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AFOTECPAM 99-104 provides a compilation of "best practices" and corporate wisdom of "how to" efficiently and effectively develop the operational suitability portion of the test concept, test plan and final report. It provides definitions of common terms and measures and identifies processes related to suitability test and evaluation. This guide will equip test teams with a solid foundational knowledge of the concepts and procedures pertaining to operational suitability test and evaluation. Detachments, test teams and support personnel should use it as a "how to" guide in conjunction with guidance provided in AFOTECMAN 99-101, *Operational Test Processes and Procedures*, and the AFOTEC OT&E Guide. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF IMT 847, *Recommendation for Change of Publication;* route AF IMT 847's from the field through the appropriate functional's chain of command. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with AF Manual (AFMAN) 33-363, *Management of Records*, and disposed of in accordance with the Air Force Records Disposition Schedule (RDS) located at **https://www.my.af.mil/gcss-af61a/afrims/afrims**. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

SUMMARY OF CHANGES

Readers should thoroughly review this significantly revised publication. Four significant changes are the updates to reference materials, linkage to high level DoD Reliability, Availability and Maintainability guidance, the incorporation of AFOTEC's process improvements and latest best practices. The formatting now conforms to the direction in AFI 33-360, *Publications and Forms Management*, Incorporating through 7 Feb 2013.

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Chapter 1

INTRODUCTION

1.1. Intent and Organization.

1.1.1. The intent of this guide is to provide a general overview of suitability and useful information to test team members assigned the responsibilities of planning, executing, and analyzing tests involving suitability areas of interest. This pamphlet is not intended to replace or supersede regulatory or statutory requirements found in other documents. This guide is meant to educate newcomers to Operational Test and Evaluation (OT&E) about the peculiarities of evaluating a system for operational suitability.

1.1.2. The main body of this guide provides a translation of real-world operations to operations in OT&E. For example, some metrics from real-world operations are not as meaningful in OT&E due to smaller sample sizes and/or shorter time periods of consideration. It is important for analysts to know this information to understand the sources of data used to assess suitability.

1.1.3. The attachments include sample test measures and provide detailed guidance for collecting and analyzing data. It is important for the operators/maintainers to know this information to understand how the data are to be collected and the goal of data collection.

1.1.4. Detachments and test teams should tailor suitability testing to their specific systems.

1.2. Operational Suitability Defined. The Defense Acquisition Guidebook (DAG) contains this definition of operational suitability: "The degree to which a system can be placed satisfactorily in field use with consideration given to availability, compatibility, transportability, interoperability, reliability, wartime usage rates, maintainability, safety, human factors, manpower supportability, logistics supportability, natural environmental effects and impacts, documentation, and training requirements." Some elements of this definition, such as safety, human factors, compatibility, interoperability and environmental effects, also apply to operational effectiveness. The current "Memorandum of Agreement (MOA) on Multi-Service Operational Test and Evaluation (MOT&E) and Operational Suitability Terminology and Definitions" and the AFOTEC OT&E Guidebook provide the same definition for operational suitability as the DAG. The MOA is located on the AFOTEC Intranet page and provides further policy, terms and definitions for the Service Operational Test Agencies (OTA) to use in suitability evaluations.

1.3. Significance of OT&E for System Suitability.

1.3.1. During OT&E, test team members will evaluate operational suitability along with operational effectiveness for a given system in order to provide a complete operational perspective to the warfighter and determine the overall mission capability of a system. The test team will evaluate the areas listed in the definition above to search for suitability shortfalls, identify them and document the results. In the end, operational suitability testing is essential because the suitability shortfalls identified in OT&E provide the warfighter with key information that plays a large role in determining the overall mission capability of a system. Thus, a carefully orchestrated suitability analysis is necessary for the Milestone Decision Authority (MDA) to make an informed fielding decision for a given system.

1.3.2. OT&E examines many facets of suitability for a given system. Some of these suitability areas may include the effects the system will have on operations tempo, what support personnel will be required to maintain the system and what level of logistics support will be needed for the system. In addition, the OT&E results will identify how deployable the system is, how often it breaks, how easy it is to fix, how time-consuming it is to fix and what type of training maintainers will need to support the system. Furthermore, OT&E will examine the type of storage and transportation needed for the system at the main and forward operating bases. OT&E will also provide the warfighter with a substantial amount of human factors data on the system's ease of use, what type of issues the user may have with the system's design, the effectiveness of system training and the impact the new system might have on the user's day-to-day mission. A well-planned, properly executed OT&E is key to identifying suitability shortfalls of a given system.

1.3.3. Proper suitability training for operational testers is of paramount importance, because suitability analysis can be difficult and costly to perform. Some areas of suitability such as reliability might be particularly difficult to test because of the limited number of hours or test articles available for the test. If the system under test (SUT) simply does not fail during the allotted time, a conclusion about mean time between critical failures will be difficult to report without other avenues of analysis. Because of difficulties such as this, the test team must have a solid plan for conducting suitability analysis, along with a well-defined methodology and a list of the models they will employ to fill any gaps in the data collected from the actual test. It is important for the test team to have a solid understanding of testing for operational suitability before planning the operational test in order to take into account the full scope of suitability testing.

1.3.4. To the warfighter, a system's suitability performance could be a major factor that determines the life-cycle cost of the system. Money is not the only cost issue. A system with suitability issues could dramatically increase the number of maintainers needed to sustain it, so fielding it could have an impact on manpower. Furthermore, a system with major human factors issues might increase operator workload dramatically. For instance, if a new chemical suit is very effective at providing protection against chemical agents, yet is significantly more thermally burdensome than the currently fielded chemical suit, the warfighter will need to weigh the added protection against the drawbacks of the excessive thermal burden. In addition, if a system needs to be stored in a climate-controlled environment, that requirement might add significant cost to its deployment in the theater if a special facility is required to store it. Moreover, if a new chemical agent detector has a high false alarm rate for detecting chemical/biological agents, the impact on base operations could be catastrophic. Alternatively, the commander may lose confidence in the detector and thus, the system becomes useless for its intended purpose. These examples represent some potential operational impacts that suitability issues may pose for a given system. It is the responsibility of the operational test community to discover these suitability shortfalls before the system is fielded in order to reduce the warfighter's risk in purchasing a system that might be extremely expensive in the long run.

1.3.5. In addition to increasing life-cycle cost, manpower, facilities and workload, suitability issues could also have a significant impact on mission capability. For example, during OT&E, reliability, availability and maintainability data will be gathered and analyzed. If a system has a large mean repair time, but also has a large mean time between critical failures,

this might not impact the system's mission capability. However, if the system experiences a critical failure often and has a lengthy repair time, this could result in low availability. Hence, even though the system might be extremely effective when available, it would not be mission capable because it is rarely available to support the warfighter.

1.3.6. OT&E also provides an opportunity to test the system with other systems to identify any problems with compatibility and interoperability. Addressing these issues early in the program's acquisition lifecycle has a much lower cost impact as opposed to making accommodations after the system is fielded. Regardless of the system under test, it is essential to determine whether it will work with the other systems in its intended environment. Suitability analysis in OT&E provides the warfighter with a measure to gauge the impact of incorporating a new system into the battlespace environment. Again, if the system is highly effective but not interoperable with the other support/supported systems, it might not be mission capable and worth fielding.

1.3.7. Another area in which suitability analysis pays dividends is identifying any natural environmental hazards or impacts the new system might cause. For example, if the combination of four new aircraft engines produces too much noise during OT&E, the refitted aircraft might not be able to fly or land in an area that has restrictions against high levels of noise. If this impact is not identified before the engine is fielded on the fleet, there may be a considerable amount of political fallout from this acquisition decision due to new restrictions on the aircraft's available basing and operating locations. A proper OT&E suitability study is invaluable to identify such environmental impacts.

1.3.8. Suitability issues can be very transparent without a properly planned and well-orchestrated OT&E for a system. Developmental Test and Evaluation (DT&E) does not provide the full compilation of data for a system under test that the warfighter needs to make an informed fielding decision. Although DT&E does not satisfy the requirements for a fielding decision, it is important for AFOTEC to be involved with DT&E. By integrating DT&E data points into OT&E events, AFOTEC can show the overall growth of the system prior to OT&E and the developer can find operationally relevant problems earlier. In addition, data from DT&E becomes available and useable for OT&E reporting. Besides using the OT&E results to make a fielding decision, the warfighter can use these results to help employ a system to accomplish the mission. The operating command can use these results to improve the system's concept of operations (CONOPS), logistics plan, maintenance plan, system training for both users and maintainers, as well as determine the scope of the system's footprint and life-cycle cost. A system's overall mission capability is determined by its effectiveness and suitability. Thus, it is very important to properly scope and plan for suitability analysis early in the OT&E process, and then carefully conduct the suitability analysis during OT&E in order to correctly resolve the overall mission capability of a given system.

1.4. Supporting RAM Documentation.

1.4.1. The August 2005 *DoD Guide for Achieving Reliability, Availability and Maintainability (RAM)* is an informative document for program managers and developers to plan for and design RAM into weapon systems early in a program. Although focused on understanding the user need, RAM design/redesign and other system engineering processes, many of the lifecycle sustainment philosophies may be carried over into the weapon system

operational demonstrations—operational test and evaluation. The guide supports the fundamental acquisition management framework principles as documented in the current DoD 5000 series. Sections of the DoD Guide for Achieving RAM include information relevant to operational test and evaluation. This information has been incorporated into this pamphlet. The DoD Guide for Achieving Reliability, Availability and Maintainability, can be found at <**https://acc.dau.mil/adl/en-US/142103/file/27585/DoD-RAMGuide-April06%5B1%5D.pdf**>.

1.4.2. The focus of the June 2009 *Department of Defense Reliability, Availability, Maintainability and Cost Rationale Report Manual* (RAM-C manual) is to assist the combat developers and program managers integrate top-level sustainment requirements early in the requirement generation phase to ensure weapon systems are sustainable and affordable throughout its life cycle. This manual also provides, "guidance in how to develop and document realistic sustainment KPP/KSA requirements and related supporting rationale," "guidance so the acquisition community understands how the requirements must be measured and tested throughout the life cycle," and "describes processes for DoD to interface with Services and programs when developing the sustainment requirements." As with the previous guide, portions of the processes outlined in the RAM-C manual may be carried over into the test and evaluation of a weapon system—ultimately achieving satisfactory RAM levels. The sections discussing the Life Cycle sustainment KPP and related KSA metrics are worth reading to explain their relevance to operational test and evaluation and AFOTEC's position on OT&E of these metrics. The *Department of Defense Reliability, Availability, Maintainability and Cost Rationale Report Manual* can be found at the following link: <**https://acc.dau.mil/adl/en-US/293762/file/44776/RAM-C%20Manual%20Jun%2009.pdf**>.

1.5. Related Issues The Chairman of the Joint Chiefs of Staff Instruction (CJCSI 6212.01F) describes the Net Ready KPP (NR KPP). DOT&E has defined two special interest items (SIIs) applicable to RAM in systems (especially software-intensive systems): compatibility and interoperability on the Global Information Grid (GIG) and Information Assurance (IA). Compatibility and interoperability discussion is included in Chapter 5. At the time of this revision, the guidance governing IA is evolving (Currently the AFOTEC Operational Testing (OT) of Information Assurance (IA) Guide, 1 June 2011). A discussion of IA is not included in this pamphlet in an effort to maintain this document's currency. A-3I maintains and disseminates guidance, and should be coordinated with to provide adequate IA testing of systems.

Chapter 2

RELIABILITY, AVAILABILITY AND MAINTAINABILITY (RAM)

2.1. Introduction. Evaluating a system's RAM plays a key role in determining whether the system can be placed satisfactorily in field use. This chapter provides test teams with details concerning RAM concepts and definitions. RAM test procedures are in the Joint Reliability and Maintainability Evaluation Team (JRMET) charter for each system under test (SUT).

2.2. Repairable and Non-repairable Systems in the Context of RAM Planning and Analysis.

2.2.1. For the purposes of RAM test planning and analysis, a system under test is either *repairable* or *non-repairable*. Repairable systems are restorable to a functioning status whenever a failure occurs. Such repair is corrective maintenance. In addition to this corrective maintenance, these systems also receive preventive maintenance (PM). The classic example of a repairable system is the propulsion system on an aircraft. Non-repairable systems are those that are not repaired once they fail; usually the system is simply discarded upon failure. While such systems receive no corrective maintenance, they may or may not receive preventive maintenance. Examples of non-repairable sub-systems that receive no preventive maintenance are an aircraft's tires, requiring disposal whenever worn out.

2.2.2. The distinction between repairable and non-repairable systems is important when selecting which measures of RAM are appropriate for the system under test. These measures in turn drive how total equipment time is broken down and what data the test team needs to collect during testing.

2.2.3. RAM analysis entails characterizing the nature of random variables and making inferences regarding expected performance in operational settings based on observations made during testing. The random variables with which we deal in RAM applications typically involve chronological time: the waiting time until an occurrence of an event, the time between the successive occurrences of events, or the time to complete some task are examples. The events of interest in RAM applications are typically failures of some sort (failures, critical failures (CF), or operational mission failures (OMF)), other events that "down" a system, or perhaps the delivery of parts needed to complete a repair job. A task duration of interest is the time to restore function to a downed system. This task has several subtasks such as diagnosing the problem, obtaining the parts to fix it, actually fixing it, and accruing administrative and logistics delays (see Figure 2.1). Depending on the RAM metric, subtask time duration may also be of interest. The actual times measured depend on the RAM requirements set forth by the user.

2.3. Dissecting Total Equipment Time.

2.3.1. A key objective for test teams to remember when planning tests for either repairable or non-repairable systems is that, in order to conduct a proper RAM analysis after the test, they need to be able to account for and break down all equipment time during the test period. At the simplest level, it is necessary that test teams collect the proper information during test to conclude, after the fact, whether the SUT was "up" or "down" at any given time during the test period. Knowing uptime and downtime will enable the computation of one of the more

basic measures of readiness, namely operational availability (A_o). A_o is simply a function of the total amount of uptime and the total amount of downtime. To compute RAM measures, total uptime and total downtime must each be further divided into several constituent parts. Figure 2.1. illustrates how total equipment time is broken into the parts needed to compute the various measures of RAM.

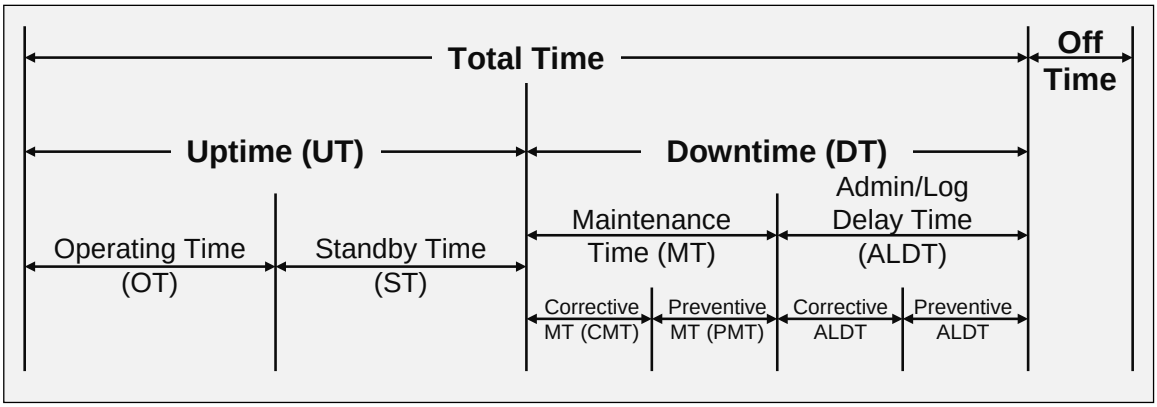

Figure 2.1. Linear Breakdown of Total Equipment Time

2.3.2. Uptime (UT), for instance, consists of Standby Time (ST)and Operating Time (OT). Downtime consists of active maintenance time and administrative/logistical delay time. Active maintenance time is subdivided into Corrective Maintenance Time (CMT) and Preventive Maintenance Time (PMT). If the system is non-repairable, corrective maintenance falls out of the breakdown and downtime includes only PMT and preventive Administrative/Logistic Delay Time (ALDT).

2.3.3. Figure 2.2. is an alternate presentation of the concept illustrated in Figure 2.1., namely, how total equipment time can be broken down into components. Total time is first split into active time and inactive time. Inactive time is not split any further. Active time is composed of uptime and downtime. Uptime and downtime are divided into multiple categories, and so on. This breakdown is obviously more detailed than the corresponding graphic at Figure 2.1. The terminology differs, and accommodates certain possibilities that the breakdown in Figure 2.1. does not allow. For example, there is a possibility of doing preventive and corrective maintenance on the system during uptime and/or during mission time.

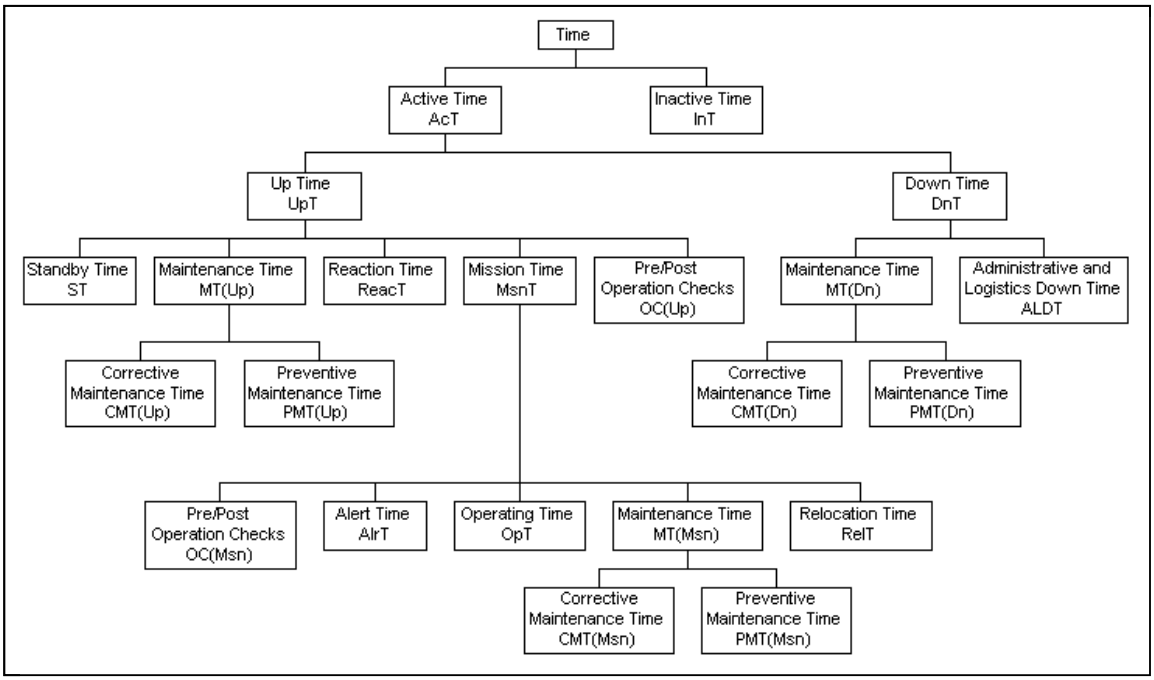

Figure 2.2. Dendritic Breakdown of Total Equipment Time

2.3.4. Presenting these two equipment time breakdowns highlights that the proper method to use depends on the particular system under test. The breakdowns given in Figures 2.1. and 2.2. likely would require tailoring to fit other systems under test. The tailoring would depend on the specific RAM measures being used (reflecting the complexity of the system and whether the system is repairable or not).

2.3.5. In any case, it is important to clearly define each segment (if using a linear breakdown as in Figure 2.1.) or each node (if using a dendritic breakdown in Figure 2.2.) such that they are mutually exclusive. The question, "What constitutes active time, inactive time, mission time, standby time, and off time?" should be asked to aid these definitions.

2.4. Analytical Products.

2.4.1. Figure 2.3. depicts a notional "state graph" of a fictional computer system under test. Assume that this computer is required to operate continuously, though it may be in a "hot standby" mode at times (not performing any of its active functions while turned on). The horizontal axis represents time and the vertical axis represents a binary *state variable* X(t) that takes value 1 when the computer is functioning or is assumed functional and takes the value 0 when it is not functional (values other than 0 or 1 are not defined). At time t_0 the computer is booted up and the observation period begins. Initially, the computer is on but standing by for a short period of time, which is counted as standby time (ST_{11}), followed by a period of operation, counted as operating time (OT_{11}). The computer is considered functional (uptime, UT_1) during ST_{11} and OT_{11}, and thus the total uptime at this point in the observational period is $ST_{11}+OT_{11}$ and total downtime is 0. At time t_1, the computer "crashes" and begins the first period of downtime (DT_1) in this test. Maintenance personnel immediately begin diagnosing the problem, which is counted as corrective maintenance time (CMT_{11}). Parts are required from supply to continue corrective maintenance. The time spent

ordering the parts and waiting for their delivery is counted as administrative and logistics delay time ($ALDT_{11}$). Once they receive the parts, they resume corrective maintenance (CMT_{12}) and at t_2, the computer is once again up and in standby mode (ST_{21}). Total downtime at this point is $CMT_{11}+ALDT_{11}+CMT_{12}$ (or $t_2 - t_1$). This graph would continue charting the state of the computer until the test period ends.

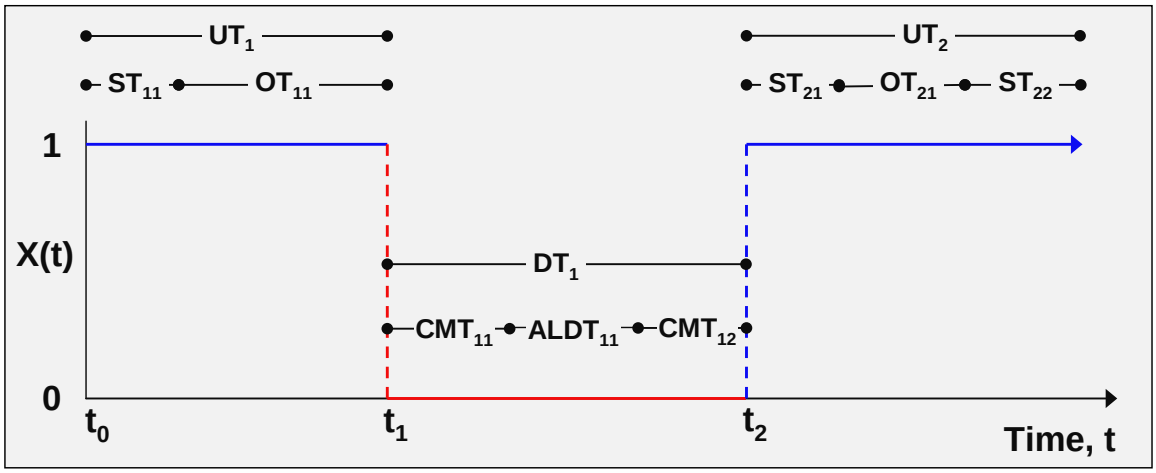

Figure 2.3. Notional State Graph

2.4.2. A tabular form of similar data is in Table 2.1.

Table 2.1. Example Failure and Repair Data

Downing Event (DE)	Type	Clock Time (hours) of DE	Inter-occurrence Time (hours)	Time (hours) to Restore Function (C/P/A*)	Clock Time (hours) Back in Service
1	OMF	170	170	10/0/1	181
2	OMF	242	61	12/0/1	255
3	OMF	293	38	12/0/1	306
4	PM	337	31	0/5/0	342

* C/P/A = Corrective/Preventive/Administrative

2.5. Probability Distributions.

2.5.1. The exponential distribution tends to be overused to describe a failure distribution, which may misrepresent the data. A primary assumption of the exponential distribution is a constant failure rate; that is, a used item is assumed to be as good as a new item and an item is just as likely to fail at the beginning of a test as at the end of a test. Usually, a failure distribution has either an increasing failure rate (system fails more often over time) or a decreasing failure rate (system fails less often over time). Since reliability is the probability that a system will perform satisfactorily for a given time (mission length), it is inappropriate to use the exponential distribution without either having relevant *a priori* data from previous

testing (e.g. utilizing Developmental Test data or data from a similar system) or waiting to model the system failure distribution after test.

2.5.2. The exponential distribution can be used when testing a system that operates as a function of a continuous measure. A continuous measure is marked by an uninterrupted response variable (e.g. time, distance, temperature, angle, etc.) and is therefore better at describing system performance than a discrete measure. In such tests, the times at which failures occur and durations of operating time without failure are important to collect. The collected data aids the determination of the failure rate (constant, increasing or decreasing). Weibull analysis determines failure rate characteristics. When a system with a constant failure rate is also repairable, the Poisson distribution is used to analyze the system's reliability.

2.5.3. In contrast to a continuous measure, a discrete measure takes on only countable values (0, 1, 2, etc.). An example of a discrete measure is the ratio of systems that fail to the total number of systems tested during a specified period. A sampling plan is required to define the interval of testing. The binomial distribution is appropriate to analyze test articles that result in a distinguishable success or failure.

