weapon system. In the following example, the work center supports one type of aircraft. We will refer to that as the primary aircraft.

The first step is to find direct man-hour expenditures. For this example, assume these figures:

Direct on- and off-equipment hours expended for primary aircraft: 1410 hours

The goal is to compute the man-hours per flying hour for the aircraft. This is sometimes called an *aircraft work ratio*. Man-hour per flying hour rates identify the portion of direct man-hours the work center is expected to work for the particular type of aircraft. Using a *minimum* of 6 months' data to compute the man-hour per flying hour, you can estimate how the work center will distribute its direct man-hours during the next month.

From the information above, you know that the direct man-hours totals 1410 hours. Now you need to know the number of flying hours this work center supported for the 6 month period. Your data source provides a total of 1867 flying hours supported for the 6-month period. To figure man-hour per flying hour, divide the number of man-hours expended by the hours flown as follows:

$$\frac{1410}{1867} = 0.755 \text{ or approximately 0.76 man-hour per flying hour}$$

This represents the sample work center's direct maintenance man-hour cost to support one flying hour by aircraft type. In this example, the man-hour cost to support one flying hour of a primary aircraft is 0.76 man-hours.

615. Assessing mission performance

Our discussion of mission performance focuses on five different rates that further assess a unit's mission performance. Identifying trends is one of the biggest strengths of performance indicators. We begin by taking a look at the break rate and follow with a discussion of the fix rate. Then we turn our attention to the abort rate, and the repeat/recur rate. We conclude the lesson with a discussion of the cannibalization rate.

Break rate

The break rate is the percentage of aircraft sorties that land with an overall landing status of code 3, which means that the aircraft is unable to complete at least one of its primary wartime missions. This condition requires that the broken system (the one identified by the code 3) must be repaired before the aircraft can be assigned another mission.

The break rate is a *macro measurement* of equipment reliability. The goal is to keep the break rate low, since a zero break rate is possible but unrealistic. Break rates are computed monthly and are tracked monthly and quarterly. For a true evaluation of equipment/system reliability, measurements must be taken at the system/subsystem level. A break rate report is usually accompanied by a breakdown of systems/subsystems that contributed to the code 3 landing status for that month.

To compute the break rate, your first step is to obtain the total number of sorties flown by end-item. That can be for either the applicable month's AUR or a locally devised data source. Once you have the required data, use the following formula to compute a break rate:

$$\text{Break Rate} = \frac{\text{Number of Sorties with Code 3 Breaks}}{\text{Number of sorties flown}} \times 100$$

For this example, use this data:

Number of sorties with code 3 breaks = 9

Number of sorties = 94

Substituting in the formula shown above, you have the following:

$$\text{Break Rate} \frac{9}{94} \times 100 = 9.6\%$$

This calculation shows that approximately 1 out of 10 sorties landed with a code 3 status.

Fix rate

Fix rates aid maintenance managers in determining if their aircraft are being repaired in a timely manner. As an analyst, your job is to compute fix rates for aircraft that land with a code 3 landing status (red X condition) that are being returned to a flyable status (e.g., FMC or PMC). Standards for the average repair time between code 3 and flyable conditions, as well as fix rates, are established by MAJCOMs.

A fix rate is used to measure speed of repair and of equipment maintainability. For fighter aircraft in a combat mission, the fix rate is critical because it could mean a combat sortie opportunity lost.

Debriefing enters code 3 write-ups into IMDS upon completion of each sortie. The controlling agency must maintain compatibility with code 3s entered by debriefing and inputting a status code (i.e., NMCM, NMCS, etc.) for each code 3 sortie using the status update (TRIC: STH). You can ensure the compatibility of each code 3 sortie entered by using the fix time rate (TRIC: FTR) report. In other words, if the aircraft lands with a code 3 status, the aircraft must be listed as NMC in IMDS for the specific WUC or system that caused the condition. You can further verify that FTR is correct by running the EST status report, format 3.

To compute the fix rate, let's say for example that the KC135 fleet at base 'A' encountered 15 sorties with code 3 failures. The goal is 12 hours for a code 3 sortie to be returned to a flyable condition. Of those listed, only seven were repaired. The fix rate is computed as follows:

$$\text{Fix Rate} = \frac{\text{Number of breaks (Code 3) fixed within } nn \text{ hours}}{\text{Number of breaks (Code 3)}} \times 100$$

$$\text{Fix Rate} = \frac{7}{15} \times 100 = 46.7\%$$

NOTE: *nn* = the time frame in hours set as a goal; the time starts after the aircraft lands.

We generally use 4, 8, or 12 as the *nn goal*, depending on the type of aircraft or mission. This calculation shows that only 46.7 percent of the code 3 failures encountered were returned to a flyable status within the 12-hour standard. If 46.7 percent is below fix rate standards (i.e., 75.5 percent), further analysis is needed to determine the underlying causes of why more code 3 sorties were not, or could not, be repaired within standards.

Abort rate

Aborts are considered deviations to the flying schedule. There are two different kinds of aborts: air aborts and ground aborts. *Air aborts* are recorded in the MIS, but are *not* included in flying scheduling effectiveness calculations. *Ground aborts* are also recorded in the MIS and usually cause a deviation that is included in flying scheduling effectiveness calculations, such as a lost sortie or late take-off.

Air aborts

An air abort is a sortie that has to make an emergency landing or must land as soon as possible because it could not continue its primary or alternate mission. Normally, a condition has occurred that makes the aircraft unsafe to fly, such as maintenance failure or bad weather.

Air abort rates are another flying performance factor that you will be computing and analyzing; you will need the following information to calculate an air abort rate: (**NOTE:** The ground abort rate will *not* be computed because some MAJCOMs identify ground aborts as maintenance cancellations.)

1. The number of sorties flown; obtain this from either the AUR or a locally established source.
2. The number of air aborts; obtain this from the AUR or from some local sources, such as by routing the debriefing forms for all aircraft that abort through the maintenance systems analysis office.

When you have the data in hand, substitute the numbers in the formula below:

$$\text{Air Abort Rate} = \frac{\text{Number of air aborts}}{\text{Total sorties flown}} \times 100$$

In the following example to determine the air abort rate use this data:

- Total sorties flown = 210
- Total air aborts = 2

Step 1: Determine the total number of sorties; in this example, 210 sorties were flown.

Step 2: Determine the number of air aborts; as shown above, two sorties were air aborted.

Step 3: Substitute the data in the formula and perform the calculation. After substitution:

$$\text{Air abort rate} = \frac{2}{210} \times 100 = .9 \text{ or } 1.0\%$$

This calculation shows that 1 percent of the sorties flown ended up as an air abort. Like the other statistics we have discussed, each command has its own standard for air aborts. Likewise, whenever the standard is exceeded, it indicates a problem.

Ground aborts

A ground abort is an event occurring after crew show time that prevents a “crew ready” aircraft from takeoff. For you to measure and monitor the number of ground aborts per sorties flown, you need to know how to determine the ground abort rate. Before doing so, you will need the following information:

- Number of sorties flown from the AUR, or from a local source used, to obtain this data.
- Number of chargeable ground aborts obtained from either the AUR or the local source that maintains this data.

For example, to determine the F–16A ground abort rate for the month of December, you use the following formula:

$$\text{Ground Abort Rate} = \frac{\text{Number of ground aborts}}{\text{Total sorties flown} + \text{Number of ground aborts}} \times 100$$

For this example, use the following data:

- Total sorties flown = 1007
- Number chargeable ground aborts = 2

Step 1: Obtain the number of sorties flown.

Step 2: Determine the number of chargeable ground aborts. (**NOTE:** Remember to count only maintenance, supply, and operations ground aborts.)

Step 3: Substitute the data in the formula and perform the calculation as shown below:

$$\text{Ground Abort Rate} = \frac{2}{1007 + 2} \times 100 = 0.2\%$$

This calculation shows that of the 1009 sorties attempted, 0.2 percent ground aborted.

Since chargeable ground aborts should be controllable, whenever you have a high rate you likely have a problem. A high rate always warrants a detailed investigation. Most MAJCOMs set standards for chargeable ground aborts, so whenever the rate exceeds the standard, an investigation should be performed to determine the cause.

Total abort rates

The total abort rate can be used as a reliability indicator and as a measure of rework. It measures “waste,” since a large percentage of resources are committed before the mission. The flying schedule is built to allow for aborts; therefore, enough sorties are scheduled to meet planned goals.

When you want to determine the total abort rate for the unit, combine both air aborts and ground aborts and complete the operations in the following formula:

$$\text{Total Abort Rate} = \frac{\text{Number of air aborts}}{\text{Total sorties flown}} + \frac{\text{Number of ground aborts}}{\text{Total sorties flown} + \text{ground aborts}} \times 100$$

For this example, use the following data:

- Total sorties flown = 500
- Total air aborts = 7
- Number chargeable ground aborts = 12

Step 1: Obtain the number of sorties flown.

Step 2: Determine the number of air aborts; as shown above, seven sorties were air aborted.

Step 3: Determine the number of chargeable ground aborts. (**NOTE:** Remember to count only maintenance, supply, and operations ground aborts.)

Step 4: Substitute the data in the formula and perform the calculation as shown below:

$$\text{Total Abort Rate} = \frac{7}{500} + \frac{12}{500 + 12} \times 100 = 3.7\%$$

This calculation shows that of the 500 sorties attempted, 3.7 percent were total aborts.

A high rate always warrants a detailed investigation. Most MAJCOMs set standards for the total abort rate, so whenever the rate exceeds the standard, an investigation should be performed to determine the cause.

Repeat/recur rate

Repeat and recur rates are perhaps the most important and accurate measure of the quality of a unit's maintenance performance. A *repeat discrepancy* is one occurring on the same system or subsystem on the first sortie, or sortie attempt, after being originally reported and cleared by maintenance. A *recurring discrepancy* occurs on the second through fourth sortie, or attempted sortie, after the original occurrence, which was subsequently cleared by maintenance.

Purpose

A unit's goal should be to have no repeats or recurs. High rates may indicate a lack of thorough troubleshooting, extreme pressure to commit aircraft to the flying schedule for subsequent sorties, or a lack of experienced, qualified, or trained technicians. The more complex the weapon system and the greater the operations tempo, the more susceptible a unit is to having repeat or recurring discrepancies. The unit's repeat/recur rate should lead to an examination of each repeated/recurred discrepancy to seek out the root causes, and to direct maintenance towards lasting fixes.

Computing

Repeat and recur rates are based on the number of system malfunctions compared to the total number of pilot reported discrepancies (PRD). To obtain the data needed to compute the repeat/recur rates, use the Repeat/Recurring Discrepancy Report (TRIC: QRE) to get the total number of repeats and/or recurs. Use the Pilot Reported Discrepancy Report (TRIC: PRD) to find the number of PRDs. To calculate the repeat, recur, and total repeat/recur rates in the following example, we will use these values:

Total repeats: 5

Total recurs: 3

Total PRDs: 421

To calculate the repeat rate, substitute the data in the following formula:

$$\text{Repeat Rate} = \frac{\text{Total repeats}}{\text{Total pilot reported discrepancies}} \times 100$$

$$\text{Repeat Rate} = \frac{5}{421} \times 100 = 1.2\%$$

To calculate the recur rate, substitute the data in the following formula:

$$\text{Recur Rate} = \frac{\text{Total recurs}}{\text{Total pilot reported discrepancies}} \times 100$$

$$\text{Recur Rate} = \frac{3}{421} \times 100 = 0.7\%$$

To calculate the repeat/recur rate, substitute the data in this formula:

$$\text{Repeat/Recur Rate} = \frac{\text{Total repeats} + \text{Total recurs}}{\text{Total pilot reported discrepancies}} \times 100$$

$$\text{Repeat/Recur Rate} = \frac{5+3}{421} \times 100 = \frac{8}{421} = 1.9\%$$

Cannibalization rate

Cannibalization (CANN) is the authorized removal of a component from one end item to be installed on another. When a required part cannot be delivered and installed on an end item by a specific time, the maintenance control officer, or designated representative, may approve a CANN. Since CANNs cause additional work and could even cause damage to perfectly good components, it is a good idea to pay particular attention to them.

Purpose

The cannibalization rate is a measurement used in conjunction with the supply issue effectiveness rate. Base supply relies on depot to replenish parts and they can use this indicator for depot support.

Computation

Computing the cannibalization rate makes it easier to compare different time periods. To compute the cannibalization rate, you need the following data:

- The total number of CANNs. Obtain this from either the materiel control section or a retrieval inquiry of the JDD subsystem. Use action taken codes T and U (T—removed for CANN and U—replaced after CANN).
- The total number of sorties flown; obtained from the AUR or a local reporting procedure.

Having collected your data, use the following formula to compute the cannibalization rate:

$$\text{Cannibalization Rate} = \frac{\text{Number of cannibalizations}}{\text{Number of sorties flown}} \times 100$$

Example: Determine the cannibalization rate for F–22s during December. There were 43 CANNs and 174 sorties flown.

Substitute the data in the formula and complete the calculations:

$$\text{Cannibalization Rate } = \frac{\text{Number of cannibalizations}}{\text{Number of sorties flown}} \times 100$$

$$\text{Cannibalization Rate } = \frac{43}{174} \times 100$$

$$\text{Cannibalization Rate } = \frac{43}{174} \times 100 = 24.7\%$$

Once you have calculated the rate, your next step is to determine if the rate indicates that improvement is required. Normally, you compare the monthly cannibalization rate to the past year's average rate. As long as the monthly rate is less than the previous year's average rate, you can assume that there is not a major problem that requires immediate attention. The reality is, of course, that improvements can always be made when the cannibalization rate is greater than zero. For this example, assume the previous year's average cannibalization rate was 37 percent. Since the newly calculated rate is less than the previous year's average, further action may not be required.

616. Computing non-cyber/space/communications mean times

In this lesson, we will cover reliability metrics that you may be asked to apply to aircraft systems and components. Specifically, we look at the mean time to repair, the mean time between failures, the mean time between critical failures, and the mean time between maintenance actions. Later you will see for these metrics used to evaluate cyber/space/communication systems and equipment.

Computing mean time to repair

Mean time to repair (MTTR) is an average time to repair the equipment. MTTR is expressed in hours. When equipment fails, maintenance managers want to know "how long will it take to repair it?" When equipment is being tracked because of its critical importance to the mission, a specific standard is established that provides an estimate for the time required to repair a particular system, equipment, or component. While the MTTR can be applied to both aerospace and cyber/space/communication equipment, our discussion focuses only on aerospace equipment.

Aerospace equipment includes aircraft, drones, and support equipment. This type of equipment is related to the aerospace operations. Aerospace equipment is further classified as either *on-equipment* or *off-equipment.*

Formulas for calculating on equipment MTTR

To calculate the on equipment MTTR, use the following formula:

$$\text{MTTR} = \frac{\text{Repair hours (on equipment)}}{\text{Repair actions (on equipment)}}$$

Information for calculating the repair hours on equipment are as follows:

- Maintenance time to repair on equipment regardless of crew size.
- Hours included in the computation depend on the WUC of the equipment. If the first position of the WUC is *not* equal to "0" and the action taken codes (ATC) equal "R," "P," "G," "K," "L," "V," "Z," or "F", then add all the labor hours, disregarding the number of crew size, under these selected ATCs to the "repair hours (on equipment)." For example, if it took 2 hours for an action taken code "R" to repair an equipment that required three members (crew size of 3), the labor hours would be "2" and not "6."

Information for calculating the repair actions on equipment are as follows:

- Number of repair actions for on equipment.
- Number of repair actions, measured in term of units, included on the computation depends on the WUC of the equipment. If the first position of the WUC is *not* equal to "0" and the ATC equals "R," "P," "G," "K," "L," "V," or "Z," then all the units reported under the selected ATCs are added and included in the "repair actions (on equipment)" calculation.
- Number of units reported under an ATC of "F" is not included because this code is not normally used for on equipment items.

Formulas for calculating off equipment MTTR

To calculate the off equipment MTTR, use the following formula:

$$\text{MTTR} = \frac{\text{Repair hours (off equipment)}}{\text{Repair actions (off equipment)}}$$

Information for calculating the repair hours off equipment are as follows:

- Maintenance time to repair off equipment regardless of crew size.
- Hours included in the computation depend on the WUC of the equipment. If the first position of the equipment WUC is *not* equal to "0" and the ATCs equal "A," "F," "G," "K," "L," "M," "N," "V," or "Z," then add all the labor hours, disregarding the number of crew size, under these selected ATCs to the "repair hours (off equipment)." For example, if it took 1 hour for an ATC "A" to repair an equipment that took two personnel (crew size of 2), the labor hours is "1" and not "2."

Information for calculating the repair actions off equipment are as follows:

- Number of repair actions to repair off equipment.
- Number of repair actions, measured in terms of units, included on the computation depends on the WUC of the equipment. If the first position of the WUC is *not* equal to "0" and the ATC equals "A," "F," "G," "K," "L," "V," or "Z," then all the units reported under these selected ATCs are added and included in the "Repair actions (off equipment)."
- Number of units reported under ATCs "M" and "N" are not included.

Combined MTTR (on and off equipment)

To calculate a combined MTTR, use the following formula to combine all the factors used:

$$\text{MTTR (on and off equipment)} = \frac{\text{Repair hours (on)} + \text{Repair hours (off)}}{\text{Repair actions (on)} + \text{Repair actions (off)}}$$

The same restrictions applied to all on and off equipment repair hours and repair actions apply to the calculation in this formula as well.

Computing mean time between failures

Mean time between failures (MTBF) is calculated to provide an average equipment operating time before a failure occurs. MTBF is expressed in hours. The two basic types of failure used for this indicator are as follows:

1. Inherent (Type 1): identifies inherent failures (*item fails due to their own internal failure pattern*). It is the actual failure of an item. For example, the flight data recorder failed due to a bad circuit card.
2. Induced (Type 2): identifies induced failures (*item fails but not due to its own internal failure*). The failure of an item is caused by an outside influence. For example, the auxiliary generator box is damaged by fire.

You determine the type of failure according to the how malfunction code (HMC) that is entered in the IMDS by the debriefing or maintenance personnel (specialist) reporting the discrepancy. The failure must be verified and the item repaired. If the item is *not* repaired (action taken code “B”, *Bench-checked serviceable—no repair required),* it is *not* counted as a failure for MTBF calculations. TO 00–20–2 contains a table of HMCs and their failure type. The failures are listed as “Type of Defect” in the TO.

There are two types of rates that follow the types of failure as listed here:

1. MTBF Type 1 (Inherent).
2. MTBF Type 2 (Induced).

In this lesson, we only compute the MTBF Type 1 because these failures are tracked more than Type 2, and the Type 1 rate is used most often. IMDS also tracks Type 1 failures and provides a background report (TRIC QMT, *Mean Time Between Failure*, Screen 197). If you need to compute Type 2 failures, you can use a retrieval utility, such as QLP, to obtain the data needed for your computation.

While MTBF can be used for system and component failures, our discussion focuses on aircraft (type “A” equipment) and engine (type “E” equipment) related components. This calculation provides the total number of true failures (type 1). You calculate the MTBF for each component or system you are interested in obtaining.

The MTBF formula you use in this case is as follows:

$$\text{MTBF Type 1 (Inherent)} = \frac{\text{Flying hours} \times \text{QPA} \times \text{UF}}{\text{Number of inherent failures}}$$

Information for calculating each component’s MTBF is in the following table:

Factors	Description
Flying hours	• The number of flying hours (by aircraft type).
Quantity per application (QPA)	• This is the number of subject components installed on the end-item. • This information is already entered in the IMDS database or can be obtained from debriefing to verify how many were affected. • A system could have more than one QPA; a component removed for repair usually has a QPA of one.
Usage factor (UF)	• It indicates the percentage a particular component is actually used. • A UF of 1 indicates 100 percent usage. If it is between 0 and 1 but cannot be 0 or greater than 1.

The MTBF calculation may be made using data for one month or as much as a year’s worth of data. However, 6 months of on the job data is sufficient because the IMDS program only keeps 180 days’ worth of data. Let’s take a look at an actual calculation in the following example.

Example: For the past 3 months, the fuel quantity indicating system (WUC 46A00) of the F–15 had 9 failures. It takes two indicators (QPA = 2) to repair the system. The indicators are used all the time (UF = 1) for all sorties. You have accumulated the following data for your calculation:

UF = 1

Quantity per application = 2

Flying hours = 216

Number of failures = 9

To compute the MTBF Type 1, enter your data in the formula and complete the math:

$$\text{MTBF Type 1} = \frac{216 \times 1 \times 2}{9} = 48$$

This shows that based on the past 3 months of data, performance failures for the fuel quantity indicating system 46A00 occurred on an average of one every 48 flying hours.

Computing mean time between critical failures

Mean time between critical failures (MTBCF) is used to measure the average time between the failures of mission-essential systems. Critical failures occur when mission-essential systems become inoperable or operate outside their specified performance range. A critical failure renders the system incapable of completing its designed function or mission. These critical system failures result in an NMC status. Note that the MTBCF *excludes* scheduled maintenance events.

The MTCBF formula applies to end-items' operating time. The operating time is expressed in hours. The total operating time is divided by the number of critical failures. You may use a single month's data or data for a whole year in computing the MTCBF. This statistic provides information about the reliability of critical aircraft systems that are required for mission success.

In general, the MTBCF is expressed in the following formula:

$$\text{MTCBF} = \frac{\text{Operating time}}{\text{Number of critical failures}}$$

Computing mean time between maintenance actions

Mean time between maintenance actions (MTBMA) is the mean time between any maintenance actions, whether it is scheduled or unscheduled. It is also known as mean time between maintenance events since maintenance actions and events have become synonymous. Examples are calibration, cleaning, adjusting, servicing, repairing, and removing. The MAJCOM sets the requirements for this rate and the parameters are selected to meet the requirements. The IMDS also tracks some of the following standard parameters, using codes for identification:

- Inherent failures.
- Induced failures.
- No-defect events.
- Total corrective events.
- Preventive maintenance events, such as scheduled inspections and other related rates (i.e., mean time between component removals).
- Other related rates.

This computation also gives us average time for end-items and is a measure of overall system or component performance. It is a good indication of system availability because it takes into account the frequency of all maintenance actions that will render a system unavailable.

Use the following formula to calculate the MTBMA:

$$\text{MTBMA} = \frac{\text{Flying Hours}}{\text{Number of Maint Events}}$$

Here, the maintenance events are selected by the MAJCOM.

In addition, when the maintenance events are divided between on-equipment and off-equipment, the lower portion of the formula is modified to distinguish between the two types. When modified for on-equipment and off-equipment types, the formula appears as follows:

$$\text{MTBMA} = \frac{\text{Flying Hours}}{\text{Number of Maint Events (on - equipment)}}$$

$$\text{MTBMA} = \frac{\text{Flying Hours}}{\text{Number of Maint Events (off - equipment)}}$$

$$\text{MTBMA} = \frac{\text{Flying Hours}}{\text{Number of Maint Events (ON)} + \text{Number of Maint Events (OFF)}}$$

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

612. Computing aircraft status rates

1. What does the MC rate represent?

2. What do maintenance status codes describe?

3. Which MC status indicates that an aircraft can perform at least one, but not all of its assigned missions?

4. What does NMC indicate?

5. What are the maintenance status codes for PMC?

6. Where can you obtain the data for computing mission capability rates?

613. Measuring flying schedule planning and execution

1. What are the two most common chargeable deviations?

2. What is a *nonchargeable* deviation?

3. Who establishes the chargeable late takeoff standard?

4. What does the FSE rate provide commanders?

5. Which type of deviations is included in computing the FSE rate?

6. Where would you get the data to compute an FSE rate?

7. What are the two types of departure reliability rates?

8. What are the three primary causes of logistics departure reliability delays?

9. What is the logistics departure reliability known as when it is primarily accounted for by the unit owning the aircraft?

10. What can you apply the departure reliability rate against?

614. Computing planning factors

1. What do UTE rates show?

2. Which measure is used to tell if an aircraft is being used efficiently?

3. What is a program UTE rate?

4. How do you define the UTE rate used in the flying hour program?

5. How are the two UTE rates calculated in the flying hour program?

6. Whom does maintenance scheduling and maintenance analysis provide planning factors to?

7. How is aircraft availability defined?

8. What is attrition?

9. How can the attrition rate be used?

10. Name some of ACC's attrition factors.

11. Spares are used to compensate for which kind of factors?

12. How often does MMA compute spare aircraft requirements?

13. Name the three categories of logistics losses.

14. Which agency determines the parameters for the man-hours per flying hour?

15. Where do you extract man-hour data?

16. List the three man-hour categories used to compute the man-hour per flying hour.

615. Assessing mission performance

1. Which landing status code is used in the break rate computation?

2. What does a 10 percent break rate mean?

3. How are fix rates used?

4. How can you verify the compatibility of code 3s entered by debriefing and controlling agencies?

5. What are the three time frames, in hours, used as a code 3 fix rate goal?

6. What is an air abort?

7. What is a ground abort?

8. How do you determine the *total* abort rate?

9. What is a *repeat* discrepancy?

10. What is a *recurring* discrepancy?

11. What may high repeat and/or recur rates indicate?

12. What are repeat and recur rates based upon?

13. What is cannibalization?

14. Who may approve cannibalizations?

15. Which action taken codes are used in cannibalization and what do they mean?

616. Computing non-cyber/space/communications mean times

1. What does an MTTR provide?

2. When adding labor hours for on equipment MTTR, what is the first position for the WUCs that are included?

3. Which ATC is *not* included for on equipment repair actions?

4. Which ATC(s) are included in off equipment repair actions if the first position WUC does *not* equal “0”?

5. Define what the MTBF indicates.

6. Describe a type 1 and type 2 MTBF failure.

7. When is a failure *not* counted as a failure for MTBF calculations?

8. Which type of failure is tracked in IMDS?

9. What does the MTBCF measure?

10. Which types of system failures are included in computing MTBCF?

11. Which type of maintenance events are used in computing the MTBMA?

12. Who sets the requirements and parameters for the MTMBA?

2–3. Analysis of Key Metrics

Local commanders at base level use key performance indicators to assess their maintenance and operations performance. These indicators reflect the "health of the fleet" and reveal the mission readiness of the unit. These same indicators go up to higher headquarters (MAJCOM commanders, air staff, and other Department of Defense [DOD] agencies) where they are used to determine the combat capability of the overall fleet. The indicators are also measured according to logistics standards. When certain areas fail to meet standards, they receive additional resources to improve performance.

As maintenance analysts, we must understand the importance of providing accurate reports to our unit commanders. Our own analytical assessment aids our units in continuously identifying problems and trends. These key indicators are among the dozen or more indicators commanders review on a monthly basis. These key mission performance indicators are contained in the unit's monthly maintenance summary.

617. Leading and lagging indicators

The maintenance analysis section is the focal point for providing data analyses and graphical presentations illustrating how well mission requirements are being met. This section's primary responsibility is to indicate where the problem is located. Maintenance analysts are trained statisticians and investigators. Our core job is to analyze raw data, identify significant trends and problem areas, and present that information to those who can correct the deficiencies. One of the analyst's most important functions is to identify impending problems that require action. Astute maintenance leaders charge the maintenance analyst with investigating problems that adversely impact unit effectiveness.

Our job as maintenance analysts is to pay attention to the key indicators affecting the health of the fleet. Management depends on us to anticipate problems and determine the reason for negative trends.

For example, when NMC rates are high, we should ask the following types of questions when investigating the reason for negative trends:

- Which systems are creating a high 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 unit 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 repeat/recurring malfunctions?
- What part or component is causing NMCS conditions? Are these normal, or is a new problem possibly emerging?
- Are items being 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 Air Force specialty codes (AFSC)?