2.5.4. Many measures of suitability (MOS) are discrete. Due to limitations during OT&E, only a certain number of systems, units, or assets can be evaluated under finite temporal, environmental, and spatial constraints. For example, a mission capable rate during test may be capable reported, but it is not operationally realistic since the utilization rate was less than that of the operational fleet. Modeling and simulation may support calculation of the MOSs, provided the data required for the model is collected. Such data may include the times at which failures occur.

2.6. Reliability.

2.6.1. Reliability is defined in a variety of ways. The Defense Acquisition Guidebook (DAG) defines reliability as, "The ability of a system to perform as designed in an operational environment over time without failure." Air Force Pamphlet (AFPAM) 63-128, *Guide to Acquisition and Sustainment Life Cycle Management*, contains a definition for weapon system reliability: "The probability that a system will perform satisfactorily for a given time when used under specified operating conditions." Note that the first definition refers to an *ability* of an item, namely its ability to perform a mission, rather than *some measure of that ability*, as in the second definition. Measures of this type are discussed in detail in the AFOTEC Measures Primer, available on the AFOTEC Intranet website. The distinction between an ability and a measure of an ability is fundamental to the discussion that follows in Section 2.7.

2.6.2. In general, reliability is a term used to describe quantitatively how failure-free a system is likely to be during a given period of operation. The International Organization for Standardization (ISO) defines reliability as the ability of an item to perform a required function, under given environmental and operational conditions, and for a stated period of time (ISO 4802). Rausand and Hoyland[1] further interpret the ISO definition, writing that the *item* to which the ISO definition refers may be any component, subsystem or system that can

[1] Rausand, M., and A. Høyland. 2004. *System Reliability Theory: Models, Statistical Methods, and Applications*, second edition. John Wiley and Sons, Hoboken, New Jersey.

be considered as an entity and that the *function* in the definition may be a single function or a combination of functions that is necessary to provide a required service.

2.6.3. The meanings of the phrases "given environmental and operational conditions" and "stated period of time" are important to the understanding of reliability. The phrase "given environmental and operational conditions" refers to the complete definition of the scenario in which the system will operate. For a cargo airframe, these conditions include climatic conditions, threats to the system and cargo type (e.g. personnel, equipment, supplies) during a selected mission profile. These conditions should reflect operational usage. The phrase "stated period of time" refers to the length of the mission described in a mission profile. The specification of the length of the interval need not be (and in many cases will not be) a simple specification of clock time. For example, a bomber aircraft mission profile will define an interval containing X bombs dropped, Y number of sorties generated, and Z hours of possessed time. Note that only the flight time in this specification involves clock time. For a simpler system, such as a dumb bomb, the interval may include a single event—detonation.

2.7. Aspects of Reliability.

2.7.1. The basic concept of reliability is that the system performs satisfactorily, where "satisfactorily" implies a lack of broad undesirable events and subsequent impacts (risk analysis). This general concept has two aspects: mission reliability and logistics reliability. Mission reliability refers to the concept of not having undesirable events (i.e. failures) during mission time and the immediate impact to that mission. In that sense, mission reliability is actually best considered in the context of effectiveness rather than suitability. Logistics reliability refers to undesirable events (including potential or pending failures) with the impact being a burden on the support system. Note that a particular undesirable event or failure could contribute to both mission reliability measures as well as logistics reliability measures.

2.7.2. Mission reliability relates to system effectiveness; logistics reliability relates to the burden of owning and operating the system. Measures of mission reliability address only those incidents that affect mission accomplishment. Measures of logistics-related reliability address all incidents that require a response from the logistics system.

2.7.3. **Mission Reliability.**

2.7.3.1. Measures of mission reliability quantify the probability that a system will perform mission essential functions for a period of time under the conditions stated in the mission profile. Mission reliability for a single-shot system, i.e., a missile, would not include a time period constraint. A system with high mission reliability has a high probability of successfully completing the defined mission.

2.7.3.2. Measures of mission reliability address only those incidents that affect mission accomplishment. A mission reliability analysis must include the definition of mission essential functions. For example, the mission essential functions for a tanker airframe might be to take off, communicate with command and other aircraft, refuel another aircraft and land. Requirements that build more specific measures could specify minimum speed, maximum time to refuel and communication range.

2.7.4. **Logistics (Maintenance/Supply) Related Reliability.** Logistics related reliability measures, as indicated above, must be selected so that they account for or address all

incidents that require a response from the logistics system. Logistics related reliability measures may be further subdivided into maintenance related reliability and supply related reliability. These measures respectively represent the probability that no corrective maintenance or the probability that no unscheduled supply demand will occur following the completion of a specific mission profile. Note that the mathematical models used to evaluate mission and logistics reliability for the same system may be entirely different.

2.7.5. AFPAM 63-128 defines both reliability and mission reliability as probabilities ("The probability of…") while it defines logistics reliability as an ability ("The ability of …"). Observe that in the former two cases, the definitions refer to a *measure of ability* (probability of…), while in the latter case, the definition refers to the *ability itself*. Additionally, measures of mission reliability are given in AFPAM 63-128, one of which is also called mission reliability (R_m)—implying that mission reliability is both an ability as well as a measure of that ability. In contrast, logistics reliability is an ability with specific measures of that ability defined later in the document.

2.7.6. For AFOTEC purposes, the definitions of reliability, mission reliability, and logistics reliability found in AFPAM 63-128 will be viewed as abilities of the system under test and, therefore, will be treated as operational capabilities (OC) of a system. An OC is a system attribute or grouping of attributes that users and subject matter experts have identified as being crucial to the achievement of critical mission elements and/or operational objectives of significant value to the warfighter. With this perspective, the definitions of reliability, mission reliability, and logistics reliability found in AFPAM 63-128 will be rewritten in terms of OCs, as:

2.7.6.1. **Reliability—**The capability of a system to perform satisfactorily for a given time when used under specified operating conditions. This suitability OC is frequently measured by the time[2] between successive occurrences of unsatisfactory performance. Exactly what constitutes unsatisfactory performance for a particular system under test must be defined in advance of testing and usually involves various categories of failures (failures, critical failures, operational mission failures), each of which must be clearly defined.

2.7.6.2. **Mission Reliability—**The capability of a system to perform its required function for a stated mission duration or for a specified time into the mission. Typical measures of this operational capability are mission reliability (note that the term mission reliability refers to the OC itself and also to one of the measures of that OC), weapon system reliability, and break rate. Note that the OC mission reliability relates to system effectiveness rather than suitability.

2.7.6.3. **Logistics Reliability—**The capability of a system to perform failure free, under specified operating conditions and time without demand on the support system. Typical measures of this suitability OC include time (or cycles, miles, etc.) between maintenance, demand, or removals.

2.7.7. **Reliability Growth.** Reliability growth is under the purview of the program office, and not specifically AFOTEC's responsibility. With that be said, AFOTEC OT&E designs

[2] Throughout this document, time does not necessarily mean clock time. Here time includes indirect measures of time like miles, rotations, cycles, etc.

and methods account for reliability growth strategies in operational assessments and evaluations. The reliability growth strategy is typically depicted by a reliability graph in the form of an idealized reliability growth curve. However, visual depictions of the growth strategies will vary widely depending on the selected units of reliability (e.g., MTBF or MR) and units of test (e.g., operating/test hours, operating months). Using reliability growth in reporting requires careful consideration to avoid inaccurately depicting a system. A-2/9 can provide guidance and assistance in developing a strategy that addresses reliability growth.

2.8. Availability. Operational availability is the probability that a system will be ready for operational use (i.e., any specified purpose) when required. Availability is the desire of operations and the goal of maintenance. Availability is dependent on reliability, maintainability and logistics supportability. A goal of the availability assessment is to determine if the system can meet the user's availability requirements stated in a capability document (initial capabilities document (ICD), capability development document (CDD), capability production document (CPD)) or another requirements document.

2.8.1. **Availability Concepts.**

2.8.1.1. Availability translates the reliability, maintainability and logistics supportability characteristics of the system into a measure of interest to the user. It is based on the question, "Is the equipment in working condition when it is needed?" The evaluator should compare the availability of the system with mission requirements contained in existing requirements documents.

2.8.1.2. Metrics of availability are generally probabilities; i.e., either the probability a system is capable of performing its mission or the probability a fleet is capable of performing its mission. During initial operational test and evaluation (IOT&E), little or no meaningful availability data may be available due to limited amounts of time and assets. Under these circumstances, the availability assessment may require extensive modeling and simulation. There are some cases where data from integrated test and evaluation (IT&E) may help evaluate availability.

2.9. Maintainability. Maintainability is the ability of an item to be retained in or restored to a specified condition when personnel having specified skills, using prescribed procedures and resources at each prescribed level of maintenance and repair perform maintenance. A commonly used working definition states that maintainability is the inherent characteristic of a design that determines the type and amount of maintenance required to retain that design in, or restore it to, a specified condition. In this definition, "retained in" refers to preventive maintenance, while "restored to" addresses corrective maintenance.

2.9.1. **Maintainability Concepts.**

2.9.1.1. Maintainability, reliability, and other logistics support drivers are major system characteristics that impact availability. While maintainability is important as a factor of availability, it also merits substantial consideration as an individual system characteristic. Maintainability is a factor of the design process and an inherent design characteristic that is quantitative and qualitative in nature and, therefore, lends itself to specification, demonstration and trade-off analysis.

2.9.1.2. Maintenance refers to all actions required to retain an item in, or restore it to, a specified condition. This includes servicing, diagnosis, removal, repair, installation,

modification, modernization, overhaul, rebuild, test, reclamation, inspection and condition determination.

2.9.1.3. Assessing maintainability, such as maintenance time, direct maintenance work hours and system downtime are collected. Data is then reported as means, either divided by some operational frequency such as flying hours, sorties or maintenance events/actions, or categorized by subsystems to highlight areas needing the most attention.

2.9.1.4. During an OT&E, both quantitative and qualitative aspects of maintainability are addressed.

2.9.1.4.1. Quantitative statistics for maintainability evaluation can be expressed as maintenance downtime per sortie, maintenance ratio (e.g., maintenance work hours per flying hour), total required work force (e.g., maintenance personnel (MP) per operational unit), time to restore a system to operational status (mean downtime), etc.

2.9.1.4.2. Qualitative aspects of maintainability include accessibility, serviceability, ease or difficulty of maintenance, safety, and human factors associated with maintenance actions. These factors affect the quantity, skill levels and specialty codes of MP and the test equipment required to maintain the system. Qualitative evaluations of maintainability are usually done by experienced maintenance technicians using subjective judgment and are supported by quantitative maintainability measures.

2.9.2. **Maintenance Demonstrations.** Testers may conduct maintenance demonstrations (M-demos) during DT&E and OT&E. During DT&E, the developmental test team conducts M-demos to demonstrate compliance with specifications. During OT&E, the test team may conduct M-demos for data gathering if done in the operational environment. Considerations concerning the use of M-demos follow.

2.9.2.1. M-demos performed during OT&E are “staged” maintenance events done in an operational environment to obtain quantitative maintainability information not otherwise available during OT&E. These are sometimes described as ease-of-maintenance demonstrations (removal and replacement of components, or performance of tasks). Other potential M-demos can be performed by intentionally inserting faulty components into the system to assess troubleshooting and repair capability. This is especially important when testing highly reliable systems where test exposure is small compared with the expected time between failures. Demonstrations may be used to quantify maintenance times for tasks that will not be required during the course of the test.

2.9.2.2. Many times the contribution of M-demos in an OT&E is limited because they account for the operational frequency and mode of failures. Additionally, M-demos do not give data on induced and no-defect failures. When employing M-demos in OT&E:

2.9.2.2.1. Clearly define and scope demo(s) in the OT&E test plan.

2.9.2.2.2. Coordinate with the using command(s).

2.9.2.2.3. Ensure M-demos are planned in detail within the Data Management and Analysis Plan (DMAP) so as to not interfere with planned operational missions. Data

from actual maintenance events that occur during the operational test can be used in satisfying requirements for M-demos.

2.9.2.2.4. Conduct M-demos in an environment that simulates as closely as possible the operational and maintenance environment planned for the item (e.g., blue-suit maintenance with no contractor involvement, cold weather maintenance with operators wearing cold weather gear, high ops tempo environments, etc.)

2.9.2.2.5. Representative working conditions, tools, support equipment, spares, facilities and technical publications that would be required during operational service.

2.9.2.2.6. Videotape for documentation and analysis.

2.9.2.3. Some data collected during M-demos may be included in RAM calculations, other data may not. For example, the repair times from an M-demo in which a failure is induced or inserted may be included in the calculation of mean repair time. However, including the maintenance event in the calculation of mean time between maintenance (MTBM) is inappropriate.

2.9.3. **Integrated Diagnostics.** Integrated Diagnostics (ID) (or simply diagnostics) are "monitoring/recording devices and software…providing the capability for fault detection and isolation, (including false alarm mitigation) to signal the need for maintenance. [They] should include user friendly features to convey system status and the effect on mission capabilities to the operator and maintainer" (DAG).

2.9.3.1. The purpose of integrated diagnostics is to provide a cost-effective capability to accurately detect and isolate all faults known or expected to occur in weapons systems. In wartime, this becomes significant in that timely identification of critical failures leads to rapid repair with minimal troubleshooting to support combat turn-around times.

2.9.3.2. The term "diagnostics" is often a general term to cover all means of determining that a system fault has occurred, and the means to determine where the fault is and to isolate it to a repairable or replaceable portion of the system. There are many other terms relating to this area, including built-in test (BIT) with built-in test equipment (BITE), built-in test and fault isolation test (BIT/FIT), and automatic test equipment (ATE).

2.9.3.3. The key to integrated diagnostics is the successful consideration and integration of the functions of detection, isolation, verification, recovery, recording and reporting, in a comprehensive and cohesive fashion, with the operator and with support functions that may be automatically, semi-automatically and/or manually controlled.

2.10. Other RAM Guidance:

2.10.1. The Chairman of the Joint Chiefs of Staff Instruction (CJCSI 3170.01H) directs (and the Manual for the Operation of the Joint Capabilities Integration and Development System further defines) a Sustainment KPP and two supporting KSAs for weapon system acquisition. The four metrics defined include: Materiel Availability (KPP); Materiel Reliability (KSA); Operation and Support Cost (KSA); and Mean Down Time. AFOTEC currently identifies measures and collects data for both Materiel Reliability and Mean Down Time. Although AFOTEC recognizes the value of the metrics to improve weapon system acquisition via increased lifecycle sustainment, testing and evaluating of Materiel Availability and Operation and Support Cost is beyond AFOTEC's scope and capability. The scope of these metrics are

fleet wide and affect the overall life cycle as opposed to individual units and short, near-term time periods typically seen in OT. Because of this constraint, AFOTEC does not have access to all necessary information to test and evaluate these metrics. AFOTEC does not directly test and evaluate the defined metrics (Operation and Support Cost, Materiel Availability), however, there may be related indirect metrics (e.g., Operational Availability (Ao)) that contribute to these lifecycle metrics.

Chapter 3

LOGISTICS SUPPORTABILITY

3.1. Introduction. Logistics supportability is the degree to which the planned logistics support (test measurement and diagnostic equipment, spare and repair parts, technical data, support facilities, transportation requirements, training, manpower, and computer resources) allows meeting system availability and wartime usage requirements. Planning for a logistics supportability evaluation is discussed in this chapter. The program office and major command (MAJCOM) use the product support elements in AFPAM 63-128 to design and develop the system. AFOTEC bases its suitability test on these documented supportability items. Table 3.1. shows the relationship between the elements of logistics support and operational suitability.

Table 3.1. Logistics Support and Operational Suitability Linkage

Logistics Support Elements (AFPAM 63-128)	**Operational Suitability (AFOTECPAM 99-104)**
Sustaining/Systems Engineering	Safety Human Factors Compatibility Natural Environmental Effects and Impacts
Design Interface	Availability Compatibility Interoperability Reliability Maintainability Human Factors
Supply Support	Wartime Usage Rates Logistics Supportability
Maintenance Planning and Management	Maintainability
Support Equipment/Automatic Test Systems	Logistics Supportability
Facilities	Logistics Supportability
Packaging, Handling, Storage, and Transportation	Transportability Logistics Supportability
Technical Data Management/ Technical Orders	Documentation Logistics Supportability
Manpower and Personnel	Manpower Supportability Logistics Supportability
Training	Training Logistics Supportability
Computer Resources	Logistics Supportability
Protection of Critical Program Info/Anti-Tamper	Availability Reliability

3.2. Definitions. The terms that follow are suitability areas that we must evaluate to assess mission capability.

3.2.1. **Sustaining/Systems Engineering—**The technical effort required to support an in-service system in its operational environment to ensure continued operation and maintenance of the system with managed risk.

3.2.2. **Design Interface—**Considers what is needed to integrate the logistics-related readiness, combat capability, systems commonality, and supportability design parameters into system and equipment design.

3.2.3. **Supply Support—**The process conducted to determine, acquire, catalog, receive, store, transfer, issue, and dispose of secondary items necessary for the support of end items and support items. The process includes initial support (provisioning) and follow-on requirements (routine replenishment).

3.2.4. **Maintenance Planning and Management—**Documents the process conducted to develop and establish maintenance concepts and requirements for the life-cycle. The process should consider all elements of maintenance support necessary to keep systems and equipment ready to perform assigned missions. This includes all levels of maintenance and implementation of those levels; includes any partnering, organic, and contract support.

3.2.5. **Support Equipment/Automatic Test Systems—**All equipment (mobile and fixed) required to support the operation and maintenance of a materiel system. This includes associated multi-use end items, ground handling and maintenance equipment, tools, meteorology and calibration equipment, test equipment, and automatic test equipment. It includes the acquisition of logistics support for the support and test equipment itself.

3.2.6. **Facilities—**The permanent, semi-permanent or temporary real property assets required to support the materiel system, including conducting studies to define types of facilities or facility improvements, location, space needs, utilities, environmental requirements, real estate requirements, and equipment.

3.2.7. **Packaging, Handling, Storage, and Transportation—**The resources, processes, procedures, design considerations, and methods to ensure that all system, equipment, and support items are preserved, packaged, handled, and transported properly, including environmental considerations, equipment preservation requirements for short- and long-term storage, and transportability.

3.2.8. **Technical Data Management/Technical Orders—**Recorded information regardless of form or character of a scientific or technical nature. This includes data rights, data management strategy, engineering data, drawings and associated documents, specifications, and the scientific or technical information (recorded in any form or medium) necessary to operate and/or maintain the defense system.

3.2.9. **Manpower and Personnel—**The identification and acquisition of military and civilian personnel with skills and grades required to operate and support a materiel system over its lifetime at peacetime and wartime rates.

3.2.10. **Training—**The processes, procedures, curricula, techniques, training devices, simulators, other equipment, and software necessary to train civilian and active duty/reserve

duty personnel to operate and support/maintain the defense system; includes acquisition, installation, operation, and support of training equipment/devices.

3.2.11. **Computer Resources—**The facilities, hardware, software, documentation, manpower and personnel needed to operate and support stand alone and embedded computer systems.

3.2.12. **Protection of Critical Program Info/Anti-Tamper—**The efforts and provisions required to protect sensitive information identified in the Program Protection Plan during operations and sustainment.

3.3. Logistics Support Concepts.

3.3.1. **Product Support.** Product support focuses on the entire life cycle of support needed to acquire and sustain a weapon system. The concept is implemented by the Department of Defense (DoD) Performance-based Logistics (PBL) strategy which seeks to link product support to weapon system performance by optimizing system availability and minimizing cost and the logistics footprint. PBL applies to both retail (base level) logistics operations and wholesale (depot) logistics operations. According to the AFI, PBL shall be implemented for new acquisition category (ACAT) I and II systems. In addition, the AFI mandates development of plans and processes such as the Life Cycle Management Plan (LCMP).

3.3.2. **Combat Support.** Agile combat support (ACS) includes actions taken to create, effectively deploy and sustain US military power anywhere—at any initiative, speed and tempo. ACS is technologically superior, robust, flexible, and fully integrated with operations. ACS capabilities include provisions for and protection of air and space personnel, assets and capabilities throughout the full range of military operations. ACS is the foundation for global air and space power engagement and the linchpin that ties together Air Force distinctive capabilities. It is the foundational and cross cutting US Air Force system of support that enables Air Force operational concepts and the capabilities that distinguish air and space power—speed, flexibility, and global perspective.

3.3.3. **Contractor Logistics Support (CLS)/Interim Contractor Support (ICS).** CLS/ICS includes the collection of logistics support activities provided under contract to a using command. CLS supports a system, subsystem, modification or equipment throughout the term of the contract. ICS is a temporary support function to provide initial logistics support until an organic capability is in place. CLS/ICS may include software maintenance; on- and off-equipment maintenance; maintenance management; maintenance planning; supply support; transportation, packaging, and handling; storage; and facility maintenance. **NOTE:** Air Force policy restricts using the developmental contractor during OT&E. They may participate only to the extent that is planned for them to be involved in the operation, maintenance, and other support of the system when the system is deployed in combat.

3.3.4. **Integrated Logistics Support (ILS).** ILS planning provides the basis to assess the planned logistics support. This involves investigating the various elements of ILS being planned for the system. The ability to assess ILS elements depends on the test environment. For example during IOT&E, support equipment and technical data may not be available or representative of the operational items. Further, the contractor typically provides supply support. Review of the LCMP and any supporting plans are critical to understand the planned logistics support for the system.

3.3.5. **Phased Logistics Support.** Systems go through a transition period from production to full operational use, therefore there should be proper time phasing of transitioning different aspects of logistics support capability. Phased logistics support begins with establishing an initial capability at the first designated operational site and then replicating this capability at other operational sites until the system is totally fielded. Once fielded, the focus shifts to maintaining the logistics support capability throughout the system's life cycle. There are three considerations for this concept to work successfully, especially during the startup period:

3.3.5.1. Depending on the type of equipment, test planners should expect a greater number of corrective maintenance (CM) actions occurring immediately after equipment delivery. Early support should consider the possibility of realizing a logistics burden beyond what was initially planned.

3.3.5.2. Formal training and system familiarization should occur; however, with this training comes increased possibility of operator or maintainer-induced failures.

3.3.5.3. For large and complex systems, the user may be able to successfully operate the system at the time of activation but is unable to provide full logistics support at all levels of maintenance.

3.4. Other Topics Related to Logistics Support. Certain systems due to their functions and operational role must be designed for protection from nuclear effects and/or from chemical, biological and radiological (CBR) contamination. There are inherent logistics considerations associated with achieving such protection. The logistical requirements of battle damage repair are another important consideration for system effectiveness and suitability.

3.4.1. **Hardness Maintenance/Hardness Surveillance (HM/HS).**

3.4.1.1. **HM/HS Concept.** The Air Force expends many dollars of scarce acquisition resources to ensure selected systems will be usable in trans- or post-attack nuclear environments. These selected systems typically have a nuclear survivability requirement. As such, they require an HM/HS concept that should be developed and documented as part of the system's LCMP. The concept should address each level of maintenance and highlight new skills that may be needed, HM/HS-peculiar support equipment that should be developed or procured, and related areas such as training, technical data, and spares. Specialized system, subsystem, line-replaceable unit (LRU) and component-level hardness testing that are planned or required should also be addressed. The focus of HM/HS concept may be restricted to looking at the effects on hardness critical items (HCIs). These are hardware items at any indenture level that are critical to nuclear hardness capability. Improper design, manufacture, assembly, modification, installation, removal or repair can degrade this capability. HCIs typically include items such as electromagnetic pulse gaskets, Zener diodes, surge arresters, and other specialized components/subcomponents selected for their nuclear hardness properties.

3.4.1.2. **HM/HS Evaluation/Assessment.** Planning for an HM/HS evaluation and assessment includes system familiarization and documentation review, involvement in DT&E test planning, and OT&E test plan and data management and analysis plan (DMAP) preparation.

3.4.1.2.1. **Systems Familiarization and Documentation Review.** One of the cornerstone tasks of HM/HS assessment planning. Specifically focus on identifying periodic maintenance inspection procedures and select those that can be performed during operational testing.

3.4.1.2.2. **Involvement in DT&E Test Planning.** Nuclear effects testing are normally the responsibility of developmental testers. OTAs provide support to these test efforts to ensure test articles are configured and operated in an operationally realistic environment such that OT&E data related to the nuclear effects testing are sufficiently met. Close coordination with DT&E test planners is essential. OTAs may require independent OT&E contractor support to assist with an HM/HS assessment. Contractor support assistance may be beneficial due to the specialized technical nature of planning, testing, limitations, and requirements involving the nuclear enterprise. One of the deliverables often required of the OT&E contractor, primarily on major weapon systems, is a nuclear assessment plan (NAP). The NAP is a structured approach to OT&E nuclear assessment planning. Test teams should contact A-2/9 for AFOTEC Technical Paper 13.1, *Introduction to the Operational Nuclear Survivability Assessment Process*.

3.4.1.2.3. **OT&E Plan and DMAP.** HM/HS is normally addressed as a measure of effectiveness (MOE) of a nuclear survivability system characteristic or under logistic supportability. Regardless of how the test plan is structured, the basic areas of assessment are usually the same. Ensure documentation of necessary resources for accomplishing the HM/HS evaluation in the test resource plan (TRP).