Categories of indicators

Most of the key metrics fall into the following two categories:

- Leading indicators.
- 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 are the first to show a problem, and the lagging indicators follow.

The two cornerstones of maintenance metrics are:

- fleet availability as measured by the MC rate; and
- program execution as measured by the UTE rate.

NOTE: MAF use movement of fuel, cargo, and people, measured by departure and arrival reliability, as a cornerstone maintenance metric. For MAF, this measure replaces the program execution UTE.

Fleet availability

These maintenance-related indicators measure logistics' ability to provide sufficient aircraft to accomplish mission requirements. Executing the flying program requires that a set percentage of the fleet is needed and must be available on any given day. 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 shown below:

Leading	Lagging
• Ground abort rate.	• MC–mission capable rate.
• Air abort rate.	• FMC–fully mission capable rate.
• MAF total air abort rate.	• PMC–partial mission capable rate.
• Code 3 break rate.	• PMCS–PMC for supply rate.
• 8-/12-hour fix rate.	• PMCM–PMC for maintenance rate.
• Logistics departure reliability.	• PMCB–partial MC both maintenance and supply rate.
• Maintenance scheduling effectiveness (MSE) rate.	• NMCM (U/S)–not MC for maintenance, unscheduled or scheduled rate.
• CANN rate.	• NMCS–not MC for supply rate.
	• NMCB (U/S)–not MC for both (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.

Program execution

These flying-related indicators show a unit's ability to fly a given schedule to accomplish the mission. A set flying schedule is planned and then carried out in the prescribed manner. This ensures that the flying program requirements are executed as well as ensuring that there is 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 listed below:

Leading	Lagging
• Programmed UTE versus actual UTE rates. • Flying-hour execution. • FSE rate. • Schedule deviation rates (chargeable and nonchargeable).	• UTE rate. • Logistics departure reliability rate.

618. Analysis and desired trends of key metrics

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, the daily statistics are a snapshot. If you only look at the daily performance statistics once a week, detecting trends may prove difficult. It is possible that performance indicators may improve just because they are being watched. Put succinctly; what gets attention, gets fixed!

In this lesson, we present some guidelines on how to analyze certain key metrics and how one rate relates to and affects another related rate. For this discussion, we focus on the two categories presented in the previous lesson—fleet availability (maintenance related) and program execution (flying related).

Maintenance-related metrics

As we discussed earlier, fleet availability metrics measure the maintenance complex's ability to meet mission requirements. Let's begin our discussion with the leading and lagging indicators associated with fleet availability and their effects. The following table covers the leading indicators:

<table>
<tr><th colspan="3">Leading Maintenance-related Metrics</th></tr>
<tr><th>Metric</th><th colspan="2">Description</th></tr>
<tr><td rowspan="3">Abort rate</td><td colspan="2">A unit's abort rate can be an indicator of both aircraft reliability and quality of maintenance performed.

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.</td></tr>
<tr><td>Air abort rate</td><td>An air abort is really an operations call. Not all airborne malfunctions result in an air abort.

If an alternate mission is flown, then it is not an air abort.

If there are a lot of air aborts (talk with operations), it may simply be a misunderstanding of the rules.</td></tr>
<tr><td>MAF total air abort rate</td><td>The MAF tracks materiel and nonmaterial aborts through the Global Decision Support System and the 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.</td></tr>
</table>

<table>
<tr><th colspan="3">Leading Maintenance-related Metrics</th></tr>
<tr><th>Metric</th><th colspan="2">Description</th></tr>
<tr><td>Code 3 break rate</td><td colspan="2">This is the percentage of sorties that land in a code 3 status.

It is 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 Repeat/Recur (R/R).</td></tr>
<tr><td rowspan="3">8-/12-hour fix rate</td><td colspan="2">This indicator shows how well the repair process is being managed.

Some repairs, occasionally, just by their nature, exceed the standard timeframe.

All repairs that exceed the standard time should be reviewed.</td></tr>
<tr><td>8-hour fix rate</td><td>The cumulative percentage of code 3 aircraft breaks recovered within 8 hours of landing.

This interval is used for fighter aircraft.</td></tr>
<tr><td>12-hour fix rate</td><td>The cumulative percentage of aircraft breaks recovered within 12 hours of landing.

This interval is reported for all other than fighter aircraft.</td></tr>
<tr><td>Logistics departure reliability rate</td><td colspan="2">Logistics departure reliability provides the percent of departures that are delayed because of supply, saturation, or maintenance problems.

AMCI 10–202, Volume 6, provides criteria for delay-code assignment. It also provides the commander with an objective measure of the air mobility system health 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.

Worldwide logistics departure reliability is essentially the same as logistics departure reliability. It provides the percent of total departures delayed for supply, saturation, or maintenance problems.</td></tr>
<tr><td>MSE rate</td><td colspan="2">This is a measure of maintenance’s ability to plan and complete inspections and periodic maintenance.

A low MSE rate may indicate that a unit is experiencing turbulence. It’s a leadership issue if the turbulence could be avoided with careful planning.

If maintenance fails to complete a scheduled action because an aircraft is broken off station, that’s a reasonable occurrence.

When maintenance fails to complete 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.</td></tr>
</table>

Leading Maintenance-related Metrics	
Metric	**Description**
CANN rate	The CANN rate is the average number of CANN actions per 100 sorties flown. A CANN action is when removing a serviceable part from an aircraft or engine and is used to replace an unserviceable part on another aircraft or engine. It is also used when a serviceable part is removed to put it 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 return to an MC status. Because supply relies on the depot for replenishment, this indicator can also be used, in part, to indicate depot support.

Now that we have completed our look at the leading indicators, let's turn our attention to the lagging indicators described in the table below.

Lagging Maintenance-related Metrics	
Metric	**Description**
MC rate	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 do not 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. Any 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.
FMC rate	It is important to 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.
PMC rate	An aircraft may be partial mission capable for either parts or maintenance, with a status that indicates the aircraft cannot perform all assigned missions. Good maintenance practice dictates that all malfunctions are fixed as soon as possible, whether or not it's convenient.

Lagging Maintenance-related Metrics	
Metric	**Description**
TNMCM (NMCM + NMCB) rate	Maintenance is responsible for keeping the TNMCM rate under control by fixing aircraft quickly and accurately. Proper 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 the 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.
TNMCS (NMCS + NMCB) rate	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 mission capable (MICAP) parts. 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? Are the base's stock levels 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?

Flying-related metrics

As we discussed earlier, flying-related, or program execution, metrics measure the unit's ability to fly a given schedule to meet mission requirements. In the following tables, we will discuss the leading and lagging indicators associated with program execution and their effects. The leading indicators are in the table below:

Leading Flying-related Metrics	
Metric	**Description**
FSE rate	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 be drawn into operation requirements versus maintenance capabilities when looking at causes of turbulence. The mission is priority number one all the time, but firm scheduling discipline is essential for effective operations.

Leading Flying-related Metrics	
Metric	**Description**
	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/Tanker Airlift Control Center (TACC) tasking's 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 as follows: • Timely aircraft preparation and repair. • Quality of maintenance. • Sense of urgency. • Crew-show discipline. • Avoidance of early and late takeoffs. • Flexibility when unplanned events arise.
Schedule deviation rates (chargeable and nonchargeable)	These are reasons why an aircraft did not fly a sortie as scheduled and are recorded as chargeable or nonchargeable for activity causing deviation (e.g., operations, logistics, air traffic control, weather, higher headquarters, etc.).

Now that we have looked at the leading flying-related metrics, let us look at the lagging rates.

Lagging Flying-related Metrics		
Metric	**Description**	
UTE rate	A unit's UTE rate is measured in the following two ways: 1. The *sortie* UTE rate: the average number sorties flown per assigned aircraft. 2. The *hourly* UTE rate: the average number of hours flown per assigned aircraft per month. Both are indicators of how well maintenance and operations are working to support the unit's flying mission.	
	Sortie UTE rate	If the unit is not 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 lay 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, affects the operation. This key indicator, particularly for fighters, serves as a yardstick for how well the maintenance organization supports the unit's mission.
	Hourly UTE rate	This indicator is shared by operations and maintenance because it reflects their combined performance. This means operations is *not* flying the programmed average sortie duration (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.

Lagging Flying-related Metrics	
Metric	**Description**
Logistics departure reliability rate	This rate provides the percent of departures that are delayed because of supply, saturation, or maintenance problems. AMCI 10–202, Volume 6, 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.

The table in figure 2–5 provides the key metric types, a brief description, their desired trend, and what to look for when the trend goes in the opposite direction.

Metric	Description	Desired Trend	Things to look for
MC Rate	The percentage of possessed hours for aircraft that can fly at least one assigned mission.	↑ (Upward)	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.	↓ (Downward)	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.	↓ (Downward)	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.	↑ (Upward)	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.	↓ (Downward)	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?
Abort Rate	The number of air aborts plus ground aborts occurring per total number of sorties.	↓ (Downward)	Quality of maintenance decreasing, especially if aborts caused by Repeat/recurring 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.	↓ (Downward)	Reliability pf parts, training deficiency, poor technical data, test equipment, or insufficient tools.
Fix Rate	The number of grounding write-ups repaired per total number of grounding write-ups that occurred.	↑ (Upward)	Training, lack of experienced technicians, poor technical data, lack of tools, or lack of test equipment.
MSE Rate	The number of maintenance actions started as scheduled per total number of maintenance actions scheduled.	↓ (Downward)	If either the unit or individual aircraft 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.

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Figure 2–5. Table of key metrics.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

617. Leading and lagging indicators

1. Metrics fall into which two key categories?

2. Instead of program execution, what does the MAF use for its metrics?

3. How is fleet availability measured?

4. How is the program execution measured for a flying program or mission?

618. Analysis and desired trends of key metrics

1. What could an abort rate relate to, as you are examining it?

2. Which type of aircraft is reported under the 12-hour fix rate?

3. How does the Air Mobility Master Plan define on-time departure?

4. Which supply measurement is used in conjunction with the CANN rate?

5. What do you need to focus on when the MC rate starts to go down?

6. As a leading indicator, which calendar schedule do you look at for the FSE rate?

7. Which UTE rate is the key indicator for fighter aircraft?

Answers to Self-Test Questions

608

1. The ability to keep equipment in a ready status.
2. A calculated percentage that provides you with an indicator of how long a selected system performs without having a malfunction.
3. A calculated percentage that indicates how much of the time a selected system performs without having a failure.

609

1. To return base-generated reparable items, authorized for base repair, to a serviceable condition at base level.
2. Contract maintenance and AFMC Depot.
3. 100 percent.

610

1. To measure adherence to scheduled maintenance plans and actions.
2. Monthly maintenance plan.
3. Fuel; oil, lubricants and servicing; supply; food services; security; fire department; base civil engineer; and base operations.
4. Investigate to determine the cause of unaccomplished events.

611

1. The average deferred discrepancies across a unit’s average possessed aircraft fleet.
2. Maintenance actions that need to be worked but are deferred to a later date when they are discovered.
3. It either is deferred to a later date, scheduled with a start date greater than 5 calendar days after the discovery date, or is AWPs not available through the local supply system.

612

1. The percentage of all possessed aircraft that are capable of fulfilling at least one of their wartime missions.
2. The capability of assigned aerospace vehicles and equipment to perform their unit assigned missions.
3. PMC.
4. That an aircraft cannot perform any of its assigned missions due to maintenance and/or supply reasons.
5. PMCS, PMCM, and PMCB.
6. From the AVS report.

613

1. Maintenance and supply.
2. One caused by reasons other than maintenance or supply, such as a late crew arrival or poor weather.
3. MAJCOMs.
4. A tool to measure their ability to plan and execute their flying requirements.
5. All deviations—chargeable and nonchargeable.
6. The AUR or a locally established format.
7. Logistics and worldwide.
8. Supply, saturation, and maintenance problems.
9. Home station.
10. To the type of aircraft or the base.

614

1. By operations, to plan the unit’s flying hour program primarily; for maintenance, usage of assigned aircraft.
2. By calculating the UTE rate and applying the normal curve.

3. The number of hours each possessed aircraft is programmed to fly to accomplish the unit's mission.
4. As the average number of sorties or hours flown per authorized or chargeable aircraft.
5. By either sortie or hourly rate.
6. Operations and maintenance managers.
7. As the percentage of a fleet not in a depot-possessed or non-mission capable status.
8. The reduction or loss of sorties due to weather, aborts, operation cancellations, or the failure of maintenance to provide aircraft for scheduled sorties.
9. To schedule additional sorties based on the attrition factor.
10. Any of the following: maintenance, operations, supply, HHQ, weather, sympathy, or air traffic control.
11. Unit-controllable causes.
12. Annually.
13. Maintenance cancellations, supply cancellations, and ground aborts.
14. MAJCOM.
15. From automated systems such as the MIS and IMDS.
16. On-equipment, off-equipment, and support general.

615

1. 3.
2. That 1 out of 10 sorties will land with a code 3 landing status.
3. To determine if aircraft are being repaired in a timely manner.
4. By using the FTR.
5. 4, 8, or 12 hours.
6. When a sortie has to make an emergency landing or must land as soon as possible because it could not continue its primary or alternate mission.
7. When an aircraft fails to take off within the grace period of its scheduled takeoff time.
8. Combine air abort and ground abort and place in the formula.
9. One that occurs on the same system or subsystem on the first sortie, or sortie attempt, after originally reported and cleared by maintenance.
10. One that occurs on the second through fourth sortie, or attempted sortie, after the original occurrence was cleared by maintenance.
11. A lack of thorough troubleshooting, extreme pressure to commit aircraft to the flying schedule for subsequent sorties, or a lack of experienced, qualified, or trained technicians.
12. The number of system malfunctions compared to the total number of PRDs.
13. The authorized removal of a component from one end-item to another end-item.
14. The maintenance control officer or designated representative.
15. T, which means removed for cannibalization, and U, meaning replaced after cannibalization.

616

1. The average time to repair equipment.
2. Any first positions that do not equal "0."
3. ATC "F."
4. "A," "F," "G," "K," "L," "V," or "Z."
5. An average equipment operating time before a failure occurs.
6. Type 1 identifies inherent failures where there is the actual failure of items; type 2 identifies induced failures, which are caused by outside influences.
7. If the item is not repaired, indicated by an ATC B.
8. Type 1 failure.
9. The average time between the failures of mission-essential systems.

10. Those that result in an NMC status.
11. Those scheduled and unscheduled.
12. MAJCOM.

617

1. Leading and lagging indicators.
2. The departure and arrival reliability rate.
3. By the MC rate, determining the health of a fleet.
4. By the UTE rate.

618

1. System malfunctions.
2. All aircraft other than fighters.
3. As those within 14 minutes of the scheduled departure time.
4. Supply issue effectiveness rate.
5. Negative trends and top system problems.
6. Weekly flying schedule.
7. Sortie UTE rate.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to AFCDA.

15. (608) Which logistics indicator shows a unit's ability to keep equipment in a *ready* status?
    a. System reliability.
    b. Airframe capability.
    c. Base level repair capability.
    d. Maintenance scheduling effectiveness.

16. (608) *System reliability* rates provide management with an indicator of how long a selected system performs *without*
    a. a failure.
    b. an abort.
    c. a breakdown.
    d. a malfunction.

17. (609) If repair is *not* authorized at base level, who forwards the item to contract maintenance or the Air Force Materiel Command (AFMC) depot?
    a. Supply.
    b. Work center.
    c. Maintenance analysis.
    d. Plans and scheduling.

18. (609) Each maintenance unit should *strive* for a base repair capability rate of
    a. 90 percent.
    b. 95 percent.
    c. 97 percent.
    d. 100 percent.

19. (609) Which *action taken* codes are used to *compute* base repair capability rates?
    a. A, F, G, K, L, V, Z.
    b. A, F, G, K, L, B, P.
    c. A, F, G, K, L, Z.
    d. A, F, B, G, K, L.

20. (610) The information required for computing maintenance scheduling effectiveness rates is found in the
    a. analysis report.
    b. inspection schedule.
    c. monthly maintenance plan.
    d. monthly maintenance summary.

21. (611) Which two categories refer to *delayed* discrepancies?
    a. Awaiting parts (AWP) or awaiting deference (AWD).
    b. Awaiting parts (AWP) or awaiting maintenance (AWM).
    c. Awaiting deference (AWD) or awaiting maintenance (AWM).
    d. Awaiting parts (AWP) or awaiting deferred discrepancy (ADD).

22. (611) If maintenance schedulers are *not able* to schedule, or combine, deferred discrepancies with more extensive maintenance actions, they should
    a. defer the discrepancies for 5 calendar days.
    b. defer the discrepancies for 7 calendar days.
    c. schedule the aircraft routinely to work the delays.
    d. defer the discrepancies until there are more to work.

23. (612) All *raw* data used to compute aircraft status rates comes from
    a. supply.
    b. debriefing.
    c. plans and scheduling.
    d. Aerospace Vehicle and Status (AVS) reports.

24. (613) The two *most common* types of chargeable mission schedule deviations are
    a. operation and supply.
    b. operation and weather.
    c. maintenance and supply.
    d. maintenance and operation.

25. (613) Which mission schedule deviation category is used when an aircraft is *cancelled* due to bad weather?
    a. Local.
    b. Chargeable.
    c. Nonchargeable.
    d. Higher headquarters.

26. (613) The *total* number of scheduled aircraft *cancellations* can be obtained from the
    a. Daily Flying Schedule.
    b. Operational Event Report.
    c. Monthly Maintenance Plan.
    d. Accomplishment Utilization Report (AUR).

27. (613) When computing the flying scheduling effectiveness (FSE) rate, this is subtracted from the *total* number of scheduled sorties.
    a. Total deviations.
    b. Number of cancelled takeoffs.
    c. Total chargeable deviations only.
    d. Total nonchargeable deviations only.

28. (613) If the number of aircraft sortie deviations *increases*, the flying scheduling effectiveness (FSE) *rate* will
    a. go up.
    b. go down.
    c. not be used.
    d. be the same.

29. (613) Which major command (MAJCOM) uses the aircraft *departure* reliability rate?
    a. Air Combat Command (ACC).
    b. Air Mobility Command (AMC).
    c. Air Force Space Command (AFSPC).
    d. Air Force Materiel Command (AFMC).

30. (613) To which activity can you apply the *departure* reliability rate?
    a. Base.
    b. Sortie
    c. Supply.
    d. Mission.

31. (614) This factor represents a historical percentage of scheduled sorties lost to causes *outside of unit control*.
    a. Abort.
    b. Spare.
    c. Attrition.
    d. Utilization.

32. (614) Which computation rate does a maintenance scheduler use to project *additional* sorties in the flying schedule to meet sortie requirements?
    a. Break.
    b. Attrition.
    c. Utilization.
    d. Departure reliability.

33. (614) Spares are used to compensate for which types of *unit-controlled* factors?
    a. Maintenance cancellations, supply cancellations, and ground aborts.
    b. Operations additions, operations aborts, and operations cancellations.
    c. Scheduling additions, training sorties, and higher headquarters tasking.
    d. Maintenance additions, flight test additions, and higher headquarters additions.

34. (614) In determining the spare factor, you compare the number of historical sorties scheduled to the number of
    a. flyable aircraft.
    b. non-flyable aircraft.
    c. first sortie logistics losses.
    d. second sortie logistics losses.

35. (614) This is *not* a factor used when you are computing the *man-hours* per flying hour.
    a. Support general.
    b. Operating hours.
    c. On-equipment man-hours.
    d. Off-equipment man-hours.

36. (615) This code is used to assess aircraft mission performance by computing the *break rate*.
    a. Fix code 3.
    b. Cap code 3.
    c. Landing status code 3.
    d. Not reparable this station (NRTS) code 3.

37. (615) Which rate is used to measure the *speed* of repair and equipment maintainability?
    a. Fix rate.
    b. Break rate.
    c. Utilization rate.
    d. Mission capable rate.

38. (615) When an aircraft lands with a code 3 landing status, enter this maintenance status code in the Integrated Maintenance Data System (IMDS).
    a. Partial mission capable (PMC).
    b. Fully mission capable (FMC).
    c. Not mission capable (NMC).
    d. Capability code 3.

39. (615) When assessing mission performance, the three time frames you would use in the *fix rate* formula are
    a. 2, 4, or 8 hours.
    b. 4, 6, or 8 hours.
    c. 4, 8, or 10 hours.
    d. 4, 8, or 12 hours.

40. (615) This type of abort is assigned when a sortie has to make an e*mergency* landing due to an *equipment failure*.
    a. Air.
    b. Ground.
    c. Emergency.
    d. Maintenance.

41. (615) When assessing mission performance, one measure of effectiveness is a *total* abort rate, which is a combination of
    a. air and ground aborts.
    b. air abort, late takeoff, and ground aborts.
    c. air abort, total deviations, and ground aborts.
    d. air abort, ground abort, and maintenance cancellations.

42. (615) When computing the cannibalization rate, use this action taken code when components are "removed for cannibalization."
    a. C.
    b. R.
    c. T.
    d. U.

43. (615) To compute the *cannibalization rate*, one of the measures to use is the number of sorties
    a. flown.
    b. scheduled.
    c. flown minus deviations.
    d. scheduled minus sorties flown.

44. (616) When computing the mean time to repair (MTTR) equipment, you would express it in
    a. seconds.
    b. minutes.
    c. hours.
    d. days.

45. (616) When computing non-cyber/space/communications mean time to repair (MTTR) and are accounting for on equipment *repair hours*, you would *not* include this item.
    a. Crew size.
    b. Equipment.
    c. Action taken codes (ATC).
    d. First position of work unit code (WUC).

46. (616) When computing non-cyber/space/communications for on equipment mean time to repair (MTTR), the *first position* of the
 a. action taken codes (ATC) is equal to zero.
 b. work unit code (WUC) is equal to zero.
 c. WUC does *not* equal to zero.
 d. ATC does *not* equal to zero.

47. (616) This is the *maximum* number of days allowed for calculating the mean time between failures (MTBF) in the Integrated Maintenance Data System (IMDS) for equipment and components.
 a. 30.
 b. 60.
 c. 90.
 d. 180.

48. (616) The mean time between critical failures (MTBCF), when assessing mission performance, gives us the
 a. percentage of failures of critical systems.
 b. percentage of critical failures in a given time.
 c. average equipment operating time of critical systems.
 d. average time between failures of mission essential systems.

49. (616) Which type(s) of *maintenance events* are included when computing for the mean time between maintenance actions (MTBMA) to assess mission performance?
 a. Scheduled only.
 b. Unscheduled only.
 c. Scheduled and unscheduled.
 d. On-equipment and off-equipment.

50. (616) This mission performance measure gives the average time for end items and is an indication of overall component performance.
 a. Mean time to repair (MTTR).
 b. Mean time between failures (MTBF).
 c. Mean time between critical failures (MTBCF).
 d. Mean time between maintenance actions (MTBMA).

51. (617) This is a *lagging* indicator associated with fleet availability.
 a. Mission capable rate.
 b. Code 3 break rate.
 c. 8-hour fix rate.
 d. Air abort rate.

52. (617) What is the *overall indicator* for measuring a flying program or mission?
 a. Abort rate.
 b. Mission capable rate.
 c. Utilization (UTE) rate.
 d. Logistics departure reliability rate.

53. (618) How does a *high abort rate* affect the flying scheduling effectiveness (FSE) rate?
 a. Keeps the FSE rate steady.
 b. Keeps the FSE rate at zero.
 c. Drives the FSE rate down.
 d. Drives the FSE rate up.

54. (618) Which fix rate time interval is reported for all aircraft *other than* fighters?
    a. 4.
    b. 8.
    c. 12.
    d. 14.

55. (618) Which rate is a key indicator, especially for fighters, which measures how successfully maintenance supports the unit's mission?
    a. Flying scheduling effectiveness (FSE).
    b. Hourly utilization (UTE).
    c. Schedule deviation.
    d. Sortie UTE.

Please read the unit menu for unit 3 and continue ➔

Student Notes

Unit 3. Cyber and Space Communication Systems/Air Force Enterprise Level Reporting

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, as this unit covers, an investigation into the circumstances is warranted. You will study methods to measure the effectiveness of cyber and space communication systems' performance metrics, on key metrics, and their impact to the Air Force mission. As mentioned before, the key term *logistics* is also synonymous with maintenance while the term *operations* is synonymous with mission. Knowing this information is important to how you perform your duties.

3–1. Cyber and Space Communication Systems Performance Indicators

Maintenance Management Analysis is not restricted to aircraft and missile units; it is also used in cyber space units. In this section, you will study some operations and maintenance indicators that are crucial to the cyber space unit mission performance and their unique equipment. Bear in mind that these indicators apply *only* to *ground* cyber space communication systems such as radar, telecom, and mobile communication equipment. As you read the following material you should notice that some computations are similar to those we have previously covered.

Communications/cyber performance metrics and algorithms are used to enhance unit readiness. These metrics provide commanders and other management personnel vital mission information to better utilize resources. You may be asked to provide information on the primary mission concerns of how well the unit is meeting mission requirements, how to improve equipment performance, emerging support problems, and identifying current trends. This is accomplished through mission availability and sustainability, reliability, and maintainability measures for ground communication-electronics (C-E) and space equipment.

619. Key cyber/space/communication terms

The Cyber/Space/Communication Equipment Status and Inventory subsystem in IMDS is the primary source of data used to compute operational availability (A_O), operational dependability (D_O), operational readiness (O_R), mean down time (MDT), MRT, and MTBCF. MTBF and MTBM, unscheduled and scheduled, can be calculated using both the Equipment Status and Inventory subsystem and JDD data. There are four primary data sources used to extract raw data to compute all cyber/space/communications algorithms as follows:

1. IMDS (Equipment Status and Inventory subsystem).
2. REMIS.

3. Global Combat Support System-Air Force Data Services (GCSS-AFDS).
4. Global Cyber Support System-Dashboard (GCSS-D).

Before we begin our discussion of the computations, you need to understand some of the terms that cyber/space/communications uses. They are defined in the following table:

Term	Definition
Active equipment	Cyber/space/communications equipment differs from aircraft, which is active all the time. Cyber/space/communications equipment defines *active equipment* as equipment installed and in use to perform an operational mission or requirement. Cyber/space/communications equipment uses this definition to determine active hours, or the number of hours possessed equipment is active.
Active hours	Possessed hours equipment is reported in use.
Availability	Percentage of the desired operating time a system is in FMC or PMC status.
Possessed hours	Total number of hours during a given month an item of equipment was possessed by an organization.
Inactive equipment	Serviceable equipment that is *not* on line or in use. This includes equipment in storage, tactical and communication equipment *not* deployed, mockups, training equipment, and equipment *not* being used to perform the organization's primary mission.
Inactive hours	Possessed hours of equipment that is reported *not* in use.
Green condition	Equipment is FMC.
Amber condition (PMC)	System or equipment functioning in such a way that it can perform at least one, *but not all*, of its missions/functions.
Red condition (NMC)	System or equipment does *not* meet the TO specifications; therefore, it is unable to perform any of its assigned missions or functions.
Operation hours	Time that the system or equipment is considered to be operable (same as uptime).
Downtime hours	Number of hours the system is in NMC or red condition status and cannot be used for a specified purpose.
Downing event	Criteria of a downing event will generally include any occurrence resulting in the system not being used for a specified purpose (red and amber statuses).
Critical failure	Any degradation, indication of failure, actual failure, or combination of problems resulting in a loss of mission-essential functions.
Scheduled maintenance	Includes accomplishment of recurring scheduled maintenance inspections and servicing, compliance with TCTOs (*excluding* immediate actions), accomplishment of scheduled time change items' replacements, and delayed or deferred discrepancies correction.
Unscheduled maintenance	Includes compliance with immediate action TCTOs, correction of discrepancies discovered during operation of equipment, and performance of repairs as a result of accidents or incidents.
Maintenance labor hours (MLH)	Hours spent to support and/or repair equipment during maintenance.

620. Availability measures

We will cover availability and sustainability measures for cyber/space/communication systems in this lesson. Availability measures are used to determine the percentage of equipment that can be expected to perform its intended functions at a given time. These measures help determine a unit's ability to successfully carry out its mission. We will discuss each separately in the following paragraphs.

Operational availability

Operational availability is used to show mission availability and capability for ground C-E and ground space C-E. The A_O rate measures the probability that the system is either operating or can operate satisfactorily under specified conditions. It is the preferred method for defining availability in the capability requirements documents.

The downtime includes all periods where the equipment was in red condition status (NMC) for any reason. The formula for calculating the A_O is as follows:

$$Ao = \frac{\text{Active hours} - \text{NMC hours}}{\text{Active hours}} \times 100$$

For example, you compute the A_O for a 31 day month with 38.4 hours of downtime as follows:

$$\frac{744 - 38.4}{744} \times 100 = 94.83$$

Operational readiness and dependability

O_R and D_O both measure the probability that the system is operating satisfactorily under specified conditions, excluding downtime for scheduled maintenance and training. The difference is in the type of equipment they measure.

Operational readiness is used for ground C-E and the operational dependability is used for space C-E equipment. The formulas for computing the O_R and D_O is as follows: (**NOTE:** Not mission capable unscheduled [NMCU] refers to hours when the system is *not mission capable* because of *unscheduled maintenance and associated delays*.)

$$O_R = \frac{\text{Active hours} - \text{NMCU hours}}{\text{Active hours}} \times 100 \qquad D_O = \frac{\text{Active hours} - \text{NMCU hours}}{\text{Active hours}} \times 100$$

621. Reliability and maintainability measures

In this lesson, we focus our attention on cyber/space/communication equipment reliability and maintainability metrics. Reliability measures reflect the probability that a system and its parts will perform its mission without failure, degradation, or demand on the support system.

Maintainability measures show how equipment is maintained, and is normally expressed as the average time to complete a maintenance action. We will cover these different categories: mean downtime, mean repair time, mean time to restore functions, mean time between downing events, mean time between failures, mean time between critical failures, and mean time between maintenance. The following table provides a break out of maintainability and reliability measures.

Reliability measures	Maintainability measures
Mean time between critical failures.	Mean downtime.
Mean time between failures.	Mean repair time.
Mean time between downing events.	Mean time to restore functions.
Mean time between maintenance: Mean time between scheduled maintenance. Mean time between unscheduled maintenance.	

Mean downtime

The MDT is a measure of the average time between losing MC or PMC status and restoring the system to an MC or PMC status. It is considered a maintainability measure where the ability of equipment to be maintained is measured, and is typically expressed as the average time to complete a maintenance action, also described as maintainability. It includes active maintenance, maintenance and supply delays, administrative delays, scheduled maintenance, and all activities that result in NMC status, including training and preventive maintenance. MDT is computed as shown below:

$$\text{MDT} = \frac{\text{NMC Hours}}{\text{Number of NMC events}}$$

Mean repair time

The MRT measures the average maintenance repair hours per maintenance repair action from the JDD. It is also another form of a maintainability measure. MRT starts when the technician arrives at the system, or equipment for on-equipment maintenance or receives the assembly, subassembly, module, or circuit card assembly at the off-equipment repair location. MRT includes all maintenance done to correct the malfunction, including preparation, accessing the line replaceable unit (LRU), troubleshooting, removing and replacing parts, repairing, adjusting, and conducting functional checks. MRT does *not* include maintenance, supply, or other delays. It is expressed in a formula as follows:

$$\text{MRT} = \frac{\text{On - Equip} + \text{Off - Equip repair hours}}{\text{On - Equip} + \text{Off - Equip repair actions}}$$

Mean time to restore functions

The mean time to restore function (MTTRF) is used to show mission availability and supportability of Space, Space Surveillance, and Missile Warning Systems. It is a measure of the average elapsed time required to restore a system to full operational status after a critical failure, including administrative and logistical delay times associated with the restoring function. The MTTRF is similar to the fix rate in aircraft units. It is a valuable indicator of equipment or system availability and the speed of repair. Calculate the MTTRF using this formula:

$$\text{MTTRF} = \frac{\text{NMCMU Hours}}{\text{NMCMU Events}}$$

Mean time between downing events

The mean time between downing events (MTBDE) is a measure of the average time between events that cause system downtime. It is an indicator of for subsystems, LRUs, and modules’ availability. System downtime includes critical or non-critical failures, scheduled maintenance, and training. MTBDE is computed using the following formula:

$$\text{MTBDE} = \frac{\text{Number of operating hours}}{\text{Number of downing events}}$$

For example, you compute the MTBDE for a 30 day month with 3 downing events as follows:

$$\text{MTBDE} = \frac{720}{3} = 240$$

Mean time between failures

The MTBF is a measure of the average operating hours between any system failure. However, it *excludes* scheduled maintenance. C-E MTBF is similar to the MTBF measure you learned about earlier. The key difference with the formulas is that active time is divided by either Type 1 (inherent) or Type 2 (induced) failures. It is expressed as follows:

$$\text{MTBF Type 1 (Inherent)} = \frac{\text{Active time} \times \text{QPA} \times \text{UF}}{\text{Number of inherent failures}}$$

Mean time between critical failures

The MTBCF is a measure of the average operating time between failures of mission-essential system functions. The MTBCF formula does *not* deviate from the aircraft MTBCF. It can relate to the frequency of events that causes the system to be unavailable and have negative impact on the mission. The MTBCF equals the total system operating time divided by the number of missions downing events, including all disabling hardware and software failure events. The MTBCF *excludes* scheduled maintenance (preventive maintenance), and is calculated as follows:

$$\text{MTBCF} = \frac{\text{Active hours - NMCMU hours}}{\text{Number of NMCMU events}}$$

Mean time between maintenance

The MTBM measures the average operating time between maintenance events—scheduled and unscheduled. The operating hours are composed of all active hours *minus* NMC hours. It provides valuable guidance and is used as an input to any manpower analysis. MTBM is used as the principal indicator of the logistics reliability of a system, subsystem, or lower-level replacement action. The MTBM is computed using either of the following two formulas (scheduled and unscheduled):

$$\text{MTBM} = \frac{\text{Active hours - NMC hours}}{\text{Number of PMCM + NMCM events}}$$

Mean time between scheduled maintenance

The mean time between scheduled maintenance (MTBSM) measures the average operating time between scheduled maintenance events. As previously discussed, scheduled maintenance includes the accomplishment of recurring scheduled maintenance inspections and servicing, complying with TCTOs (excluding immediate actions), accomplishing scheduled time changes, and correcting delayed or deferred discrepancies. It is computed as follows:

$$\text{MTBSM} = \frac{\text{Operating hours}}{\text{Number of Scheduled Maintenance events}}$$

Mean time between unscheduled maintenance

The mean time between unscheduled maintenance (MTBUM) measures the average operating time between unscheduled maintenance events, such as compliance with immediate action TCTOs, correction of discrepancies discovered during equipment operation, and performance of repairs as a result of accidents or incidents. It is calculated using the following formula:

$$\text{MTBUM} = \frac{\text{Operating hours}}{\text{Number of Unscheduled Maintenance events}}$$

622. Utilization and manpower

The utilization rate (UR) calculates the average use of a system during a specified calendar period. It is expressed as a ratio of active hours to possessed hours.

Utilization

The utilization rate is a simple computation that indicates the relationship of an equipment's use and possession. This is a measure of availability. The utilization rate is calculated as follows:

$$\text{UR} = \frac{\text{Active hours}}{\text{Possessed hours}}$$

For example, to find the utilization rate of a ground radar system with 170 active hours 400 and possessed hours in 2015, you would make the following substitutions and solve:

$$\text{UR} = \frac{170\text{ hours}}{400\text{ hours}} = 0.425$$

Manpower

Manpower is an estimate, or requirement, for human resources in support of operations and maintenance. The maintenance labor hours per active hour (MLH/AH) is used to calculate the manpower requirement. Lead commands must consider utilization and manpower measures when describing high-level logistical requirements.

The MLH/AH shows the labor hours spent maintaining equipment in relation to the time it was operational. You obtain the MLH/AH by dividing the total on and off maintenance labor hours by the active hours accumulated by the system. The MLH/AH is calculated as follows:

$$\text{MLH/AH} = \frac{\text{On/Off equipment labor Manhours}}{\text{Active hours}}$$

Look at the example below. To find the maintenance labor hours per active hour of a ground radar system whose active hours for the past month are 14, and its maintenance labor hours are 28, substitute the formula above and complete the math:

$$\text{MLH/AH} = \frac{28}{14} = 2$$

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

619. Key cyber/space/communication terms

1. Which IMDS subsystem is the primary source of data to compute cyber/space/communication algorithms?

2. Define active hours.

3. Which availability statuses are used to determine the percentage of a system's operating time?

4. Define possessed hours for cyber/space/communication equipment.

5. Which type of condition is assigned when a system or equipment can perform at least one, but not all, of its missions or function?

6. Define a critical failure.

620. Availability measures

1. What is determined by availability measures?

2. What does the operational availability rate depict?

3. What kind of downtime hours are used to calculate operational availability?

4. What do the operational readiness and dependability rates depict?

621. Reliability and maintainability measures

1. Which measure shows the probability that a system and its parts will perform its mission without failure, degradation, or demand on the support system?

2. What do maintainability measures reflect?

3. What does the MDT measure?

4. What does the MRT measure?

5. What does the MTTRF measure?

6. What does the mean time between downing events measure?

7. Which type of systems does the MTBCF measure?

8. When is the MTBM used?

622. Utilization and manpower

1. What does utilization show?

2. What is used to estimate manpower requirements in support of maintenance and operations?

3–2. Air Force Enterprise Level Reporting

Over the past 20 plus years, the Air Force created numerous data systems to track all facets of the aircraft, missile, and communication maintenance environments. The two major systems are the IMDS, and the Mobility Air Force Logistics Command & Control (MAF LOG C2) system, formerly known as Core Automated Maintenance System (CAMS) G081. Additional systems, such as the Integrated Logistic System–Supply (ILS–S), formerly known as the Standard Base Supply System (SBSS), were created to support their respective AF communities and missions. Ultimately, well over a hundred systems were created that resulted in massive amounts of data, but there was no common way to retrieve and effectively use it from a global AF perspective.

As a result, a centralized data service was created to feed key information from each of the stand-alone databases, which provides the capability to consolidate and standardize the data for use at all AF levels. Having the raw data available for reports is extremely helpful, but an easy to use interface that quantifies massive amounts of data and displays it as an easy to view format on an end user's desktop if needed. In this lesson, you will learn about the Global Combat Support System–Air Force Data Services (GCSS-AFDS), which consolidates data from multiple systems and allows you to run reports. You will also learn about the Logistics, Installations and Mission Support-Enterprise View (LIMS-EV), which provides an easy to use graphical interface with standardized and customizable views.

The AMC determined a need existed for a central repository devoted to all command-related functional areas. As a result, the US Transportation Command (USTRANSCOM) funded a Global Decision Support System (GDSS) to provide combatant commanders, throughout military operations, MAF LOG C2 information for near-real-time total asset visibility. Lastly, we will cover the Global Cyber Support Systems Dashboard (GCSS-D) capability to display C-E performance metrics and maintenance documentation from one integrated application.

623. Global Combat Support System—Air Force Data Services

GCSS-AFDS is a centralized system for collecting, storing, and sharing data from other database systems. It provides data warehousing, data analysis, and decision support for the AF enterprise. Strategic data for the maintenance and supply communities is sent from several different databases.

This lesson is concerned with only two of the databases: IMDS and MAF LOG C2. Hourly, historical data is sent from each database and stored in the GCSS. Status, inventory, maintenance repair for specific work unit codes, and associated data are a few of the items you can retrieve using custom-built Business Objects (BOBJ) reports.

In previous lessons, you learned to compute rates using data from a variety of sources. Raw data is a critical source for conducting data pulls, making comparisons among similar equipment, or extracting data related to fleet performance. This is invaluable from the base, higher headquarters, or AF level.

Accessing GCSS-AFDS

The GCSS-AFDS is available via the AF Portal (https://www.my.af.mil). It is accessed by logging into the AF Portal home page with your controlled access card, then selecting “Applications A–Z” under the “Applications” box towards the top of the screen. This displays an alphanumeric index. Select “G” and then scroll down until you see “GCSS-AF Data Services.” You may also access it by searching via the keyword by entering “GCSS-AF Data Services” in the search box.”

NOTE: You may add the GCSS-AFDS link to your AF Portal favorites by clicking on “Add to My Favorites” just below the “GCSS-AF Data Services” link.

Navigating Info View

The info view interface allows you to view documents, customize your workspace, and get help. The entry point is your Home Page and is divided into two areas: the dashboard navigation bar and workspace panel.

Dashboard navigation bar

The dashboard navigation bar includes the following options:

- Home—This tab will take you back to the homepage.
- Documents—This tab is where you will store all of your corporate reports. The folders within the tab include: My Favorites, My Alerts, Subscribed Alerts, and Personal Categories.
- Application—This option will let you design custom views as well as define corporate reports. There are three parts in application section: Business Intelligence (BI) Workspace, Module, and Web Intelligence Application.
- Help menu—This menu provides access to the user manual.
- Preferences—This option gives you the ability to specify requirements you need as a user.
- Log Off—This option allows you to logout of Business Objects.

Workspace panel

The workspace panel is located in the center of the screen and displays the page you are viewing, folder properties, or a report. When you are on the homepage tab the following sections will be shown: My Recently Viewed Documents (up to ten), My Recently Run Documents, Unread Messages in My Inbox, Unread Alerts, and My Applications.

Working with documents

Many documents already exist and were created to pull the most commonly requested data. From the “Folder” view, under “Public Folders”, you will see the “Corporate Documents” folder. You will see numerous folders categorized by type of report in this folder.

Select any of the folders to view the existing reports. You may select a report and associated data from the last time it was ran, which is displayed in the workspace panel. Some reports, such as the type of aircraft, will prompt you for user input before executing.

If it does, click the “Run Query” link after typing in the requested data. After the report is displayed, the bottom of the panel shows the last date that data was pulled. To review the document summary, click on the report icon at the top left of the screen. To view current data, simply select the “Refresh Data” button just above the report. The report will execute and display the latest data.

Saving documents

Documents can be saved to your personal folder. This is useful if you find a report you want to use on a regular basis or for use in a briefing or slideshow. Open the report and click the “Document” drop down icon in the top left corner of the workspace panel. You will be prompted for a name and location. Use “My Folders” and save it under “Favorites.” To open the report, navigate to “My Folders” and select “Favorites.” You can select the report and refresh it as needed.

Sending documents

Documents can also be sent to another user’s inbox. Click on the report you want to send. After it opens, scroll across the toolbar and click the “Send to User” icon drop down box. Once you select a GCSS user’s’ name, click on the arrow to add their name to the “Selected Recipients” box. Under the “Send as” section, you will select “Copy” or “Shortcut,” then click “Send.”

Editing documents

Documents can be edited to modify the query associated with it. For example, a report that retrieves data on F–16 aircraft may be changed to retrieve F–15 aircraft data. Documents can only be edited in your personal folder. Navigate to your personal folder and find the document you want to change. On the far right hand side of the toolbar, click on the drop down menu that says “Design.”

Select “With Data” option. At the top of the panel, make sure you click the “Data Access” tab. When the “Data Access” is highlighted, you will see two tabs: “Data Providers” and “Data Objects.” Select “Data Providers” and double click on the “Edit” button underneath it. The query panel will appear and you can make modifications. When you are finished, save the changes as the existing report or a new report. Select “Run Query” to verify that your changes are correct.

Exporting documents

Quite often, you will want to save the report to either view on your computer or manipulate in other ways. Output can be exported to Excel, PDF, or files known as comma separated values (CSV), by clicking on the export icon in the toolbar then following the prompts. You may also open the document and wait for the report.

Select the “Document” drop down button, and then “Save to my computer as.” Choose the format you want. Your internet browser may prompt you to allow downloaded content. If so, select “Allow” and repeat the steps above. You will receive a file download dialog box. Choose “Save” and then the location you want to save it on your computer.

Creating new documents

You may find that the existing reports do not pull the data you need. To create a new query, click on “My Applications” and select the “Web Intelligence Application;” this will create a “Web Intelligence” tab. Click on the first icon in the toolbar to create a “New” document. You will then have two options: “No Data Source” or “Universe.” Data is stored in a “Universe.” A universe is a logical group of data with a name that is easy to identify based on the type of data available.

Select a universe, and then the “New Document” pane appears. To the left are all the data items available in the universe you selected. For example, to select a type of aircraft, you might see “Aerospace Vehicle Inventory Status Utility” as one of your selections. When you select a universe, notice the “Help” box below. It will provide a description of information stored in that universe.

Click the right facing, double-headed arrow to add it to the “Result Objects” area. To the left, you will see the entire data items available in the Aerospace Vehicle Inventory Status Utility universe. To select a type of aircraft, click on the “Debriefing” folder and select “Debrief MDS.” You then drag “Debriefing MDS” to the “Results Objects” area. Continue to do this to retrieve all the related data items for your MDS. Remove data items by selecting the item and dragging it to the universe outline.

At this point, a filter can be applied to limit the data. Using the "Debriefing" folder as an example, you might want to prompt someone running the report to enter the geographic location of the aircraft they want to view. By selecting "Debrief Geographic Location" under the "Debriefing" folder, you can create a list of MDSs at a specific location. Use the drop down box to the left and highlight "Prompt" for a specific filter each time the query is ran, "Constant" to use the criteria typed in the box, or "Value(s) from list" to search from the options available. You can get an idea of what your report will return by clicking on the "Data Preview" section. It has a "Refresh" button that shows a glimpse of the data based on the filters and objects you chose.

Finally, select "Run Query" to view your new report, then save the file to your "Favorites" folder if the results meet your expectations. Otherwise, continue to add or remove data items located in the "Universe" as needed.

Practice and patience are required to properly create reports, so use every opportunity to enhance your skills and learn to exploit the data for use in your day-to-day analysis.

624. Logistics Installation Mission Support-Enterprise View

LIMS-EV is a BI gateway providing a standardized data extraction capability for reporting and for analysis. LIMS-EV provides a single entry point on the Air Force Portal that hosts a variety of capabilities in a flexible, dynamic, web-based environment. This capability supports reporting and analyzing requirements using scorecards, dashboards, and predictive analysis to all levels of users: strategic, operational, and tactical.

Accessing LIMS-EV

LIMS-EV is available via the AF Portal (https://www.my.af.mil). Log into the AF Portal home page and select "Applications A-Z" below the "Applications" box towards the top of the screen. This displays an alphanumeric index. Select "L" and then scroll down until you see "LIMS-EV Weapon System View (WSV)." You can also search via keyword by entering "LIMS-EV Weapon System View" in the search box. The LIMS-EV Weapon System View site is a controlled site and requires approval via a request for access to capability link, provided under the description and contact information. You will need to provide your name, AF Portal User ID, and ask for access to the Weapons System View. Once you have access, click on the "LIMS-EV Weapons System View" link.

NOTE: You may add the LIMS-EV Weapon System View link to your AF Portal favorites by clicking on "Add to My Favorites" just below the "LIMS-EV Weapon System View" link.

Weapons system view

From the application menu, select the Weapons System View. This view is the single source to examine analytical metrics for current, historical, and operational weapons systems information.

The interface is easy to use and very intuitive after using it for a few minutes. The date range for historical data is from 1991 to the present, and is customizable to display by day, month to date, calendar quarter, fiscal quarter, calendar year, and fiscal year spanning the entire period. Data is available by total Air Force, MAJCOM, down to the unit level by mission design (MD) or mission design series (MDS).

Analytical modules include a metric search, work unit code search, and leadership dashboard. The metric module is the default home page within the weapons system view. You may search the metrics view by selecting filter criteria by aircraft or equipment details, data range or metrics. The work unit code module provides search criteria for WUC, or work unit code logistics control numbers or reference designators. This is further broken down by the top 5, 10, 25, or specifically by 2, 3, or 5 digit codes for aircraft or equipment. The leadership dashboard provides a quick look at the fleet and has drill down capability to display trends at the MD level. The standards and goals are also easily viewable and you can drill down.

The weapons systems view of LIMS-EV does not replace the authorized MIS (IMDS, MAF LOG C2, or REMIS) that are used in reporting metrics to your MAJCOM. This application should only be used as a tool to compare or contrast analysis findings. You will find this helpful during special studies or comparing your base to another base. Requesting daily unique raw data pulls is a good use of this application.

625. Global Decision Support System–2

The Global Decision Support System-2 (GDSS2) enables AMC to fulfill global mobility missions by combining unit-level and force-level planning, scheduling, and tracking of all mobility airlift and air refueling missions into one modernized system that interface data with 40 other systems. It will provide combatant commanders MAF C2 visibility of aircrews, cargo aircraft, and ongoing mobility missions regardless of their location. GDSS2 is AMC's primary mission execution system for data entry requirements. This system is heavily used by the operations group schedulers, as well as your own Plans, Scheduling, and Documentation (PS&D) section. As a maintenance analyst stationed at an AMC base, you will use this system to pull historical data that the G081 is not capable of producing.

Requesting access

To gain access to the GDSS2, you will need to contact the unit program account manager (UPAM). At times, this position resides within the PS&D or MMA sections. Similar to a database manager who oversees access to IMDS or G081, the UPAM oversees access to the GDSS2. The UPAM also assigns the appropriate roles and modifiers for users to perform their required duties. Once you contact your UPAM, you will receive a GDSS2 request form. The UPAM will submit your completed request form to AMC, and you will receive a GDSS2 userid and password.

Program Management Office

The Program Management Office (PMO) is the single point of contact for GDSS2 hardware and software problem resolution, providing around-the-clock technical support to all users 365 days a year. If you need assistance in training, you can search for the GDSS2 help desk on the AF portal. To access the GDSS training site for training material (i.e., training documents, checklist, CBTs, ATO, etc.) you need an active GDSS2 account.

Metrics

The Logistic Departure Reliability (LDR) rate is governed by AMCI 10−202V6, *Mission Management and Reliability Reporting System.* The LDR rate measures the reliability of missions that take off on time against those that are delayed due to maintenance, supply, or transportation. Training missions, as identified in their mission number, are not calculated in the LDR. Since flying scheduling deviations are not recorded in the G081, the GDSS2 is the only official historical data source used to compute the LDR rate. Within the reports library, a mission details logistics report is ran to obtain the data to compute the LDR rate. When reviewing the report, the wing command post is responsible for inputting all data for each logistical delay. Maintenance Operations Center (MOC) controllers verify the delay remarks for accuracy with the production superintendent, known as the pro-super.

Scheduling

Schedulers use the GDSS2 to generate daily/weekly flying schedules in conjunction with excel products for Operations and Maintenance presentations, be it meetings and/or slides.

The GDSS2 provides schedulers the capability to ensure accurate information is provided in the correct form to make effective decisions. It provides a set of collaborative decision making tools enabling schedulers to monitor and manage the initial planning, execution, and reporting to fulfill all global mobility missions.

Also, the GDSS2 provides the foresight to schedule airframes to meet specific mission needs by creating detailed filters for a specific Air wing, squadron, or MDS. PS&D is able to track mission changes in real time for the most up-to-date information. The logistics and aircraft management application within GDSS2 provides the functionality to monitor assigned aircraft both at home and off station. This application interfaces with data from CAMS-For Mobility/G081.

Overall, GDSS2 works as a share point between Plans & Scheduling and the Operations Group to view upcoming mission details and specifics needed to pass on to the maintainers who prep airframes for mission needs.

626. Global Cyber Support Systems Dashboard

The Global Cyber Support Systems Dashboard (GCSS-D) is a BI gateway deployed within the Global Combat Support System (GCSS)-Air Force (AF) to provide a single, integrated application in support of cyber/communications warfighter readiness, effectiveness, and mission performance. The dashboard provides quick access to data and to answers across all functional areas of maintenance, including equipment status reporting, inventory tracking, and maintenance documentation. It applies the transparent data reporting and analytical capabilities provided by LIMS-EV to C-E equipment, allowing users to view and display data by serial number for all levels.

Accessing GCSS-D

GCSS-D is available via the AF Portal (https://www.my.af.mil). Log in to the AF Portal home page and select "Applications A-Z" under the "Applications" box towards the top of the screen. This displays an alphanumeric index. Select "G" and then scroll down until you see "Global Cyber Support Systems Dashboard." You can also search via keyword, by entering "GCSS-D" in the search box. GCSS-D is controlled and requires access approval before you can use it and can be requested by including your name and your AF Portal User ID, with a request for access. Access requests and questions can be submitted to the application organizational box cyss.man.maintenance.data.analysis@us.af.mil.

NOTE: You can add the GCSS-D link to your AF Portal favorites by clicking on "Add to My Favorites" just below the "GCSS-D" link.

Metrics Search View

The metrics search view allows users to drill into the status, performance, and maintenance metrics. Status selections in this view are based on current and past equipment statuses pushed from the IMDS to REMIS. Data can be selected by rates or hours (total active hours and possessed hours), and common rates are NMC, NMCS, NMCU and PMC. Performance selections in this view are in either rates or hours with common rates being: A_o, O_r, D_o, UTE, MTBCF, and MTBF. Maintenance metrics are based on the maintenance data documentation (MDD) in support of on-/off-equipment maintenance and gives you the SRD and job control number (JCN) information to include ESR data. All data and charts can be generated in PowerPoint/Excel formats to allow users to export it for future use.

JCN search view

This view provides users the capability to drill into a specific JCN for the MDD. Mainly used when a user knows a specific JCN and only needs the detailed MDD to support it. All data and charts can be generated in Microsoft PowerPoint and Excel formats to allow users export it for future use.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

623. Global Combat Support System—Air Force Data Services

1. Which two areas is the Home Page if the GCSS-AFDS Info View divided into? Explain each.

2. What types of formats can GCSS-AFDS documents be exported to?

3. What is a universe?

624. Logistics Installation Mission Support-Enterprise View

1. How do you access the LIMS-EV?

2. What is provided via the LIMS-EV Weapons System View?

3. Which tabs are analytical modules or data organized under?

625. Global Decision Support System-2

1. What is AMC’s primary mission execution system?

2. Who do you contact to gain access to GDSS-2?

3. What metric is used as the GDSS-2’s only official historical data source?

626. Global Cyber Support Systems Dashboard

1. Which type of equipment does the GCSS-D support?

2. Where do you gain access to the GCSS-D?

3. Which types of views are available in GCSS-D?

Answers to Self-Test Questions

619

1. Cyber/space/communication equipment status and inventory.
2. The number of possessed hours equipment is reported in use.
3. FMC and PMC.
4. Total number of hours an organization had an item of equipment during a given month.
5. Amber (PMC).
6. Any degradation, indication of failure, actual failure, or combination of problems resulting in a loss of mission-essential functions.