3.4.1.3. **Other HM/HS Considerations.** The HM/HS evaluation should focus on the ability of military personnel to perform the required HM/HS procedures (during periodic maintenance inspection intervals) and the ability of the logistics support system to support HM/HS. The data for this evaluation should come from DT&E, documentation review and operational test experience. Also, evaluate the ability to detect hardening degradations.

3.4.2. **CBR Contamination.**

3.4.2.1. **CBR Contamination Concept.** Consider the use of CBR warfare protective clothing and equipment when estimating the utility of a system operated under CBR contamination threat conditions. Requirements documents may require the new system be operable and maintainable by personnel wearing cold weather clothing or the chemical warfare ensemble configured for a specific protective posture. Demonstration of this capability is usually a part of M-demos. If an M-demo is required for OT&E, there are two key questions that focus on developing a CBR contamination concept: 1) Can the SUT accomplish its assigned task under CBR contamination threat conditions?, and 2) Can the SUT be properly and safely operated and maintained by personnel wearing CBR contamination protective clothing? The latter is the focus of the suitability effort and involves a careful look at human factors issues, safety, maintainability and documentation. Proper planning and preparation of resources to implement a CBR M-demo becomes a critical task of the suitability personnel.

3.4.2.2. **CBR Contamination Capability.** The LCMP should define a program to ensure CBR contamination capability is not compromised during the system life cycle.

Careful attention to loss of configuration control, use of improper spares or repair parts, performance of inappropriate maintenance or repair, or hardness degradations due to normal operations, maintenance and environments is important. These characteristics apply to both the prime equipment and support equipment. Logistic evaluators should review the requirements document and maintenance concept with CBR contamination issues in mind. The four key questions to ask are:

3.4.2.2.1. Can the SUT be properly and safely operated and maintained by personnel wearing CBR contamination protective clothing?

3.4.2.2.2. Is an M-demo required to answer this question?

3.4.2.2.3. If an M-demo is required, what is the scope of the M-demo (i.e., is there a need to demonstrate full capability or will the demonstration of a partial capability suffice)?

3.4.2.2.4. Is the system and program documentation adequate to plan a comprehensive M-demo?

3.4.2.3. **Additional CBR Considerations.** Focus the M-demo planning effort to capture CBR contamination-specific data on human factors (HF), safety and maintainability impacts. Determine when and where the M-demo should be done. Consider the following: additional training required for test team personnel performing the M-demo, protective clothing/ensembles in the right quantity to perform the M-demo, video documentation, and security considerations that may impact the M-demo. Finally, ensure significant aspects of the M-demo are accounted for in the Test and Evaluation Master Plan (TEMP).

3.4.3. **Battle-Damage Repair (BDR).**

3.4.3.1. **BDR Concept.** The BDR concept is based on demonstrating the accomplishment of BDR procedures. This can also be done using M-demos, during DT&E, OT&E, or through IT&E.

3.4.3.2. **BDR Procedures.** The LCMP should address the acquisition of BDR procedures, technical orders, supplies, tools, manuals and training to ensure rapid return of battle damaged systems. BDR plans may also address HM/HS.

Chapter 4

USAGE RATES

4.1. Introduction. Usage rates impact operational tasks of deploying a system, sustaining deployed operations and maintaining employment or operational readiness. Usage rates, their derivation, measures and methodologies are discussed in this chapter.

4.2. Definitions.

4.2.1. **Unit Type Code (UTC)—**A five-character alphanumeric code associated with a particular type of unit. It designates a specific capability. A UTC is the basic building block used in force planning and the deployment of Air Expeditionary Task Forces (AETF). A UTC depicts a force capability with personnel and/or equipment requirements. The assignment of a UTC categorizes each type of organization into a class or kind of unit having common distinguishing characteristics. Planners use UTCs to document total manpower and logistics requirements needed to support the national military strategy during deliberate, crisis action, and rotational planning. For a complete definition and breakdown of UTCs and their purpose, reference AFI 10-401, *Air Force Operations Planning and Execution.*

4.2.2. **Utilization Rate (UTE)—**A UTE is a unit of use (i.e., sorties, operating hours, etc.) over a defined baseline (i.e., possessed hours, time period, number of aircraft, etc). The unit of measure for each part of the formula is unique to the end item being measured. Aircraft systems, ground-based communication systems, and ground-launched missile systems are all measured differently. Example formulas for most applications are in AFPAM 63-128, Utilization Rate (UR).

4.2.3. **Mission Capability (MISCAP)—**A MISCAP defines the mission a UTC is capable of accomplishing. It contains the following: 1) Type and amount of workload the UTC is capable of performing, 2) The type of base where the UTC may be employed (bare base, main operating base, forward operating base, or advanced operating base in accordance with Joint Publication (JP) 1-02, *DoD Dictionary of Military and Associated Terms*), 3) Other UTCs which are required to support the defined capability, and 4) Any other information pertinent to that UTC. The MISCAP is the only part of the UTC that could be classified. More detailed information on the MISCAP portion of the UTC is in AFI 10-401.

4.2.4. **Sortie Generation Rate (SGR)—**SGR is an aircraft-unique description of a specific by-day generation requirement, as opposed to a UTE rate which is an average usage rate over a specified period. The intent of SGR is to show the capability to meet the by-day Air Tasking Order (ATO) requirements derived from operation plans (OPLAN).

4.2.5. **Wartime Usage Rate—**A quantitative statement of the projected manner in which the system is to be used in its intended wartime environment. It describes the projected intensity at which the system is to be used in accomplishing wartime missions. The statement is usually formatted as a UTE or SGR. Wartime usage rate may also be referred to as a surge capability. In accordance with Air Combat Command Instruction (ACCI) 21-165, *Aircraft Flying and Maintenance Scheduling Procedures,* a surge (during home-station ops) is defined as an increase in flying schedule by fifty percent or greater.

4.2.6. **Wartime Mission—**Actions required to be performed by the system as defined by the user in CONOPS, OPLANs or other support concepts.

4.3. Sources of Usage Rate Data.

4.3.1. To properly evaluate the ability of a system to achieve a given usage rate, testers must first begin with the requirements documentation related to the system. Compare CDD requirements with UTCs and the corresponding MISCAPs designated for the system or for the items it supports. If the system under test does not have a UTC or fit within an existing one, usage rate data will be required from the warfighter/user's CONOPS or relevant requirements document. However, if the system does have a prescribed UTC, then requirements documents may contain either a requirement to increase the UTC usage rate by a specific amount or usage rates required to support taskings. The relationship of UTCs to an item's intended usage in the field could help testers form relevant evaluations of systems. Understanding the elements of a UTC and the information it provides will ensure the test is structured around the system's intended operational environment, with the right levels of support and usage rates.

4.3.2. UTCs are elements of a capability available to combatant commanders to plan for and execute operations. Types of UTCs include independent, dependent and supporting UTCs; each should be considered for initial test designs. UTCs are applicable to all types of military operations, from direct combat to operations other than war. UTCs and peacetime/wartime usage rates come from the warfighter/user. When using UTCs as references for test development, ensure they are current. Consider all applicable UTCs in which the system may be tasked, as UTCs affect UTEs. For example, the UTC designator for a tanker aircraft would start with "3Y", which defines its deployment capability as a "Refueling Aircraft."

4.3.3. The primary source for testers to determine proper usages rates from a UTC is the MISCAP. The MISCAP will describe the intended capability a UTC is to provide to the Combatant Commander. The MISCAP, when compared to the logistics requirements listed in the UTC, frames the capability within the support package intended to enable it. The support package details will include listings for spare parts, manpower (by Air Force specialty code [AFSC] and skill level), support equipment and aerospace ground equipment for all on- and off-equipment maintenance. For the tanker example, the MISCAP would include the Air Force's capability to provide global reach. The tanker's MISCAP may include the craft's effective range, fuel storage capacity, the types of bases to which that unit may be deployed, and other UTCs that will be required to support the system (e.g. a UTC code beginning in "9AD" that designates an "Air Refueling Headquarters" may be necessary to support the operation of the system).

4.4. Usage Rate Evaluation Considerations.

4.4.1. **Utilization Rate versus Sortie Generation Rate.**

4.4.1.1. The definitions of UTE and SGR are in Section 4.2. It is easy to confuse the two requirements or their measures—some people even use the terms interchangeably. Nevertheless, SGR is typically a more definitive requirement that applies directly to an end item's intended use in a specified environment. SGR may be defined for peacetime or wartime. During the standard Air Tasking Order cycle, planners levy sortie

requirements on wings and units per day. Each day, deployed units report capabilities through their chain of command; Air Planners in the Air and Space Operations Center use these reports to develop plans for executing the air war. A UTE rate captures the *average* rate over a period of time. In contrast, SGR is a specific by-day requirement.

4.4.1.2. Tables 4.1. and 4.2. contain example test data and illustrate how the same data set, based on the differences in the definitions, may or may not meet requirements. Table 4.1 contains example Sortie per Aircraft (SPA) values for the requirement, "Sortie Generation Rate shall equal the Sortie per Aircraft."

Table 4.1. SPA Requirements

Days	**SPA**
1-5	4
6-10	3
11-30	2.5

Table 4.2. Example Test Data

Day	1	2	3	4	5	**AVG**
SPA	5	3	5	3	5	4.2

4.4.1.3. Considering the sample data in Table 4.2., if the requirement was for a UTE rate of 4 over a period of five days, the displayed average of 4.2 exceeds that requirement and would be rated favorably. However, the requirement as given is for an SGR, and a close examination of the data shows peaks and dips in sortie performance, with two out of five days not meeting the requirement of 4.

4.4.1.4. To understand the operational relevance of numbers such as these, consider a deployed unit of 12 F-15Cs. Planners depend on the unit to provide 48 sorties per day on days 1 through 5 of a conflict (4 sorties per aircraft **X** 12 aircraft = 48 sorties). If the performance matched that of the example test data on day 1, the F-15s exceeded expectations providing 60 sorties for tasking. However, on day 2 that number drops to only 36 sorties, 12 short of the planned requirement of 48.

4.4.2. **Usage Rates and Modeling and Simulation.** Availability is accurately characterized when compared to a given usage rate. If a reported availability was the factor of a low UTE rate, then the number may be inflated. Accurate availability should be derived when compared to the usage rates that the user defines. A natural limitation to test environments is the inability to construct complete scenarios that encompass all of the factors of the intended environment. In an effort to provide these answers under test constraints, modeling and simulation (M&S) is often used. Availability and usage rate models are usually one in the same, and run with different controlled inputs. M&S is used by framing the intended environment with the correct level of assets (i.e., number of aircraft), manpower, spare parts, support equipment and facilities, etc., along with the inherent reliability characteristics of the system under test. Model outputs using these defined characteristics should provide usage rate data relevant to the ability of the support concept and reliability characteristics to support

user requirements. Sensitivity analysis on specific effects of the constraints could be run (given the model has the proper level of fidelity) to provide users and decision makers with valuable inputs and characterization of system performance and limitations.

4.5. Usage Rate Measures. The measures listed below are for reference only. Actual measures should be rooted in the verbiage of user requirements documents. If the interpretation of these documents is vague or difficult to discern, the test team should make every effort to receive clarification in writing from the user.

4.5.1. **Flying Hours per Life Unit (FH/LU)**—Number of flying hours from wheels up to wheels down, collected over a specified period.

4.5.2. **SGR**—Total number of sorties per aircraft per day. This is usually a number like 3 or 2.4.

4.5.3. **Operation Hours per Life Unit**—The number of operating hours collected over the OT&E period (or deemed OT relevant) divided by the life unit of interest. This is applicable to ground systems.

4.5.4. **UTE**—For aircraft, the average number of sorties or hours flown per authorized or chargeable aircraft per relevant time period, such as a day or month. This is usually a number such as 18 or 21 per month.

Chapter 5

COMPATIBILITY AND INTEROPERABILITY

5.1. Introduction. Compatibility and interoperability during test planning, execution, and reporting are discussed in this chapter. The definitions of these terms and related key terms follow.

5.2. Definitions.

5.2.1. **Compatibility—**The capability of two or more items or components of equipment or material to exist or function in the same system or environment without mutual interference. There are various types of compatibility (each with different meanings). Hence, it is important to know what type needs consideration during test. A few common types are electrical, electromagnetic, human-systems interface, and physical. Electromagnetic compatibility (EMC) is the primary type of compatibility for OT.

5.2.2. **Interoperability—** The ability to operate in synergy in the execution of assigned tasks (JP 1-02). Functionally, this is the ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together. Interoperability is achieved when information or services can be exchanged directly and used effectively by all applicable system users. See Chairman of the Joint Chiefs Of Staff Instruction (CJCSI) 6212.01E, *Interoperability and Supportability of Information Technology and National Security Systems*, and the DAG, Section 7.3., for additional guidance on interoperability. These references introduce the Net Ready Key Performance Parameter (NR KPP). Interoperability is a DOT&E special interest item (SII). There is also an NR KPP study report (available as of 8 Mar 13 at **https://acc.dau.mil/CommunityBrowser.aspx?id=126642**) which may be helpful in planning the interoperability evaluation.

5.2.3. **EMC—**The ability of systems, equipment, and devices that utilize the electromagnetic spectrum to operate in their intended operational environments without suffering unacceptable degradation or causing unintentional degradation because of electromagnetic radiation or response. EMC involves the application of sound electromagnetic spectrum management; system, equipment and device design configuration that ensures interference-free operation; and clear concepts and doctrines that maximize operational effectiveness (see the DAG). Electromagnetic Environmental Effects and Spectrum Management (E3/SM) is a special interest item for AFOTEC. Considerations include transmitter power, emission bandwidth, modulation scheme (frequency hopping), spread spectrum (frequency modulation), tuning range, duty cycle, receiver sensitivity, antenna type (parabolic, horn, whip), beam-width, gain, polarization, height and directivity (directional, omni-directional).

5.2.4. **Mutual Interference—**Mutual interference refers to an electromagnetic spectrum user's receipt of electromagnetic energy from emitters in the operational environment that causes unacceptable performance degradation to that user's systems. The key word is "unacceptable," since the nature of electromagnetic fields and phenomena precludes exclusion of unintended reception under all circumstances.

5.2.5. **Physical Compatibility—**The "form and fit" in the design and integration of components and subsystems into the overall weapon system. Considerations include

interconnecting cabling mechanical linkages, signal interface connectors and weapon interlock devices.

5.3. Planning For Test. As defined above, there are both effectiveness and suitability aspects of compatibility and interoperability (C-I). The system developer should document requirements for C-I testing in the DT portion of the TEMP (see the DAG, Section 9.5). The OT planner should consider CI at the operational level above the often purely technical characteristics of system design. A key element of the OT planner's job is the consideration of the performance of the weapon system in its intended operational environment with other friendly weapon systems deployed to accomplish warfighter tasks. The OT planner should accomplish coordination with outside agencies such as the Joint Spectrum Center and Joint Interoperability Test Command (JITC).

5.3.1. **Compatibility.**

5.3.1.1. Compatibility concerns the capability of the equipment in the system to operate with each of the required supporting equipment items such as electrical power generation, air conditioning, hydraulic power subsystems, etc. It also addresses the interface with logistics support items including test equipment, servicing equipment, maintenance stands, and elements of the transportation systems. Compatibility includes considerations for physical, functional, electrical/electronic, environmental conditioning, human factors and electromagnetic environmental effects. Although much of detailed compatibility testing falls in the domain of DT, there may be occurrences of compatibility problems uncovered in OT. For this reason, OT planners should:

5.3.1.1.1. Identify any special resource/system requirements for testing compatibility during OT in the TEMP.

5.3.1.1.2. Be aware of modifications/upgrades potential for introducing compatibility problems, especially if the upgrade involves integrating non-developmental items into the system.

5.3.1.1.3. Be attentive of procedures being used (i.e., the compatibility of two systems may depend on how the procedures are followed).

5.3.1.2. As stated earlier, EMC is the primary type of compatibility for OT. Many weapon systems utilize the electromagnetic spectrum for command, control, information transfer, telemetry or guidance. Efficient and effective transmission and receipt of commanding, controlling, and telemetry information often becomes the critical link to successful task accomplishment. When a weapon system is employed in a joint theater of operations and is degraded or negated by electromagnetic interference (EMI) from friendly forces, that weapon system's capability is reduced as surely as if it were degraded or negated by enemy action. The importance of developing weapon systems that can utilize the electromagnetic spectrum effectively has led to DoD-level interest in properly designing weapon systems with consideration of EMC. Here are some basic principles of EMC:

5.3.1.2.1. EMC seeks to control or limit the undesirable effects of EMI on systems in a specific environment. EMI occurs when an electromagnetic signal intended for one receiver (circuit) reaches and impacts another receiver (circuit) for which it was not intended. Successful control of EMI will have the characteristics of reducing the

levels or magnitudes of undesired voltages and/or currents in the affected system to a point where performance degradation is minimized or acceptable.

5.3.1.2.2. The OT planner will be more interested in verifying EMC during scenarios involving intersystem and system-to-environment situations:

5.3.1.2.2.1. **Component.** The EMI cause and effect is wholly constrained to an electronic subsystem such as a radio receiver or computer or electronic equipment rack.

5.3.1.2.2.2. **Intrasystem.** EMI cause and effects are located within a larger system such as an aircraft or missile. An example of this type of EMI scenario would be an aircraft's weather radar that interferes with the operation of an onboard inertial navigation computer.

5.3.1.2.2.3. **Intersystem.** EMI cause exists outside the weapon system in a constrained environment essential for the operation of the weapon system. An example would be a nearby ground-based air traffic control radar that interferes with an aircraft's ultrahigh frequency (UHF) air-to-ground radio during the aircraft's flight operation.

5.3.1.2.2.4. **System-to-Environment.** This is the most complex environment for EMI interactions. EMI sources and receivers (victims) are part of a major deployment of many weapon systems as in a theater of operations.

5.3.1.2.3. User requirements start the process of developing systems with good EMC. A battlefield task that requires forces to detect or operate in widely separated formations will often utilize the electromagnetic spectrum in some form to accomplish this type of mission. An example might be to detect enemy armored vehicles day or night in the presence of smoke and dust. The designer may consider some form of radar type system optimized for use in the stated environment. Some required design choices are the output power, effective radiated power and frequency range of the radar. Each of these design factors will have an implication for the eventual EMC of the deployed system.

5.3.1.2.4. The process of determining the frequency range of operation is one of the most important aspects in a design that will have good EMC characteristics. Contact the installation frequency monitor and the appropriate communication guide to aid in determining frequency availability. Consider the threat emitters likely to be present in the operational environment, friendly emitters deployed with the system, and the existing usage of the electromagnetic spectrum by host nations if EMC is to be preserved. Other factors are required power, antenna type and effective radiated power, modulation scheme, and electronic combat countermeasures. Early identification of potential co-channel and in-band interference situations will allow design changes at a point in the acquisition cycle where changes cost.

5.3.1.2.5. Table 5.1. is a matrix of factors and descriptors affecting EMC that may help in OT&E planning for the EMC evaluation. Consider other factors and descriptors for the particular system under test.

Table 5.1. Notional Factors and Descriptors Affecting EMC OT&E Planning

Factors	**Descriptors**
Type of Warfare Encountered	Conventional; Nuclear; Guerrilla
Command, Control, and Communications Network Size	Two Or More; One Only (Single Site)
Mission	Strategic; Tactical; Special Operations
Path Obstacles	Clear; Obscured; Knife-Edge Diffraction
Climate	Temperate; Desert (Arid); Arctic
Interference Sources	Jamming: Adaptive, Broadband, Spot; Industrial/Man-Made Noise; Friendly Emitters
Communication Density	Low; High
Mission Duration	Round The Clock; Scheduled; Random/Unscheduled

5.3.2. **Interoperability.** The acquisition strategy should describe the treatment of interoperability requirements. If an evolutionary acquisition strategy involves successive increments satisfying time-phased capability needs, the program manager should address each increment and the transitions from increment to increment. A NR KPP, of which interoperability is a part, is required for all Information Technology and National Security Systems defense acquisition and procurement programs. There are two general aspects of interoperability: information related, and non-information related.

5.3.2.1. Information related interoperability deals with the exchange of information within the delivered system and between the delivered system and other systems necessary for mission accomplishment (to include other Services, interagencies and coalition partners as applicable). For a given system, there could easily be hundreds, thousands, even millions of communication pathways in which information can be exchanged. Not all require examination during testing. Usually, key components of the system are checked for compliance with engineering and technical standards according to the system's integrated architecture views. Testing also focuses on the exchange of key information between key network nodes. Because OT planners do not test for compliance (DT does this), the focus for OT is on assisting the DT community during IT&E, following AFMAN 63-119, *Certification of System Readiness for Dedicated Operational Testing*, interoperability template guidance on readiness for OT, and noting any interoperability problems during OT. For programs that require joint interoperability certification, OT planners will include the JITC in the OT. For specifics concerning JITC involvement, see Section 3.f. of the "Memorandum of Agreement (MOA) on MOT&E." The MOA is located on the AFOTEC Intranet page.

5.3.2.2. Non-information related interoperability deals with fuel formulation, mechanical connectors, armament, power characteristics and other technology considerations that are usually addressed during DT. OT should focus on human-machine interface and assess

the impact of any non-information related interoperability problems as they arise during test.

5.4. Test Execution and Reporting Considerations.

5.4.1. EMC of operational systems has traditionally been measured in OT&E during analysis of degradation or failures of the system. When analysis revealed that EMI caused or had a high probability of causing the observed faults, this was recorded and allocated in scoring the OT&E test data. This provided only a point-in-time estimate and did not provide conclusive evidence of future system performance in the operational environment. Modeling and simulating the expected operational environment using proven EMC analysis models will provide an important contribution in determining the effectiveness or suitability of the weapon system in the operational environment.

5.4.2. Interoperability evaluation involves addressing the ability to exchange information across an interface; conformance to standards defined for format, language, syntax, vocabulary, and interface operating procedures; and information exchanged among command, control, communications, computers and intelligence (C4I) systems using message text formats, tactical digital information links, or other combat data links for its timeliness, accuracy, and usability.

5.4.3. Consider obtaining the following information/data before or during test:

5.4.3.1. Results of developmental testing of C-I. Tests that demonstrate the degree of susceptibility of receiver systems to the type of potential interference are important. Also important are tests that evaluate intrasystem integration (as on a satellite, airframe or missile) and the resistance of receiver subsystems to conducted interference conditions.

5.4.3.2. A list of C-I issues that would impact certification to go to OT&E (see AFMAN 63-119).

5.4.3.3. The use of special facilities, instrumentation, and simulation required to assess/evaluate C-I.

5.4.3.4. A list of data needed by JITC to complete their recommendation for Net Ready certification.

5.4.3.5. Common frequency usage between the source and receiver.

5.4.3.6. Time when the source and receiver are using the same frequency resource(s).

5.4.3.7. Spatial (distance and bearing) relationships of all receivers in relation to emitters.

Chapter 6

TRANSPORTABILITY

6.1. Introduction. System transportability is a key factor in rapid deployment of a system and, once deployed, sustaining the system at wartime utilization rates in the deployment theater. Transportability, therefore, is a dynamic concept, intimately related to system CONOPS and unit mission tasks. No single methodology can be used to measure transportability in every situation; rather, the suitability evaluator must consider factors relating to the system, its mission, the environment, support infrastructure and other factors., A combination of techniques are then used to determine the suitability of the system with respect to transportability. This chapter provides general considerations that may be used in planning transportability evaluation.

6.2. Definitions.

6.2.1. **Transportability—**The capability of material to be moved by towing, self-propulsion, or carrier through any means such as railways, highways, waterways, pipelines, oceans, space, and airways. Full consideration of available and planned transportation assets, mobility plans/schedules and the impact of system equipment/support items on the strategic mobility of operating military forces is required to achieve this capability.

6.2.2. **Packaging, Handling, Storage, and Transportation (PHS&T)—**One of the ten integrated logistics support (ILS) elements; the resources, processes, procedures, and design considerations and methods to ensure that all system, equipment, and support items are preserved, packaged, handled, and transported properly, including environmental considerations, equipment preservation requirements for short- and long-time storage, and transportability.

6.2.3. **System—**For transportability evaluation purposes, the system includes not only prime mission equipment, but also all associated support equipment, personnel, spares, and any other dedicated materiel required for the system to perform operational suitability tasks.

6.3. Transportability Concepts. The concept of transportability has two major components: A physical or dimensional component and a readiness component.

6.3.1. The physical or dimensional component focuses on ensuring that the physical dimensions and characteristics of system hardware are compatible with and fall within the carrying capacity of the planned transportation mode. The unit of analysis is the individual system and its associated items. This component generally involves related packaging, handling, and storage (PH&S) concepts focused on the capability to package, handle, and preserve all system equipment and support items. Mission, design specifications, item configuration, safety, geographic and environmental considerations, and packaging and preservation concepts influence this component.

6.3.2. The readiness component focuses on system deployability and sustainability. It focuses on how system physical characteristics, CONOPS, maintenance concept and other factors react with deployed unit missions and deployed resources to determine the ability to perform operational suitability tasks. The units of analysis include both the individual system and the entire fleet or collection of individual items. Operational test planning for the readiness component of system transportability should: proceed from an understanding of

how the system will be tasked to deploy, timing of deployment; cargo processing infrastructure at deployed locations, immediacy of operational tasking upon initial arrival at deployed locations, the relationship between system demands on the transportation system, and available transportation resources.

6.3.3. The concepts below are useful in putting specific user transportability requirements into practice. These concepts are valuable, as they apply to transportability, rather than simply satisfying ICD/CDD/CPD requirements (i.e., number of XYZ pallets, etc.). Other sources should be utilized such as system CONOPS, operational plans, and data on available infrastructure.

6.3.3.1. **Operational Transportability**. Operational transportability is a notional concept of the degree to which an item is movable by specified transportation means using given transportation assets. The following should be considered when working to develop transportability requirements and measures with the user: how many things must be transported; how quickly must they be transported; what personnel, materiel handling assets and facilities will be required at points of departure, inter-modal nodes, and destinations; and storage and packaging requirements.

6.3.3.1.1. For example, the user often may have an idea of transportability requirements in terms of C-17-equivalent airlift loads, or total pallet positions. OT&E personnel should work with the user to develop the operational transportability concept that will focus analysis of transportability requirements.

6.3.3.2. **Operational Sustainment Transportation Burden**. A notional concept expressed as the degree to which the operation of a system at specified rates/intensities for a specified duration will drive specific transportation infrastructure requirements. An example would be intermediate maintenance support items, such as an engine test cell capability for a particular fighter engine, which are planned to be deployed as engine spares are depleted -- the movement of the test cell would be a transportation requirement driven by the fighter.

6.4. Transportability OT&E Planning Considerations.

6.4.1. OT&E evaluators may assess items which range from the acceptability of packing techniques and materials for transporting spare parts (particularly hazardous material, cure-dated and fragile items) to equipment required for reassembly at destination. Specific areas depend upon characteristics of the system under test; the technical order (T.O.) concept provides a framework for selecting individual items. Common test planning considerations include: protection from weather and rough handling; requirements for outsize components; unique packaging, crating, or handling needed for such components; amount of provisioning needed to meet rapid deployment requirements; requirements for shipping and storage containers; and requirements for handling, carrying, and protective devices required for dust, shock, impact, moisture, etc.

6.4.2. **Physical/Dimensional Component Testing.** The physical/dimensional component of system transportability is generally examined during developmental testing. However, OT&E planners should work closely with the developer, user and system program office (SPO) to ensure all requirements are clear.

6.4.2.1. For example, the developing contractor may be able to demonstrate successful loading of a system aboard an aircraft during daylight in mild weather conditions. Although this data may prove relevant to OT, it does not mean that the user's personnel will meet with the same success when attempting to load the system under more challenging weather or lighting conditions.

6.4.2.2. Similarly, design requirements aimed at making a system transportable by a single individual may be shown to have been met during DT&E and IT&E, but the operational suitability question is, "Can the individual carry the system and still perform other required operational duties, or is there a negative impact on the individual's combat effectiveness?" The OT&E suitability personnel should work to ensure that DT&E and IT&E address such questions, and if not, ensure they are included in OT&E events. OT&E interests in the physical/dimensional component of transportability generally fall within the following areas:

6.4.2.2.1. Can the system be prepared for transportation?

6.4.2.2.2. Can the system be physically transported?

6.4.2.2.2.1. Can the system be processed by available material handling equipment?

6.4.2.2.2.2. Can the system be physically loaded, carried by and unloaded from truck, rail, ship, commercial aircraft, C-130, C-5, C-17 and/or space transportation system?

6.4.2.2.2.3. Is the system compatible with the 463L pallet system?

6.4.2.2.3. What limitations does the system place on the transport system?

6.4.2.2.3.1. Are there special handling considerations (hazardous or perishable cargo, security requirements, couriers, etc.)?

6.4.2.2.3.2. Do cargo incompatibilities exist?

6.4.2.2.4. What is the weight and cube of the system?

6.4.2.2.4.1. How much is outsize or oversize?

6.4.2.2.4.2. How many pallet positions or equivalents are required?

6.4.2.2.5. Can the system withstand transportation-induced handling/environmental stresses without damage?

6.4.2.2.6. Can the system be unpacked, reassembled, set up, and initiate operations?

6.4.2.2.7. What items must be transported to the deployed location to operate and sustain the system, and what is their transportability?

6.4.2.2.8. What supplies, equipment, personnel and facilities are required in the above actions?

6.4.2.2.9. How much time is allotted, available and required in the above actions?

6.4.3. **Readiness Component Testing**. Testing the readiness component of system transportability requires an integration of physical/dimensional data with an understanding of

unit missions, operational plans, deployed infrastructure and other issues to answer the following refinements of the basic transportability questions:

6.4.3.1. Can the system be prepared for transportation (and transported) with the personnel, equipment, and facilities specified in the CONOPS, under operationally realistic conditions, within times required by operational plans? Individually? As a fleet?

6.4.3.2. Can the system withstand operationally realistic transport conditions in all expected transport modes without damage?

6.4.3.3. Can the system be unpacked, reassembled and set up with the personnel, equipment, and facilities specified in the CONOPS, under operationally realistic conditions, within times required by operational plans? Individually? As a fleet?

6.4.3.4. Can the items required to operate and sustain the system be transported to the deployed location with the personnel, equipment, and facilities specified in the CONOPS or plan, under operationally realistic conditions, within times required by operational plans? Individually? As a fleet?

6.4.4. **Test Activities and Scenarios**. Answering the transportability question may require integration and aggregation of data from numerous differing sources. Qualitative measures of the suitability of the planned PH&S capability may be captured by standard questionnaires to obtain expert opinions in this area. Modeling and simulation may be required to fully understand the impact of deploying the entire fleet of a new system on the global transportation network and the flow of other assets. Suitability evaluation personnel should work to ensure that all suitability testing requirements are fully incorporated into test plans, to include dedicated suitability events and required modeling and simulation efforts. Additional considerations for planning test actions, events and scenarios include:

6.4.4.1. The suitability test planner should incorporate deployment activities into the mission scenario that will be used during operational testing. While it may not be necessary to actually deploy the system during operational testing, all aspects of preparing the system and its support equipment for deployment should be exercised to evaluate manpower, material and time requirements.

6.4.4.2. Time to prepare the system and support equipment for transport should be evaluated and assessed. If deployment by different modes of transportation is required, preparation times for the most likely mode should be evaluated. Typically, the user will state the requirement in terms of the system and/or support equipment being prepared for transport in not more than “x” hours from formal notification to deploy.

6.4.4.3. There are unique factors to loading aircraft with system support equipment that cannot be captured by modeling and simulation. Although a volumetric model shows no problems when loading a given aircraft, support equipment may fail based on un-modeled ramp angle and expansion joint interference with equipment casters. When possible, actual airlift assets should be used to evaluate, by actual loading, the amount of airlift assets required to deploy the system and its support equipment.

6.4.4.3.1. If the requirement is, for example, to deploy the system in four or fewer C17 equivalent loads, it is not necessary to bring four C-17 aircraft to the test

location. One or two aircraft and multiple loads would appropriately demonstrate the transportability requirement and may provide a more controlled data collection environment. AF logistics software systems such as Logistics Module (LOGMOD) and Automated Air Load Planning System (AALPS) can help determine airlift requirements.

6.4.4.4. If it is not possible to evaluate such transportability requirements by actual demonstration, as a bare minimum, a thorough and detailed load plan for the entire initial deployment package should be prepared. Air Mobility Command personnel should participate in both the load planning and evaluation.

6.4.4.5. Upon completion of the deployment-related transportability evaluation, the system and/or support should be placed into operation (as if it had just arrived at the deployment location) to demonstrate time requirements related to beddown, setup, reassembly, etc.

Chapter 7

SAFETY AND ENVIRONMENTAL IMPACTS AND EFFECTS

7.1. Introduction. Regulations governing safety and health in OT&E and AFOTEC's process to achieve compliance with those regulations are discussed in this chapter. SUT environment, safety and occupational health (ESOH) considerations shall not be viewed as OT&E evaluation criteria. For the criteria to be real or valid, the SUT must be able to pass or fail. In the operational scenario, however, any person recognizing an unsafe potential (failure) must intervene and "knock-it-off" before the failure event—there is no other option. Therefore, the "ESOH" criteria cannot be valid for operational test. Test teams are expected to describe perceived SUT ESOH failure potentials to give the full operational picture to users but we will not evaluate to those potentials. Many tests involve potentially dangerous activities. In addition, management is responsible for providing proper training in health and safety matters, equipment, controls, and the environment to ensure the safety of all personnel and equipment involved. The ESOH certification board (ESOHCB) safety certification is AFOTEC management's record of reviewing SUT ESOH issues, of mitigating those issues to acceptable levels and when necessary of raising the decision level suitably to the increased residual risk. On occasion, the Navy as OTA, will construct a Safety critical operational issue (COI) or other "safety" criteria for a SUT. Individual test teams will have to deal with this very issue and attempt to measure to the unrealistic criteria which asks, "Is this system safe for use by typical users in the typical environment." The only acceptable answer is "Yes," or the test must be incomplete because the test team cannot have completed an "Unsafe" test.

7.2. ESOH. The three basic principles of ESOH are to sustain readiness, leverage resources, and to be a good neighbor. The test director (TD) is responsible to provide a safe and healthy workplace, enhance mission accomplishment, preserve resources and minimize risks—on and off the installation or public lands. AFOTEC Safety (SE) supports these responsibilities with subject matter experts assigned to the core/test teams.

7.3. ESOH Council (ESOHC). The Secretary of the Air Force and AF Chief of Staff directed all AF organizational levels to develop a comprehensive ESOH management system to systematically pursue the Secretary of Defense's significant accident reduction objective. The ESOHC is the senior environment, safety and health steering group at each level of command. The AFOTEC ESOHC meets at least semi-annually to sustain a systematic, interdisciplinary approach to ESOH and ensure core mission areas integrate this approach into planning, budgeting and decision-making. Membership includes representatives from all two-letter offices. The Commander serves as chairperson of the ESOHC, which normally occurs during the semi-annual Commanders Conference. The required minimum agenda is in AFI 90-801, *Environment, Safety, and Occupational Health Councils*.

7.4. ESOH Statutory Compliance.

7.4.1. The AFOTEC ESOH-Management System addresses the requirements of Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation*, the National Environmental Policy Act (NEPA), the Occupational Safety and Health Act, and other laws brought to bear under these broad umbrellas. AFI 99-103, *Capabilities-Based Test and Evaluation*, requires independent government technical and safety personnel to examine

the technical and safety aspects of test and evaluation (T&E) plans that involve government resources prior to commencement of test activities. The Environmental and Occupational Health and Safety Plan (HSP) documents compliance to protect test teams and AFOTEC from a legal challenge or a violation. Publishing the HSP accomplishes compliance to the following additional statutes: Occupational Safety and Health Act of 1970; Executive Order 12196 *Occupational Safety and Health Programs for Federal Employees*; 29 Code of Federal Regulations (CFR) 1960, *Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters*; 29 CFR 1910, *Occupational Safety and Health Programs*; Air Force Policy Directive (AFPD) 32-70, *Environmental Quality*; AFPD 48-1, *Aerospace Medical Program (Health)*; AFPD 63-1, *Acquisition and Sustainment Life Cycle Management*; AFPD 90-8, *Environment, Safety & Occupational Health Management and Risk Management*; AFPD 91-2, *Safety Programs*; and AFPD 99-1, *Test & Evaluation Process.*

7.4.2. To help cover these areas during test development, the Test Director should include a statement along these lines in charter type documents: Provide AFOTEC with relevant operational safety, suitability and effectiveness (OSS&E) (ref. AFI 63-1201, *Life Cycle Systems Engineering*) related information to include but not limited to the following: Current/draft OSS&E Assurance Plan; System Safety Plan, System Level Assessment; and Programmatic Environment, Safety, and Occupational Health (PESHE) plans/assessments along with related Operating Instructions on Internal Modification Processing, Configuration Control, Deficiency Reporting Process & Procedures, Engineering Change Proposal Process & Procedures, Materiel Improvement Project Review Board Process & Procedures, etc.

7.5. ESOH-Management System (ESOH-MS). The ESOH-MS is the starting point for every AFOTEC test activity and the ticket to a safe, compliant activity. ESOH-MS is comprised of a collection of tools that includes Standard Work templates, Systems Safety analysis databases, and the ESOH certification process, ultimately resulting in an ESOH Certification for Test. The system aggregates data through the life of a program, maintains individual records of each test activity, certifies safety and environmental planning and supports the "Readiness for Dedicated Operational Test" decision. Prior to or in Initial Test Design (ITD), the AFOTEC/SE point of contact (POC) will initiate the ESOH-MS for the core team to capture known technology and ESOH factors and develop an initial technology risk assessment. Then, as the test team develops each operational test concept, the safety office POC will initiate an activity-specific certification for each test activity. The ESOH-MS process will be available to the test director and has the capability to branch out to safety subject matter experts and other test experts as required to accomplish a thorough analysis and develop the identified hazard list with mitigations. Early initiation of ESOH-MS is critical to allow adequate time to request environmental analysis and scope test risks. Since complex environmental analyses can take years to complete, the TD should consult with the safety office POC early in test concept to determine whether a "long pole" may exist. The system connects the team and safety office subject matter experts to develop risk factors, assess installation environmental documentation, and determine the activity risk level. ESOH-MS facilitates all of these phases and builds the HSP.

7.6. ESOH Planning and Review Process. AFOTEC/SE assigns safety POCs to advise and consult on ESOH-related matters with the Detachment/SE, and attends program ESOH meetings. The SE POC leads the initial technological review in pre-planning phases and can guide the test teams during site safety and environmental compliance planning for test execution. Programs

should conduct an ESOH review at least once a year to review changes and catch up on issues. The ESOH review composition is tailorable. Consider including the program office, sponsor, AFOTEC/SE POC, Det/SE and others as needed. Safety-related concerns are normally identified during OT planning, combined DT/OT events, and at system safety working group meetings or system safety design review meetings. Identified hazards must be controlled or mitigated to acceptable levels before start of test, and ESOH-MS is designed for this purpose.

7.7. HSP.

7.7.1. The safety office POC uses the ESOH-MS to build the HSP interactively with the test team. The HSP covers environmental and occupational health and safety issues while documenting compliance with laws and regulations. It is the key document evaluated at the ESOHCB. The HSP is the TD's (or the onsite responsible person's) daily pretest/deployment briefing guide. When used, the HSP assures statutory compliance and produces a solid foundation for test site Operational Risk Management considerations.

7.7.2. Hazards are identified in the HSP, each with an initial risk level (Low, Medium, High and Extremely High) that is controlled or mitigated as well as practicable to reduce the risk. Table 7.1. is an aid tailored from AFPAM 90-902, *Operational Risk Management (ORM) Guidelines and Tools*, which can be used to help assess ESOH risk levels for each type of hazard. This is a subjective process and should not be confused with the deficiency report (DR) or systems safety processes. Residual risk is the remaining mishap risk that exists after control measures are in place. The HSP finally considers all residual risks to assess an overall risk level for mission impact to test activities which determines the risk acceptance authority. At the detachment the appropriate operational impact risk acceptance decision authority for Low risk, no impact to test activities is the test director; for Medium risk, minimal impact to test activities is the director of operations; and for High risk, substantial impact to test activities is the commander. The AFOTEC/CC is the risk acceptance authority for Extremely High risk, severe impact to test activities. This decision authority can accept the risk and proceed or elevate (or consult other General Officers prior to making a risk decision in the case of the AFOTEC Commander) the decision to the next higher authority level. Whenever any identified hazard's control measure(s) cannot be implemented, the risk level reverts back to the initial (higher) risk, which in-turn may require elevating the decision level before proceeding with the activity.

Table 7.1. Risk Level Matrix

Mishap Risk Index			**AFOTEC Mission Impact**	
Severity Probability	**I Catastrophic**	**II Critical**	**III Moderate**	**IV Negligible**
A – Frequent	**EXTREMELY**			
B – Likely	**HIGH**	**HIGH**		
C – Occasional			**MEDIUM**	
D – Seldom				**LOW**
E – Unlikely				
Risk Assessment Value (AFPAM90-803)	**Technology (Mil Std 882E)**	**Impact to Test Activities**	**Mission Impact Acceptance Level**	
Extremely High	**High**	**Severe**	**AFOTEC Commander**	
High	**Serious**	**Substantial**	**Detachment Commander**	

Medium	Medium	Minimal	Detachment Director of Operations
Low	Low	No	Detachment Test Director

7.8. ESOHCB.

7.8.1. The ESOHCB assembles to consider all outstanding ESOH risk factors, to formalize the risk acceptance decision authority, and to certify the environmental, safety and occupational health analyses in a certification memorandum. The ESOHCB is accomplished about four weeks before test readiness review (TRR), or before test start if TRR is not required. The TD works with the safety office POC, and the Detachment safety office to prepare and coordinate the ESOHCB, which the safety office chairs. The ESOHCB may be conducted in-person, teleconference or video teleconference. The board structure is tailorable to the programmatic situation; for example, the ESOHCB for an ESOH-controversial program could demand a formal meeting with multiple attendees whereas a well-structured and well-documented program with significant but acknowledged risks could be as simple as a teleconference between the TD, Detachment safety office POC, safety office POC, Director of Safety and the chairperson. The ESOHCB focuses on the safety of test, technology and environment as they pertain to the scope of the test activities. The Board pays particular attention to the HSP as the TD's primary ESOH field source for ESOH hazards and mitigations, and emergency and mishap notifications. Additional sources include AFMAN 63-119, Attachment 25, *Programmatic Environmental, Safety, and Occupational Health (PESHE)* criteria; Safety deficiency reports (DR); environmental considerations; deployment issues; system safety deficiencies related to the system under test; occupational health; infrastructure support requirements; and others.

7.8.2. The ESOHCB gives the test activity an overall risk assessment based on identified hazards and mitigations applied. The ESOHCB then considers how those risks will potentially impact test activities. Table 7.2. outlines ESOH-related impact potential for mishap risk factors and establishes the appropriate risk decision authority. The Director of Safety assigns the final risk in the form of a certification memorandum (ESOHCB Memo) and signs the memo. The appropriate risk decision authority for the test activity will accept the risk and approve the ESOHCB Memo. After risk acceptance and approval, a copy of the ESHOCB Memo will be forwarded as "info" to the next higher decision authority as level of risk dictates (i.e. TD to DO to Det/CC to AFOTEC/CC). Coordination and approval of the ESOHCB Memo will be accomplished prior to TRR for OT&E or prior to test activity start.

Table 7.2. ESOH Operational Impact Matrix

No Mission Impact: No ESOH hazards have been identified that impact test activities. Known hazards identified have been adequately controlled (mitigated) to acceptable levels. The potential ESOH-related capability impacts are negligible. The Test Director or higher is the risk decision authority to accept the hazard controls.
Minimal Mission Impact: Some ESOH hazards have been identified with minimal impact on test activities. Known hazards have been adequately identified and controlled (mitigated) to an acceptable level. Some conditions will not be resolved prior to the test but sufficient mitigation measures are in place to reduce the operational objective limitations. The Detachment Director of Operations or higher is the appropriate level to accept the limitations.

Substantial Mission Impact: Some ESOH hazards have been identified with substantial impact on test activities. Known hazards have been adequately identified and the majority were resolved or mitigated. ESOH-related operational objective impacts were mitigated to acceptable levels. Some will not be resolved by test completion that may limit mission capability and may potentially influence affected test results. The Detachment Commander or higher is the appropriate level to accept and manage the limitations.
Severe Mission Impact: There are ESOH shortfalls identified with severe impact on test activities. The majority of known hazards have been identified and controlled (mitigated) to an acceptable level. However, some ESOH-related operational objectives have the potential to limit test capabilities and will not be resolved in time. If it is deemed necessary to proceed with the test considering these significant limitations, it may be appropriate that Senior (General Officer) level external involvement occur along with the AFOTEC Commander accepting responsibility to proceed with test execution.

Chapter 8

HUMAN FACTORS (HF)

8.1. Introduction. A broad introduction to the scope of issues and methods employed in the OT&E of HF/human systems integration (HSI) issues are discussed in this chapter, and should be used as a guide to the different types of T&E services and support available from HF/HSI analyst. For more specific information on questionnaires, see the AFOTEC Questionnaire Guide, available on the AFOTEC Intranet website.

8.2. Definitions.

8.2.1. **HF—**HF is the science/discipline that applies information about human behavior, abilities, limitations and other characteristics to the design of systems for effective human use.

8.2.2. **HSI—**HSI covers seven human integration areas of concern (domains) that are incorporated into the design of acquisition programs. Although in OT&E HSI focuses on HF engineering (HFE), it also incorporates several areas not normally considered in the strict domain of human factors. The seven domains of HSI are manpower and personnel; training; safety and occupational health; human factors engineering; survivability; and habitability. Although the Air Force has no specific requirement for acquisition programs to have a dedicated HSI plan or program, look for HSI to be incorporated into the systems engineering plan (SEP) or the LCMP. When the term HSI is used in an Air Force document, it refers to all the domains with a primary interest in the requirement to incorporate HFE considerations into the acquisition.

8.3. HF/HSI Policies. DoDI 5000.02, Enclosure 8, Human Systems Integration, paragraph 1, specifically mandates human factors engineering considerations, as a part of human-systems integration, and must be included in all acquisition programs: "The PM shall have a plan for HSI in place early in the acquisition process to optimize total system performance, minimize total ownership costs, and ensure that the system is built to accommodate the characteristics of the user population that will operate, maintain, and support the system." The DAG further expands on this requirement in Chapter 6.

8.4. HF/HSI Areas of Expertise. Detachment or A-9I HF analysts can assist test teams with the formulation of HF aspects of OT&E and provide required analytical support. This aid can help in the following functional areas: HF issues, ergonomics (workstation design or "switch technology"), anthropometrics (size, accommodation or fit), workload and fatigue, human performance and situational awareness evaluations, computer usability, personal equipment usability, human-machine interface, training, and questionnaire development and administration.

8.5. HF/HSI Test Measures. The first step is to identify a HF/HSI analyst for assistance on the program. The HF/HSI analyst will review documents and consult with the TD and/or the test team to develop recommendations for appropriate HF/HSI test measures. A large number of HF measures are subjective yet quantitative; in other words, they utilize near-interval scale questionnaire methodologies and are analyzed using descriptive statistics. Observational methods may also be used by the test team. Sometimes, interviews may be conducted to obtain desired data or users may be asked to choose from a response among a set of categories, which

are examples of qualitative data. HF questionnaires are usually web-based using AFOTEC's enterprise software solution (Vovici). Once appropriate measures are developed and approved, they will be incorporated into test planning documents.

8.6. HF/HSI Test Plan Inputs. COIs are critical elements or operational objectives of the mission that support mission accomplishment. When formulating each specific measure it should be descriptive enough to show its relation to the associated COI. These MOEs/MOSs can be distributed throughout the test plan and listed underneath multiple COIs. They may require multiple pieces of data/information to resolve them satisfactorily. Examples of appropriately stated HF MOEs/MOSs are:

8.6.1. MOE: Operator ratings of control and display usability.

8.6.2. MOE: Crew ratings of situational awareness.

8.6.3. MOS: Maintainer ratings of ease of maintenance.

8.7. HF/HSI Test Execution. Each test team will determine the roles and responsibilities for their team's evaluation of HF/HSI during test execution. Test teams should have draft questionnaires reviewed by the HF/HSI analyst for quality well ahead of the start of OT&E (ideally during the test planning phase). Test teams should also have the HF/HSI analyst review and comment on the HF/HSI portions of DMAPs and detailed test procedures (DTPs). In general, HF questionnaires are administered as close to the event/activity as possible (e.g., at the end of test mission, or a maintenance demonstration).

8.8. Questionnaire Support. The Detachment HF/HSI analyst and A-9I personnel ensure AFOTEC questionnaires used during operational test are of the highest quality and conform to AFOTEC best practices and technical standards. The HF/HSI analyst working with the test program will work with the TD and test team to provide questionnaire software training, instruction in the development of questionnaires, and review the formatting of questionnaires. The HF/HSI analyst should be involved in this process at the earliest possible date. The following is the recommended TD/test team procedure:

8.8.1. Identify MOEs/MOSs which may require questionnaire data.

8.8.2. Consult with the HF/HSI analyst about appropriateness of questionnaires as a source of data.

8.8.3. Ask the HF/HSI analyst to provide the test team with the appropriate questionnaire software, handbooks, examples of questionnaires, etc.

8.8.4. Consult with the HF/HSI analyst about appropriate format for administering questionnaires.

8.8.5. Develop draft questionnaires for collection of data to address appropriate test measures.

8.8.6. Have the HF/HSI analyst review draft questionnaires.

8.8.7. Format questionnaires in the desired method of administration (computer-based, web-based, paper, interviews etc.).