620

1. Percentage of equipment that can be expected to perform its intended functions at a given time.
2. Probability that the system is either operating, or can operate, satisfactorily under specified conditions.
3. Red condition status (NMC)
4. Probability that a system is operating satisfactorily under specified conditions excluding downtime for scheduled maintenance and training.

621

1. Reliability.
2. Ability of equipment to be maintained.
3. Average time between losing MC or PMC status and restoring the system to an MC or PMC status.
4. Average maintenance repair hours per maintenance repair actions from the JDD.
5. Average elapsed time required to repair and restore equipment or a system to full operational status after a critical failure.
6. Average time between events that cause system downtime.
7. Mission-essential.
8. As a principal indicator to determine reliability of systems, subsystems, or lower-level replacement action.

622

1. The calculation that provides the relation of equipment's use and possession, measuring availability.
2. Maintenance labor hours per active hour.

623

1. (1) Dashboard navigation bar: Includes the home tab, documents tab, application option, help menu, preferences, and logoff option.

   (2) Workspace panel: Displays the page you are viewing, folder properties, or reports.
2. Excel, PDF, or CSV files.
3. Data that is grouped logically with a name that is easy to identify based on the type of data available.

624

1. Via the AF Portal.
2. It serves as the single source to examine analytical metrics for current, historical, and operational weapons systems information.
3. The metric, work unit code, and leadership dashboard.

625

1. The GDSS-2.
2. The UPAM.
3. The LDR.

626

1. Cyber/communications.
2. Via the AF Portal.
3. Metrics Search and JCN Search.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to AFCDA.

56. (619) Which term is associated with cyber/space/communication training equipment?
    a. Active.
    b. Inactive.
    c. Red flagged.
    d. Non-functional.

57. (619) For cyber/space/communication equipment, the number of hours a system *cannot* be used for a *specified* purpose is designated as
    a. active.
    b. inactive.
    c. downtime.
    d. possessed.

58. (620) When computing for communication-electronics (C-E) equipment *operational availability*, you need its
    a. active and inactive hours.
    b. active and not mission capable hours.
    c. operational and inactive hours.
    d. operational and not mission capable hours.

59. (621) The cyber/space/communication *mean downtime* is also expressed as the average time to complete
    a. full downtime hours.
    b. maintenance action(s).
    c. restoration to mission capable status.
    d. restoration to partial mission capable (PMC) status.

60. (621) Which cyber/space/communication mission performance indicator is a valuable indicator of equipment or system maintainability and speed of repair?
    a. Utilization rate.
    b. Operational availability.
    c. Mean time to restore functions (MTTRF).
    d. Mean time between maintenance (MTBM).

61. (621) The cyber/space/communication mean time between downing events (MTBDE) is an indicator of subsystems, line replaceable units (LRU), and modules'
    a. reliability.
    b. capability.
    c. availability.
    d. maintainability.

62. (621) The cyber/space/communication mean time between critical failures (MTBCF) measures the average operating time between failures of these type of *system functions*.
    a. Ground-based.
    b. Aircraft-related.
    c. All base support.
    d. Mission-essential.

63. (621) When computing the cyber/space/communication mean time between critical failures (MTBCF), you get the operating hours from the *total*
    a. system downtime.
    b. equipment downtime.
    c. system operating time.
    d. equipment operating time.

64. (621) Mean time between scheduled maintenance (MTBSM) is a cyber/space/communication computation. In determining the MTBSM, scheduled maintenance includes scheduled maintenance inspections, scheduled time changes, delayed discrepancies, and
    a. non-immediate action time compliance technical orders (TCTO).
    b. immediate action TCTOs.
    c. repairs as a result of accident or incident.
    d. operator-reported discrepancies.

65. (622) The cyber/space/communication equipment *utilization rate* (UR) is a *ratio* of
    a. active hours to inactive hours.
    b. active hours to downtime hours.
    c. active hours to possessed hours.
    d. inactive hours to possessed hours.

66. (622) Use this measure to estimate the *manpower* requirement in support of maintenance and operations.
    a. Maintenance utilization rate.
    b. Maintenance events off equipment.
    c. Maintenance labor hours per mission.
    d. Maintenance labor hours per active hour.

67. (623) Historical data is sent from the Integrated Maintenance Data System (IMDS) and the Mobility Air Force Logistics Command & Control (MAF LOG C2) to the Global Combat Support System–Air Force Data Services (GCSS–AFDS). How often is the information sent from the IMDS to the MAF LOG C2 and GCSS-AFDS?
    a. By transaction.
    b. Hourly.
    c. Daily.
    d. Weekly.

68. (623) The Global Combat Support System–Air Force Data Services' (GCSS–AFDS) Info View Home Page is divided into how many areas?
    a. 1.
    b. 2.
    c. 3.
    d. 4.

69. (624) The Logistics, Installations and Mission Support-Enterprise View (LIMS-EV) has the capability to support this level of users.
    a. Logistical, operational, and supervisory.
    b. Strategic, operational, and logistical.
    c. Strategic, logistical, and supervisory.
    d. Strategic, operational, and tactical.

70. (624) The date range for Logistics, Installations and Mission Support-Enterprise View (LIMS-EV) data is
    a. 1991 to present.
    b. 1993 to present.
    c. 2001 to present.
    d. 2003 to present.

71. (624) This is the *default home page* for the Logistics, Installations and Mission Support-Enterprise View (LIMS-EV) Weapons System View.
    a. Status.
    b. Metric.
    c. Debrief.
    d. Work Unit Code.

72. (625) Within Air Mobility Command (AMC), which system do the Operations Group schedulers and the Plans, Scheduling, and Documentation (PS&D) section heavily use?
    a. Logistics, Installations and Mission Support-Enterprise View (LIMS-EV).
    b. Reliability and Maintainability Information System (REMIS).
    c. Global Decision Support System 2 (GDSS2).
    d. Core Automated Maintenance System G081.

73. (625) The Global Decision Support System-2 (GDSS2) is the *only* official historical data source used to compute this rate.
    a. Maintenance Scheduling Effectiveness (MSE).
    b. Flying Schedule Effectiveness (FSE).
    c. Logistic Departure Reliability (LDR).
    d. Air Abort.

74. (625) Which agency works with the production superintendent (pro-super) to check delay remarks for accuracy in the Global Decision Support System-2 (GDSS2)?
    a. Maintenance Operation Center controllers.
    b. Plans Scheduling & Documentation.
    c. Operations Group.
    d. Command post.

75. (626) The Global Cyber Support System Dashboard's (GCSS-D) Metric Search View allows users to drill-down into the areas of status, performance, and
    a. maintenance.
    b. availability.
    c. utilization.
    d. supply.

76. (626) In the Global Cyber Support System Dashboard (GCSS-D), selecting current and past equipment statuses is based on information pushed from the
    a. Mobility Air Force Logistics Command & Control (MAF-LOG C2) to Reliability and Maintainability Information System (REMIS).
    b. Comprehensive Engine Management System (CEMS) to REMIS.
    c. Integrated Maintenance Data System (IMDS) to REMIS.
    d. MAF-LOG C2 to REMIS.

Please read the unit menu for unit 4 and continue ➔

Unit 4. Maintenance Data Analysis

IN THIS UNIT, you will examine the overall analysis process as it relates to your maintenance analyst job. It is critical that you have a good working knowledge of the entire analysis process from start to finish. You need to have a systematic program to collect and manipulate data, set up correct parameters, and interpret the results. As a prerequisite for conducting in-depth analysis, you must know what data is available and how to use it to identify problems impacting your units' performance. In short, both data flow and data use, including JDD, set the stage for the analysis process—a comprehensive approach that covers each problem-solving step. Next, you will learn about your responsibilities in the analysis process and the statistical pitfalls to avoid. Finally, you will learn the steps of preparing and presenting a special study.

4–1. Analyst Tools and Responsibilities

To be an effective analyst, you must know where you are going and have a good idea of how to get there. This requires a plan of attack and there are tools available to help you get there. Your responsibilities are wide and varied and it is important to learn what they are so supervisors and commanders can make good decisions based on the information you provide. By carefully following the 12–step analysis process, knowing your responsibilities and data sources, and avoiding common statistical pitfalls, you will be able to provide this required information with a high level of confidence in its accuracy.

627. Twelve–step analysis process

The 12–step analysis process provides an effective and logical plan to follow. Never forget that your primary responsibility is to provide meaningful information that will enable maintenance managers and supervisors to make sound managerial decisions.

As you work your way through this unit and learn about the various statistical tests, the ways to collect data, and how to interpret the results, keep in mind that you must do these 12 steps within the framework of the analysis process. This process guides you in a concise and logical way, keeping assumptions to a minimum and always building upon itself, from simple to complex. Since some of you may not be familiar with the statistical tests involved with maintenance analysis, we will go over the 12–step analysis process in a general way, keeping specific test details to a minimum.

Perform analysis

Your commander may suspect there is a problem and request you to perform an analysis, or you may find something that you believe warrants investigation. In either case, begin by clearly defining the problem. This helps you and anyone else who might work on the study to pinpoint exactly what to look for. A clearly defined statement of the problem helps keep you focused on your purpose. For example, you may suggest that cannibalizations are increasing. You may state the problem as a hypothesis, “Cannibalizations are on the increase,” and proceed from there to prove or disprove your theory. Since hypothesis testing was discussed in the previous volume, we won’t revisit it here; review that information before continuing if you need to refresh your memory.

Where and how

Effective analysts know where they are going, have a good idea how to get there, and are not sidetracked along the way. They constantly remind themselves that their primary responsibility is to provide meaningful information to help managers and supervisors make good decisions. Remember, the maintenance mission is to maintain a reliable weapon system through the effective and efficient use of available resources. As an analyst, you possess the key to assisting managers by placing things in the proper perspective.

Where to begin

Speaking of placing things in the proper perspective, begin by gathering the facts, keeping assumptions to a minimum, not jumping to conclusions, and asking yourself the important questions below:

- Are the facts real?
- Are all the facts there, or are more facts available elsewhere?
- How do the facts compare to what you expected?
- Can you mold the facts to tell the story accurately?
- How do you think the story will end?
- Identify and examine anything that affects your interpretation of the facts.
- Are problems caused by something or someone? How and why?
- Should procedures be changed?
- What corrective action would you recommend?
- Is corrective action being taken, and how effective is it?

Sketch the process

When you accomplish the preceding, you will have completed a thumbnail sketch of the 12–step analysis process. To be successful, the process requires that you be totally objective, and to fairly and accurately assess the condition of the organization and the weapon system. The 12–step analysis process is a multifaceted approach used by analysts to solve management problems. There will be times that you will use each step of the process and at others, you will only use some of the steps. The problems you encounter determine the steps you will follow.

Process

The 12–step approach to the analysis process is a continuous cycle, illustrated in figure 4–1. Each step is labeled so that you can follow it more easily. In the following paragraphs we take a more detailed look at each of the steps in the process.

Step 1—Collect Data

This first step, or the point of departure for the 12–step analysis process, is to collect data. You can gather data from different sources—data system outputs, schedules, and so on. In fact, the next lesson covers various data sources that may be available to you. An active analyst is constantly collecting data (information). Besides those routine computer runs, letters, schedules, and memos that pack filing cabinets, everything you see and hear is a potential input to the 12–step analysis process as listed in the table.

Data Collection	
Step	**Description**
Facts or opinions	Gather whatever data you deem necessary to prove or disprove your theory. The data may be either facts or opinions. You can obtain factual data from maintenance reports, utilization reports, status reports, inquiry reports, or any of the other numerous sources of data available to you. Usually, factual data is better than opinions because facts can be supported. Opinions, on the other hand, are experience-based. You can gather it by talking with shop chiefs, maintenance people, mechanics, quality assurance (QA), coworkers, or by using your own experience. These two types of data go hand-in-hand. The factual data provides you with the numbers, which you then analyze, and then, based on your analysis, you can gather opinion data about why the problems occurred.
Three-phase process	Data collection itself is a three-phase process, consisting of the following: 1. Identifying. 2. Interpreting. 3. Extracting information. You may find it helpful to use worksheets during the data collection process. The thought process required to build an adequate worksheet allows you to think through the three phases of data collection before starting. These phases do not occur in any particular order nor can you readily identify where one stops and another starts. The important thing is that all three phases occur and yield results.

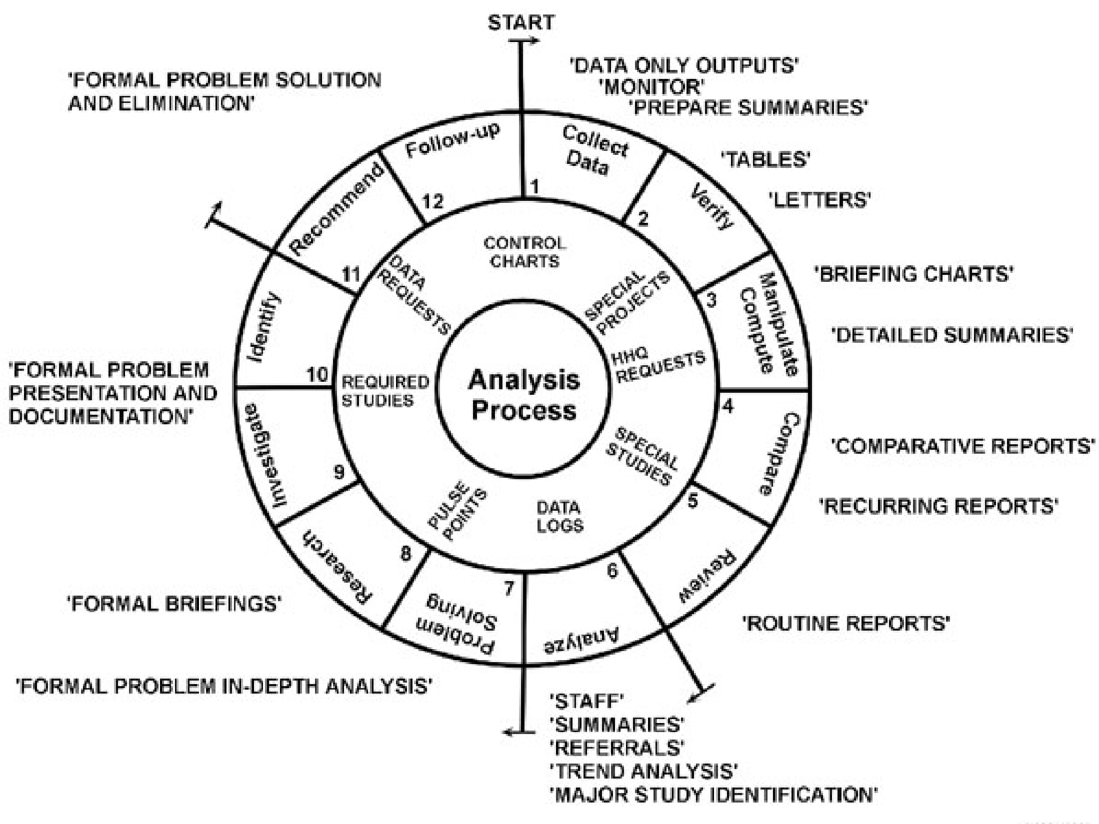

Figure 4–1. The 12–step analysis process.

Step 2—Verify

We cannot overemphasize the verification step! Even though it is the second step in the 12–step analysis process, it is the first step that makes or breaks credibility; therefore, verify all data you use. How many times has a supervisor casually entered your office to show you an error in one of your maintenance reports? The error probably was the result of a missed verification step, whether it was verifying the raw data or verifying (proofreading) the output product. Verification occurs many times throughout the 12–step analysis process and requires that you understand the data systems and other sources from which you draw your information.

Step 3—Manipulate/Compute

Raw data is usually unacceptable for presentations. It may be difficult to understand and may even be misleading. When you have an accurate and complete set of data with which to work, put it into a usable form. This is the next task: manipulate and/or compute the data to a useful, meaningful form.

The generally acceptable forms for presentation include tables, charts, and graphs. In addition, you may need to compute averages, rates, percentages, and so on. Scrutinize both the format and your computed data to ensure that the information is in the form most meaningful to those who will use it. As you accomplish this step, remember that organizing your data to tell the story at a glance may save you time later. Also, consider the type of chart, graph, or other visual medium that will present the results in the most effective manner.

Step 4—Compare

At this point, your data is in a usable form, and this is the first opportunity to compare it with standards, past performance, or expected results. This comparison is a relatively simple one. Is the trend stable, increasing, or decreasing? Are there more deviations than expected? Were the goals accomplished? Did the rate rise or drop as anticipated? When making these comparisons in this fourth step of the process, you will get an idea of the kind of questions that need answering and the direction the analysis will take. Finally, remember to check maintenance operating procedures to ensure a unit or work center is not operating under waivers that you were not aware of.

Step 5—Review

While asking yourself simple questions about the data, you will probably find information that requires further explanation. You want to provide additional information for areas that raise obvious questions. By reviewing the data in this manner and providing those answers, you will save yourself time and will not need to do it over when the questions surface. Your answers (or extra input) could come from the same source you used in the first step of this process, other sources, or your personal knowledge as an analyst. Many analysis products will be completed at this stage of the 12–step analysis process. For example, your maintenance summary is a report, not an analysis, and ends at step 5. Review the material again to ensure accuracy before releasing these products (e.g., charts, reports, slides, etc.). Also, ask a coworker to review your findings.

Step 6—Analyze

Now that you have gathered, verified, manipulated, compared, and reviewed your product, you must determine if you need to proceed further along the 12–step analysis process. This step—analyzing—is nothing more than a logical thinking process. The success of this thinking process depends on your knowledge of the available information sources and the organization, your understanding of the statistics, and your experience. Examine the items listed in the table below—organization, statistics, and experience since you have already learned about the information sources.

Areas to Analyze	
Area	**Description**
Organization	You must know the makeup of your organization. This includes the structure of the unit (who is responsible to whom), the mission of the unit (overall objective), the goals of the unit, the responsibilities of each agency within the unit (how the system should work), and knowing who the key people are.
Understanding statistics	As the statistical expert in your organization, be a thorough and questioning analyst who will deliberately examine and cross-examine the use, meaning, and application of each statistic used. Answer the following questions: • Do you know what the statistics (data) tell you? • What elements make up a particular statistic? • Are they meaningful? • What effect does a change in one element have on the statistic? • What effect does a change in one statistic have on the values of other statistics? • How accurate are your data sources? If you understand your statistics, you can properly apply them. In addition, if you have that understanding, you will reduce the risk of making erroneous statements or reaching invalid conclusions. The many formulas listed in volume three (statistical methods) represent the basic measurement tools for evaluating selected management indicators.
Statistics	Statistics are probably the most misused and misunderstood type of support. But if you properly collect and wisely use statistics, they can help you clarify or provide support for your recommendations. Not all figures, however, are statistics; some are simple numbers. Statistics show relationships such as largeness or smallness and increases or decreases. They also summarize large collections of facts or data. Before you use statistics, ask yourself these questions. • Are the statistics recent? • Do the statistics indicate what they intend to? • Do the statistics cover a long enough time or large enough sample size to be reliable? • If the statistics are drawn from a sample, does the sample accurately represent the population? • When the statistics indicate a difference, are the differences significant? • When comparing things, are the units of measure compared the same? • Do the statistics come from a reliable source? • Are the statistics presented to their best advantage to aid management in making decisions?
Personal job experience	The final element required for successful interpretation (analysis) of your data deals with personal job experience. Job experience is learning by doing. In this process, it applies to logical thinking—cause and effect, or pro and con. Logical thinking is a learned skill, and by developing it, based on past mistakes, your analyses (interpretations) will be meaningful.
Data testing	At this point of the 12–step analysis process, you determine which statistical tests best fit your data without distorting its true meaning. After gathering the factual data, you are ready to analyze it. Begin by determining which of the many statistical techniques to use—control charts, trend analysis, correlation analysis, and so on. We covered all of these tests in detail in volume three of this course. Refer to it if you need to refresh your knowledge.

Step 7—Problem solving

Problem solving is the seventh step of the 12–step analysis process. You enter this phase when the analysis indicates that a problem exists. The completed analysis generally provides the basis for making one of two statements: my analysis indicates no problem or my analysis indicates a problem exists. If you make the second statement, you have definitely entered the problem-solving step Problem-solving techniques will provide you with a step-by-step approach to defining the problem and laying the groundwork for further analysis. Select a problem-solving method that works best for you. One method might be to state the problem, gather data, list possible solutions, test the possible solutions, select the best solution, act, and follow up. You can find several types of problem-solving methods in publications.

Step 8—Research

Research, the eighth step of the 12–step analysis process, means gathering all needed information. Once you have determined a problem exists, you are no longer doing a simple analysis, and you can't depend on simple analysis techniques to correct any deficiencies. You are starting an in-depth study that will involve gathering additional information to fully understand the problem. This may mean studying technical data, instructions, and manuals, or trying to find out what others say about the problem or factors that surround it. You may need to review job control logs, shop logs, memos, and other sources of information. Many offices on a base maintain information that could help solve the problem. Ask yourself these two important questions.

1. What information do they have?
2. Can they help me solve this problem? (**NOTE:** The point is that there is more to analysis than machine runs and quality control reports.) The table below provides some elements of research and associated descriptions:

Research Elements	
Element	**Description**
Value	After you have gathered the additional information, verify, compare, and analyze it to determine its value. At this point, you should have a better idea of the root cause of the problem.
Research	With an objective clearly in mind, you are now ready to research the subject. Your own experiences, the experiences of others gained through conversations and interviews, and written or observed material are your main research sources. The *first step* in researching a problem is to determine what you already know about it. The personal knowledge you have gained through daily observations and group standup briefings is an excellent starting place. The most important thing about personal knowledge is that it points out gaps in knowledge where you need further research. The *second step* in the research process is to use the experiences of others. Maintenance personnel who are knowledgeable of the problem area may provide valuable input to your research. The best source is an expert who can help clarify your thinking, provide facts and testimony, and suggest sources for further research. Your *third step* is to use available technical data. Depending on your problem, you will find that some regulations, manuals, pamphlets, and operating instructions (OI) are more useful than others. If you have difficulty locating a specific reference, contact the TO library or base publication distribution office.
Notes	As you do your research, remember to take careful notes. Do not begin organizing ideas before you have enough material. Take the extra effort to document every idea that relates to your problem. Determine what kind and how much support to include in your presentation. The amount of research you need to perform and report depends on your purpose, how much your receivers already know, and how much they need to know.

Step 9—Investigate

This ninth step generally requires that you get from behind your desk and visit people in your organization. Ask questions and solicit ideas, follow up on statements (verify), and if you need technical help from quality control or other agencies, call on them. Evaluate all the information you have obtained. If you have been thorough, you can be reasonably sure that you will be able to determine why the problem exists. Sometimes a problem may disappear or improve while you are still conducting your investigation. When this happens, continue. A thorough investigation will determine if the problem is actually solved or if it is just a temporary repair. Either way, complete the analysis, document your findings, and inform the managers concerned.

Step 10—Identify

Identify is the 10th step in the 12–step analysis process. Too often, the analyst gets so involved in chasing new problems discovered during the investigation phase, the main objective is overlooked (identifying the cause of the original problem). Throughout the process, keep the objective in sight. When you conclude your study, identify those deficiencies that caused the problem and document your findings.

Step 11—Recommend

From the first step in the 12–step analysis process, you have been formulating possible solutions. Now, as you do the 11th step, you must pick the best one and recommend appropriate action. After all, you have been working the problem from the beginning and you may understand the problem and its causes and effects better than anyone else may. If you present your study meaningfully, management should adopt your recommendation. But, if they do not, do not worry. You have achieved your objective—identify the cause and provide a logical explanation.

Step 12—Follow-up

Following up is the final, or 12th, step. No analysis is complete without a follow-up to close the analysis process loop. Regardless of the product (analysis, study, or referral), this step is where you determine if the problem has been truly resolved. Follow-up itself is a form of analysis and can begin the entire process again. Follow-up is essential because of the following:

- Tells management whether it chose the proper action in response to the problem.
- Determine the actual costs of the action taken, if needed.
- Measures the success or failure of both the original study and resulting actions.
- Measures the effectiveness of the 12–step analysis process.
- Provides results that generate effective management practices.

The table below provides some considerations for various follow-up practices:

Follow Up Considerations	
Item	**Description**
Methods	The methods required in the follow-up phase are the same used to produce the original study. This may seem redundant, but it does not require the same degree of effort that went into the original study. Continue to track the significant data used until you can determine that the problem has undergone a long-term fix. Then, document your follow-up findings and inform management of the results, both good and bad. At the conclusion of analyzing the facts, you are ready to plan the written report or oral presentation.
Output products	The 12–step analysis process facilitates the generation of output products at four points—after steps 5, 6, 10, and 12.

Follow Up Considerations	
Item	**Description**
	Figure 4–1 identifies some examples of output products next to the corresponding steps required to produce the output products. For example, initiating a referral is completed at step 6. What you call your product depends on how far you have penetrated the 12–step analysis process and your purpose.

628. Maintenance data sources

According to sources, it is appropriate to distinguish the kinds of statistical data used by an analyst. The main distinction is between data that originates within a particular organization and data that originates outside of it. You cannot conduct a thorough study without using both internal and external data. Information associated with the operations of the maintenance organization is considered *internal* data. On the other hand, information received from a squadron outside of your maintenance organization is considered *external* data. Using the complete information chain will keep you informed and improve the validity of your studies.

Automated information systems

Automated information systems, such as the IMDS, REMIS, or MAF LOG C2, contain a wealth of information about your unit's performance. There is never a good excuse for not being familiar with the data systems that contain information about a weapon system and its supporting work force. You must know the management products thoroughly and be able to retrieve additional data by computer inquiry as you need it.

When selecting an information source, consider each source as though it were a separate, but integral part of a puzzle. Each piece must relate to other pieces as well as to the entire puzzle to achieve a complete picture. Missing pieces of information can lead to distortion and could cause the decision maker to take the wrong course of action. A good rule to follow when analyzing data is to constantly cross check the data for accuracy and completeness. Do not accept any data at face value.

Data integrity is paramount when dealing with any data source. More importantly, always consider the competency of the source and the accuracy of the source document by asking questions to arrive at clear answers.

Other sources

Do not limit yourself to relying solely on automated information systems for information. Although they are important and you must know what they can do for you, do not neglect other important sources. There is a wide selection of information sources available. But, first, you must know the inner workings of the organizations that make up your unit.

Organizational chart

Find an organizational chart and study it. Try to answer these two important questions about each function: What kinds of things do they do? What kinds of information do they provide? Remember, everyone provides information to someone. If organizational charts are inappropriate, use the base phone book. Supply, cost analysis, management engineering, and quality assurance are only a few of the information sources that provide maintenance-related information.

Have you ever reviewed reports of an activity inspection, materiel deficiency, or quality verification inspection produced by quality control? Have you looked at manpower studies done by management engineering or cost analysis?

Off-base sources

Additional sources are also available off base. Consider using information from your sister units and higher headquarters. Higher headquarters usually distribute comparative data to its bases. In addition, you can establish recurring requirements for monthly summaries from other bases. An analysis of your unit's performance compared to that of similar units and the command average could be very useful to key managers. Compare your wing's performance to other wings and talk to other analysts to share ideas for achieving successful mission performance.

Reports

Reports are nothing more than a method of conveying raw or summary information. However, they are not analyses and they can, and often do, raise questions that may require further research, study, or referral action. The greatest advantage of reports is that they are relatively easy to prepare and are the fastest means of formally disseminating information. Reports, however, have serious disadvantages.