8.8.8. Consult users for comments on correctness of content in the questionnaires and any other additional suggestions.

8.8.9. Perform a dry run of questionnaire administration.

8.8.10. Have the test team collect questionnaire data during test execution.

8.8.11. Identify the test team personnel who will analyze and evaluate questionnaire data for test report. Consult the HF/HSI analyst for assistance.

Chapter 9

DOCUMENTATION

9.1. Introduction. Documentation is the critical link between the user and the system and forms the foundation of training, maintenance instructions, operational procedures, and continuity. This chapter provides general guidance and considerations, which should be used in planning documentation evaluation.

9.2. Definitions.

9.2.1. **Documentation—**Documentation includes operator and maintenance instructions, repair parts lists, and support manuals, as well as manuals related to computer programs and system software such as the software load instruction, user manuals, and systems administrator manuals. The focus is not only what the deliverables are, but how user-friendly and informative the documents are in completing the mission.

9.2.2. **Technical Data—**Recorded information, regardless of form or character, of a scientific or technical nature. Documentation of computer programs and related software is technical data; computer programs and related software are not technical data. Financial data or other information related to contract administration is also included.

9.2.3. **Technical Manual (TM)—**A publication that contains instructions for the installation, operation, maintenance, training, and support of weapon systems, weapon system components, and support equipment. TM information may be presented in any form or characteristic including, but not limited to, hard copy, audio and visual displays, magnetic tape, disks, and other electronic devices. A TM normally includes operational instructions, maintenance instructions, parts lists or parts breakdown, and related technical information or procedures exclusive to administrative procedures. T.O.s that meet the criteria of this definition may also be classified as TMs.

9.3. Documentation Test Planning Considerations.

9.3.1. Technical data are the link between personnel and equipment. Traditionally, they have been paper products, but the current USAF trend is toward automation (i.e. digital technical data). Assess the usability, completeness, correctness and understandability of the technical data. The assessment of technical data is usually based on operator or maintainer subjective evaluations collected using questionnaires. Guidance can be obtained from HF analysts located at the Detachments or A-9I and can provide detailed assistance in producing, administering and evaluating survey instruments related to technical data.

9.3.2. Suitability personnel should ensure they have access to and familiarity with data deliverables available from the SPO or other program sources. The data deliverables process should be reviewed before test design activities begin.

9.3.3. Suitability personnel should monitor SPO technical data validation planning and implementation efforts to ensure verified technical data are available for dedicated OT&E.

9.3.4. Validated technical data are required to begin OT&E. (AFOTECMAN 99-101; T.O. 00-5-1, *Air Force Technical Order System*; and, T.O. 00-5-3, *AF Technical Order Life Cycle Management*)

9.3.5. Suitability personnel should also be knowledgeable of the SPO and users' plans for verification of technical data, plans for providing formal publications to units, and information media/style (paper or digital, checklist, pocket size, military, commercial, etc.) being considered. These factors will have an impact on the usefulness of the documentation.

9.3.6. Consider Joint Computer-Aided Acquisition and Logistics System (JCALS) requirements for technical data. Future systems should be as paperless as possible.

9.3.7. Documentation should identify Hardness Maintenance/Hardness Surveillance (HM/HS) processes and hardness critical items (HCIs).

9.3.8. Documentation should contain an adequate number of illustrations, reference any special tool and test equipment required, have a table of contents and an index, and reference other documents such as T.O.s needed to complete tasks.

9.3.9. Installation, hardware and safety provisions between related manuals should be consistent. Troubleshooting procedures and illustrated parts breakdown should be addressed.

9.3.10. Documentation should be readable at the required level of understanding.

9.3.11. The test team should participate and provide inputs through the program office into the review of the technical data specifications, tabletop reviews of technical data, and the contractor's technical data development effort. The team should evaluate the technical data during its day-to-day use, and participate and provide inputs to the program office during in-process reviews to ensure all previously found discrepancies are corrected.

9.3.12. Do not confuse the scope of a documentation evaluation done as part of an operational assessment (OA) with that for an OT&E. For an OA, the scope encompasses reviewing program-related documentation (ICD, CDD, etc.), as well as technical documentation. For an OT&E, the documentation evaluation focuses on technical manuals.

9.4. Documentation Measures.

9.4.1. The documentation evaluation is primarily subjective in nature and typical measures include:

9.4.1.1. MOS: Maintainer ratings of technical orders

9.4.1.2. MOS: Operator ratings of manuals

9.4.2. Potential objective measures (especially for software intensive systems) include:

9.4.2.1. MOS: Percentage of tasks or procedures documented. This metric indicates how complete the documentation is at the time of OT&E. The percentage can be tracked over time to indicate a (maturing or non-maturing) trend.

9.4.2.2. MOS: Percentage of procedures or tasks that are erroneous. This metric indicates the extent of unclear tasks, tasks that have too much detail, insufficient detail, etc.

9.5. Documentation Data Requirements. Data requirements usually include:

9.5.1. Air Force Technical Order (AFTO) Form 158, *Technical Order Review Comment Sheet,* for preliminary T.O.s.

9.5.2. AFTO Form 22, *Technical Manual (TM) Change Recomendation and Reply*, or AFTO Form 27, *Preliminary Technical Order (PTO) Publication Change Request*, submitted in accordance with (IAW) T.O. 00-5-1. These are the DRs for technical data.

9.5.3. Proposed and actual delivery schedules for publications and for validation and verification plans and schedules.

9.5.4. Standard questionnaire formats and assistance, which can be obtained from the Det HSI technical lead or A-2/9 personnel.

9.5.5. Minutes and worksheets from any specification reviews, prepublication reviews or other such meetings.

9.6. Documentation Evaluation Considerations. Evaluation/assessment of technical data should determine the adequacy of the technical data to support mission requirements and to identify technical data deficiencies. Technical data can be evaluated/assessed in terms of the usability, completeness, correctness and understandability of the data for their intended use. This is a qualitative assessment requiring judgmental criteria.

Chapter 10

TRAINING

10.1. Introduction. The evaluation of training will focus on the adequacy of operator and maintainer training, the transfer of training to the system's tasks, and training in general for the system under test. This training is important because inadequacies may impact effectiveness and suitability measures. In addition, if the system under test is a training system, the test team may evaluate training planning since training implementation typically occurs after OT. Training requirements and general considerations when conducting training evaluations are discussed in this chapter.

10.2. Training and Training Support. Training for a system under test consists of the procedures, techniques, training devices, and equipment used to train civilian, active duty, and reserve military personnel to operate and support the materiel system. This includes operator and maintainer training, new equipment training, initial, formal, and on-the-job training. During OT&E, the planned training program, along with any training devices and equipment, should be evaluated.

10.3. Training OT&E Methodology. The test methodology includes the following activities performed by test team evaluators:

10.3.1. Review technical, reliability, and maintainability (R&M) data on system hardware, software, and support equipment to identify training-related issues.

10.3.2. Examine training created/delivered by developer for content completeness and adequacy.

10.3.3. Review operational, maintenance, logistics and training support concepts to determine any unusual or adverse implications on training.

10.3.4. Interview operations and maintenance personnel to identify areas where equipment design, configuration or complexity may impact training.

10.3.5. Interview training personnel to assess the adequacy of training materials, equipment and technical data.

10.3.6. Perform over-the-shoulder observations of operations and scheduled/unscheduled maintenance tasks to identify problems encountered by personnel and determine whether or not the problems are training-related.

10.3.7. Develop and administer questionnaires/surveys to trained personnel upon completion of training courses and, as appropriate, operational test scenarios.

10.3.8. Provide training evaluation status reports to the TD.

10.3.9. Pay special attention to certification/recurring training requirements such as Weapons Loading, Engine Run Certification, etc.

10.3.10. Provide the Det human systems integration (HSI) analyst with the information to perform a thorough technical review of all test plans/reports and test plan/report briefings. Provide A-9I with the information to perform a headquarters-level technical review of all test plans/reports and test plan/report briefings.

10.3.11. Use surveys, interviews, or other appropriate techniques to evaluate/assess the transfer of training to the system tasks that are required for correct performance on the job.

10.4. Training Considerations.

10.4.1. The OT&E effort focuses on whether personnel with system training can operate, maintain, and support the system in its intended environment. This includes an assessment of specialties and skill levels required to perform base-level tasks, as well as the need for new specialties or unique training requirements for existing specialties to support system-unique requirements. It also includes evaluating training conducted prior to and in support of OT&E (usually Type 1) and providing information to assist in refining training requirements, technical training materials, and facilities required to support systems during operational use. It is sometimes possible to perform actual or inferred correlation between performance on training tasks and the tasks performed during operational test, which amounts to a measure of training transfer using an objective methodology. A training deficiency exists when the training provided does not address the skills needed to operate or maintain the system.

10.4.2. Maintenance training should be analyzed for all levels of maintenance and include the training program and technical orders, as well as training aids, simulators, and support equipment used at each maintenance level.

10.4.3. The Det HSI analyst can assist with the identification of training issues and measures, methods and resources for performing training evaluations. In addition, there are training questionnaires that are tailorable to your test program. Examples of appropriately stated training MOSs are:

10.4.3.1. MOS: Maintainer ratings of technical training course.

10.4.3.2. MOS: Maintainer ratings of on-the-job training.

10.4.3.3. MOS: Operator ratings of unit-level training.

10.4.4. Air Education and Training Command Studies and Analysis Squadron (AETC/SAS) can provide assistance in conducting training assessments on larger, more complex training systems/acquisitions. AETC/SAS is located at Randolph AFB, Texas and can be reached at 210-652-5229 or DSN 487-5229.

Chapter 11

MODELING AND SIMULATION (M&S)

11.1. Introduction. Suitability M&S used in OT&E is discussed in this chapter. M&S tools and several legacy tools available during the different phases of operational testing are also discussed. Selection of specific M&S tools for use during OT&E is the responsibility of the Detachment, with support from A-2/9 & A-5/8 analysts and the Operations Directorate (A-3) test program manager. Specific guidance for using M&S is available in AFI 161001, *Verification, Validation and Accreditation (VV&A)*, and AFI 16-1002, *Modeling and Simulation (M&S) Support to Acquisition*. Additional guidance for OT&E is available in AFI 99-103 and AFOTECMAN 99-101.

11.2. Models and Simulations.

11.2.1. In addition to real data available from automated data system reports, logistics management information (LMI) reports, and committee/team agreements, suitability evaluators often require M&S to help plan the suitability test, help perform an OA, and/or augment field test results. This is especially true if the OT&E lacks test realism because of various test limitations (e.g., not enough spares). Any M&S (in-house developed, contractor-developed, commercial off-the-shelf, or other) used in support of OT&E requires sufficient, documented verification and validation to support accreditation of the specific application and test process it supports (AFOTECMAN 99-101). Currently available suitability M&S languages and tools include:

11.2.1.1. **Weibull++.** Part of ReliaSoft's suite of reliability software products (**http://www.reliasoft.com/products.htm**), Weibull++ performs life data analyses utilizing multiple lifetime distributions, including all forms of the Weibull distribution, with a clear and concise interface geared toward reliability engineering.

11.2.1.2. **BlockSim.** Another tool in ReliaSoft's suite of reliability software products, BlockSim provides a comprehensive platform for system reliability, maintainability, availability, optimization, throughput, life-cycle cost and related analyses using the exact system reliability function and/or discrete event simulation. BlockSim provides sophisticated and flexible capabilities to model systems using a reliability block diagram (RBD) or fault tree analysis (FTA) approach.

11.2.1.3. **Reliability Growth Analysis (RGA).** Developed in a joint effort between Dr. Larry Crow (**http://www.reliasoft.com**) and ReliaSoft Corporation, the leading authority in the field of RGA, along with key development partners in government and industry (including the U.S. Navy and John Deere), RGA combines comprehensive and powerful reliability growth analysis software with fielded (repairable) systems analysis capabilities for determining the optimum overhaul time and other results without the detailed data sets that would normally be required. Note: as of 26 Mar 2013, ReliaSoft software is not authorized on Air Force networks

11.2.1.4. **Matrix Laboratory (MATLAB)/Simulink.** A product of The MathWorks, MATLAB (which stands for matrix laboratory) is a high-level language and interactive environment that performs computationally intensive tasks more efficiently than traditional programming languages. Capabilities include graphics features to visualize

engineering and scientific data including 2-D and 3-D plotting functions, 3-D volume visualization functions, tools for interactively creating plots, and the ability to export results. Simulink is a platform for multi-domain simulation and Model-Based Design of dynamic systems. It provides an interactive graphical environment and a customizable set of block libraries that allow an analyst to accurately design, simulate, implement, and test control, signal processing, communications, and other time-varying systems. Visit **www.mathworks.com** for more information.

11.2.1.5. **Crystal Ball.** Crystal Ball is a user-friendly, graphically oriented forecasting and risk analysis program that takes the uncertainty out of decision-making. This tool is useful for aggregating distributions when no known analytical method exists. Visit **www.oracle.com** for more information

11.2.1.6. **Rapid Availability Prototyping for Testing Operational Readiness (RAPTOR).** ARINC commercially markets RAPTOR which models system RAM characteristics based on a system's reliability block diagram. Visit **www.arinc.com/products/raptor/index.html** for more information.

11.2.1.7. **ReALOps.** ReALOps is an integrated tool to perform reliability, availability and logistics analysis. The tool was developed by SAIC to produce maintenance metric indicators and outputs (such as MC, Ao, MTBM, MTBR, MTBCF, etc.) from probabilistic and exponential distributions.

11.2.2. Some government-owned legacy models support M&S to varying degrees. Use of these models and tools will generally require modification and subsequent verification, validation, and accreditation for specific test program use. Examples include Logistics Composite model and Aircraft Readiness Model (ARM) The AFOTEC Catalog of Modeling, Simulation, and Analysis Tools located on A-2/9's section of the the AFOTEC intranet contains links to various M&S repositories. These repositories in turn contain M&S descriptions and POC information.

11.2.3. Test team members should consider these tools for their applications to OT&E. During OT&E, these tools may be applied in ways that are not generally seen in the field.

11.2.4. Since tool availability, as well as the guidance that governs M&S, change frequently, it is important to consult the latest version of the instructions outlined in paragraph 11.1. It is good practice to contact A-2/9 to obtain information and assistance on current tools available, technical support, and direct M&S support.

Chapter 12

HOW TO TAILOR TESTING

12.1. Introduction. General guidance on tailoring suitability testing is provided in this chapter. Definitions and equations for specific suitability measures can be found in Attachment 5, Sections A6A, A6B and A6C of this publication, AFPAM 63-128, and "Memorandum of Agreement on Multi-Service Operational Test and Evaluation and Operational Suitability Terminology and Definitions".

12.2. Tailoring Suitability Testing for Systems (General). Tailoring suitability OT&E involves identifying system characteristic measures that relate to the MOSs such as those defined in Attachment 5, Sections A6A, A6B and A6C of this publication, establishing data requirements for these measures, arranging to obtain the data from various sources, and planning the evaluation of operational suitability. Each of these tasks should relate to the overall framework established by the test concept. Discussion on how to accomplish the tailoring of tasks is given in the remainder of this pamphlet.

12.2.1. **Data Requirements.** Data required to calculate an MOS need to be measurable and collectible in test or the MOS needs to be answered using modeling and simulation. Data may vary with the test environment.

12.2.1.1. During IOT&E and qualification operational test and evaluation (QOT&E), the test environment may not represent the intended operational environment. As a result, direct measurement (or demonstrated values) may be augmented with data from similar systems, testing, and contractor estimates to produce operationally meaningful estimates. Simulation models are then used to estimate measures such as A_o. Examples of these data include logistics delay times (LDTs), administrative delay times (ADTs), expected manpower, expected sparing, expected support equipment, number of each type of mission attempted (simulators), number of each type of mission completed (simulators), environmental factors (ground communication/weather systems), expected inventory size/authorization, and delivery schedules (munitions).

12.2.1.2. During follow-on operational test and evaluation (FOT&E), the test environment is generally representative of the intended operational environment. Therefore, the following data may be used directly to calculate the MOSs: fully mission capable (FMC) hours; partially mission capable (PMC) hours; non mission capable (NMC) hours; number of sorties, number and type of assigned aircraft, personnel, and support equipment; number of possessed hours/days; uptime hours; downtime hours (ground communication/weather systems); and inventory size (munitions).

12.2.2. **Data Sources.** As with data, data sources vary with the test environment.

12.2.2.1. During IOT&E, data are available from contractor reports, other evaluation areas of the test, operational and maintenance concepts, weapon system and equipment LMI, automated data systems (such as Integrated Maintenance Data System (IMDS), G081, Systems Effectiveness Data System (SEDS), Micro-OMNIVORE, and integrated weapon system management (IWSM) databases), and similar systems. When using data obtained outside of OT&E, ensure that the SUT was production representative and

evaluated in the operationally relevant environment, otherwise the data may be invalidated for OT&E use.

12.2.2.2. During FOT&E, data are available from IMDS status data, from FOT&E logbooks, and other automated data systems.

12.2.3. **Evaluation of Suitability Elements.**

12.2.3.1. Once the MOSs are identified and agreed to by test participants, the method of evaluation is determined. Evaluation may be accomplished by directly measuring MOSs in test and/or, where appropriate, measuring MOSs and using M&S to extend the results of the field test. Once measured, the MOSs are compared to the user's threshold as stated in the requirements document. The rating methodology and reporting differ for an OA, an operational utility evaluation (OUE), and an OT&Erefer to the AFOTECMAN 99-101 for specific guidance on rating MOSs and COIs.

12.2.3.2. The overall suitability evaluation (i.e., is the system suitable) should relate to the test concept by answering how well the suitability attributes contribute to the critical elements or operational objectives of the mission. If the system performs its tasks well or meets its required functional characteristics, then answer the overall question affirmatively .

12.3. Tailoring Suitability Testing for Joint Programs. The "Memorandum of Agreement on Multi-Service Operational Test and Evaluation and Operational Suitability Terminology and Definitions" governs OT&E of multi-service programs. This MOA is located on the AFOTEC Intranet page. Each participating OTA should provide their OT&E requirements for incorporation into the TEMP and/or OT plan.

Chapter 13

MANAGING OPERATIONAL SUITABILITY DATA

13.1. Introduction. Suitability data management used in OT&E is discussed in this chapter. A discussion of common analysis tools and several automated tools available during test concept development, test planning and test execution is also provided. Selection of specific suitability data tools for aircraft, command, control, communications, computer, and intelligence (C4I) and space systems is the responsibility of the test director (TD) with support from A-2/9 analysts.

13.2. Data Management Procedures.

13.2.1. Data management is the process of identifying, collecting, processing, analyzing, reporting, storing and disposing test-related data. An effective data management system results in efficient use of resources and credible information upon which to draw test conclusions. Collecting reams of data is not necessarily effective. The test team should plan to collect the minimum amount of data required to support measuring the measures of suitability (MOSs).

13.2.2. AFOTEC test teams use data management methods based on lessons learned from previous tests, the test plan, test team resources, and on-going program events. Before the test begins, detachment suitability personnel review the test plan to identify required data and determine whether the data will be collected by the test team or from activities conducted by external organizations (e.g., contractors and development testers). If data is used from tests conducted by others, test plans of those agencies should be reviewed to determine whether OT data requirements will be satisfied and production-representative testing occurred in an operationally realistic environment. If AFOTEC requirements are satisfied, coordinate with the external agency and collect the data for analysis. It is acceptable to use test and analysis reports from other agencies at the highest possible level of aggregation. If test team participation is required, they should jointly develop and coordinate plans to collect and analyze data.

13.3. Data Management and Analysis Plan (DMAP). Refer to AFOTECMAN 99-101 and the DMAP template, located on the AFOTEC Intranet website.

13.3.1. The DMAP is initiated during the Test Concept phase and refined during the Test Planning phase. The DMAP is the primary tool to ensure required data are identified, recorded, collected, reduced, processed, verified, analyzed and evaluated to support each test event. The DMAP is designed to be a working document used in the actual conduct of a test and is not intended for external coordination. It should provide a flexible means of updating test data requirements, data presentation format, planned analysis techniques, and captures the overall scope and methodology of the test program. It should address:

13.3.1.1. Dissemination of data between different locations.

13.3.1.2. Data processes to avoid duplication of effort.

13.3.1.3. Focal points and responsibility centers for data management.

13.3.1.4. Who will collect the data, how the data will be analyzed, how the data will be presented, application of detailed test procedures (DTPs), etc.

13.3.1.5. Calculations and data processing equipment to be used. The analysis techniques and evaluation procedures should spell out who will do what with which technique.

13.3.1.6. Disposition policies for all test data describing the exact procedures and media to be used in storage.

13.3.2. The DMAP is generally organized by COI, but may be tailored depending on the requirements of the test (see DMAP Template located on the AFOTEC Intranet website).

13.3.3. The DMAP should specifically address any data requirements that differ from common practice or require special attention from the test team and specify in detail the data requirements, procedures, and definitions for these requirements. The DMAP should also address any data collection requirements unique to the test.

13.3.4. Special attention should be given to the use of data from a developer. Data requirements should be coordinated with the system program office (SPO) at the earliest possible date to ensure they are specified by contract. Where possible, develop specific techniques to ensure the contractor data are representative of the production-ready system under operational conditions.

13.3.5. The DMAP should include provisions for maintaining the data system. An example is external agency programming support available throughout the test program when required (as when the data processing system is developer-supplied). For any specially developed data programs, system maintenance requirements should receive special attention and should be specified in detail.

13.4. Tasks for Suitability Personnel.

13.4.1. Specify the suitability database(s) in the AFOTEC test plan. The quality of any database output will be only as good as the quality of the data input to that database (garbage in/garbage out). Database selection should take into account measures of interest required to be supported by the data, quantity of data available and known data quality of the database. Products from Air Force Materiel Command (AFMC) data systems can be of significant benefit for logistics assessments during test planning and conduct. However, AFMC reports are often published approximately 60 days after the closeout date for each monthly or quarterly cycle. This reporting delay can significantly limit their usefulness in preparing evaluation reports at the end of test. Examples of typical database systems are:

13.4.1.1. **Micro-OMNIVORE.** The AFOTEC-developed Micro-OMNIVORE enables the user to consolidate selected maintenance and operating time data and to perform detailed statistical analyses. Micro-OMNIVORE accepts data as input from IMDS, SEDS, and IMDS for airlift (GO81) (see all below).

13.4.1.2. **SEDS.** SEDS is an Air Force Test Center RAM data acquisition, storage, retrieval, reporting, and analysis system developed primarily for test purposes (especially DT&E of aircraft systems). SEDS has many common elements with the standard Air Force maintenance data collection system, IMDS, but it is more useful because it provides a capability for a narrative presentation of discrepancies and corrective actions, delay codes, required AFSCs, ground support equipment data, diagnostic data, and technical data.

13.4.1.3. **IMDS.** IMDS, formerly known as Core Automated Maintenance System (CAMS), is the Air Force's standard system for collecting maintenance data on operational Air Force systems. IMDS products can provide specific quantitative data for failures and discrepancies, maintenance actions, and maintenance work-hours for a specific calendar period.

13.4.1.4. **GO81.** An automated maintenance management system used primarily by Air Mobility Command.

13.4.1.5. **Reliability Engineering Management Information System (REMIS).** REMIS is an Air Force standard data system for reliability information, which aggregates data and provides additional reports and analysis.

13.4.1.6. **IWSM Database.** The program office may establish an IWSM database, containing LMI data, schedules, DR status, etc.

13.4.1.7. **Equipment Inventory, Status and Utilization Reporting System.** AFI 21-103, *Equipment Inventory, Status and Utilization Reporting,* provides detailed historical records for systems availability and utilization reporting.

13.4.1.8. **Standard Base Supply System (SBSS).** The SBSS is an automated inventory accounting system useful in analyzing organic supply support. In cases where supply support is not organic (for example, IOT&E), other supply measurement systems may need to be developed.

13.4.1.9. **Manual Databases.** Manual databases include maintenance logbooks and videotape libraries.

13.4.1.10. **Test Team-Developed Databases.** In some cases, no automated maintenance database exists and/or the system is too complex to rely on manual methods such as logbooks and video libraries. Alternatively, outputs from many of the above databases are best consolidated into one, for data analysis. The test team may develop databases using commercial off-the-shelf software (e.g., Excel or Access).

13.4.2. In the test resource plan (TRP), include requirements for computers, programmer support (e.g. Access database programmers), video recorders, scanners, storage media, instrumentation and similar resources.

13.4.3. Unique automated data processing requirements, such as data processing equipment or contractor support, should be coordinated with the AFOTEC communications and information team (A-6).

13.4.4. Sustainment representatives should participate with test team personnel on the Joint Reliability and Maintainability Evaluation Team (JRMET) and Test Data Scoring Board (TDSB). The primary representative is the TD, assisted by the analyst/engineer. While AFOTEC is not bound by the JRMET's interpretation of the data, an agreement is usually reached and a common database is established for use by all participating agencies. In cases where agreement is not reached, the specific items should be coded in the common RAM database for separate DT&E and OT&E analysis.

13.5. Other Data Sources. During multi-service test, AFOTEC personnel may use Army or Navy data systems, particularly if the Air Force is not the lead service ("MOA on MOT&E" This

MOA is located on the Policy Center page under the AFOTEC Policy menu item of the AFOTEC Intranet home page)

13.5.1. **Army Data Systems.** Suitability personnel participating in MOT&E with the Army as lead, should obtain a copy of Department of Army Pamphlet (DAP) 73-1, *Test and Evaluation in Support of Systems Acquisition*. This document describes the Army Test Incident Reporting System and is available at **http://www.apd.army.mil/jw2/xmldemo/p73_1/head.asp** as of 8 Mar 2013.

13.5.2. **Navy Data Systems.**

13.5.2.1. **Naval Aviation Maintenance and Materiel Management (Aviation 3-M) System.** Aviation 3-M combines RAM and logistics supportability data into one system.

13.5.2.2. **Navy Ship's Maintenance and Materiel Management System (3-M).** Ship's 3-M system is analogous to the aviation 3-M systemit contains active and mothballed equipment, a maintenance data processing system, and an alteration management system for shipboard configuration control.

13.5.3. **Government-Industry Data Exchange Program (GIDEP).** The GIDEP is a cooperative activity between government and industry participants to automatically exchange technical data essential in the research, development, production and operational life cycle of systems and equipment. The GIDEP maintains specialized data banks, which are available to government and industry.

13.5.4. **Defense Logistics Studies Information Exchange (DLSIE).** DLSIE is chartered by DoDI 5154.19, *Defense Logistics Studies Information Exchange (DLSIE)*. DLSIE collects, organizes, stores, and disseminates information pertaining to logistics studies, models, management information, and related documentation, which may benefit the DoD logistics management and research community. By reviewing the DLSIE collection, logistics research activities can avoid spending defense dollars on previously completed research.

13.5.5. **Defense Technical Information Center (DTIC).** DTIC, a primary field activity of the Defense Logistics Agency, is the central banking institution for DoD's collection of research and development (R&D) information in virtually all fields of science and technology. DTIC has the mission to exploit the contents of its collection to answer three basic questions relative to the research, development, test and evaluation (RDT&E) program of the DoD: what research is being planned; what research is currently being performed; and what results were realized by completed research? The AFOTEC historian (HO) is the focal point for interfacing with DTIC. HO maintains a significant number of DTIC documents and periodically receives a catalog of new publications from DTIC.

13.5.6. **Logistics Management Information (LMI).** LMI consists of summaries and data required by the government to perform acquisition logistics management functions. The LMI is important to suitability test planning and execution because it is the major source of data used to develop the support system. The LMI should provide detailed information on how the SPO intends to address each of the 10 integrated logistics support (ILS) elementsextremely useful in the OT&E suitability analysis effort. It also shows the detailed factors on which the support system is based. These can be used to reveal potential problem areas.

13.6. JRMET.

13.6.1. Air Force policy, including AFI 99-103, dictates test and operational data collection and analysis systems be complementary to each other to verify RAM performance throughout the system or equipment life cycle. The purpose of the JRMET is to review raw RAM data for accuracy, completeness, and operational relevance.

13.6.2. The AFMC program manager (PM) is responsible for establishing a JRMET (or similar team), to assist in reliability and maintainability data collection, analysis, verification, and categorization during DT&E and OT&E. The system program office (SPO) establishes and chairs the JRMET during DT&E and IT&E. If for any reason the program office chooses not to chair or participate, AFOTEC may chair the JRMET. During dedicated OT&E, the AFOTEC TD (or designated representative) chairs the JRMET. Participants include representatives from the supporting and operating commands, the DT&E and OT&E test teams, and developer when appropriate.

13.6.3. Specific responsibilities of JRMET participants are specified in the JRMET charter. The charter also states policy for the joint use of RAM data, exchanges of RAM information, classification criteria for system-related failures/faults, and administrative procedures for conducting JRMET meetings. The intent of having a charter is to avoid duplication of effort. If a charter is not established, the JRMET functions normally will be assigned within the SPO. A-2/9 has several JRMET charter templates for use when interfacing with the SPO.

13.6.4. JRMET meetings serve as an ideal forum for reviewing RAM data, familiarization with RAM terminology, obtaining joint agreement on the use of RAM data, and ensuring data accuracy. JRMET meetings should be held periodically as RAM data are collected. Actual operational suitability T&E data reduction, analysis, and evaluation are normally not done at the meetings; rather, the JRMET logistics personnel should accomplish this after each JRMET meeting to obtain estimates of applicable MOSs.

13.6.5. AFOTEC involvement in the JRMET entails understanding the data for OT&E purposes and assisting the SPO and developer in data interpretation from an operational perspective. Whereas AFOTEC is not bound to contractual interpretation of test data, agreements are usually reached to establish a common database for use by all participating agencies. As test team members may be unfamiliar with the JRMET organization and functions, they should review the JRMET charter and convene a pre-JRMET meeting consisting of suitability, and logistics personnel, and appropriate operating command personnel. The pre-JRMET meeting is normally held one day before the formal JRMET meeting. Key questions to answer at the pre-JRMET/JRMET meetings are:

13.6.5.1. Is a failure relevant or test specific? Treat all failures as relevant until the developer or SPO proves otherwise.

13.6.5.2. Did the failure critically impact the mission?

13.6.5.3. Do computed values of RAM measures relate to contractual and/or operational requirements?

13.6.5.4. Are values of RAM measures expressed as progress points on a growth curve, end of test values, or as mature system values?

13.6.5.5. Was the failure software-related?

13.6.5.6. Has a failure-related DR been written, or is one needed?

13.6.6. During IOT&E, software failures should be scored the same as hardware failures since both have a similar impact on mission performance. Software failures may be tracked separately for the purpose of providing additional insights, but all software failures should be counted toward reliability metrics. Exclusion of system failures or maintenance actions in RAM calculations is at the discretion of the JRMET, but should be documented. AFOTEC measures maintainability at the organizational or field level. Any maintenance at the field level in support of software counts as repair time. This includes time to reboot or restore the system, data backups, system administration and configuration management.

13.6.7. In summary, the JRMET allows AFOTEC to reconcile data differences with the SPO or contractor. If agreement cannot be reached on scoring specific data, AFOTEC reserves the right to flag the data for OT&E use and report using the flagged data. Other agencies also benefit by gaining the latest test information that may be used in updating logistics plans, LMI, initial provisioning estimates and life-cycle cost estimates. Although the main concern of the JRMET is scoring RAM data, the TD verifies all test data. A-2/9 maintains a framework for JRMET charters and provides assistance in establishing JRMET function.

13.7. Test Data Scoring Board (TDSB). The TDSB is a government-only forum to score and categorize the data reviewed and accepted by the JRMET. The purpose of the TDSB is to remove perception of developer bias in the data-scoring process. The PM establishes and chairs the TDSB during DT&E and IT&E. During dedicated OT&E, the AFOTEC TD (or designated representative) chairs the TDSB. Participants include representatives from the supporting and operating commands and the DT&E and OT&E test teams, but exclude the developer. Restrictions stated in Public Law (US Code, Title 10) prohibit all system developers from TDSB participation. Although the main concern of the TDSB is scoring RAM data, the TD verifies all test data. If agreement cannot be reached on scoring specific data, AFOTEC reserves the right to flag data for OT&E use and report using the flagged data. A-2/9 may provide assistance in establishing a TDSB.

Chapter 14

DEFICIENCY REPORTING

14.1. Introduction. Deficiency reports may arise while testing and evaluating any of the operational suitability elements. This chapter discusses deficiency categories and AFOTEC's roles and responsibilities with respect to deficiency reporting.

14.2. Deficiency Reporting.

14.2.1. AFOTEC is responsible for supporting the Deficiency Report (DR) process by reporting deficiencies found during OT&E. The integrated test team (ITT) charter designates a sub-group to define and document DR strategy and procedures consistent with T.O. 00-35D-54 and AFI 99-103 (T.O. 00-35D-54 and AFI 99-103 contain detailed information about the DR process). DR strategy and accompanying procedures are established prior to milestone B. Deficiency report status is included in the final OT&E report. Deficiencies that impact the operational safety, suitability and effectiveness (OSS&E) of systems or equipment in development, test or employment are required to be reported (see Table 14.1.). Deficient conditions are identified according to criteria and report type and categorized according to their impact to mission.

Table 14.1. Attributes which may affect OSS&E

Compatibility	Malfunction
Design	Quality
Difficulty of operation or maintenance	Reliability
Effectiveness	Reparability
Environmental	Safety
Expense of operation or maintenance	Security
Fidelity/conformity of technical publications	Suitability
Human Factors	Survivability
Integration	Training Fidelity
Interoperability	Undocumented features
Logistics supportability	Utility
Maintainability	Vulnerability

14.2.2. Category (CAT) I deficiencies require the immediate attention and response of the system Program Manager and Chief/Lead Engineer to mitigate risk and/or limit/resolve mission impact. Strict application of CAT I criteria is essential. If a Category I condition is noted or suspect, assess safety, mission or operational impact and include a detailed statement outlining the safety, mission or operational impact to the system or end item. Category II deficiencies impede or constrain successful mission accomplishment (system impacts OSS&E but does not meet the safety or mission impact criteria of a Category I

deficiency). Category II deficiencies may also include recommended enhancements that improve or complement successful mission accomplishment, but are not absolutely required. An enhancement report should not be designated as such solely due to an "out-of-scope" condition as described in contractual requirements (see Table 14.2.). Program Managers will not close deficiencies as enhancements solely because they are "out of scope" to contractual requirements. Enhancement deficiencies will be assessed as a potential requirement and prioritized based upon their impact to OSS&E.

Table 14.2. DR Category and Priority Determination

Annotate the DR Category (I or II) and the corresponding priority. Submit a Category I DR and assign the corresponding priority when a condition:		
CAT I	**Priority**	**Impact**
	Emergency	If uncorrected, may cause death, severe injury, or severe occupational illness and no workaround is known; or, if uncorrected, may cause major loss or damage to equipment or a system and no workaround is known; or, prevents the accomplishment of an essential capability or critically restricts OSS&E, to include required interaction with other mission critical platforms or systems, and no acceptable workaround is known.
	Urgent	Adversely affects an essential capability or negatively impacts OSS&E and no acceptable workarounds are known or adversely affects technical, cost or schedule risks to the project or to life cycle support of the system, or, results in a production line stoppage and no acceptable workaround is known.
When the condition does not meet the safety or mission impact criteria of a Category I report, submit a Category II DR with the corresponding priority when the condition:		
CAT II	**Priority**	**Impact**
	Urgent	Adversely affects an essential capability or negatively impacts OSS&E and adequate performance is achieved through significant compensation or acceptable workaround and or adversely affects technical, cost or schedule risks to the project or to life cycle support of the system, but an acceptable workaround is known.
	Routine	Does not affect an essential capability but may result in user/operator inconvenience or annoyance. Adequate performance is achieved through minimal compensation. Results in inconvenience or annoyance for development or maintenance personnel, but does not prevent the accomplishment of the task. Adequate performance is achieved through minimal compensation. Any other effect, i.e., enhancements having little or no impact to OSS&E under current requirements.

NOTES:

1. Careful consideration should be given in assigning the category and corresponding priority recommendation to accurately define the deficiency's impact.

2. Prior to test, the test team and program office shall ensure understanding and consensus of priority definitions. If required, definitions may be further defined in the local operating procedures to support the individual test program.

3. T&E deficiency category and priority will be determined by the test director. Subsequent changes may occur only with consensus of primary Materiel Improvement Project Review Board (MIPRB) members (program office, lead operating command, and applicable test director). See AFI 99-103, *Capabilities-Based Test and Evaluation* for additional T&E information.

4. Originators/Originating Points should consider and document factors such as cost, schedule and performance risks; availability of spares; difficulty of operation or maintenance, repair, or replacement; system redundancy; associated trends; secondary failures or damages; and environmental impacts among other possible factors.

5. Workarounds refer to approved/authorized alternate procedures which could include, but are not limited to: manual processes, order of task accomplishment, more restrictive or intensive procedures, and the use of back-up or redundant systems or processes, etc.

14.2.3. The following are typical OT&E DR concerns which require follow-up during and after completion of testing: verify program managers do not close out DRs without consensus of the stakeholders (e.g., users and operational testers); if a contractor DR database is used, verify seamless portability into the government system has been accomplished; and ensure open DRs are transferred to program office POCs upon completion of AFOTEC involvement.

14.2.4. **Classified Deficiency Reporting.** Ensure coordination with the applicable PM representative and provide information per the applicable program security guide.

SCOTT D. WEST
Major General, USAF
Commander

Attachment 1

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Abbreviations and Acronyms

3-M—maintenance and materiel management

AALPS—Automated Air Load Planning System

ACAT—acquisition category

ACCI—Air Combat Command Instruction

ACS—agile combat support

ADT—administrative delay time

AETC/SAS—Air Education and Training Command Studies and Analysis Squadron

AETF—Air Expeditionary Task Force

AFI—Air Force instruction

AFMAN—Air Force manual

AFMC—Air Force Materiel Command

AFOTEC—Air Force Operational Test and Evaluation Center

HO—AFOTEC History Office

AFOTECMAN—AFOTEC Manual

AFOTECPAM—AFOTEC pamphlet

AFPAM—Air Force Pamphlet

AFPD—Air Force policy directive

AFSC—Air Force specialty code

AIS—automated information systems

ALC—air logistics center

ALDT—administrative and logistics delay time

Aa—achieved availability

Ai—inherent availability

Ao—operational availability

As—stockpile availability

ATE—automatic test equipment

ATO—Air Tasking Order

Aviation 3M—Aviation Maintenance and Material Management

BDR—battle damage repair

BIT—built-in test

BIT/FIT—built-in test/fault isolation test

BITE—built-in test equipment

BR—break rate

C4I—command, control, communications, computers and intelligence

CAMS—Core Automated Maintenance System

CAT—category

CBR—chemical, biological and radiological

CDD—capability development document

CF—critical failure

CFR—Code of Federal Regulations

C-I—compatibility and interoperability

CJCSI—Chairman Joint Chiefs of Staff Instruction

CLS—contractor logistics support

CM—corrective maintenance

CMT—corrective maintenance time

CND—cannot duplicate or could not duplicate

COI—critical operational issue

CONOPS—concept of operations

CPD—capability production document

DAG—Defense Acquisition Guidebook

DAP—Department of Army Pamphlet

DART—deficiency analysis ranking technique

DE—downing event

DIFM—due in from maintenance

DLSIE—Defense Logistics Studies Information Exchange

DMAP—data management and analysis plan

Do—operational dependability

DoD—Department of Defense

DoDI—DoD instruction

DOT&E—Director, Operational Test and Evaluation

DR—deficiency report

DSMC—Defense Systems Management College

DT—developmental test

DT&E—developmental test and evaluation

DTIC—Defense Technical Information Center

DTP—detailed test procedures

E3/SM—Electromagnetic Environmental Effects and Spectrum Management

EMC—electromagnetic compatibility

EMI—electromagnetic interference

EOQ—economic order quantity

ESOH—environment, safety and occupational health

ESOHC—Environment, Safety and Occupational Health Council

ESOHCB—Environment, Safety and Occupational Health Certification Board

ESOH—MS - Environment, Safety and Occupational Health Management Survey

FAR—false alarm rate

FDE—force deployment evaluation

FH—flight hour

FH/LU—flying hours per life unit

FMC—fully mission capable

FOT&E—follow-on operational test and evaluation

FR—fix rate

FTA—fault tree analysis

GIDEP—government-industry data exchange program

GIG—Global Information Grid

GO81—IMDS for Airlift

HCI—hardness critical item

HF—human factors

HFE—human factors engineering

HM/HS—hardness maintenance/hardness surveillance

HQ—headquarters

HSI—human system integration

HSP—health and safety plan

IA—Information Assurance

IAW—in accordance with

ICD—initial capabilities document

ICS—interim contractor support

ID—integrated diagnostics

ILS—integrated logistics support

IMDS—Integrated Maintenance Data System

IMT—information management tool

IOC—initial operational capability

IOT&E—initial operational test and evaluation

IRSP—in place readiness spares package

ISO—International Organization for Standardization

ISSL—initial spares support list

ITD—initial test design

ITT—integrated test team

IWSM—integrated weapon system management

JCALS—Joint Computer-Aided Acquisition and Logistics System

JITC—Joint Interoperability Test Command

JP—joint publication

JRMET—Joint Reliability and Maintainability Evaluation Team

KPP—key performance parameter

KSA—key system attribute

LCMP—life cycle management plan

LCOM—logistics composite model

LDT—logistics delay time

LMI—logistics management information

LOGMOD—Logistics Module

LRU—line-replaceable unit

LSA—logistics support analysis

LU—life unit

M&S—modeling and simulation

MAIS—Major Automated information System

MAJCOM—major command

MATLAB—matrix laboratory

MC—mission capable

MDA—milestone decision authority

MDAP—Major Defense Acquisition Program

MDT—mean downtime

M-demos—maintenance demonstration

MESL—minimum essential subsystem list

MIL—HDBK - military handbook

MIL—STD - military standard

MIPRB—Materiel Improvement Project Review Board

MISCAP—mission capability

MMH—maintenance man-hours

MMH/LU—maintenance man-hours per life unit

MOA—memorandum of agreement

MOE—measure of effectiveness

MOHBFA—mean operating hours between false alarms

MOS—measure of suitability

MOT&E—multi-service operational test and evaluation

MP—maintenance personnel

MPT—manpower, personnel, training

MRSP—mobility readiness spares package

MRT—mean repair time

MT—maintenance time

MTBCF—mean time between critical failures

MTBD—mean time between demands

MTBDE—mean time between downing events

MTBF—mean time between failures

MTBM—mean time between maintenance

MTBME—mean time between maintenance events

MTBOMF—mean time between operational mission failures

MTBR—mean time between removals

MTBSM—mean time between scheduled maintenance

MTBUM—mean time between unscheduled maintenance

MTTFL—mean time to fault locate

MTTR—mean time to repair

MTTRF—mean time to restore function

NAP—nuclear assessment plan

NEPA—National Environmental Policy Act

NMC—not mission capable

NMCB—not mission capable both (i.e., maintenance and supply)

NMCM—not mission capable maintenance

NMCS—not mission capable supply

NR KPP—net-ready key performance parameter

NRTS—not repairable this station

OA—operational assessment

OC—operational capability

OH—operating hours

OMF—operational mission failure

O&S—operations and support (usually used in relation to cost)

OPLAN—operation plan

OPR—office of primary responsibility

ORM—operational risk management

OSS&E—operational safety, suitability and effectiveness

OT—operational test

OTA—operational test agency

OT&E—operational test and evaluation

OUA—operational utility assessment

OUE—operational utility evaluation

PBL—performance-based logistics

PESHE—Programmatic ESOH Evaluation

Pcnd—percent cannot duplicate

Pfa—percent BIT false alarms

Pfd—percent BIT fault detection

Pfi—percent BIT fault isolate

Prtok—percent retest okay

PH&S—packaging, handling and storage

PHS&T—packaging, handling, storage and transportation

PM—preventive maintenance or program manager (context sensitive)

PMC—partially mission capable

PMCB—partially mission capable both

PMCM—partially mission capable maintenance

PMCS—partially mission capable supply

PMT—preventive maintenance time

POC—point of contact

QOT&E—qualification operational test and evaluation

R&D—research and development

R&M—reliability and maintainability

RAM—reliability, availability and maintainability

RAPTOR—rapid availability prototyping for testing operational readiness

RBD—reliability block diagram

RDS—Records Disposition Schedule

RDT&E—research, development, test and evaluation

ReALOps—Reliability, Availability, and Logistics Operations

REMIS—Reliability and Maintainability Information System

RGA—Reliability Growth Analysis

RLA—repair-level analysis

Rm—mission reliability

R_S—storage reliability

RTOK—retest okay

SATAF—site activation task force

SBSS—Standard Base Supply System

SE—support equipment

SEDS—Systems Effectiveness Data System

SEP—systems engineering plan

SGR—sortie generation rate

SII—special interest item

SMR—source, maintainability and recoverability

SPA—sorties per aircraft

SRU—shop-replaceable unit

SPO—system program office

SSWG—sortie surge weapons generation

ST—standby time

SUT—system under test

T&E—test and evaluation

TD—test director

TDSB—test data scoring board

TEMP—test and evaluation master plan

TM—technical manual

TO—tasking order

T.O.—technical order

TRP—test resource plan

TRR—test readiness review

UHF—ultrahigh frequency

UR—utilization (or usage) rate

USAF—United States Air Force

UT—uptime

UTC—unit type code

UTE—utilization rate

VV&A—verification, validation and accreditation

WSR—weapon system reliability

Terms

Abort—Failure to accomplish a mission for any reason, other than enemy action. It may occur at any point from initiation of operation to destination. (JP 1-02)

Accreditation—The official determination that a model or simulation (or other test capability) is acceptable for a specific purpose. (DODD 5000.59)

Acquisition—The conceptualization, initiation, design, development, test, contracting, production, deployment, and logistics support, modification and disposal of weapon and other systems, supplies, or services (including construction) to satisfy DoD needs, intended for use in or in support of military missions. (Defense Systems Management College (DSMC) Glossary)

Acquisition Category (ACAT)— Acquisition categories determine the level of review, decision authority, and applicable procedures. They facilitate decentralized decision making and execution, and compliance with statutory imposed requirements. There are three ACATs based on research, development, T&E (RDT&E) and/or procurement costs stated in fiscal year (FY) 2000 dollars. (Defense Systems Management College (DSMC) Glossary)

Acquisition Process—DoDI 5000.02, defines the acquisition process as Pre-System Acquisition, Systems Acquisition, and Sustainment and Disposal. Normally, this process consists of discrete logical phases separated by major decision points, called milestones. The phases span the life cycle of a weapon system and provide a means of progressively translating broadly stated mission needs into well-defined system-specific requirements.

Pre—System Acquisition—Pre-System Acquisition is composed of on-going in development of user needs, science and technology, and concept development work specific to the development of a material solution to an identified need. One path into systems acquisition begins with examining alternative concepts to meet a stated mission need. This path begins with a decision to enter concept and technology development at milestone A. The phase ends with the selection of a system architecture and the completion of entrance criteria into milestone B and system development and demonstration phase.

Systems Acquisition—Systems acquisition is the process of developing concepts into producible and deployable products that provide capability to the warfighter. The concepts to exploit in systems acquisition are based on analysis of alternative ways to meet the military need, including commercial and non-developmental technologies and products and services determined through market analysis. Systems Acquisition consists of two phases: system development and demonstration initiated by a milestone B decision, and production and deployment initiated by a milestone C decision.

The purpose of the system development and demonstration phase is to complete the discovery process, develop a system, reduce program risk, ensure system supportability, design for producibility, assure affordability and demonstrate system integration and utility. Discovery and development are aided by the use of simulation—based acquisition and test and evaluation and guided by a system acquisition strategy and TEMP. The purpose of

milestone B is to authorize entry into system development and demonstration. Entrance into system development and demonstration is dependent on three things: technology maturity (including software), validated requirements and funding. Prior to entering system development and demonstration, there will be requirements documents validated by the requirements authority. The requirements documents contain operational performance requirements and addressing cost for a proposed concept or system.

The objectives of the production and deployment phase are to achieve an operational capability that satisfies mission needs. The purpose of milestone C is to authorize entry into low—rate initial production for Major Defense Acquisition Programs (MDAP) and major systems or into production or procurement for non-major systems that do not require low-rate production. The production requirement of this phase does not apply to Major Automated Information Systems (MAIS) or software-intensive systems with no developmental hardware components. However, software has to prove its maturity level prior to deploying to the operational environment. Once maturity has been proven, it is baselined and a methodical and synchronized deployment plan is implemented to all applicable locations.

Sustainment and Disposal—The objectives of this activity are the execution of a program of support that meets support performance requirements and sustainment of systems in the most cost-effective manner for the life cycle of the system.

The sustainment program includes all elements necessary to maintain the readiness and operational capability of weapon and other materiel systems. The scope of support varies among programs but generally includes supply, maintenance, transportation, sustaining engineering, data management, configuration management, manpower, personnel, training, safety, occupational health, C4I and environmental management functions. This activity also includes the execution of operational support plans. A follow—on operational test and evaluation program that evaluates operational effectiveness, survivability, suitability and interoperability, and that identifies deficiencies will be conducted, as appropriate.

> At the end of its useful life, a system must be demilitarized and disposed. The PM will address in the acquisition strategy demilitarization and disposal requirements. During demilitarization and disposal, materiel determined to require demilitarization is controlled and disposed in a way that minimizes DoD's liability due to environmental, safety, security and occupational health issues.

Air Abort—A failure of an airborne aircraft so that it cannot effectively accomplish its primary or alternate scheduled mission because of a reported malfunction.

Availability:—Availability (Launch, Space, Control, User)—A measure of the degree to which the segment (launch, space, control, and user) is in an operable and committable state at the start of a mission when the mission is called for at any (random) time. (AFPAM 63-128)

Availability (Materiel)—A measure of the percentage of the total inventory of a system operationally capable (ready for tasking) of performing an assigned mission at a given time, based on materiel condition. (JCIDS Manual)

Availability (Operational)—A_o is the probability that a system can be used for any specified purpose when desired. It includes both the inherent R&M parameters and logistics support effectiveness of the system that relates to the total time the system might be desired for use.