Recurring reports have a bad habit of existing even after they are no longer needed. Because they become routine, questioning their usefulness is often forgotten. Eventually, your effectiveness as an analyst is severely impaired, if not destroyed, due to so many reports. It is essential that you question each recurring requirement to ensure that a real need exists for the data and decide if you want to keep a copy of a report. You should also question the frequency of the report.

NOTE: Your MAJCOM mandates some reports; requiring you to publish them periodically. Many reports are just as useful if published quarterly or semiannually instead of monthly.

Finally, the results you gain should at least be worth the effort it takes to prepare the report. Reports have a definite place in the analysis process. Use them wisely to save yourself time and effort, to inform people in the maintenance complex of how they are doing, and to identify potential problem areas so that the organization can manage to avoid more problems. More importantly, do not substitute reports for analyses.

Analysis

The best way to fill the gap in a group of meaningful statistics is to produce an *analysis* as a distinctive output product. Simply stated, the analysis separates a subject into its various parts to arrive at a meaningful interpretation of the facts. An analysis is not necessarily time consuming if you have an adequate knowledge of the management concepts, organizational structure, wing agencies' functions, present condition of your organization, and a thorough understanding of what each statistic or data element provides. Analysis takes place when you combine this knowledge and understanding with characteristics such as a database (structure), quality, experience, workload, management, and performance to arrive at a conclusion. Let's take a look at a simple example.

Assume that your organization is 97 percent manned. However, the wheel and tire shop is only 75 percent manned. Is there a manning imbalance? What should you consider? Below are some areas of consideration:

- Does the shop have 10 people authorizations or only six (data sources)?
- What is the skill level of those assigned (quality)?
- What is the team structure (experience)?
- What is the shop backlog (workload)?
- What is the group commander's priority (management)?
- What is the past output of the shop (performance)?

Job data documentation

Most of us can relate to the JDD as huge amounts of paper with numerous lines of print. Although this may be true, there is more than that to JDD. It provides information about parts failed, high man-hour consumers, distribution of man-hours, and total man-hour costs of the maintenance operation. For example, AFMC is a prime user of the JDD system. It monitors the MTBF, develops spares levels, and analyzes serially-controlled and time change items, warranty repairs, and many other areas outlined in the 00–20–2 series technical orders. Therefore, we must ensure AFMC receives the most accurate JDD data possible.

Uses

Since you may not be completely familiar with JDD information, we will discuss some ways that it can be used. For this example, suppose a new wing is activated, all resources are in place, and you are assigned to a new model aircraft. You are a unique organization because you are the only unit that uses this aircraft. The aircraft's care and maintenance is entirely in your organization's hands. Well, when you received the aircraft everything was new and in working order. But as time passed, maintenance was performed, TCTOs were completed, and improvements were made so the unit could continue using aircraft for their intended purpose. All this information was entered into and recorded by the JDD system.

Never-ending book

The JDD system is like a never-ending book; each JDD line entry helps to tell part of the story. This story is vital to the continued management and effectiveness of the aircraft. Although AFMC puts the story together by MDS, you should be aware that as aircraft age and are modified, requirements change. So, just because you do not have new aircraft, do not think you can do without JDD. Educating yourself on the purpose and operations of the JDD system is your responsibility. Visit the work centers and discuss JDD with supervisors and mechanics. Help them understand the different stories in the book; but before you can do this, you must understand it yourself. For example, be aware of completed maintenance actions such as items removed, repaired, reinstalled, removed, and replaced, and the subsequent repair or NRTS actions to properly complete the analysis process.

With your knowledge and understanding of the recording procedures of the 00–20 series TOs, you can help the mechanics accurately document the story the way it actually happened. You can help them and, in turn, ensure data integrity, expedite data entry and processing, reduce late man-hour reporting, and get them to document factually. The following are examples of questions the JDD can answer for you:

- How many man-hours are required to perform the look phase of scheduled inspections?
- How many man-hours are expended on unscheduled maintenance actions?
- How many discrepancies does QA discover during follow-up inspections?
- How many man-hours is foreign object damage (FOD) costing your unit?
- When does the daily workload peak for a particular work center?
- What and how many components are coded NRTS Code 4 due to lack of parts?
- Are there any NRTSs due to lack of technical skills or lack of technical data?
- What components, if any, are causing alert force degradation?
- What discrepancies are the flight crews discovering during preflight?
- How many tires are changed during the flight crew's preflight?
- How many tires are changed and for what reason? Is FOD a problem?
- How many man-hours are expended checking reported malfunctions and finding that no malfunction exists?

- Which components are cannibalized most frequently?
- What type and how many failures are found during engine test stand operations?

629. Analyst's responsibilities

As an analyst you have certain responsibilities to uphold. You must always maintain a position of trust and integrity with those to whom you interact. Commanders and managers at all levels must always have faith in your analyses and reports.

Management information

One of your responsibilities as an analyst is to be the maintenance complex's main source of management information. You will also find that you will be called on more and more to supply data for the operations complex. Use your statistical and analytical abilities to convert raw data into meaningful management indicators. Your assessment must be objective and provide specific answers—the why, how, when, and where—for the decision makers so they can take appropriate actions. You are responsible for providing a quality service, not only to the group commanders, but also to squadron and work center managers. They may need your help interpreting the information; your job is to provide it. You also provide objective feedback (both good and bad) to the decision makers and help those work center supervisors who seek your assistance. This allows you to emphasize one of your primary jobs, which is analyzing unit performance. The other, of course, is database management.

Integrity and accuracy

Your charter is to be responsive to the mission and needs of the organization, its supervisors, and to uphold the integrity and accuracy of analysis products. Never place routine administrative details ahead of ensuring the organizational health of your unit. Simply providing summaries of data, listing of discrepancies, and publishing monthly statistics is not enough; that is not analysis. As mentioned earlier, an analysis breaks a subject down into its various parts to arrive at a meaningful interpretation of the facts.

Credibility

Credibility begins with maintaining accurate data and includes the initiative, imagination, curiosity, broadmindedness, and judgment that follow the recordkeeping function. Always be objective; ensure you are using accurate data, and provide logical, realistic solutions. Statistics won't always reveal what you want just because you think they should. At times, you may wonder if it is worth the extra effort, but when a study leads to an answer that can save thousands of dollars or increases performance, the effort is well worth it. The table below lists and describes some elements of credibility:

Credibility Elements

Element	Description
Working knowledge	Having a working knowledge of methods and techniques relevant to sound management principles, statistics, and analysis procedures. Understanding of such methods will only furnish you the tools to diagnose internal conditions and provide viable alternative solutions to problems. Not having this knowledge causes your credibility as an analyst to suffer if your analysis process is that of a data clerk (bean counter) and your assistance to the maintenance complex takes the form of page after page of numbers (beans) without narration, explanations, or justifications.
Projection	Being an analyst is not easy. Do not respond only to the current concerns of management, but by projecting what the data depicts today, you can inform the decision-makers of what they should be concerned about or expect tomorrow. Staying abreast of what is happening around you by being alert during staff meetings and maintaining a trusting, working relationship with the managers and supervisors you serve.

Pulse points

Pulse points are places within a unit where you get information that enables you to assess the condition of the organization. Where are these points? They are different for each unit. They are all points that you can use to stay attuned to what is going on in the unit. Some examples are the daily group standup meeting, scheduled meetings, wing standup, and the debriefing section. This list could go on, but you get the idea. Stay informed to be responsive to the needs of your unit. This is essential if you are to provide important management information to maintenance managers.

Organizational function

Earlier, we noted that one of your responsibilities as an analyst is to assess the condition of your organization. We also emphasized that you must be attuned to what is going on, respond to the current concerns of management, and be able to use data for projecting the future course of selected events. To do this in a meaningful way, you must know what makes your organization function and constantly keep your finger on your organization's pulse.

If you are not focusing information into a set of meaningful indicators or organizational pulse points, you are not doing your job. Remain alert and be responsive to the needs of your organization. Know what is important to the managers and supervisors within your organization and respond to their needs. Look for ways you can best measure your organization's performance and point out both strong and weak areas. Then, if possible or appropriate, draw some conclusions about future possibilities and alert management to potential problems or opportunities.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

627. Twelve-step analysis process

1. What is the analysis process?

2. List the 12 steps of the analysis process and give a brief description of each.

628. Maintenance data sources

1. What is the difference between internal and external data?

2. What must you constantly check for when analyzing data?

3. When studying an organizational chart, what two important questions about a function must you answer?

4. What are four on-base offices that maintain information relevant to you as an analyst?

5. How is a report used?

6. Name the greatest advantages of using a report.

7. What is a disadvantage of recurring reports?

8. What affect does an analysis have a problem?

9. As an analyst, what is your responsibility concerning the JDD system?

629. Analyst’s responsibilities

1. Name three of your primary responsibilities as an analyst in the analysis process.

2. How does credibility apply to the analysis process?

3. Define and give examples of pulse points as they apply to the analysis process.

4–2. Statistical and Data Analysis Processes and Tools

Because a key aspect of statistical analysis is substituting measurement for opinion and hunches, analysts sometimes place too much confidence in the information obtained by statistical methods. Using the 12-step analysis process has netted good results and tends to be a good method for arriving at true problems.

630. Statistical pitfalls

Securing accurate information on a problem may go beyond making mathematical calculations and precise measurements. Because of the abstract nature of statistics, you can unintentionally make serious errors when analyzing maintenance data. When analysts observe a simple set of facts, they have a certain amount of protection against drawing incorrect conclusions. The more complex the analysis of the data is based upon to base conclusions upon, the less opportunity there is to know the reliability of the data source.

Statistical pitfalls can appear in a variety of ways. Although many examples of the incorrect uses of statistical data are possible, an understanding of what is wrong with the analysis usually requires an understanding of the correct method of making the analysis. The possible statistical pitfalls are many and can include mistakes in recording data or in making calculations. Most errors, however, are easily avoided by paying attention to detail. The following are some pitfalls that you may not be familiar with:

- Bias.
- Noncomparable data.
- Incorrect projection of trends.
- Improper assumptions regarding relationships.
- Comparison with an abnormal base.
- Improper sampling.
- Misuse of statistical software programs.

We will take a closer look at these in the following paragraphs.

Bias

Unconscious bias is one of the most common pitfalls in using statistical analysis. It is difficult for an analyst to be completely objective or without preconceived ideas on a subject. In its simplest form, *bias* means that an analyst gives more weight to supporting facts than to conflicting data. An extreme case of bias is a situation where you (or another analyst) selects a course of action and then uses or manipulates statistical data to justify the selected course of action. This process is backwards.

Always base your decision on the statistics. Be aware that when maintenance managers use statistical data or the results of statistical analyses in statistical studies, they may sometimes suspect that you have manipulated the data to support your side of the story. Striving for integrity and basic decisions or recommendations on a solid statistical footing can practically eliminate any basis for bias.

Noncomparable data

An ever-present pitfall when using statistical data is the failure to ensure that the data used to make comparisons is comparable. It is imperative that data always be comparable; if not, the conclusion drawn could be highly inaccurate. The following are some noncomparable situations to avoid:

- Applying a parametric test to nominal or ordinal data.
- Comparing northern and southern tier bases.
- Comparing two different seasonal trends (June–September versus November–February).

Incorrect projection of trends

Making decisions about the future is almost always based on existing trends, since the only information you can use is taken from historical data. Many decisions are arbitrarily made on the basis of an existing trend without considering the trend's stability. For example, you may forecast a requirement for B–1B high frequency (HF) radios based on the average replacement rate of the past 2 years as exhibiting a constant rate of change. However, further research may indicate that the maturation period pushed the number of replacements in the first 2 years of production, but recent modifications or a new HF model might suggest a different repair or replacement rate. Incorrect projections based on past trends is a pitfall that has repeatedly discredited the use of statistical analysis.

Improper assumption regarding relationships

Understanding the cause-and-effect relationship between maintenance events is an extremely important element when analyzing data. Obtaining an accurate explanation of the cause of a given event is not easy. Even if you compile accurate statistical data to describe what happened, it is not a simple matter to determine why it happened. As you learned from your study of correlation, it is incorrect to conclude that one event caused the other simply because they occurred together. Often it is possible to make a case for either factor being the cause, and it may be equally likely that both events were the result of a third.

Comparison with an abnormal base

Always base a comparison of maintenance performance data with previous periods on the assumption that the period used for comparison is either average or normal. If the period used as the basis for comparison is abnormal, your conclusions may be incorrect. Therefore, you must ensure that the base used for comparison was not an extreme value that gave an incorrect impression. If, for example, an analyst reported that the direct utilization rate was 15 percent higher this quarter than last, it immediately implies increased on- and off-equipment maintenance actions.

But, if the quarter used as the base for comparison is abnormal, the conclusion based on that data may be incorrect. The low direct utilization rate during the previous quarter may have been due to decreased equipment failures or runway closure. If the equipment does not fail, repairs are not required. Similarly, if the runway closes, the aircraft cannot fly or fewer sorties are flown at another location. The point here is that the base must accurately reflect the normal state as closely as possible.

Improper sampling

To avoid working with extremely large populations, you normally use samples as the basis for most of your statistical analyses. If you select these samples properly, they will have basically the same characteristics as the populations from which they were drawn. But, if the samples are selected incorrectly, the results of your study may be meaningless. Since it is not easy to select a sample correctly, there is always the danger that a sample study will give inaccurate information. Sampling is based on two important factors. First, decide if there is enough similarity among the data (raw values) in a population that a few values will adequately represent the characteristics of the total population. Second, the sampling error (if any) must be within acceptable limits and not distort the study. Therefore, a good sample must be precise, without bias, and represent the population.

Misuse of statistical software programs

The widespread use of computers has been so rapid that it tends to create problems unless analysts use statistical results with extreme care. You must realize that the computer does only what it is instructed to do. Furthermore, the validity of the results it generates depends both on the quality of the raw data you enter and on the programmed procedure it uses to analyze the data. If you use incorrect analytical methods, use an inappropriate statistical software program, or even write an erroneous computer program, the results may not help improve decisions, regardless of how rapidly the computations occur.

Using inaccurate data to make a decision based on complex data analysis will yield worse results than if simple methods of analysis are chosen. More importantly, this can lead to making incorrect decisions. If you are using a computer program for your calculations, always take the same care in selecting the analysis program that you do with the data and the methods of analysis; use the same criteria that you would use if the calculations were performed manually with a scientific calculator.

631. Applying the 12–step analysis process

You must be able to apply the 12–step analysis process to real-world problems with a high degree of confidence in the results. Since an important part of the process deals with statistical tests and their interpretation, you must be familiar with the overall concept of statistical analysis.

Now that we have gone over some of the procedures you will follow when conducting a statistical study, let's apply the 12–step analysis process to a sample problem. Before we do, you must understand that each statistical study is different. Two analysts doing identical studies may use different methods and techniques. The sample we will use is one of many, so use it as an example.

Problem

Suppose the group commander feels that your base (base A) is having a higher NMCM rate than normal. For comparison purposes, we have obtained 12 months' of NMCM percentages and percent of overtime man-hours data (fig. 4–2) for your base and a base with a similar mission and equipment. You must now try to show if a problem actually exists. Using the 12-step process, we provide examples below.

Step 1—Collect data

Collect the data, remembering not to overlook any available source. Use existing maintenance summaries, reports, telephone calls, and anything else you may think of. It is never a bad move to collect as much data as you can to begin with. Just make sure that it is not meaningless data. Experience will help you determine what type of data you should go after.

Step 2 —Verify

You must now verify the data's accuracy. This could mean crosschecking other data sources to ensure that the information is the same. You may have to call the appropriate maintenance shops to determine if the IMDS data is accurate. Remember that your findings and conclusions will only be as good as your data.

NMCM Rates			Percent of Overtime Man-hours	
Month	***Base A***	***Base X***	***Base A***	***Base X***
Jan	7.5	3.7	6.9	4.8
Feb	4.3	4.1	5.3	4.7
Mar	4.1	4.3	5.2	4.5
Apr	4.6	3.6	5.3	4.6
May	4.7	4.5	5.4	5.2
Jun	4.9	4.5	5.5	4.7
Jul	5.1	4.2	5.4	5.3
Aug	5.0	4.4	5.4	5.1
Sep	5.1	3.9	5.5	4.9
Oct	5.4	4.5	5.4	4.8
Nov	5.3	4.1	5.9	5.0
Dec	5.7	4.2	6.6	4.7

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Figure 4–2. NMCM rates and overtime man-hours.

Step 3—Manipulate/compute

The most common approach is to manipulating maintenance data is to arrange it in chronological order. Figure 4–2 has been set up in this way. As you can see, however, data in a tabular format is usually not easy to interpret. Graphing the data makes it far easier to observe any possible relationships or differences. Figures 4–3 and 4–4 show the NMCM rates and overtime data, respectively, plotted graphically.

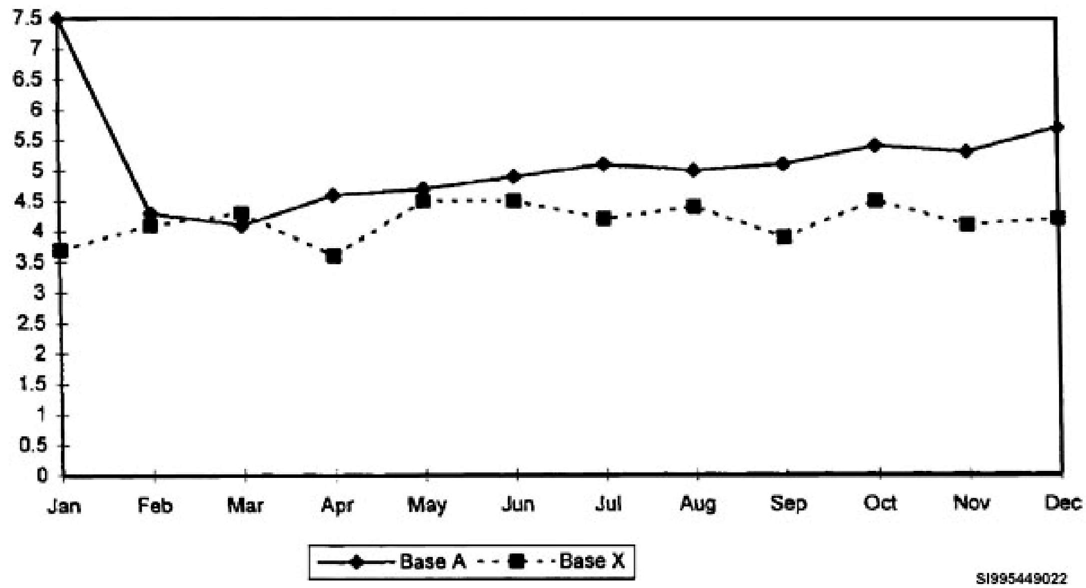

Figure 4–3. NMCM rates plotted graphically.

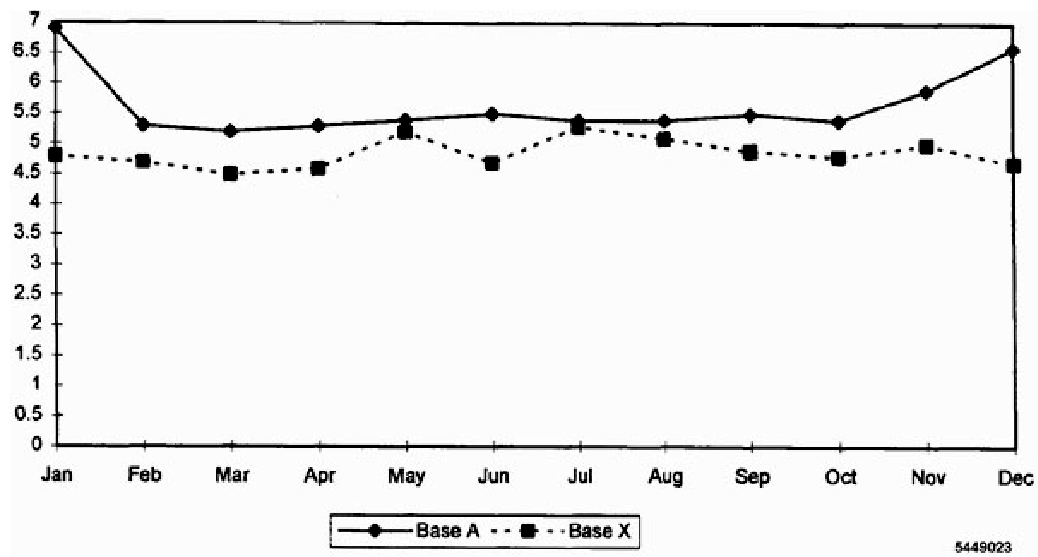

Figure 4–4. Overtime rates plotted graphically.

Step 4—Compare

Comparing the data between the two bases, you can see that an apparent difference exists. We say apparent because in the field of statistical analysis, it is not advisable to draw conclusions on data relationships until statistical tests have been run on the data. No matter how obvious the visual relationship is, run those tests to be scientifically accurate and surer of your results. In saying that, you must also understand there will be exceptions to the rule. For example, if your base's average mission capable rate for the year is 67 percent and the command standard is 85 percent, this can be readily determined graphically. Your job is to find out why this problem exists.

Step 5—Review

Review your data if possible. Double-check for accuracy at this point.

Step 6—Analyze

Analyze the data, draw appropriate conclusions, and present your findings. Using the steps from the statistical testing guide, precede as follows for the NMCM data. (**NOTE:** As stated earlier, detailed explanations of the various statistical techniques and tests are covered in another volume. Do not worry if you do not understand some of the statistical terms given in the example. The important point is to gain an understanding of how to apply the 12–step analysis process to real-world problems. The same type of problems will be reviewed, step by step, in the applicable units.)

1. NMCM data is already continuous, so it is not necessary to convert it to continuous.
2. Graph the data on regular graph paper or use a computer spreadsheet to see how the samples compare with each other (fig. 4–3). There appears to be an increasing trend for base A (except for January), so consider checking for significance of trend. Since at least 24 months of data are necessary to determine significance of trend, it is not feasible to apply this test to 12 months of data. The step of actually plotting the data on regular graph paper or on a computer spreadsheet is very important. As we have said, it is much easier to see what is actually happening by looking at a graph than by looking at a list of raw numbers (fig. 4−2). Plotting data can show if there is an increasing, decreasing, stable, or nonlinear trend (including seasonal variation). It can possibly prevent you from computing an unnecessary trend based on data that covers only a short period or that does not appear to be significantly changing.
3. Plot the data on normality paper if you anticipate comparing the two units using parametric two-sample tests after graphing the data. Since you have two samples, plot both distributions.
4. Assume at this point that the data for both samples is normal except for the extreme value of 7.5 for your base. Perform the T test for outliers. You should find that the test statistic exceeds the critical value. Therefore, this point is an outlier and must be removed. (**NOTE:** After completing this study, you must investigate the outlier.)
5. After calculating your $\Sigma\chi, \overline{X}, s$ and so on, for sample A (since you eliminated the outlier), you are ready to check for homogeneity of variance. By using the homogeneity of variance F test, you find that you accepted the null hypothesis because the F test statistic is *not* greater than the F critical value for a level of confidence of 95 percent.
6. Since you have homogeneity of variance, the next step is to check the means using the T test. Here, you reject the null hypothesis because the T test statistic is greater than the T critical value for a level of confidence of 95 percent.
7. You, therefore, decide a problem exists in the NMCM rates because your average is 4.927, while that of the other unit is 4.167. In addition, you had an extremely high value of 7.5 for January that needs further evaluation.

To help determine why you have a problem, return to step 1 of the test guide and analyze the overtime data for the two bases using the same procedures as you did for NMCM rates. Perform the following:

1. The data is already continuous.
2. Plot the overtime data on regular graph paper or a computer spreadsheet (fig. 4–4). Because you have only 12 months of data, you cannot determine if there is a significant trend.
3. Check for normality. A normality check indicates that one sample is normal and one is not. Next, turn to the nonparametric Mann Whitney U-test because both samples must be normal to use a parametric test.
4. In the Mann Whitney U-test, reject the null hypothesis because the U test statistic is less than the U critical value for a confidence level of 95 percent.
5. Since your unit's overtime average is 5.65, while the other unit's average is 4.858, you again have a problem.

Based on the data gathered, below are some considerations:

Overtime up

Both the NMCM percent (fig. 4–3) and the overtime percent (fig. 4–4) have risen over the period of time as you compare and contrast the two graphs.

Relationship

By looking at regular graphs of your plotted data for NMCM and overtime, you see what appears to be a relationship. It appears that as your NMCM increases, so does the overtime. Next, test this theory using Spearman's correlation coefficient. Here you find that the test statistic is greater than the Spearman's critical value for a confidence level of 95 percent. So there's a definite positive relationship between NMCM and overtime—this simply means that one is related to the other.

Differences

You have now determined there are significant differences in the areas of outlier tests, both two-sample tests, and the correlation test.

Step 7—Problem solving

Once you have determined that an actual problem exists, as in this case with high NMCM and overtime rates, you must now undertake a logical and systematic approach to solving it. Any problem-solving method can be used. Once you settle on a formal problem-solving plan, you are ready to continue with the 12–step analysis process. One of the most common methods follows:

1. State the problem.
2. Gather data.
3. List possible solutions.
4. Select the best solution.
5. Act.
6. Follow up.

Step —8 Research

At this point, you must gather all the needed data, including opinion-type data. In an actual situation, you would gather factual and opinion data from shop chiefs, maintenance people, mechanics, QA data and personnel, coworkers, as well as yourself. Because we can't simulate gathering opinionated data in this volume, substitute your own field experience instead. While you can probably think of many reasons for these high rates, you must be patient and ensure that you thoroughly research the subject before reaching a conclusion.

Step 9—Investigate

This step goes along with researching the problem. Visit the maintenance shops that are experiencing the overtime and ask questions. Evaluate all the data you have collected and investigate any and all probable reasons for the problem. For this example, we have provided a synopsis of the findings and a discussion of each in the table below:

Synopsis of Findings	
Finding	**Discussion**
Reasons for difference	The January NMCM percent for your base was an outlier. Investigation revealed that the wrong figures were input for that month. The true NMCM rate should have been 4.5.

Synopsis of Findings	
Finding	**Discussion**
Yearly average	Your yearly average for the NMCM was much higher than that of the other base (4.9 versus 4.2). Although your average was higher, you were actually comparable with them during February and March. Since then, your NMCM rate has been increasing. You found this increase was due to the rotation of people and having trained people who shipped out while untrained people were shipping in. As a result, the NMCM rate has been increasing to undesirable limits.
Maintain equipment	Since you are still required to maintain mission essential equipment despite having untrained personnel, it is necessary to increase the percent of overtime man-hours (a direct relationship as shown by the rejection of Spearman's correlation coefficient).
Overtime	Since your unit is working so much overtime, the percent overtime man-hours is higher and increasing as compared to the other unit's overtime percent (5.7 versus 4.9).

Step 10—Identify

Make sure that you have identified all the reasons that caused the problem and document them. In this case, the personnel rotations and the unchanging demands for maintenance caused the problem.

Step 11—Recommend

At this point, you must look through all of your possible solutions and select the best one to recommend. Depending on how critical the situation is, you may recommend temporary assistance from another base or an increase in the training tempo, if possible.

Step 12—Follow-up

You must follow up on the study. Check to see if the applied solution is actually solving the problem. Ask such questions as: Is the NMCM rate going down, leveling off, or increasing? You have to stay on top of the whole process until you are sure the situation has been resolved.

632. Using data analysis tools

The best way to analyze measures of a process is to create a picture of the data you have gathered. This is also true for presenting information. Looking at pictures and diagrams helps you understand the data better than looking at text and numbers. There are many ways to organize and create a visual picture of data and information. Similarly, there are numerous ways to present graphics with some of the technological multimedia advances.

In this section, we will look at some basic charts, diagrams, and other visual tools that help us organize our analysis and presentation. You are probably familiar with some of them already. This section is a consolidation of previous visual tools you have already seen and some additional ones. We frequently use these tools in our jobs for both data analysis and the presentation of the results from our analysis.

Gathering data is an essential task of the maintenance analyst. But it does not stop there. The first six steps of the analysis process (collecting, verifying, manipulating/computing, comparing, reviewing, and analyzing) deals with the study of the data for the subject you have identified, whether it is a recognized problem or an emerging trend. Once you have gathered your data, the next question is what is there to do next. In the volume on statistical methods, we studied some of the methods we will mention in this discussion. We will review some of them and add a few that aren't necessarily statistical tools but are analytical tools that can assist us in the process. These are visual tools that help us organize and analyze data. You will briefly study the tables, charts, graphs, and diagrams that are very useful on the job.

Table

A table is a mass of data that is sorted, counted, and arranged systematically into rows and columns. The actual arrangement of the rows and columns depends on the purpose of the table. All data appearing in a table should have clear captions so that supplemental explanations are not needed. Tables vary from simple lists, in two or three columns, to complicated lists that require many column headings and subheadings. A simple table of two sets of data is shown in figure 4–5.

RELATED DATA

X	Y
2	2
4	8
5	6
5	12
6	10
7	10
7	14
7	16
9	16
10	20

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Figure 4–5. Sample table.

Scatter diagram

An effective approach to the study of the correlation between two sets of data is to make a simple scatter diagram—a graph or picture showing the relationship between two sets of measures or data. You use the scatter diagram to determine a degree of relationship between two sets, whether they are positive or negative. It is an essential tool for correlation analysis. The sample in figure 4–6 is a plot of the data shown on the sample table in figure 4–5.

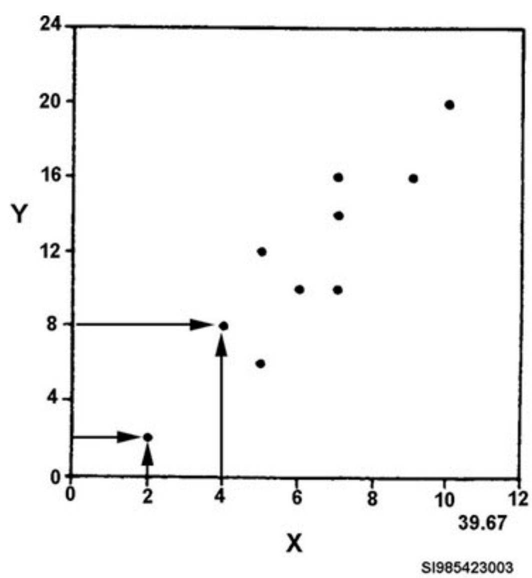


Figure 4–6. Sample scatter diagram using figure 4–5 data.

Each point on a scatter diagram represents the paired values from two sets of data (fig. 4–5). All the points are plotted to apply the correlation test, using the coefficient of correlation as the indicator of a strong correlation. Remember from Volume 3 that the coefficient goes from –1 (negative relationship) to +1 (positive relationship). A coefficient with a value close to zero suggests a very low relationship between the two sets of data. A coefficient of zero indicates no relationship between the two sets.

Histogram and frequency polygon

The histogram and the frequency polygon are used in frequency distribution. A *histogram* consists of a series of rectangles. Each rectangle represents one class of data. The lines that divide one rectangle from one another are not drawn down to the baseline. Histograms are based on the assumption that the individual values falling within each interval are evenly distributed over the interval, and the total area of the histogram represents the total number of individual values in the distribution.

The *frequency polygon* is easier to draw than the histogram and gives a better idea of the general shape of the distribution. When constructing a frequency polygon, you plot the frequencies of the various class intervals against the corresponding midpoints. You then connect the points that have been plotted by straight lines.

On the other hand, the histogram gives a better representation of the number of individuals in each class. A frequency polygon and a histogram representing the same distribution can be drawn on the same axes; as shown in figure 4–7. The line that goes up or down represents the frequency polygon since they connect midpoints of the histogram. The histogram starts on a lower limit, gives a step-wide change from interval to interval, and ends on a lower limit.

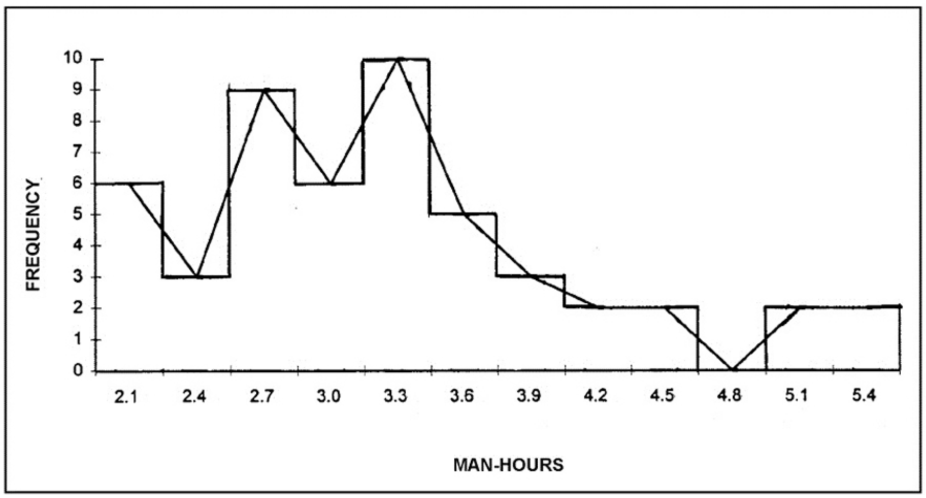


Figure 4–7. Sample histogram and frequency polygon for the same distribution.

Control chart

Control charts are important tools used to study and control repetitive maintenance performance. They indicate the manner in which a process is operating and when to make corrections to maintain quality.

A control chart has a centerline (CL), which represents the average, an upper control limit (UCL), and a lower control limit (LCL) (fig. 4–8). Points representing the quality of performance are plotted in the order of production.

As shown in figure 4–8, the points tend to vary above and below the CL. Most of the points fall between the UCL and LCL. When a point representing a sample, or an individual value, falls outside the control limits, as shown in figure 4–8, it could have happened by chance. But, the best bet is to say that the extreme variation is due to an assignable cause. Points outside the control limits are called *out-of-control points*.

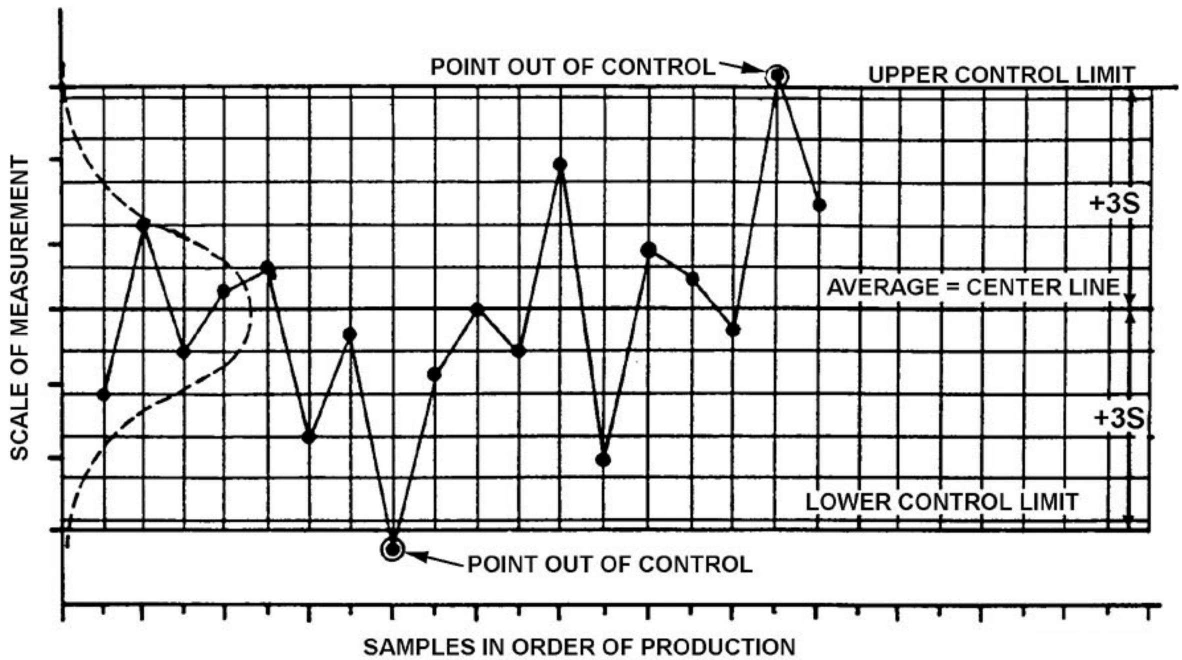


Figure 4–8. Typical control chart.

Several ways to detect an out-of-control process were discussed in Volume 3 if you need to refresh your memory. You use control charts to detect the presence of assignable causes for variation in a maintenance process. While the control chart tells you when to look for a problem, it does not identify the problem. When a control chart indicates that a problem exists, you must identify its cause and recommend a corrective action to prevent its recurrence.

Flowchart

Flowcharts are maps or graphical representations of a process. Steps in a process are shown with symbolic shapes, and the flow of the process is indicated with arrows connecting the symbols. Flowcharts are particularly useful for improving the quality of work because they display how a process currently functions or could ideally function. Flowcharts can help you see whether the steps of a process are logical, uncover problems, define the boundaries of a process, and develop a common base of knowledge about a process. Flowcharting a process often brings to light redundancies, delays, dead ends, and indirect paths that would otherwise remain unnoticed or ignored. But flowcharts do not work if they aren't accurate or if you do not follow the process.

There are many varieties of flowcharts and dozens of symbols that you can use. Although there are many symbols that can be used in flowcharts to represent different kinds of steps, accurate flowcharts can be created using very few (e.g., oval, rectangle, diamond, delay, and cloud). We have used the hypothesis testing flowchart as an example with two variations developed by other maintenance analysts. Bear in mind that these are samples and must *not* to be used with the material in Volume 3. One uses a block diagram with rectangular boxes (fig. 4–9); the other is a more detailed flowchart with commonly used symbols (fig. 4–10). The detailed flowchart shows a step-by-step roadmap of all events and decisions in a process. Create a flowchart that best suits your purpose.

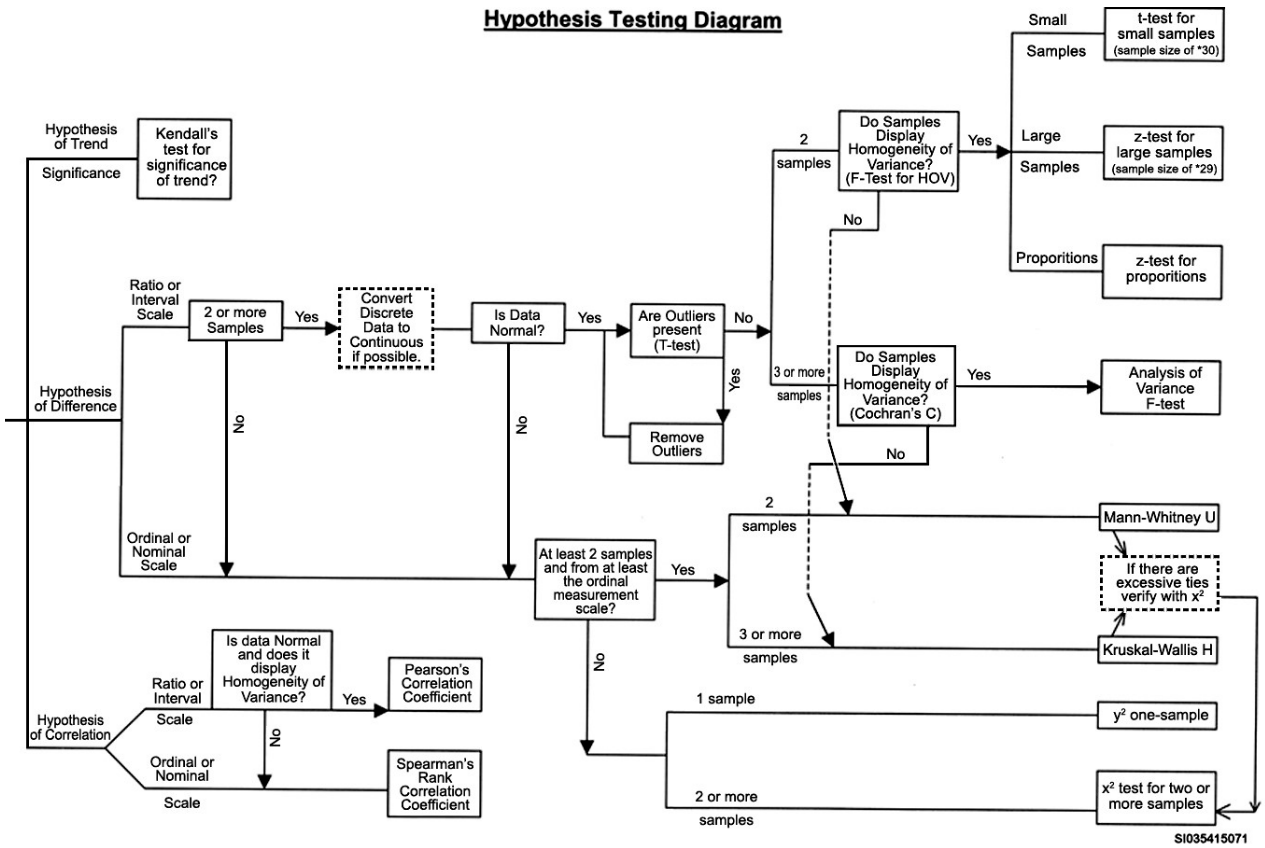


Figure 4–9. Hypothesis testing block diagram.

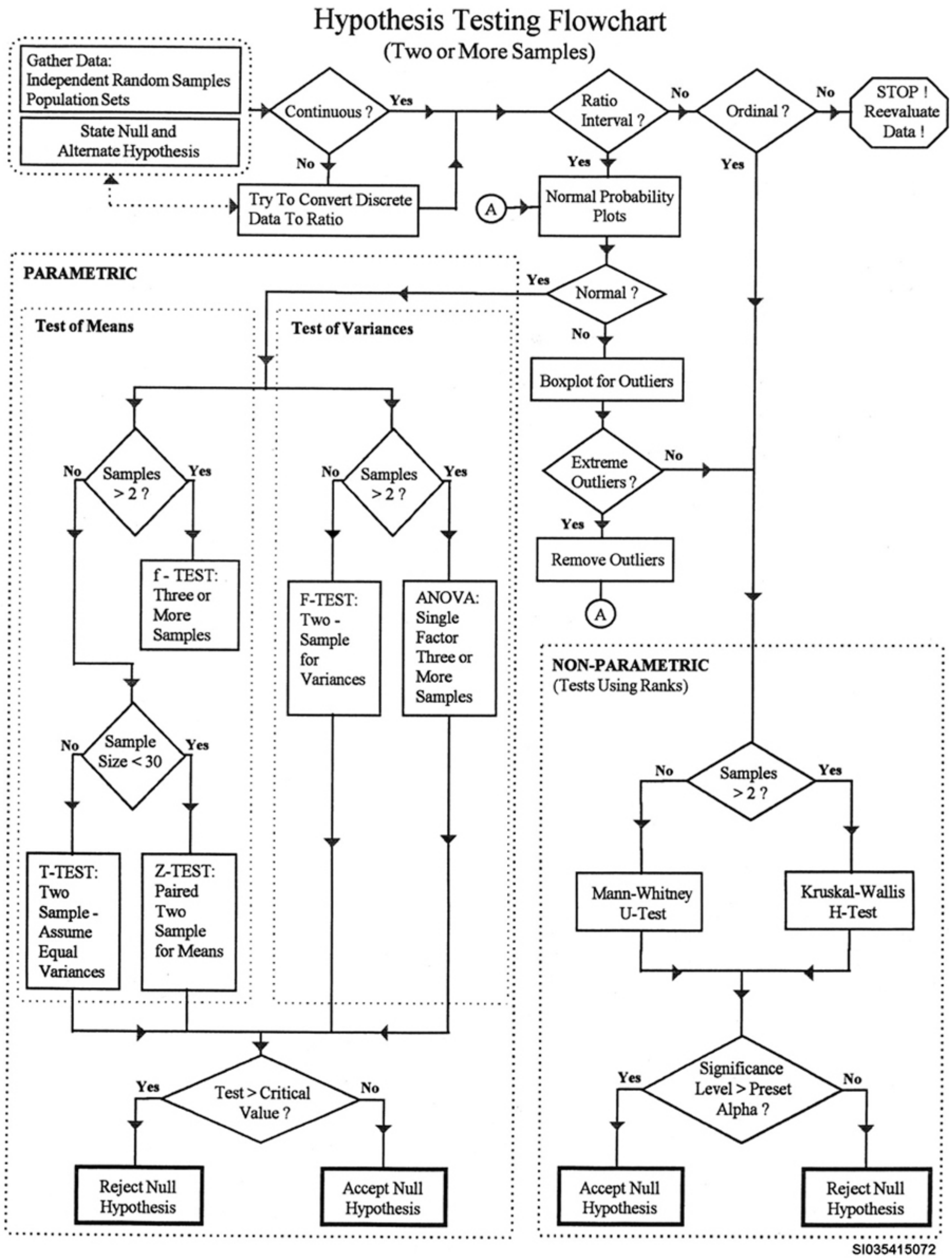


Figure 4–10. Hypothesis testing flowchart.

To construct an effective flowchart, be sure to include the factors listed below:

- Define the process with starting and ending points.
- Complete the big picture before filling in the details.
- Clearly define each step in the process. Be accurate and honest.
- Identify nonessential steps that can be bypassed.
- Show the flowchart to other people involved in the process to get their comments.

A thorough flowchart should provide a clear view of how a process works. With a completed flowchart, you will be able to address the following areas:

- Identify nonessential steps right away.
- Identify responsibility for each step.
- Discuss problems in the process.
- Determine major and minor inputs into the process.

Cause and effect diagram

Another diagram that has found its way into the analysis process is the cause-and-effect diagram, which is also known as the "fishbone." The cause-and-effect diagram is used to explore all the potential or real causes (or inputs) that result in a single effect (or output). Causes are arranged according to their level of importance or detail, resulting in a depiction of relationships and hierarchy of events. This can help you search for root causes, identify areas where there may be problems, and compare the relative importance of different causes.

Causes in a cause-and-effect diagram are frequently arranged into major categories. The sub-causes related to the major cause are branched out under each major cause. You should not use more than four major categories. Using more than four makes the diagram look complicated because of the sub-causes attached to it. The cause-and-effect is very useful in searching for problems in a process that might be the root cause of a problem. The categories you use should suit your needs.

The cause-and-effect diagram is also called the fishbone diagram because it resembles the skeleton of a fish. The main causal categories are drawn as "bones" attached to the spine of the fish (fig. 4–11). These guidelines can be helpful, but should not be used if they limit the diagram or are inappropriate. Figure 4–11 shows the classic fishbone diagram while figure 4–12 is an example of a fishbone diagram used to look for causes of low aircraft sortie utilization. Figure 4–12 uses the categories of Supply, Maintenance, Operations, and Training.

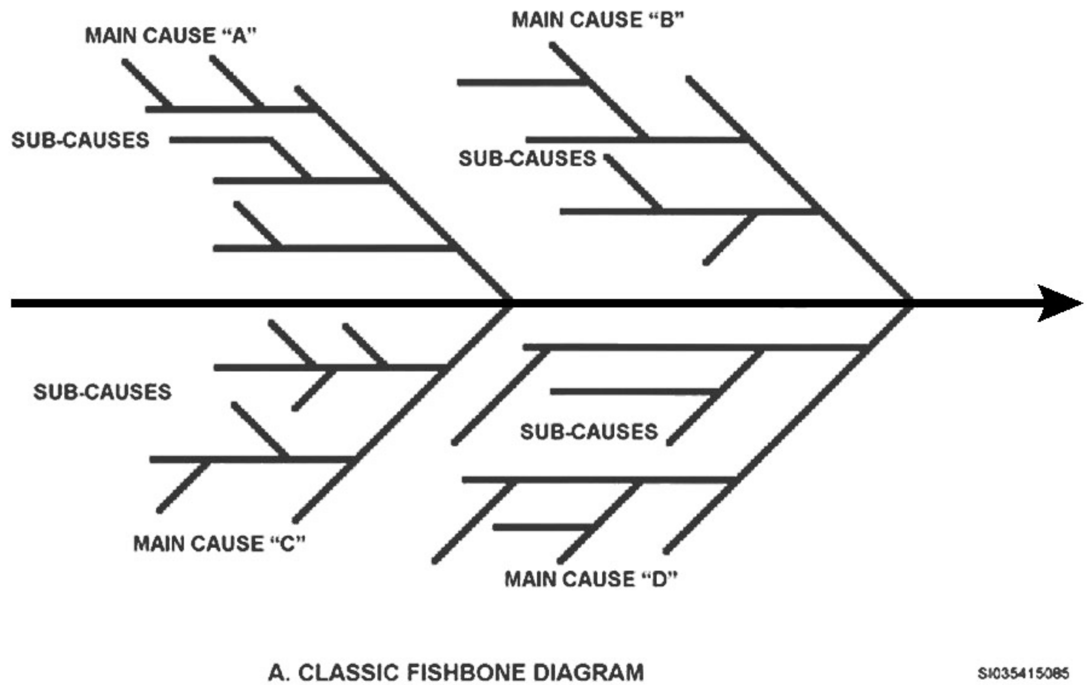


Figure 4–11. Cause and effect (fishbone) diagram.

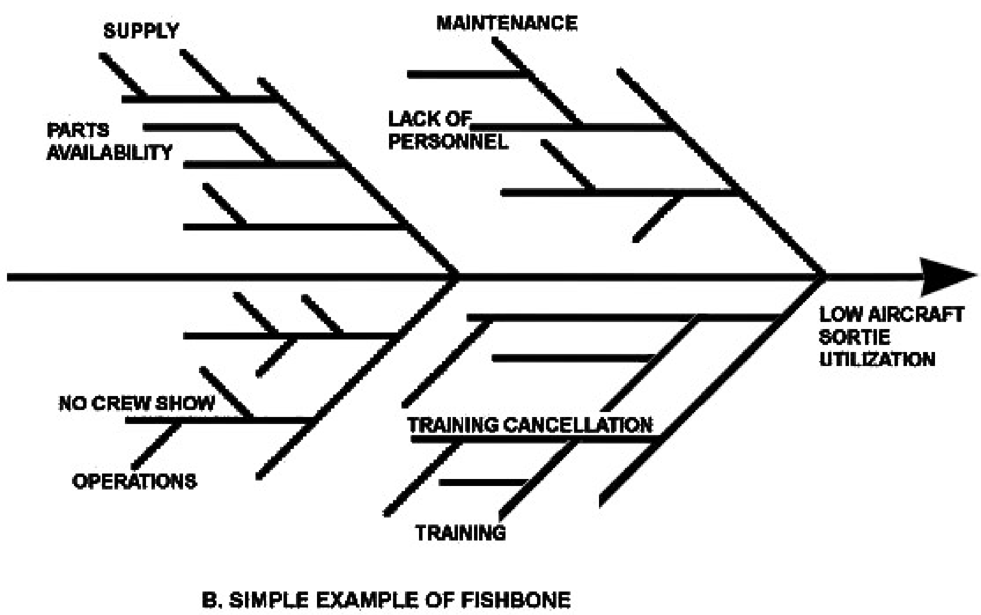


Figure 4–12. Sample cause and effect (fishbone) diagram for aircraft sortie utilization.

633. Selecting analysis presentation tools

When you have completed your information gathering, research, and made your analysis, the next step is to present the information. At this point, you will find that there are many different presentation mediums to select from. However, they all boil down to three basics: text, numbers, and graphics. In this lesson, we focus on basic graphic tools—such as tables, charts, and graphs—that you usually develop for presenting your findings. These types of presentations are used in documents and reports, such as the monthly maintenance summaries and special studies. You also use these same tools when presenting your information at briefings and meetings. Let's take a look at the most commonly used tools and their types.

Table

Tabular presentations are most convenient for illustrating numerical data appropriate to one subject. The table offers data that can be visually compared and digested by the reader in addition to offering a permanent record of the analysis. Do not put too much information in the table or you risk the viewer overlooking some of the important items. There are formal rules that apply to choosing a table format or arrangement. However, when making a selection keep in mind that a table should be free of excessive detail and should enhance rather than detract from your presentation.

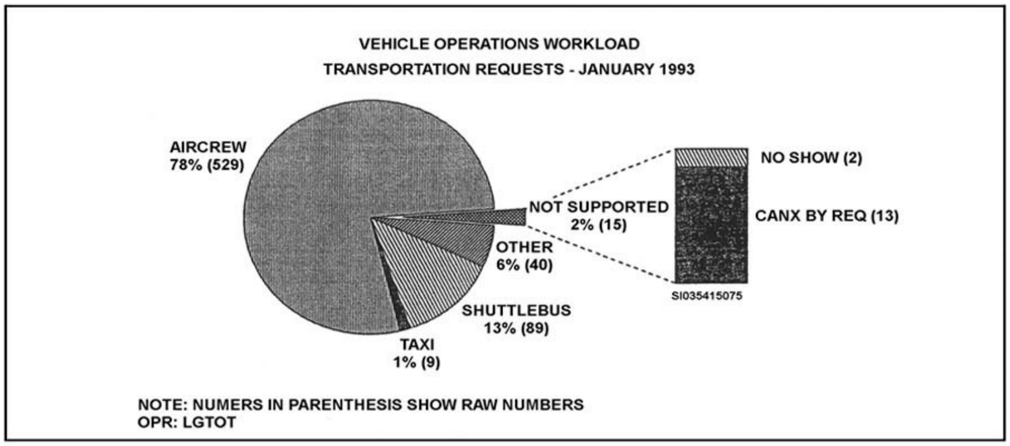
Tables vary from simple lists, in two or three columns, to complicated lists requiring many column headings and subheadings. Although a plain table may lack the eye appeal of a well-designed chart or graph, it is usually combined with a chart to provide a graphical comparison of data in a single viewing.