Availability (Stock)—As is the probability a system or weapon's specified resources are available for use (not in the repair pipeline) over a storage life at a random point in time. (AFPAM 63-128)

Bench Check—A workshop check for the condition, completeness, or working order of a piece of equipment. (AFI 21-101, *Aerospace Aircraft and Equipment Maintenance*)

Cannibalization—The authorized removal of specific components from one item of Air Force property for installation on another item of Air Force property to meet priority requirements with the obligation of replacing the removed components. (AFI 21-101)

Cannibalization Rate—A measure of on-equipment cannibalization actions (removals) performed to keep an end item in operationally ready condition. The rate may be expressed as average cannibalization per sortie, per 1,000 flying hours, or other life unit. (AFI 21-101)

Cannot Duplicate (CND)—A maintenance event for which an operationally observed or recorded malfunction for a system or subsystem cannot be duplicated or confirmed by maintenance personnel. CND should be reported as rate per sorties, flying hours or operating hours (OH). (AFPAM 63-128)

Code 3—a grounding condition for which the aircraft is unable to meet at least one of its wartime missions.

Compatibility—Capability of two or more items or components of equipment or material to exist or function in the same system or environment without mutual interference. (JP 1-02) The capability of a system to be operated, maintained, and resupplied by persons wearing a full complement of individual protective equipment, in all climates for which the system is designed, and for the period specified in the capabilities documents.

Computer Resources Support—The facilities, hardware, software, documentation, manpower, and personnel needed to operate and support embedded computer systems.

Concept of Operations (CONOPS)—Verbal or graphic statement, in broad outline, of a commander's assumptions or intent in regard to an operation or series of operations. The CONOPS frequently is embodied in campaign plans and operation plans; in the latter case, particularly when the plans cover a series of connected operations to be carried out simultaneously or in succession. The concept is designed to give an overall picture of the operation. (JP 1-02)

Contractor Logistics Support—Logistics support activities provided under contract to a using command.

Corrective Maintenance—All actions performed as a result of a failure to restore an item to a specified condition. Corrective maintenance can include any or all of the following steps: localization, isolation, disassembly, interchange, reassemble, alignment and checkout. (AFPAM 63-128)

Critical Failure—See Failure.

Deficiency Report (DR)—A report used to identify, document, and track system deficiency and enhancement data while a system is in advanced development, test and evaluation, or operational transition. (T.O. 00-35D-54)

Dependability—The probability that a system is operable at any time during an interval that has no preventative maintenance downtime.

Deployability—A function of system reliability, characteristics of required maintenance equipment, processes that support the flow of required spares and support equipment, and the maintenance concept. Deployability can be expressed as required airlift to support deployment of initial and follow-on support elements, numbers of personnel required for setup and operation of any equipment (air, power, etc.), and the amount of resupply. (AFPAM 63-128)

Depot—Level Maintenance—Maintenance performed on material requiring major overhaul or rebuild of parts, assemblies, subassemblies, and end items, including the manufacture of parts, modification, testing, and reclamation. Depot maintenance supports lower levels of maintenance by providing technical assistance and performing that maintenance beyond their responsibility or capability, providing stocks of serviceable equipment, and using more extensive facilities for repair than are available in organizational- or field-level maintenance activities. (AFI 21-101)

Depot—Level Maintenance Support—Maintenance and modification support accomplished or provided by an air logistics center (ALC). It includes organizational- and intermediate-level maintenance or modification work that cannot be economically accomplished within the using command's total resources (and is so certified by the using command HQ); and, depot-level maintenance or modification work that, because of the job complexity, requires special skills, tools, equipment, or facilities that are available only at a depot-level facility. (AFI 21 101)

Depot Maintenance Facility—This is a military or contractor facility that performs depot-level maintenance modification of aircraft/missiles. (AFI 21-102)

Developmental Test and Evaluation (DT&E)—DT&E is that T&E conducted to assist the engineering design and development process and to verify attainment of technical performance specifications and objectives. DT&E is normally accomplished or managed by the DoD component's systems, hardware/software integration, related software, and prototype or full-scale engineering development models of the system. T&E of compatibility and C-I with existing or planned equipment and systems are also included.

Diagnostics—The ability of integrated diagnostics (ID—automated, semiautomatic, and manual techniques taken as a whole) to fault-detect and fault-isolate in a timely manner.

Documentation—Comprises operator and maintenance instructions, repair parts lists, and support manuals, as well as manuals related to computer programs and system software.

Downtime per Sortie—For a specified period of time, the total time the system is not mission capable, maintenance (NMCM), scheduled or unscheduled. Not mission capable, supply (NMCS) or not mission capable both (NMCB), scheduled or unscheduled, in clock hours, divided by the number of sorties.

End Item—A final combination of end products, component parts, and/or materials ready for their intended use, e.g., aircraft, ships, tanks, mobile machine ship.

Engineering Change Proposal—The document for proposing design changes to an item, facility, or part, delivered or to be delivered, which will require revision to contract specifications, engineering drawings, or documents referenced that are approved or authorized for applicable items under government contracts.

Environmental Effects—The effects of the natural environment on the system. For example, corrosion is a natural environmental effect caused by weather and ocean conditions. ("Memorandum of Agreement on Multi-Service Operational Test and Evaluation and Operational Suitability Terminology and Definitions")

Environmental Impacts—The system's impact on the natural environment as a result of its operational use, maintenance, transportation and storage. For example, impacts include pollution (noise, air and water), threat to endangered species and threat to public health. ("Memorandum of Agreement Multi-Service Operational Test and Evaluation and Operational Suitability Terminology and Definition")

Environment, Safety, and Health:—Environment—Used as a general reference, environment includes the generic natural environment; e.g., weather, climate, ocean conditions, terrain, and vegetation. Environment includes those conditions observed by the system during operational use, standby, maintenance, transportation and storage.

Safety—Safety is freedom from conditions, which can cause death, injury, occupational illness, or damage to or loss of equipment or property. Support equipment normally conducts formal safety assessments. Safety considerations should be included in maintainability or logistics supportability assessments.

Health—The overall condition (i.e., body and mind) of an organism at a given time.

Environment, Safety, and Occupational Health Certification Board (ESOHCB)—AFOTEC board convened four weeks before TRR to ensure readiness for OT&E is not affected by safety or environmental-related issues.

Evaluation—The review and analysis of qualitative and/or quantitative data obtained from design review, hardware inspection, testing and/or operational usage of equipment.

Failure:—Standard Definition—The events, or inoperable state, in which any item or part of an item does not, or would not, perform as previously specified.

Operational Mission Failure—A failure that could preclude successful completion of a mission, and must be specifically defined for each system.

Software Failure—The termination of the ability of a functional unit to perform its required function as a result of a software problem or an event in which a system or system component does not perform a required function within specified limits. A failure may be produced when a fault is encountered. (AFPAM 63-128)

Critical Failure—A failure, or combination of failures, that prevents an item from performing a specified mission. A system degradation, indication of failure, or actual failure that prevents a system from performing a specified mission. (AFPAM 63-128) Critical failures do not have to occur during a mission or directly in the system; they merely must or could cause mission impact (e.g. personnel, publications, etc.).

Failure Rate—The total number of failures within an item population divided by the total number of life units expended by that population, during a particular measurement interval under stated conditions.

False Alarm—A system-indicated malfunction that had no follow-on request for a CM action, and, thus, cannot be validated. Different from a CND where degradation occurs, but the degradation cannot be duplicated. (AFPAM 63-128)

False Alarm Rate (FAR)—The frequency of occurrence of false alarms, which is calculated by dividing the total number of false alarms by the total number of life units (e.g., time, cycles, etc.).

Fix Rate—The percent of aircraft returning from a sortie with a critical failure resulting in an NMC status and that are repaired and returned to MC status within a specified period of time (for example 50% in 2 hours). (AFPAM 63-128)

Follow—on Operational Test and Evaluation (FOT&E)—Follow-on Operational Test & Evaluation (FOT&E) continuation of IOT&E or QOT&E. FOT&E answers specific questions about unresolved COIs and test issues, verifies the resolution of deficiencies determined to have substantial or severe impact on mission operations, or completes areas not finished during the I/QOT&E. Requirements for FOT&E are documented in an approved AFOTEC OT&E report prior to the planning of the FOT&E.

Foreign Object Damage—Damage to or malfunction of an aircraft, missile, or drone caused by an object that is alien to an area or system, being ingested by, or lodged in a mechanism. (AFI 21-101)

Global Information Grid (GIG)—The globally interconnected, end-to-end set of information capabilities, associated processes, and personnel for collecting, processing, storing, disseminating, and managing information on demand to warfighters, policy makers, and support personnel.

Government—Industry Data Exchange Program (GIDEP)—An Army-, Navy-, Air Force-, and NASA-sponsored program for the exchange of data among government agencies and industry to reduce the costs of investigative efforts on parts and materials.

Ground Abort—Any aircraft confirmed by maintenance as operational and ready for flight that fails to launch for any system malfunction/failure/reject.

Hazard—A condition that is prerequisite to a mishap. (MIL-STD 882D)

Hazard Probability—The aggregate probability of occurrence of the individual events (conditions). (MIL-STD 882D)

Hazard Severity—An assessment of the consequences of the worst credible mishap that could be caused by a specific hazard. (MIL-STD 882D)

Hazardous Materials—Any substances or materials that pose a threat to human health or the environment typically because of their toxic, corrosive, ignitable, explosive, or chemically reactive nature.

Human Factors Engineering (HFE)—The application of knowledge of a human's capabilities and limitations to the planning, design, development, and testing of aerospace systems, equipment, and facilities to achieve optimum personnel safety, comfort, and effectiveness compatible with systems requirements.

Human Systems Integration (HSI)—HSI optimizes the human part of the total system equation by integrating HFE; manpower, personnel, training (MPT); health hazards; safety factors;

medical factors; personnel (or human) survivability factors; and habitability considerations into the system acquisition process.

Human Factors (HF)—A body of scientific facts about human characteristics. The term covers all biomedical and psychological considerations; it includes, but is not limited to, principles and applications in the areas of human engineering, personnel selection, training, life support, job performance aids and human performance evaluation.

Information Assurance (IA)—Information operations that protect and defend information and information systems by ensuring their availability, integrity, authentication, confidentiality, and non-repudiation. This includes providing for the restoration of information systems by incorporating protection, detection, and reaction capabilities.

Initial Operational Capability (IOC)—The first attainment of the capability to employ effectively a weapon, item of equipment, or system of approved specific characteristics, and which is manned or operated by an adequately trained, equipped, and supported military unit or force. (JP 1-02)

Initial Operational Test and Evaluation (IOT&E)—An independent and dedicated operational test and evaluation conducted in as realistic an operational environment as possible to estimate the prospective system's overall operational capability determined by effectiveness, suitability, and other operational considerations. In addition, OT&E provides information on organization, personnel requirements, doctrine and tactics. It may also provide data to support or verify material in operating instructions, publications and handbooks.

Initial Spares Support List (ISSL)—A list of spares and repair parts and quantities required for organizational and field maintenance initial support of an end item for a given period of time. Quantities established for ISSLs will be equal to initial base stockage objective.

In—Process Review—A review of a material development project conducted at critical points in the development cycle for the purpose of evaluating the status of the project, accomplishing effective coordination, and facilitating proper and timely decisions bearing on the future course of the project.

Integrated Diagnostics—A structured approach to use the most effective combination of a system's automated, semiautomatic, and manual diagnostic resources in a total system supportability approach that provides the required performance information to the appropriate personnel when needed and the supporting mechanisms to efficiently isolate all faults to the specific malfunctioning item. (AFPAM 63-128)

Built—in Test Equipment (BITE)—Any device permanently mounted in the prime equipment and used for the express purpose of testing the prime equipment, either independently or in association with external test equipment.

Built—in Test/Fault Isolation Test (BIT/FIT)—Can employ information from a wide variety of sensors, especially using machine reasoning in onboard processors to interpret the indications.

Automatic Test Equipment (ATE)—Any automated device used for the express purpose of testing prime equipment; usually external to the prime device (e.g., support equipment).

Integrated Logistics Support (ILS)—A disciplined, unified, and iterative approach to the management and technical activities necessary to integrate support considerations into system and equipment design; develop support requirements that are related consistently to readiness

objectives, to design, and to each other; acquire the required support; and provide the required support during the operational phase at minimum cost.

Integrated Logistics Support (ILS) Elements:—Maintenance Planning—The process conducted to evolve and establish maintenance concepts and requirements for the lifetime of a materiel system.

Manpower and Personnel—The identification and acquisition of military and civilian personnel with the skills and grades required to operate and support a material system over its lifetime at peacetime and wartime rates.

Supply Support—All management actions, procedures, and techniques used to determine requirements to acquire, catalog, receive, store, transfer, issue, and dispose of secondary items. This includes provisioning for initial support as well as replenishment supply support.

Support Equipment—All equipment (mobile and fixed) required to support the operation and maintenance of a material system. This includes associated multi-use end items, ground handling and maintenance equipment, tools, meteorology and calibration equipment, test equipment, and automatic test equipment. It includes the acquisition of logistics support for the support and test equipment itself.

Technical Data—Recorded information regardless of form or character of a scientific or technical nature.

Training and Training Support—The processes, procedures, techniques, training devices and equipment used to train civilian and active duty and reserve military personnel to operate and support a materiel system.

Facilities—The permanent, semi-permanent or temporary real property assets required to support the material system, including conducting studies to define types of facilities or facility improvements, location, space needs, utilities, environmental requirements, real estate requirements, and equipment.

Packaging, Handling, Storage, and Transportation—The resources, processes, procedures, design considerations, and methods to ensure that all system, equipment, and support items are preserved, packaged, handled, and transported properly, including environmental considerations, equipment preservation requirements for short- and long-term storage, and transportability.

Design Interface—The relationship of logistics-related design parameters, such as R&M, to readiness and support resource requirements. Logistics-related design parameters are expressed in operational terms rather than inherent values and specifically related to system readiness objectives and support cost of the material system.

Integrated Test and Evaluation (IT&E)—An efficient approach to T&E, executed with the deliberate intent and planning to use specific test events and activities for both developmental test and operational test analysis and reporting, when there are clear cost and/or schedule advantages. The high cost or lack of sufficient test articles may provide an overall benefit for DT&E and OT&E teams to share test resources and data. IT&E usually ends with a phase of dedicated OT&E. AFOTEC always considers doing IT&E for all programs. The restriction for contractor involvement in USC, Title 10 applies only to dedicated OT&E.

Interoperability—The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together.

Joint Reliability and Maintainability Evaluation Team (JRMET)—established by the PM, assists in the collection, analysis, verification, and categorization of reliability, maintainability, and availability data. The JRMET may also review applicable Deficiency Reports (DRs) and recommend whether or not they should be closed.

Levels of Protection—The degree of preservation, packaging and packing required to prevent deterioration or damage to supplies and equipment because of the hazards to which they may be subjected during shipment and storage.

Life—Cycle Cost—The total cost to the government of acquisition and ownership of the system over its useful life. It includes the cost of development, acquisition, support, and where applicable, disposal. (DSMC Glossary)

Life unit—A measure of use duration applicable to the item (such as operating hours, cycles, distance, rounds fired, and attempts to operate). (DAG)

Line—Replaceable Unit (LRU)—An item that is normally removed and replaced as a single unit to correct a deficiency or malfunction on a weapon or support system and item of equipment. Such items have a distinctive stock number for which repairs may be locally authorized to support the removal and replacement action. These items are repair cycle assets subject to/due in from maintenance (DIFM) controls (T.O. 00-20-3) and may be disassembled into separate components during shop processing. Components, shop-replaceable units (SRU), may also be repair cycle assets subject to DIFM controls if they are processed separately and spares are locally authorized and maintained to support intermediate-level repair of the LRU. (AFI 21-101)

Logistics: —Logistics is the science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations that deal with: 1) Design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel, 2) Movement, evacuation, and hospitalization of personnel, 3) Acquisition or construction, maintenance, operation, and disposition of facilities, and 4) Acquisition or furnishing of services. (JP 1-02)

Logistics can also be defined as the functional fields of military operations concerned with: 1) Material requirements, 2) Production planning and scheduling, 3) Acquisition, inventory management, storage, maintenance, distribution and disposal of materiel, supplies, tools, and equipment, 4) Transportation, telecommunications, petroleum, and other logistical services, 5) Supply cataloging, standardization, and quality control, 6) Commercial and industrial activities and facilities including industrial equipment, and 7) Vulnerability of resources to attack damage.

Logistics Management Information (LMI)—The selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the systems engineering process, to assist in causing support considerations to influence design, defining support requirements that are related optimally to design and to each other, acquiring the required support, and providing the required support during the operational phase at minimum cost. LMI was previously known as the logistics support analysis (LSA) process.

Logistics Resources—The support personnel and materiel required by an item to ensure its mission performance. It includes tools, test equipment, repair parts, facilities, TM and administrative supply procedures necessary to ensure the availability of these resources when needed.

Logistics Supportability—The degree to which the planned logistics support allows the system to meet its availability and wartime usage requirements. Planned logistics support includes the following: test, measurement, and diagnostic equipment; spare and repair parts; technical data; support facilities; transportation requirements; training; manpower; and software. (DAG)

Low—Rate Initial Production—The production of a system in limited quantity to be used in OT&E for verification of production engineering and design maturity and to establish a production base.

Maintainability—The ability of an item to be retained in or restored to specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair. (AFPAM 63-128)

Maintenance—All actions necessary for retaining material in or restoring it to a serviceable condition. Maintenance includes servicing, repair, modification, modernization, overhauls, inspection, condition determination, corrosion control and initial provisioning of support items. (AFI 21-103)

Maintenance Action—An element of a maintenance event. One or more tasks necessary to retain an item in, or restore it to, a specified condition. (AFI 63-101, *Acquisition and Sustainment Life Cycle Management*)

Maintenance Concept—A description of the planned general scheme for maintenance and support of an item in the operational environment. (MIL-HDBK 470A)

Maintenance Downtime per Sortie—For a specified period of time, the total time the system is NMCM and NMCB, scheduled, in clock hours, divided by the number of sorties.

Maintenance Event—One or more maintenance actions required to effect preventive and CM, including troubleshooting, due to any type of failure or malfunction, scheduled maintenance, or servicing as applicable. (AFPAM 63-128)

Maintenance Man—Hours per Life Unit (MMH/LU)—The maintenance hours required divided by the appropriate life unit. (AFPAM 63-128)

Maintenance Personnel Per Operational Unit—(The user of this term needs to define the operational unit.) The number of maintenance personnel that will be required to support an operational unit (excluding depot level and other manpower that is excluded from maintenance planning factors by AFI 38-201) under specified operating and maintenance concept. (AFPAM 63-128)

Maintenance Ratio—The cumulative number of maintenance work-hours during a given period divided by the cumulative number of life units (e.g., OH).

Manpower Supportability—The identification and acquisition of military and civilian personnel with the skills and grades required to operate and support a material system over its lifetime at peacetime and wartime rates. ("Memorandum of Agreement on Multi-Service Test & Evaluation and Operational Suitability Terminology and Definitions")

Mature System—An operational system is considered mature when its R&M characteristics cease to improve significantly with continued use. System, subsystems and components all mature at varying rates and lengths of time. Unless otherwise specified, a system is considered to have mature R&M characteristics two years after the IOC date.

Mean Downtime (MDT)—The average elapsed time, as a result of a downing event, required to restore a system to full operating status includes maintenance, supply and administrative delay times. Besides the inherent repair and maintainability characteristics, field conditions such as tech-order availability and adequacy, support equipment capability and availability, supply levels, manning, experience level and shift structure also affect downtimes.

Mean Repair Time (MRT)—MRT is the average on-equipment, off-equipment or both corrective maintenance times. It includes all maintenance actions needed to correct a malfunction, including preparing for test, troubleshooting, removing and replacing parts, repairing, adjusting, reassembly, alignment, adjustment, and checkout. MRT does not include maintenance, supply or administrative delays.

Mean Time Between Critical Failures (MTBCF)—MTBCF is the average time between failures of mission-essential system functions. Critical failures do not have to occur during a mission, they merely must or could cause mission impact.

Mean Time Between Demands (MTBD)—A measure of the system reliability parameter related to demand for logistics support; it is the total number of system life units (e.g., flying hours (FH) and sorties) divided by the total number of item demands on the supply system during a stated period of time.

Mean Time Between Downing Events (MTBDE)—MTBDE is the average time between events that bring the system down (e.g., critical or non-critical failures, preventive maintenance, training, maintenance and supply response, administrative delays and actual on-equipment repair).

Mean Time Between Failures (MTBF)—MTBF is a basic measure of reliability for repairable items; it is the mean number of life units during which all parts of the item perform within their specified limits during a particular measurement interval under stated conditions.

Mean Time Between Maintenance (MTBM)—The total life units (for example, OH, FHs or rounds) divided by the total number of maintenance (base level) events for a specific period of time.

Mean Time Between Maintenance (Induced)—The average time between the on-equipment corrective events associated with malfunctions resulting from other than internal design and manufacturing characteristics, for example, improper maintenance, operator error, foreign object damage and failures caused by malfunction of associated equipment.

Mean Time Between Maintenance (Inherent)—The average time between the on-equipment corrective events associated with malfunctions resulting from internal design and manufacturing characteristics.

Mean Time Between Maintenance (No Defect)—The average time between the on-equipment corrective events associated with equipment which has no confirmed malfunction, such as removals which subsequently bench check satisfactory.

Mean Time Between Maintenance (Preventive)—The average time between maintenance events including removals, replacement or reinstallation associated with scheduled maintenance or time changes.

Mean Time Between Operational Mission Failures (MTBOMF)—The total operating time (e.g., driving time, flying time or system-on time) divided by the total number of OMFs.

Mean Time Between Removals (MTBR)—A measure of the system reliability parameter related to demand for logistics support. The total number of system life units divided by the total number of items removed from that system during a stated period of time. This term is defined to exclude removals performed to facilitate other maintenance and removals for time compliance T.O.s (product improvement).

Mean Time Between Scheduled Maintenance (MTBSM)—The total operating time divided by the total number of scheduled maintenance events.

Mean Time Between Unscheduled Maintenance (MTBUM)—The total operating time divided by the total number of incidents requiring unscheduled maintenance.

Mean Time To Failure—A basic measure of reliability for non-repairable items; it is the total number of life units of an item divided by the total number of failures within that population during a specified time interval under stated conditions.

Mean Time To Repair (MTTR)—(A contract term only) A basic measure of maintainability; it is the sum of corrective maintenance times at any specific level of repair divided by the total number of failures within an item repaired at that level during a particular interval under stated conditions.

Mean Time to Restore Functions (MTTRF)—MTTRF is the average elapsed time, as a result of a critical failure, required to restore a system to full operating status. It includes administrative and logistics delay times associated with restoring function following a critical failure.

Minimum Essential Subsystem List (MESL)—The MESL lists the minimum essential subsystems needed to perform the intended missions. All intended mission profiles will have a MESL. The MESL is used to judge the mission criticality of failures during testing. (AFPAM 63-128)

Micro—OMNIVORE—A data retrieval and analysis system.

Mishap—An unplanned event or series of events resulting in death, injury, occupational illness, or damage to or loss of equipment or property, or damage to the environment. (MIL-STD 882D)

Mishap Risk Assessment—The process of characterizing hazards within risk areas and critical technical processes, analyzing them for their potential mishap severity and probabilities of occurrence, and prioritizing them for risk mitigation actions.

Mishap Severity—An assessment of the consequences of the most reasonable credible mishap that could be caused by a specific hazard.

Mission Capable (MC)—The ability of a system to perform at least one of its assigned peacetime or wartime missions. If no wartime mission is assigned, the system must be capable of performing any one assigned mission (AFI 21-103 and AFPAM 63-128). MC rate is the percentage of possessed time that a weapon system can perform its assigned missions mission

capable time divided by total possessed time. MC rate may be expressed as the sum of FMC and PMC rates.

Mission Reliability—See Reliability.

Mobility Readiness Spares Package (MRSP)—An air transportable package of spares and repair parts required to sustain planned wartime or contingency operations of a weapon system for a specified period of time pending re-supply. MRSPs will include spares and repair parts for aircraft, vehicles and other equipment, as appropriate. MRSPs are normally pre-positioned with the using unit.

Not Mission Capable (NMC)—A status code which the system or equipment cannot perform any of its primary missions. It can be followed by a reason code meaning maintenance (M), supply (S) or both (B). (AFI 21-103)

Not Repairable This Station (NRTS)—A status condition determined during shop processing of an item used to indicate that the item cannot be repaired at base level because of lack of authorization, technical skills, parts, facilities, manpower, or any other causes. (T.O. 00-20-1)

Off—Equipment Maintenance—In-shop maintenance actions performed on removed components, except complete aircraft engines.

On—Equipment Maintenance—Maintenance actions accomplished on a complete end item such as aircraft, trainers, support equipment, communication-electronic-meteorology equipment, complete round munitions and uninstalled aircraft engines.

Operating Command—The command or agency primarily responsible for the operational employment of a system, subsystem, or item of equipment; it is also a participating command.