Pie chart

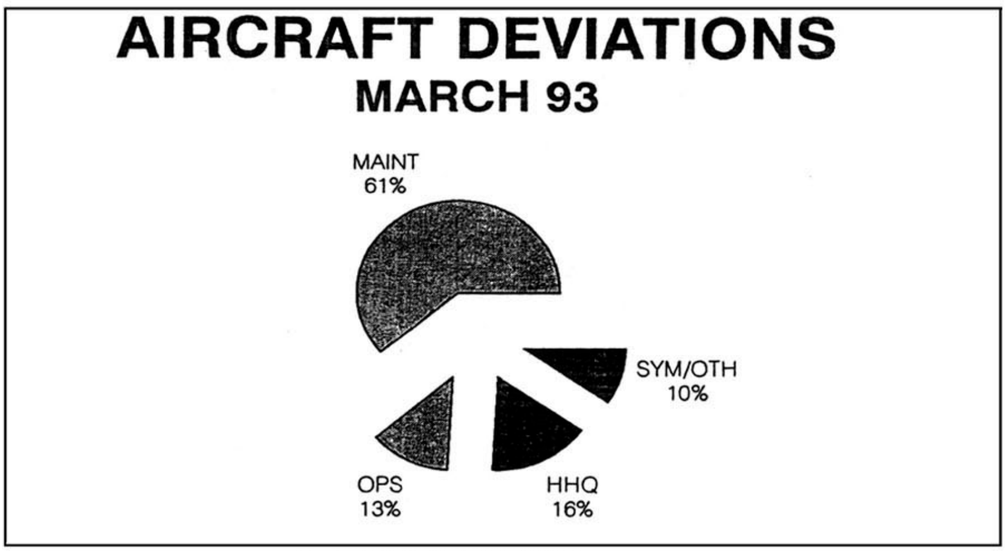
Pie charts are used to show classes or groups of data in proportion to the whole data set. The entire pie represents all the data, while each slice represents a different class or group within the whole. If you want to compare parts to a whole, the pie chart is an effective medium. Pie charts are most effective when they stand alone and represent 100 percent of the item under consideration. If you need to use more than one pie chart in the same presentation, make them the same size and ensure that they represent 100 percent of the subject.

Spreadsheets and graphics programs provide the ability to present a percentage breakdown within a pie chart. When you separated the groups by their individual values and enter these into the program, the software automatically calculates the percentages and creates the proportional parts of the pie. However, to avoid a cluttered appearance, try to limit your pie chart to no more than five segments or groups. Label your segments horizontally for easy viewing. Labels may be placed inside or outside the pie segments. Avoid too much text around the pie chart.

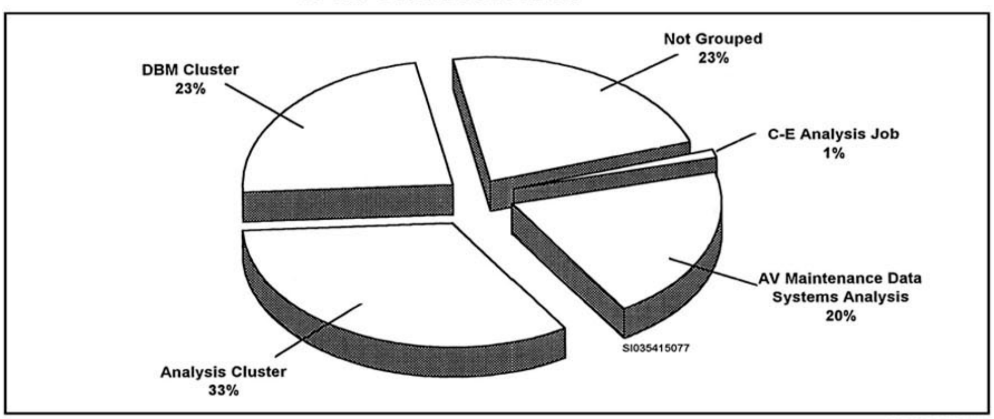
The two basic pie charts are the two-dimensional (2-D) and the three-dimensional (3-D) chart. Each type is capable of numerous variations depending on the software that is used to create them. Figure 4–13 shows examples of three different pie charts.



A. PIE CHART WITH EXPANDED SECTION



B. EXPLODED PIE CHART



C. 3-D PIE CHART

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Figure 4–13. Sample of pie charts.

Bar chart

Bar charts, like pie charts, are useful for comparing classes or groups of data. In bar charts, a class or group can have a single data category, or they can be broken down further into multiple categories for a greater depth of analysis.

Using bar charts is one of the simplest and most effective ways of presenting data to compare two or more coordinate items. They are especially useful for displaying small amounts of data or when you wish to emphasize the actual values. Do not try to put more than 12 months of data on a single bar chart because excessive data makes comparison difficult since there are too many things to look at.

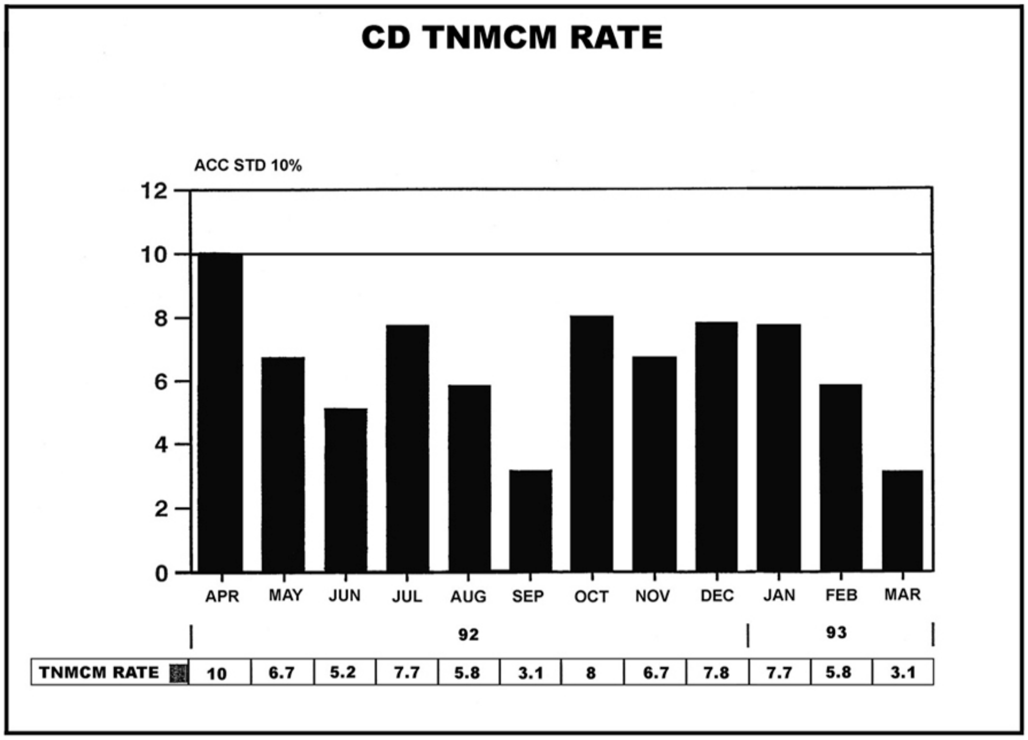
Although the bars may be placed either vertically or horizontally, the spacing between the bars is an important consideration. As a rule, the spacing between bars should not be less than half nor no more than one bar width. Additionally, the height or length of the longest bar should use most of the enclosed graph. Use color, shade, or crosshatching on the bars to obtain contrast. Like any bar chart, comparison is based on the direct linear values: the length of the bars is determined by the value of an amount for each category.

The bars may be created in 2-D or 3-D. They may also be arranged chronologically or by magnitude. You should obtain a definite contrast between the bars and the chart background by using crosshatching or coloring the bars.

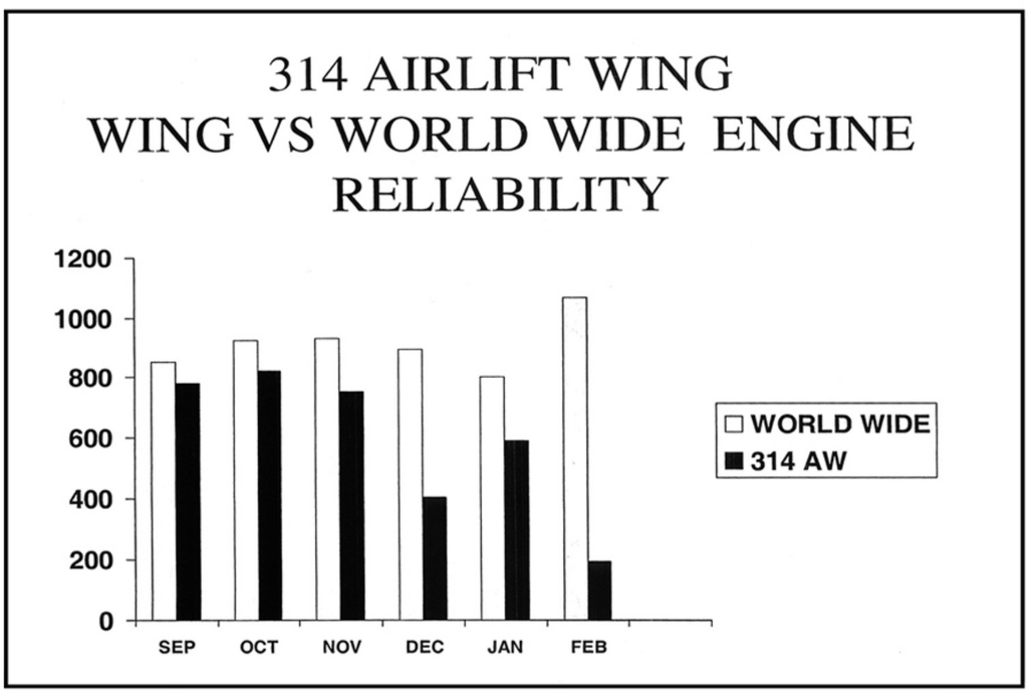
Look at figures 4–14 and 4–15 as you study the different types of bar charts. We will also briefly discuss these examples. One type is the simple bar chart. In a simple bar chart, each bar stands alone and represents the absolute number or percentages for a particular period. An example of a simple bar chart with single data is in figure 4–14 (A). Since the chart is presenting a single data type, all the bars are the same color. Notice that the bars are being compared to a standard—in this example, to the ACC standard of 10 percent. A simple table showing the numbers is positioned below the chart.

Figure 4–14 (B) shows a simple bar chart that compares two sets of data. Each set of bars is contrasted (black vs. white). Notice that in both charts, the magnitude (values) is on the vertical scale while the months are on the horizontal scale.

Another type of bar chart is the divided bar chart. In this chart, each bar is subdivided into parts representing the whole. The scale values of the divided bar are based on the absolute numbers or percentage. Note that a single bar chart may represent either absolute values or percentages, but *not* both. Figure 4–15 (A) shows a divided bar chart in 3-D while figure 4–15 (B) shows a 2-D divided bar chart. In figure 4–15 (B), many comparisons are being made within the chart. The arrow pointing down shows a desired trend or goal to meet.



A. BAR CHART SINGLE DATA



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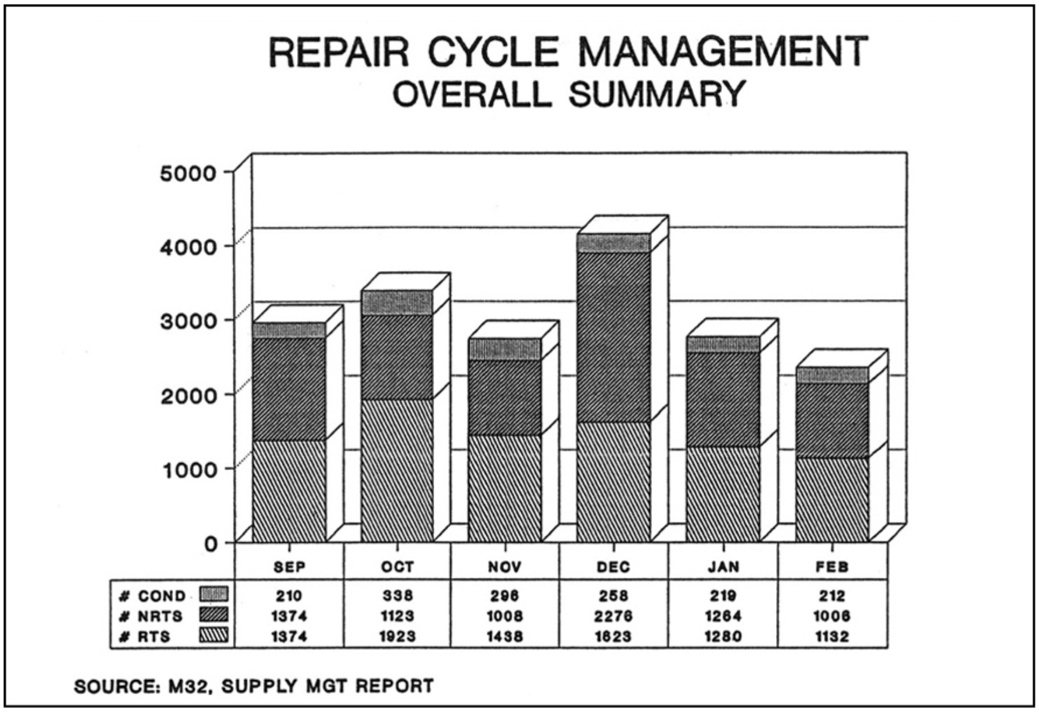
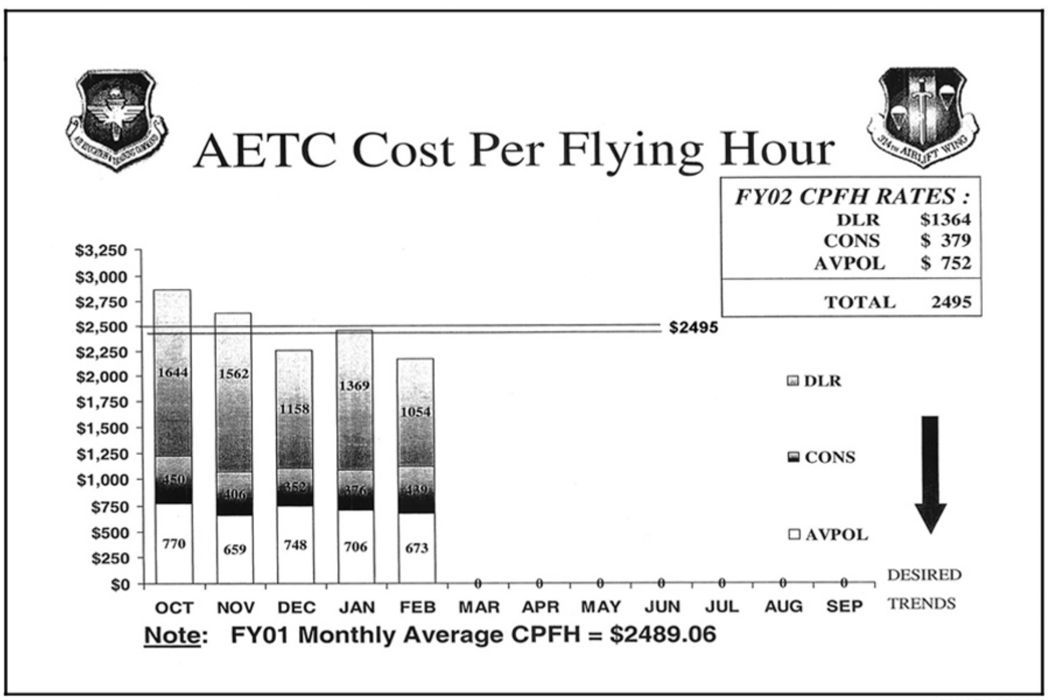
B. BAR CHART, TWO SETS OF DATA

Figure 4–14. Two simple bar chart examples.



A



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B

Figure 4–15. Two divided bar chart examples.

Line chart

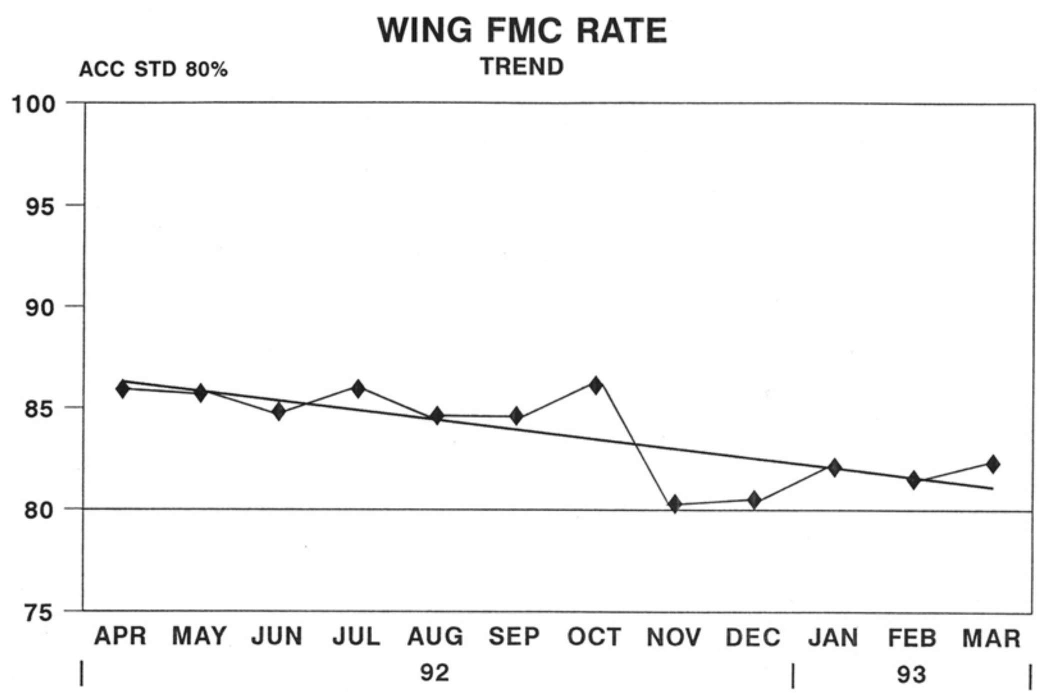
A line chart is a simple and effective means of presenting events that have occurred over a period. It may be used to show and project trends, compare series, and emphasize movement rather than actual values. The scales may represent a percentage, time, absolute number, or some other value. A line chart may also show more than one variable as well as an average or desired rate line. The line chart is also called a trend chart.

A line chart is also referred to as a historical curve because of its unique capability for describing data over a period. Time series show a continuous movement of the variable and create a more accurate impression in a line curve. On the other hand, the bar chart has a definite break between each bar; a line chart can run continuously from point to point without a break. The line chart also creates a continuous movement of data through time and shows the magnitude depicted on the chart.

When reading this kind of chart, remember the lines between the points only serve as a means for connecting the points. They establish the direction the data moves in and have no other purpose or value. The curve, or line, helps carry the eye from point to point; thus, creating the impression of movement through time.

Line charts are an effective means of showing the relationship of more than one variable dealing with similar objects. A line chart may have more than one line. However, do not add too many lines because they get confusing. If you are going to add a trend line, the slope of the line can be computed using the least squares method (covered in Volume 3). It is better to make more charts than to overcrowd one.

Figure 4–16 shows a line chart for a single set of data. It includes a trend line and a horizontal line to show the standard. It is combined with a table directly below it showing the exact values for each month.



FMC RATE ◆	85.9	85.7	84.8	85.9	84.6	84.6	86.1	80.3	80.5	82.1	81.5	82.3

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Figure 4–16. Line chart for one set of data.

Figure 4–17 shows two related line charts with both charts showing two sets of data compared to a standard. Note that the line representing the standard is drawn straight across at the point representing the standard on the Percent axis. There are no trend lines shown. However, the desired trend is shown in the form of an arrow on the chart.

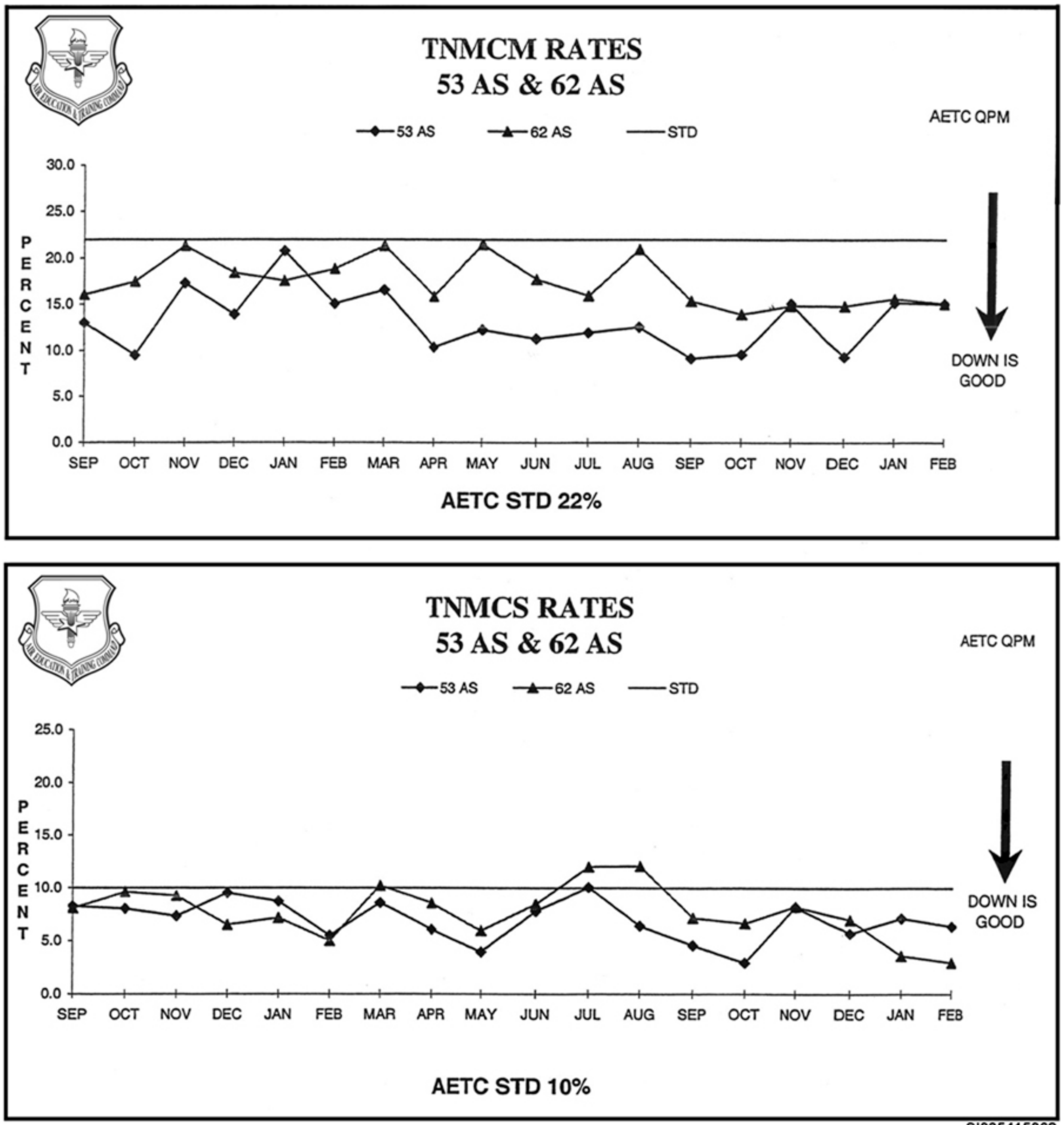

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Figure 4–17. Two related line charts with two sets of data.

Combining charts and tables

Tables are usually added to bar charts and line charts to show actual values. The table is usually placed on the page below the chart. When placing a table under a bar chart, the values for each bar are aligned vertically to each other. This gives more meaning to the bars. The same is true for a table placed under a line chart. The columns containing the values in the table correspond to the individual points on the line chart. Figure 4–14 (A) shows an example of a bar chart and a line chart.

Pareto chart

The Pareto chart is a specialized type of bar chart. It breaks down a group by categories and compares them from largest to smallest. It is used to look for the most frequently occurring problem or items that cause the most problems. The basic underlying assumption of the Pareto chart is that 80 percent of the problem comes from 20 percent of the causes.

The Pareto chart is a graphic tool for both data analysis and presentation. The chart is meant to show where the source of a problem's major cause or causes. The Pareto is a bar chart version of a pie chart. The data is arranged by categories or group using bars that are proportional in magnitude (height) to each other. The bars are arranged in such a manner that starts with the highest bar and steps down to the lowest.

Two vertical scales are used. The vertical scale on the left shows the bar's value while the vertical scale on the right shows the corresponding percentage of the whole. The horizontal scale across the bottom identifies the different categories. For this chart, the values of all the bars are the total of all causes, while the sum of all the bar's percentages equals 100 percent.

To illustrate this principle, look at figure 4–18. The Pareto chart shows the system failures of work unit code (WUC) 42000. Each category at the bottom represents the number of failures for a system component. All component failures total 100. (**NOTE:** We use 100 as an arbitrary number for this example to simplify its corresponding percentage.) The component 42EB0, with the largest failures (30), starts the line of bars for the rest of the components (13, 12, 11, 10, … 2).

This same component accounts for 30 percent of the system failures. The curve line is actually a series of slope lines for each bar to show that, together, the bar percentages add up to 100 percent. This is known as the cumulative percentage line.

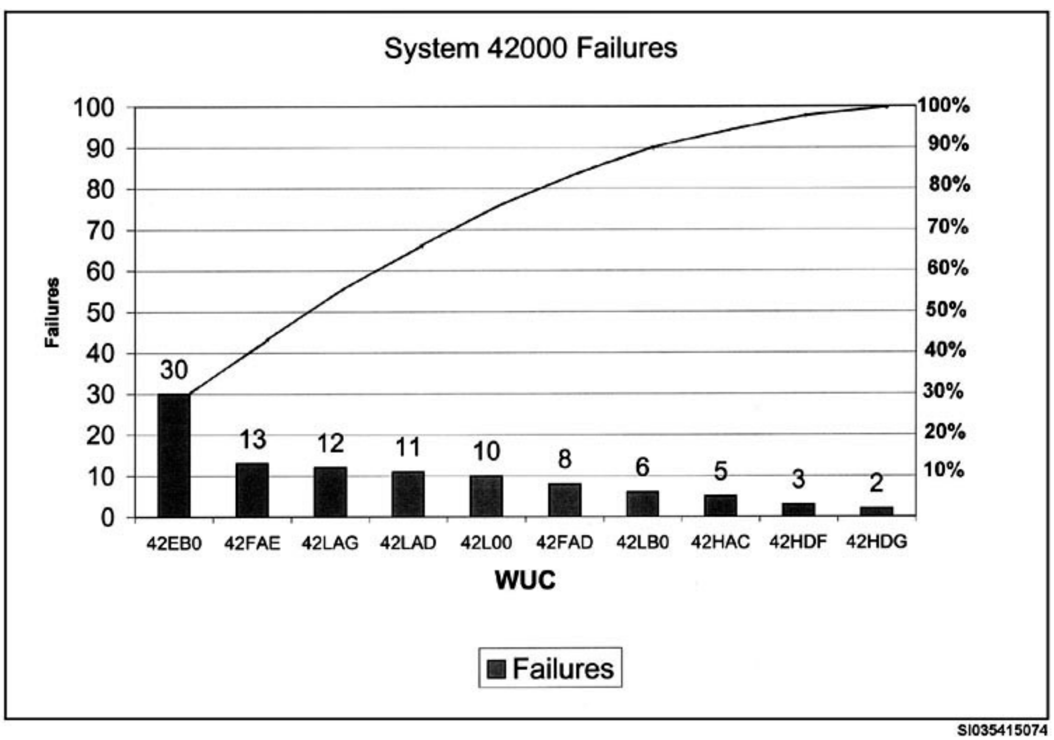

Figure 4–18. Pareto chart.

From looking at the sample Pareto chart, it is obvious that there is one item/shop/element that towers above the others and some bars tower above most of the others. These are the items that need close attention. A Pareto chart can be useful when conducting and presenting a special study. Some business statistics software includes the construction of this chart. You can determine its appropriateness based on the issue or problem at hand.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

630. Statistical pitfalls

1. Match each term in column B with its application in column A. Items in column B may be used only once.

Column A	*Column B*
____ (1) Assuming one event is directly correlated to another because they occur at the same time.	a. Bias.
____ (2) Giving more weight to supporting facts than to conflicting data.	b. Noncomparable data.
____ (3) Applying a parametric test to nominal or ordinal data.	c. Incorrect projection of trends.
____ (4) Showing a significant increase in one rate on the basis of a comparison that is not normal.	d. Improper assumption regarding relationship.
____ (5) Using statistical measures to validate results based on the quality of raw data.	e. Comparison with an abnormal base.
____ (6) Selecting data that did not represent the population and was not accurate.	f. Improper sampling.
____ (7) Discrediting past trends as a pitfall of statistical analysis.	g. Misuse of statistical software programs.

2. What can result from using inaccurate data based on complex data analysis when using a statistical software program?

631. Applying the 12–step analysis process

1. What is the advantage of data being displayed graphically?

2. At what point in the analysis process do you gather opinion-type data?

3. During the follow-up phase, what questions would you ask about the NMCM rate?

632. Using data analysis tools

1. Which graphic tool is essential for correlation analysis?

2. Which two diagrams are used to show frequency distribution?

3. In a control chart, how are points plotted?

4. What is a flowchart?

5. What do the “bones” in the fishbone diagram represent?

633. Selecting analysis presentation tools

1. What is usually combined with a chart to compare data with graphics in one viewing?

2. Why should you limit your segments to no more than five when constructing a pie chart?

3. Name two types of bar charts.

4. Why is a line chart also called a historical curve?

5. What is the basic assumption of a Pareto chart?

4–3. Special Study

This section places special emphasis on a comprehensive special study. You apply the analysis process to effectively produce a product. If your analysis is properly applied, then maintenance leadership can make good decisions based on objective data.

634. Preparing a special study

The study you produce will aid maintenance managers in making good decisions that ultimately affect the Air Force mission. Examples are provided to give you a better idea of how these products look. As a maintenance analyst, your responsibility is to make professional products and improve the maintenance management process in your workplace.

Now that you have mastered the analysis process and are familiar with some statistical analysis concepts, this lesson and the others in this section focus on preparing a special study and presenting the special study's report. Let's begin by describing a special study what it involves.

Purpose of a special study

Maintenance managers at the field level (maintenance supervisors, squadron commanders, group commanders, and wing commanders) are concerned with how well the unit is meeting its mission requirements, how to improve equipment performance, and how to identify any problems that affect the mission. When operational requirements have not been met, an investigation to determine the cause, or causes, is usually initiated. This then often becomes a special study.

A special study is both an investigation and in-depth analysis of any subject to determine the root cause of a specific problem. Once the cause is determined, the special study is completed by providing possible solutions or remedies for the problem.

You can initiate a special study in either of the following two ways:

1. After the fact as a result of an analysis of unit performance. For example, suppose that the sortie abort rate started increasing in April 2015 and reached an unsatisfactory level. However, at the same time, all abort rates had been declining since January 2015. In this situation, commanders would want to find out what happened, which could trigger a special study directed by the wing commander or a higher echelon.
2. The result of an analyst reviewing a report on, or data gathered, for an equipment or mission analysis. This is where you discover the emergence of negative trends. Initiating a special study at this point is a proactive approach and preferred by both maintenance managers and analysts.

Negative trends

Identifying negative trends is often an indication that further investigation is needed. At this point, you should consider contacting the different maintenance work centers and support offices, such as QA and the maintenance operations center (MOC), for assistance with your investigation. You should also consider the following questions when reviewing negative trends:

- What systems are creating a high failure rate?
- What factors are causing an increase or decrease in the failure rate?
- Are specific aircraft or equipment causing trend changes?
- What systems are causing the aircraft to be in a non-flyable status?
- What parts or components are causing high malfunctions?
- Can the items be repaired on station?
- Is supply support sufficient?
- Is the lack of personnel, training, technical data, or equipment and tools affecting certain systems?

Conducting the special study

When you identify a negative trend, you should begin your investigation right away. You may be able to prevent the problem from having a serious effect on the unit. For example, if you may discover that your assigned F–15s are experiencing fuel leaks in their external tanks and the reportable problem has steadily increased. You should bring this to the attention of your maintenance officer along with a recommendation to start a special study right away. This is how the process starts and is the ideal time to determine the reasons why certain external fuel tanks are leaking.

Five basic elements

Listed below are the five basic elements of a special study are:

1. Purpose.
2. Assumptions and limitations.
3. Investigation and findings.
4. Conclusion.
5. Recommendations.

You begin by organizing your study. All elements involve answering the following five basic questions listed in the table below:

Basic Questions for all Special Study Elements	
Question	**Finding the Answers**
Purpose *Why are you doing the study?*	This is where you state the reason for the study. **Example: "**To investigate the apparent increase in abort rates for the wing's F–15s."
Assumptions and limitations *What is the scope of the study?*	You state your assumptions/limitations concerning the problem such as below: "The F–15 sortie abort rate for the wing started increasing beginning April 2006." You identify the problem area and define the length of data involved. This will keep you focused on the subject.
Investigation and findings *What is really happening?*	You start seeking data from documented records, conduct interviews with key people, research technical publications and, possibly, related reports. Findings are the hard facts you have gathered that support your assumption. You tell what you did and what you have found. Your investigation revealed that there have been similar abort studies in the past. Your findings indicate the systems causing these aborts.
Conclusion *Why is it happening?*	This section contains the conclusion based on your findings. There may be more than one conclusion. For our example, your conclusion might correlate one data set with another or show that there are several causes.
Recommendations *What should be done about it?*	You can make recommendations based on your conclusion about the findings. In our sample study on F–15 abort study, you can recommend more than one viable solution, especially those that need considerations. Sometimes, the decision may require another study in itself but it is out of your hands now.

How well you answer these questions will determine the success of your study. In the next lesson, we will look at a hypothetical special study report and discuss how these five elements were followed.

NOTE: There are numerous special studies available for reference and personal browsing. Some are on the Internet (official Air Force Web sites as a service of sharing information among maintenance analysts). You should avail yourself of this opportunity to learn from others who can personally assist you. Contact your MAJCOM functional managers for these sources.

Preparing

Once you have completed your special study, your next task is to present your findings, analysis, conclusion, and recommendations. The first task is to prepare your data. Preparing your data involves organizing all of your materials into a neat, presentable format. This means arranging your information in a way that makes sense to the person who requested the information.

Organizing

To organize your information, follow the five basic elements of a special study; namely, purpose, assumption and limitations, investigation and findings, conclusion, and recommendations. We will follow this order in the table below about organizing your special study:

Elements of a Sample Special Study	
Element	**Description**
Purpose	The purpose of your special study is usually driven by your own analysis of trends, which you bring up to your supervisor and the chain of command where it concerns your commander and higher echelons. From there you can anticipate the initiation of a special study. In the case of our sample study, the direction to conduct a special study came from the MAJCOM HQ. You must include this in your report; naming the level of authority and the names of the officials involved, if necessary. You include background information to substantiate or support your purpose.
Assumptions and limitations	When you start gathering information to support your assumptions, you must establish some limitations. These include: • the length of time given to conduct the study known as the *suspense;* • the length of time for the investigation; • the boundaries of the data; • the organizations from which you will obtain information; and • the amount of information needed to satisfy your assumptions.
Investigation and findings	You want to show the results of your investigation and your findings, which reveal information you have gathered. The two most commonly used visual aids are tables and charts, which are used as follows: • Tables provide an organized manner to show the data collected. • Charts are a visual representation of the data where you assign meaning to the data, such as trends and comparisons. In tables, you can arrange data alphabetically, chronologically, or numerically. Simplify your tables. Create tables to present information by subject, such as a table of system failures, a table of aircraft equipment identification, or a table of organizations. Create these tables separately. Do not cram too much information in one table. A lined table is preferred; especially if you have a lot of data to show. Charts provide a graphic representation of the data with meanings attached to them. Bar graphs are good for comparisons while a line chart shows trends. You may also compare trends on the same chart, but limit your chart to no more than five lines as follows: • One line showing the standard. • Two lines representing the data. • Each data line accompanied by a trend line, if necessary. This means that you compare only two line trends in one chart; too many lines on a chart can be confusing and strains the eyes of the viewer.

Elements of a Sample Special Study	
Element	**Description**
Conclusion	Your conclusion answers the purpose of the study by summarizing the information gained from your investigation and findings. You give your analysis based on the data gathered and what you discovered. All your assumptions must be supported. If an assumption is weak, then state why. Your conclusion must be an objective overview of the findings. Quantify your observations using percentages when dealing with large numbers to show impact. For example, instead of just saying 100 out of 200 sorties aborted, you may add that 50 percent of the sorties for the month were aborted, while showing the raw numbers at the same time. Try to keep your conclusion brief and straight to the point. Avoid pointing the blame to any personnel, shop, or organization. You are not doing a criminal investigation. Do not be a detective. Refrain from making recommendations at this point. Save your recommendations for the "Recommendation" section of your study.
Recommendations	When you give recommendations, you are *not* solving the problem. It is not your responsibility to provide solutions. Instead, you set the direction for the commander to base his decisions. You have provided enough information for the commander, whether at the group, wing, or MAJCOM level, to start implementing solutions. If you have done a thorough investigation, the information you have gathered adds strength to your recommendations. For example, if your investigation took you to all possible work centers involved in the study, then you can make mention of the fact that one or two work centers can be part of the solution. Even publications you have researched can point to some solutions. Your investigation might discover a flawed maintenance procedure in the technical order, which requires immediate attention. **NOTE:** Again, your special study provides the commander with a solid tool to assist them in directing solutions.

635. Presenting a special study

The two methods used to present your special study are:

- written report, and
- oral presentation.

Both methods employ the basic five elements of a special study; the only difference is the presentation medium of presentation. Let's look at both methods, beginning with the written report.

Written report

The written report is a formal way of presenting your special study. This is a self-explanatory document that provides enough information for the commander, or any interested organization, to act upon. Written reports are used instead of an oral presentation when the report's requester is geographically separated and a meeting cannot be arranged. Reports are also available for distribution to concerned and interested agencies. You always prepare a written report even if you intend to present it in person.

You may add other documents such as the statistical methods and tools you used; they may be correlation, scatter diagrams, parametric and non-parametric tests, and so forth. However, use only relevant information. Do not include data that became irrelevant after statistical tests showed that they did not meet the criteria. Keep your report short by using only relevant information.

Oral presentation

This is known as the "Stand Up." It could also be called a briefing. The purpose of the stand-up presentation is to deliver your special study to the commander, staff, and all interested personnel. A meeting is arranged for the presentation. More specific information about preparing and conducting effective meetings will be discussed later in this unit. This lesson also gives guidelines for oral presentation and the written report. You must still follow the principles taught in other courses for conducting briefings. Air Force Handbook (AFH) 33–337, *The Tongue and Quill*, is one of the most useful references for military speaking.

The format for the presentation is very similar to the written report. However, you will present your visual aids using computer-based presentation software and a large-screen display. Use the same information, including visual aids (charts and tables), as is in the written report. There are many presentation equipment and computer programs available. You usually develop your visual aids (charts and tables) with the same program you will use for the presentation. Multimedia programs such as Microsoft PowerPoint are commonly used to present slides as visual aids. They are very effective and easily used for your presentation.

Unlike on the written report, use brief text on your visual aid slides. Use bullets instead of paragraphs. As the briefer, you provide the explanation as you present your information to your audience (the receiver of the special study).

Use printed handouts if you have many terms and acronyms to explain. Also, use your printed special study handouts to reference sources and to make any acknowledgements.

Prepare copies of all documents—such as raw data and other statistical tools (scatter diagram, histogram, etc.)—used for the analysis of the report. Have them available in case they are requested after your presentation.

Presenting a presentation orally is preferred over a written report because you have the opportunity to clarify your findings in front of all people concerned. This also reduces the potential for misunderstanding among many units involved. If appropriate, give a copy of your written report to people scheduled to attend the briefing so that they can preview the information to be presented. This gives you the opportunity to make amendments or corrections when identified by respective units (unit personnel names, correct terms used, etc.) before the briefing.

The maintenance management analysis office may vary the format for the written report and oral presentation to meet the requirements of the intended audience (receiver of the report). However, you must still follow the five basic elements (purpose, assumptions and limitations, investigation and findings, conclusion, and recommendations) in structuring your presentation.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

634. Preparing a special study

1. What is a special study?

2. What are the two ways used to initiate special studies?

3. What is the preferred approach in initiating a special study?

4. What are the five basic questions asked when organizing your special study?

635. Presenting a special study

1. What are the two methods used to present a special study?

2. Which method is used as the formal way to present a special study?

3. Why do the formats for the special study differ?

Answers to Self-Test Questions

627

1. A multifaceted approach analysts use for solving management problems.
2. (1) Collect data: use different sources such as systems outputs and schedules.
   (2) Verify: requires you to understand the information and its sources and includes proofreading.
   (3) Manipulate/Compute: putting your data into a usable form for presentation such as tables and charts.
   (4) Compare: a comparison of the date to the standards, past performance, or expected results.
   (5) Review: provide additional information for obvious questions and review the data for accuracy.
   (6) Analyze: using a logical thinking process, to determine if you need to proceed, depending upon your knowledge.
   (7) Problem Solving: a step-by-step procedure used to define the problem and lay the groundwork for further analysis.
   (8) Research: gathering all the needed information from all the available resources to help in fully understanding the problem.
   (9) Investigate: evaluate all the information you have obtained.
   (10) Identify: determining the cause of the original problem.
   (11) Recommend: choosing the best solution to the problem.
   (12) Follow up: to determine if the problem has truly been resolved.

628

1. Information that originates within an organization (e.g., the operations of the maintenance wing) is classified as internal data. Information that originates outside of an organization (e.g., a squadron outside of your maintenance wing) is classified as external data.
2. Data integrity by considering the competency of the source and accuracy of the source document.
3. (1) What kind of things they do?
   (2) What kind of information does it provide?

4. (1) Supply.
   (2) Cost analysis (formally Management analysis).
   (3) Management engineering.
   (4) Quality assurance.
5. As a method of conveying raw or summary information.
6. Relatively easy to prepare and the fastest means to formally disseminate information.
7. They could continue to exist even after they are no longer needed.
8. It separates a subject into its various parts to arrive at a meaningful interpretation of the facts.
9. To educate oneself on the purpose and operations of the JDD system.

629

1. Any three of the following:
   (1) Maintain the trust of all members you interact with.
   (2) Provide management information to the maintenance complex.
   (3) Supply data for the operations complex.
   (4) Convert raw data into indicators.
   (5) Provide objective feedback to decision makers and supervisors.
   (6) Analyze unit performance.
2. By maintaining accurate data, including the use of initiative, imagination, curiosity, and judgement in recordkeeping; always be objective, use accurate data, and provide logical and realistic solutions for corrective action.
3. They are places within a unit that analysts use to get information on assessing the condition of the organization. Some examples are daily group standup meetings and the debriefing section.

630

1. (1) d.
   (2) a.
   (3) b.
   (4) e.
   (5) g.
   (6) f.
   (7) c.
2. The results yield worse results than if simple data analysis is used.

631

1. It is far easier to observe any possible relationships or differences.
2. During step 8, Research.
3. Is it going down, leveling off, or increasing?

632

1. Scatter diagram.
2. Histogram and frequency polygon.
3. In the order of production.
4. A graphical representation of a process.
5. Main causal categories.

633

1. A table.
2. To avoid a cluttered appearance.
3. Simple bar chart and divided bar chart.

4. Because it uniquely describes data over a period.
5. That 80 percent of the problem comes from 20 percent of the causes.

634

1. An investigation and in-depth analysis of a subject to find out the root cause of a specific problem that also provides possible solutions.
2. (1) As a result of an analysis of a unit performance and directed by the commander.
   (2) Through an equipment or mission analysis initiated by the analyst.
3. Proactive approach by the analyst.
4. (1) Why are you doing the study?
   (2) What is the scope of the study?
   (3) What is really happening?
   (4) Why is it happening?
   (5) What should be done about it?

635

1. Written report and oral presentation.
2. Written report.
3. To satisfy the requirements of the intended receiver of the report.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to AFCDA.

77. (627) In which step of the 12-step analysis process do you put your collected data into a usable form?
    a. Verify.
    b. Analyze.
    c. Compare.
    d. Manipulate/Compute.

78. (627) In which step of the 12-step analysis process would you consider such questions as "Is the trend stable" and "Are the deviations greater than expected?"
    a. Verify.
    b. Review.
    c. Compare.
    d. Research.

79. (627) When investigating a problem during the 12-step problem analysis process, why should you continue even if the problem seems to have disappeared?
    a. The disappearance may only be temporary.
    b. It can determine the cost of the action taken.
    c. This information may be needed at a later date.
    d. All investigations must be closed out and the results filed.

80. (628) One of the tools an analyst uses is information associated with a maintenance organization's operations. This type of information is considered
    a. external data.
    b. internal data.
    c. standards.
    d. factors.

81. (629) One of your responsibilities in the analysis process is that your assessments *must* be objective and specifically answer the
    a. purpose of the study.
    b. outcome of the study.
    c. why and how a problem occurs.
    d. why, how, when, and where questions.

82. (629) As a maintenance data systems analyst, using credibility is *best described* as
    a. making statistics display your recommended corrective actions.
    b. being consistently objective, using accurate data, and providing realistic corrective actions.
    c. keeping the group commander informed and consistently providing realistic corrective actions.
    d. being able to assess the conditions of a unit, being objective, providing logical solutions, and providing realistic corrective action.

83. (629) Which statement *best describes* a pulse point in a unit for gathering information on the unit's condition?
    a. A squadron party.
    b. The debriefing section.
    c. An informal group meeting.
    d. To convert raw data into meaningful statistics.

84. (630) Considering statistical pitfalls, the *validity* of computer-generated data depends on the
    a. quality of the raw data and the sample size.
    b. procedure and accuracy with which the data is analyzed.
    c. quality of the raw data and the procedure with which it is analyzed.
    d. procedure with which it is analyzed, the critical values, and sample size.

85. (631) When applying the 12-step analysis process to a problem, this is the *most common* approach to arranging maintenance data.
    a. Descending order.
    b. Chronological order.
    c. Order of importance.
    d. Serial number order.

86. (632) Which diagram is an *essential* tool for *correlation analysis*?
    a. Histogram.
    b. Scatter diagram.
    c. Frequency polygon.
    d. Cause and effect diagram.

87. (632) Which diagram or chart can be used together with the frequency polygon in *frequency distribution*?
    a. Histogram.
    b. Flowchart.
    c. Control chart.
    d. Cause and effect diagram.

88. (632) The points in a *control chart*, which is one data analysis tool, represent
    a. paired data.
    b. distribution.
    c. cause and effect.
    d. quality of performance.

89. (632) Symbolic shapes and arrows can be found in this data analysis tool.
    a. Flowchart.
    b. Control chart.
    c. Scatter diagram.
    d. Cause and effect diagram.

90. (633) Pie charts are *effective* as a data analysis tool when they represent what percentage of the item under consideration?
    a. 25.
    b. 50.
    c. 75.
    d. 100.

91. (633) Bar charts, as a data analysis tool, are used for comparing
    a. groups of data.
    b. trends of data.
    c. variables of time.
    d. causes of problems.

92. (633) Which chart, as a data analysis tool, *best describes* data over a period of time?
    a. Pie.
    b. Bar.
    c. Line.
    d. Pareto.

93. (634) This kind of approach would *initiate* a special study during an equipment analysis and is preferred by maintenance managers and analysts.
    a. Critical.
    b. Reactive.
    c. Proactive.
    d. Responsive.

94. (634) When establishing the *scope* of a special study, while applying the analysis process, you are defining the
    a. purpose.
    b. conclusion.
    c. investigation and findings.
    d. assumptions and limitations.

95. (635) When presenting a special study, as an application of the analysis process, which medium is the formal method of presentation?
    a. Video.
    b. Secure line.
    c. Written report.
    d. Oral presentation.

Glossary

Terms

bias sample—A sample prejudiced toward one view—may be intentional or unintentional.

coefficient—A single number representing the amount of change or effect in a process.

correlation—The relationship between variables.

cumulative frequency distribution—A distribution that accumulates its values from class to class.

cyclical variation—The natural flow of data with no outside influences.

degrees of freedom—The number of times data change in a series, N - 1.

deviate—A value which differs from the average or normal.

discrete data—Whole numbers only.

extrapolation—Extending a linear trend line for the purpose of making predictions.

First look—assessment of maintenance capabilities

frequency polygon—A graph connecting the midpoints of several frequency classes.

harmonic mean—An average of rates, such as rate of time or rate of speed.

histogram—A graph showing the ranges of classes within a distribution.

mean—The numerical average of a series.

median—The positional average of a series.

mode—The most frequent value of a series.

moving average—The sequential averages of subgroups in a series.

parameter—Measures that describe data populations, normally symbolized by Greek letters.

secular variation—Trend due to assignable cause.

seasonal variation—Changes in data caused by elements of calendar time.

sampling distribution—The average distribution of sample values, normal or typical reference for comparison.

standard deviation—The average deviation of data values from their mean.

standard error—The measurement of difference between a sample's values and its population's values.

stratified sampling—Subgrouping data before sampling the subgroups.

systematic sampling—Taking every Nth item in a series.

symmetrical distribution—Data that has equal quantities on both sides of the mean.

time series—Data measured across a period of time.

trend—The secular variation in the flow of data.

variance—The average deviation of the square of a variable about the square of the mean, standard deviation squared.

variability—Dispersion or scatter of values within a distribution.

Symbols

β	beta
X2	chi-square test
df	degrees of freedom
r	denotes Pearson's coefficient of correlation
ρ	denotes Spearman's coefficient of correlation
f	frequency
l	identifies class lower limits in a frequency distribution
X	individual value
α	level of significance, used to determine confidence level of probability
$\overline{X}$	mean
$\overline{\overline{X}}$	mean of mean
md	median
mo	mode
Z	number of standard deviations on a normal curve table
n	number of values in a sample (sample size)
N	number of values in a series
μ	population average or mean
$\surd$	radical (square root)
R	range of data elements in a series
Σ	shows the summation of a series of values
σ	standard deviation of a population
S	standard deviation of a sample
(-)	when a bar is placed above a symbol, this indicates an average of the values represented by the symbol, eg, $\overline{X}$ = mean of Xs

Abbreviations and Acronyms

2LM	two-level maintenance
3LM	three-level maintenance
Ao	operational availability
ACC	Air Combat Command
AF	Air Force
AFMC	Air Force Materiel Command
AFSC	Air Force specialty code
AGE	aerospace ground equipment
ALC	Air Logistics Center
AMC	Air Mobility Command
AMCI	Air Mobility Command Instruction
AMXS	aircraft maintenance squadron
ANG	Air National Guard
ASD	average sortie duration
ASR	Aircraft System Reliability/Capability Report
ATC	(TRIC) action taken code
AUR	Accomplishment Utilization Report
AVS	Aerospace Vehicle Status (also a TRIC)
AWM	awaiting maintenance
AWP	awaiting parts
BI	Business Intelligence
BPO	basic postflight
BOBJ	Business Objects
CAMS	Core Automated Maintenance System
CANN	cannibalization
CC	commander
C-E	communication-electronics
CEMS	Comprehensive Engine Management System
CL	centerline
CND	cannot duplicate
CONUS	continental United States
CSV	comma separated values

DD	deferred (or delayed) discrepancy
DDR	deferred (or delayed) discrepancy rate
D_o	operational dependability
DOD	Department of Defense
EOR	end-of-runway
ESR	Equipment Status Report
EVL	Event Listing (TRIC)
FMC	fully mission capable
FOD	foreign object damage
FSE	flying scheduling effectiveness
FTR	fix time rate
GCSS-AF	Global Combat Support System–Air Force
GCSS–AFDS	Global Combat Support System–Air Force Data Services
GCSS-D	Global Cyber Support Systems Dashboard
GDSS	Global Decision Support System
GDSS2	Global Decision Support System 2
HF	high frequency
HHQ	higher headquarters
HMC	how malfunction code
HPO	hourly postflight
HSC	home station check
IMDS	Integrated Maintenance Data System
ILS–S	Integrated Logistic System–Supply
JCN	job control number
JDD	job data documentation
LCL	lower control limit
LCN	logistics control numbers
LDR	Logistic Departure Reliability
LIMS–EV	Logistics, Installation and Mission Support–Enterprise View
LRU	line replaceable unit
MAF	Mobility Air Forces
MAF LOG C2	Mobility Air Force Logistics Command & Control
MAJ	major inspection
MAJCOM	major command
MC	mission capable/mission capability

MD	mission design
MDD	maintenance data documentation
MDS	mission design series
MDT	mean down time
MESL	mission essential systems list
MICAP	mission capable
MIN	minor inspection
MIS	maintenance information system
MLH	maintenance labor hours
MLH/AH	maintenance labor hours per active hour
MMA	Maintenance Management Analysis
MOC	maintenance operations center
MP/U	maintenance personnel per operational unit
MPD	Maintenance planning document
MRT	mean repair time
MSE	maintenance scheduling effectiveness
MTBCF	mean time between critical failures
MTBDE	mean time between downing events
MTBF	mean time between failures
MTBM	mean time between maintenance
MTBMA	mean time between maintenance actions
MTBSM	Mean time between scheduled maintenance
MTBUM	mean time between unscheduled maintenance
MTTR	mean time to repair
MTTRF	mean time to restore function
MXG	Maintenance Group
NDI	non-destructive inspection
NMC	not mission capable
NMCB	not mission capable both
NMCBS	not mission capable both scheduled
NMCBU	not mission capable both unscheduled
NMCM	not mission capable maintenance
NMCMA	not mission capable airworthy
NMCMB	not mission capable maintenance both
NMCMS	not mission capable for maintenance scheduled

NMCMU	not mission capable maintenance unscheduled
NMCS	not mission capable supply
NMCU	not mission capable unscheduled
NRTS	not reparable this station
O_R	operational readiness
O&M	operation and maintenance
OG	Operations Group
OI	operating instruction
OS	operational squadron
OSS	operational support squadron
OTTO	on-time takeoff
PAI	primary aircraft inventory
PDM	programmed depot maintenance
PE	periodic
PER	Performance Report (TRIC)
PMC	partial mission capable
PMCB	partial mission capable maintenance and supply
PMCM	partial mission capable maintenance
PMCS	partial mission capable supply
PMEL	precision measurement equipment laboratory
PMO	Program Management Office
PR	preflight
PRD	pilot reported discrepancy/Pilot Reported Discrepancy Report (TRIC)
PS&D	Plans, Scheduling, and Documentation
QA	quality assurance
QLP	query language processor
QPA	quantity per application
QRE	Repeat/Recurring Discrepancy Report (TRIC)
R/R	Repeat/Recur
REMIS	Reliability and Maintainability Information System
SBSS	Standard Base Supply System
SE	support equipment
SM	single manager
SRD	Standard Reporting Designator
STH	status update

TACC	Tanker Airlift Control Center
TCTO	time compliance technical order
TDY	temporary duty
TH	thruflight
TNMCM	total not mission capable for maintenance
TNMCS	total not mission capable supply
TO	technical order
TRIC	Transaction Identifier Code
UCL	upper control limit
UF	usage factor
UPAM	unit program account manager
UR	utilization rate
USTRANSCOM	US Transportation Command
UTE	utilization
WDM	workday month
WG	wing
WUC	work unit codes

Student Notes

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