Operational Assessment (OA)—Analysis of progress toward operational effectiveness and suitability made by an independent operational test activity, with user support as required, on other than production systems. Additionally, AFOTEC assesses progress toward overall mission capability. The focus of an operational assessment is on significant trends noted in development efforts, programmatic voids, areas of risk, adequacy of requirements, and the ability of the program to support adequate operational testing. Operational assessments may be made at any time using technology demonstrators, prototypes, mockups, engineering development models or simulations, but will not substitute for the independent OT&E necessary to support full production decisions. An OA conducted before, or in support of, Milestone B is an early operational assessment.

Operational Availability (AO)—A_O is the probability that a system can be used for any specified purpose when desired. It includes both the inherent R&M parameters and logistics support effectiveness of the system that relates to the total time the system might be desired for use.

Operational Dependability (D_O)—D_O is the probability that a system can be used to perform a specified mission when desired. It includes both the inherent R&M parameters and logistics support effectiveness of the system that relates to all time the system might be desired for mission use and for which critical failures could occur. The difference between A_O and D_O is that D_O is used for systems that can be repaired during the mission.

Operational Effectiveness—The overall degree of mission accomplishment of a system used by representative personnel in the context of the organization, doctrine, tactics, threat (including

countermeasures and nuclear threats), and environment in the planned or operational employment of the system. (AFPAM 63-128)

Operational Mission Failure—See Failure.

Operational Suitability—The degree to which a system can be placed satisfactorily in field use with consideration given to availability, compatibility, transportability, interoperability, reliability, wartime usage rates, maintainability, safety, human factors, manpower supportability, logistics supportability, natural environmental effects and impacts, documentation, and training requirements. (DAG)

Operational Task—An individual military operation that is accomplished in support of an operational objective. (AFOTECMAN 99-101)

Operational Test and Evaluation (OT&E)— The field test, under realistic combat conditions, of any item of (or key component of) weapons, equipment, or munitions for the purpose of determining the effectiveness and suitability of the weapons, equipment or munitions for use in combat by typical military users, and the evaluation of the results of such test. (10 USC Section 139)

Operational Utility Assessment (OUA)—OUAs are used to determine operational utility in support of assessments conducted on innovation programs. An OUA is planned, conducted and reported by adapting the OT&E construct to the technology being assessed.

Operational Utility Evaluations (OUE)—OUEs are evaluations conducted to demonstrate or validate new operational concepts or capabilities, upgrade components, or expand the mission or capabilities of existing or modified systems. OUEs are not used when IOT&E, QOT&E, or Force Deployment Evaluation (FDE) are required or are more suitable.

Organizational—Level Maintenance—The maintenance and repair performed by the activity level that uses the system's equipment within the activity's capability (DSMC Glossary). Organizational maintenance normally consists of inspecting, servicing, lubricating, adjusting and replacing parts, minor assemblies and subassemblies.

Partially Mission Capable (PMC)—The percentage of possessed time that a system is capable of performing at least one but not all of its assigned wartime missions. PMC may be subdivided into PMC maintenance (PMCM), PMCS and PMCB. (AFI 21-103)

Participating Command—A command or agency designated by HQ USAF to support and advise the program manager during the execution of a program.

Possessed Hours—The total hours in a given period that assigned equipment is under the operational control of the designated responsible organization.

Preventive Maintenance— All actions performed in an attempt to retain an item in a specified condition by providing systematic inspection, detection, and prevention of incipient failures (DAU Glossary).

Qualification Operational Test and Evaluation (QOT&E)—The operational testing performed on programs instead of IOT&E for which there is no RDT&E-funded development effort.

Readiness—The ability of forces, units, or weapon systems or equipment to deliver the outputs for which they were designed (includes the ability to deploy and employ without unacceptable delays). (JP 1-02 and AFPAM 63-128)

Reliability—The ability of a system and its parts to perform its mission without failure, degradation, or demand on the support system. (DAG)

Logistics Reliability—A measure of a system's capability to operate as planned under the defined operations and support (O&S) concepts using specified logistics resources (for example, spares or manpower). (AFPAM 63-128)

Mission Reliability (R_m)—The probability that the system is operable and capable of performing its required function for a stated mission duration or at a specified time into the mission. R_m is based on the effects of system reliability during mission time only. R_m does not take into account system maintainability.

Reliability Analysis Center—An official DoD contractor-operated center located at Rome Air Development Center authorized to collect, analyze, and disseminate reliability data and information on microcircuits, solid state devices, non-electronic parts and equipment, and systems.

Repair—Level Analysis (RLA)—The basic decisions about: 1) Repair versus throwaway, and 2) The most desirable repair posture.

Risk—An expression of the possibility of a mishap in terms of hazard severity and hazard probability. (MIL-STD 882D)

Safety—Freedom from conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment (*DOT&E Operational Suitability Guide, Volume I – A Tutorial*).

Safety of Test—The application of safety and management principles, criteria, and techniques to achieve acceptable risk, within the constraints of operational effectiveness and suitability, time, and cost, throughout all phases of the testing to ensure personnel are safe from illness, injury, and accidents.

System Safety—The application of engineering and management principles, criteria, and techniques to achieve acceptable mishap risk, within the constraints of operational effectiveness and suitability, time, and cost, throughout all phases of the system life cycle.

Shop—Replaceable Unit (SRU)—A module for an LRU which can be removed from the LRU at an intermediate repair facility.

Software Failure—See Failure.

Sortie Generation Rate—The average number of sorties produced per aircraft in a defined operating period. (AFPAM 63-128)

Suitability—See Operational Suitability.

Support Equipment—See ILS Elements.

Sustainability:—Wartime Sustainability—The ability to maintain the necessary level and duration of operational activity to achieve military objectives. It is a function of providing and

maintaining levels of ready forces, material and consumables necessary to support the military effort. (JP 1-02)

Peacetime Sustainability—The ability to maintain the necessary levels of forces, material, and consumables to support the burden of ownership of the system.

System Program Office (SPO): —The organization comprised of technical and business management and administrative personnel assigned full time to a system program director. The office may be augmented with additional personnel from participating organizations.

The office of the program manager and the single point of contact with industry, government agencies and other activities participating in the system acquisition process. (DSMC Glossary)

Technical Manual (TM)—A publication that contains instructions for the installation, operation, maintenance, training, and support of weapon systems, weapon system components, and support equipment. TM information may be presented in any form or characteristic, including, but not limited to, hard copy, audio and visual displays, magnetic tape, discs, and other electronic devices. A TM normally includes operational and maintenance instructions, parts lists or parts breakdown, and related technical information or procedures exclusive of administrative procedures. T.O.s that meet the criteria of this definition may also be classified as TMs.

Technical Order (T.O.)—An Air Force publication that gives specific technical directives and information with respect to the inspection, storage, operation, modification and maintenance of given Air Force items and equipment.

Test and Evaluation (T&E): —The term "test" denotes any project or program designed to obtain, verify and provide data for the evaluation of R&D other than laboratory experiments; progress in accomplishing development objectives; performance and operational capability of systems, subsystems, and components; and equipment items. The term "evaluation" denotes the review and analysis of quantitative data produced during current or previous testing, data obtained from test conducted by other government agencies and contractors, from operation and commercial experience, or combinations thereof.

Process by which a system or components are compared against requirements and specifications through testing. The results are evaluated to assess progress of design, performance, supportability, etc. Three types of T&E occur during the acquisition cycle: Development (DT&E), Operational (OT&E) and Production Acceptance (PAT&E). (DSMC Glossary)

Threshold—Minimum acceptable operational value for a system capability or characteristic below which the utility of the system becomes questionable.

Training Requirements—The processes, procedures, techniques, training devices and equipment used to train civilian and active duty and reserve military personnel to operate and support a material system. This includes individual and crew training, new equipment training, initial, formal and on-the-job training and logistics support planning for training equipment and training device acquisitions and installations. (*DOT&E Operational Suitability Guide, Volume I – A Tutorial*)

Transportability—The capability of material to be moved by towing, self-propulsion, or carrier via any means, such as railways, highways, waterways, pipelines, oceans, and airways. (Full consideration of available and projected transportation assets, mobility plans and schedules, and

the impact of system equipment and support items on the strategic mobility of operating military forces are required to achieve this capability.) (JP 1-02)

Unscheduled Maintenance—Corrective maintenance required by item conditions.

Utilization Rate—The average life units expended or missions attempted (launched and airborne) per system or subsystem during a specific interval of time. (AFPAM 63-128)

Verification, Validation & Accreditation (VV&A)—1) Verification: The process of determining that a model or simulation (or other test capability) implementation accurately represents the developer's conceptual description and specifications. For model and simulation, verification also evaluates the extent to which the model and simulation has been developed using sound and established software-engineering techniques. 2) Validation: The process of determining a) the manner and degree to which a model and simulation (or other test capability) is an accurate representation of the real-world from the perspective of the intended uses of the model and simulation, and b) the confidence that should be placed on this assessment. 3) Accreditation: An official determination that a model or simulation is acceptable for a specific purpose, and is based on a five-step process: identify test issues; review validation documentation; compare test capabilities and validation information with test issues; identify potential shortfalls; and develop and execute strategy to address shortfalls (assess risk).

Wartime Usage Rates—The quantitative statement of the projected manner in which the system is to be used in its intended wartime environment. (*DOT&E Operational Suitability Guide, Volume I – A Tutorial*)

Weapon System Reliability (WSR)—The probability that a system will complete a specified mission, given that the system was initially capable of performing that mission.

Attachment 2

RELIABILITY MEASURES

A2.1. Introduction. This attachment provides a discussion of reliability measures in general and presents examples of system-specific measures.

A2.2. Time Between Failures.

A2.2.1. Time between failures is the primary measure of reliability. The mean of many such times is the most commonly used metric of reliability known as the mean time between failures (MTBF). It is defined as the total functioning life of a population of an item during a specific measurement interval, divided by the total number of failures within the population during that interval. MTBF can be interpreted as the expected length of time a system will be operational between failures.

A2.2.2. We need not restrict ourselves only to the mean to describe the typical time between failures. Also possible, and sometimes preferable, are a variety of other statistics (metrics) such as the median, maximum, and minimum times between failures. Just as the mean is not the only metric for describing the typical time between failures, time need not be the only measure of life between failures. Cycles, miles, events, or other measure-of-life units are also admissible and are sometimes more informative than clock time, permitting the time between failures measure to be tailored to the reliability requirements of a specific system. Some examples of this tailoring are: rounds between failures, miles between operational mission failure, time between unscheduled maintenance actions, cycles between downing events, sorties between any maintenance actions. In the most general sense, reliability is measured by life units (hours, cycles, miles, etc) between events. These events must be clearly defined in advance and might include failures, critical failures, operational mission failures, downing events, maintenance actions or others.

A2.2.3. **Failure Rate.** Failure rate is defined as the number of failures of an item per measure-of-life unit (e.g., cycles, hours, miles or events as applicable). This metric is more difficult to visualize from an operational standpoint than the MTBF metric, but is a useful mathematical term which frequently appears in many engineering and statistical calculations. The failure rate is simply the reciprocal of the MTBF metric.

A2.3. Reliability Incident Classification. An understanding of the relationships existing between the reliability aspects above and other terms is essential to the knowledgeable application of these parameters.

A2.3.1. **Mission Failures—**Mission failures are the loss of any of the system's mission-essential functions. Along with system hardware/software failures and any SUT failure, operator errors and errors in publications that cause such a loss are included in this category. Mission failures are related to mission reliability measures because they prevent complete mission accomplishment.

A2.3.2. **System Failures—**System failures are malfunctions that may or may not affect the system's mission-essential functions, and they may or may not require spares for correction. A system failure generally requires unscheduled maintenance so system failures heavily influence maintenance-related reliability.

A2.3.3. **Unscheduled Spares Demands—**Unscheduled spares demands are used to evaluate supply-related reliability. All unscheduled spares demands require a response from the supply system, so they form the basis for evaluating supply-related reliability.

A2.3.4. **System or Mission Failures Requiring Spares—**System or mission failures that require spares for correction are the most critical. Mission, maintenance and supply reliabilities are affected, and the system runs the risk of being held in a non-mission-ready status for an extended period of time by logistics delays.

A2.4. System-specific Example Measures.

A2.4.1. **Aircraft.**

A2.4.1.1. **Mission Reliability (R_m).** R_m is the probability that the system is operable and capable of performing its required function for a stated mission duration or at a specified time into the mission. R_m is based on the effects of system reliability during mission time only. R_m does not take into account system maintainability. For systems with failures distributed exponentially, R_m is defined as

$$R_m = e^{-(t\,/\,\mathrm{MTBCF})}$$

where *t* is the average mission time and mean time between critical failures (MTBCF) is the average time between failures of mission-essential system functions. Specific mission times should be used to determine the R_m for each mission if the system is used under significantly different mission lengths. **NOTE:** Exponential systems are systems whose times to failure exhibit an exponential probability density function (i.e., systems that exhibit a constant failure rate). In addition, MTBCF may be the same as mean time between operational mission failures (MTBOMF) for some joint programs, however the distinction should be defined in the JRMET Charter.

A2.4.1.1.1. **Weapon System Reliability (WSR).** WSR is an expression of R_m often used in aircraft system testing. It is the probability of completing the mission (i.e., peacetime and/or wartime) without critical failures. It is important to clearly define the mission into specific mission phases (i.e., take-off, ingress/cruise, release weapons/loiter, egress, and landing phases for an aircraft) to maximize the available data during test. Environmental profiles such as temperature, air density, humidity, vibration, shock or corrosive agents may be considered as factors delimiting R_m. Mission-critical systems should be identified for each mission phase. WSR is expressed as

$$\mathrm{WSR} = \frac{\text{successful missions}}{\text{attempted missions}}$$

A2.4.1.1.2. **Break Rate (BR).** BR is the percentage of sorties from which an aircraft returns from an assigned mission with one or more inoperable ("code 3") mission-essential systems that were previously operable. Break rate includes "code 3" conditions, such as ground and air aborts. BR is calculated with

$$\mathrm{BR}\ (\%) = \frac{\text{number of aircraft code 3 events during measurement period}}{\text{number of sorties flown during period}} \times 100$$

A2.4.1.2. **Logistics Reliability.** Logistics reliability is the ability of a system to perform failure-free under specified operating conditions and time without demand on the

logistics support system. Logistics reliability addresses all incidents that require a response from the logistics support system. A measure of logistics reliability is the time between maintenance. A typical metric for aircraft systems is the mean time between maintenance (MTBM). Data collection systems allow tracking of standard MTBM parameters such as inherent malfunctions, induced malfunctions, no-defect events, total corrective events, preventative maintenance, removals or demands. MTBM is expressed as the average flying hours between scheduled and unscheduled maintenance events for the appropriate, selected parameter based on MAJCOM requirements:

$$\text{MTBM} = \frac{\text{flying hours}}{\text{number of maintenance events of interest}}$$

A2.4.2. **C4I Systems.**

A2.4.2.1. **Logistics Reliability.** Logistics reliability captures the system's frequency of maintenance under defined operational and support concepts, using specific logistics resources. A measure of logistics reliability is the time between maintenance. A typical metric of logistics reliability is the MTBM. It is the average time between all maintenance events, that is, both scheduled and unscheduled events for hardware and software:

$$\text{MTBM} = \frac{\text{number of operating hours}}{\text{number of maintenance events}}$$

This is equivalent to

$$\text{MTBUM} = \frac{\text{MTBUM x MTBSM}}{\text{MTBUM + MTBSM}}$$

where mean time between unscheduled maintenance (MTBUM) and mean time between scheduled maintenance (MTBSM) are most often defined as

$$\text{MTBM} = \frac{\text{number of operating hours}}{\text{number of unscheduled maintenance events}}$$

$$\text{MTBSM} = \frac{\text{number of operating hours}}{\text{number of scheduled maintenance events}}$$

A2.4.3. **Munitions/Missile Systems**

A2.4.3.1. **Storage Reliability (R_S).** For munitions/missiles, R_S is defined as the probability the system will be removed from storage and pass BIT and visual inspection. R_S is equivalent to the Navy's operational availability for munitions/missiles. Typically, R_S cannot be calculated during OT&E due to the immature logistics environment, test-unique events required to prepare weapons for test (such as telemetry kit installation), and non-representative storage and transportation procedures for OT weapons. However, R_S could be modeled with data from surveillance programs of similar systems or from accelerated life testing.

$$R_S = \frac{\text{number of weapons removed from storage not experiencing critical failures prior to aircrew acceptance}}{\text{number of weapons evaluated}}$$

A2.4.3.2. WSR. WSR is an expression of R_m often used in munitions/missiles testing. It is the probability of completing the mission (i.e., peacetime and/or wartime) without

critical failures. It is important to clearly define the mission into specific mission phases to maximize the available data during test. For example, captive-carry, launch, free-flight cruise and terminal phases may be considered for a missile. This allows data from backup missiles, captive-carry tests, mission aborts, and other mission events to be included in the WSR database. WSR is expressed as

$$\text{WSR} = \frac{\text{successful missions}}{\text{attempted missions}}$$

Attachment 3

AVAILABILITY MEASURES

A3.1. Introduction. This attachment provides a discussion of the difficulty of measuring availability directly, general availability measures and system-specific availability measures.

A3.2. Discussion.

A3.2.1. Availability, as defined in AFPAM 63-128, is the degree (expressed in terms of 1.0 or 100 percent as the highest) to which one can expect an equipment or weapon system to work properly when it is required. In practice, this may include reliability as well as maintainability and logistics information. A system's availability may suffer because it breaks frequently (reliability), a fix requires a substantial amount of time (maintainability) or parts may have to travel a great distance (logistics). In operational testing, we are not usually able to collect enough data to answer the availability question directly. Instead, we collect reliability, maintainability and logistics information which is entered into a model to arrive at a reasonable estimate of availability for a given operational scenario.

A3.2.2. To illustrate the difficulty of measuring availability directly, consider MC Rate. MC Rate is determined by

$$\text{MC} = \frac{\text{number of FMC hours + number of PMC hours}}{\text{possessed hours}}$$

MC Rate is subject to the influence of other factors such as utilization rate. For example, if the plane is FMC but isn't flown, the MC Rate increases. In operational testing, it is difficult, if not impossible, to determine MC Rate satisfactorily without using modeling and simulation. In general, there will be too few test articles and the team will not have the aircraft for sufficient time to collect enough information to answer the question with adequate confidence.

A3.2.3. It is best to collect as much data as possible during an operational test. You don't want to find out the analysis needed is impossible because you missed something simple. Collect times and types of failures and repair times. Collect information on parts delays to the extent possible. Collect information on the number of personnel required to restore functionality. This information is common to IMDS and GO81. However, if it is not available in an existing database, collect all data that may be required.

A3.2.4. Analysis of this data depends on the time and money available. It is seldom simple and usually requires a great deal of discussion and research into the different methods available. A-2/9 can help determine the best method of analysis as well as analyze the data.

A3.3. General Availability Measures.

A3.3.1. A_0 provides the most realistic measure of availability of systems deployed and functioning in a combat environment.

A3.3.1.1. A continuous model is appropriate for aircraft sitting on a ramp.

$$A_0 = \frac{\text{uptime}}{\text{total time}}$$

A3.3.1.2. A discrete model (also referred to as Demand Availability) is appropriate for a satellite that is continuously orbiting and receives discrete demands for its services.

$$A_0 = \frac{\text{number of times the system is available}}{\text{number of times the system is required}}$$

A3.3.2. Achieved Availability (A_a) is a measure primarily used during developmental testing when the system is not operating in its intended support environment.

$$A_a = \frac{\text{operating time}}{\text{operating time} + \text{total maintenance time}}$$

A3.3.3. Inherent Availability (A_i) is useful in determining basic operational characteristics under controlled conditions such as in a contractor's facility and usually should not be used to support an operational test. However, automated information systems (AIS) occasionally use this concept as a definition of D_o.

$$A_i = \frac{\text{operating time}}{\text{operating time} + \text{total corrective maintenance time}}$$

A3.3.4. Achieved Availability and Inherent Availability may be useful in OT&E since they focus on the system, whereas Operational Availability includes the effects of operating procedures. Achieved Availability and Inherent Availability also indicate the availability possible if logistical and administrative delays are not present.

A3.4. System-specific Example Measures.

A3.4.1. **Aircraft.**

A3.4.1.1. **Availability.** Usually the entire aircraft (including all its subsystems and support equipment) is assessed in terms of its availability. Subsystems are important only to the extent that they contribute to the mission and support of the aircraft. Subsystem mission criticality will be defined in a MESL. For example, if the avionics system is critical to the mission of the aircraft, the impact of the avionics system's availability on the availability of the host aircraft should be assessed. If the avionics system is not critical to the mission of the aircraft, no availability assessment is required (nor is it desired). MOSs for availability are generally expressed as percentages, e.g., either the percentage of time a system is capable of performing its mission or the percentage of time a fleet is capable of performing its mission. The selection of MOSs for availability should be based on the terms found in AFPAM 63-128 and the requirements document. These MOSs are difficult to measure during IOT&E where many support elements are not representative of the operational environment. During a typical IOT&E, modeling may be required to estimate and project these measures. A-2/9 is the focal point for logistics modeling efforts. During FOT&E, with representative support elements in an operational organization, these MOSs may be measured directly.

A3.4.1.2. **Sortie Generation Rate (SGR).** SGR is expressed as the number of sorties per aircraft per relevant period of time such as a day or month. It is calculated by averaging the sorties during the measurement period and dividing this figure by the average number of possessed aircraft (for peacetime) or authorized aircraft (for wartime). A sortie starts when the aircraft begins to move forward on take-off and ends when the aircraft returns to the surface and either the engines are stopped, the aircraft is on the surface for five minutes (whichever occurs first), or a change is made in the crew. SGR is calculated through direct measurement or from simulation results depending on the

realism of the test environment. Because most aircraft can perform several missions, it may be necessary to calculate several SGRs to represent the full range of operational mission requirements.

$$SGR = \frac{\text{total number of sorties / total number of aircraft}}{\text{number of days}}$$

or

$$SGR = 1 - \frac{\text{number of ground aborts + number of air aborts}}{\text{number of ground aborts + number of sorties}}$$

This measure typically applies to the total aircraft system and is not used for avionics systems and simulators. However, the impact of a new avionics system on the host aircraft's SGR may be measured.

A3.4.2.1. **Ao**. A_o is the probability that a system can be used for any specified purpose when desired. It includes both the inherent R&M parameters and logistics support effectiveness of the system that relates to the total time the system might be desired for use. The continuous model given in paragraph A4.3.1.2. for A_o is equivalent to

$$A_o = \frac{MTBDE}{MTBDE + MDT}$$

A3.4.2.1.1. MTBDE is the average time between events that bring the system down (e.g., critical or non-critical failures, scheduled maintenance and training). Besides the inherent repair and maintainability characteristics, field conditions such as tech-order availability and adequacy, support equipment capability and availability, supply levels, manning, experience level and shift structure also affect downtimes.

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

A3.4.2.1.2. MDT is the average elapsed time, as a result of a downing event, required to restore a system to full operating status. Downtime includes maintenance and supply response, administrative delays, and actual on-equipment repair.

$$MDT = \frac{\text{total downtime}}{\text{number of downing events}}$$

A3.4.2.2. **D_o.** Operational Dependability is the probability that a system can be used to perform a specified mission when desired. It includes both the inherent reliability and maintainability parameters and logistics support effectiveness of the system that relates to all time the system might be desired for mission use and for which critical failures could occur.

$$D_o = \frac{MTBCF}{MTBCF + MTTRF}$$

A3.4.2.2.1. MTBCF is the average time between failures of mission-essential system functions. Critical failures do not have to occur during a mission; they merely must or could cause mission impact.

$$MTBCF = \frac{\text{number of operating hours}}{\text{number of critical failures}}$$

A3.4.2.2.2. Mean time to restore functions (MTTRF) is the average elapsed time, as a result of a critical failure, required to restore a system to full operating status. It includes administrative and logistics delay times associated with restoring function following a critical failure.

$$\text{MTTRF} = \frac{\text{total critical restore time}}{\text{number of critical failures}}$$

A3.4.2.2.3. **NOTE:** Consider the question, "Does the system need to be performing its specified mission to count against D_o?" The key is to think, not in terms of collecting data for D_o, but collecting data for MTBCF. The answer is dependent on the definition of when critical failures can occur for the system. If CFs can occur only during the specified mission for that system, then yes. If CFs can occur during non-mission time, then no, the calculated value of D_O may then approach that for A_0. The definitions for A_o and D_o are different in that A_o time includes all time the system may be called upon to workmission or not. D_o time includes time the system may be called upon to perform its mission and time that a critical failure could occurto emphasize again, a CF need not occur during a mission to cause mission impact unless defined that way for the system.

A3.4.2.3. **Utilization Rate (UR).** UR is the average life units (LU) used or missions attempted per system during a specified interval of clock time. There may be both peacetime and wartime rates.

$$\text{UR} = \frac{\text{number of operating hours}}{\text{number of possessed hours}}$$

A3.4.3. **Munitions/Missile Systems.**

A3.4.3.1. **Stockpile Availability (A_s).** Missiles and munitions should be able to withstand long periods of storage with little maintenance and still perform with high reliability. A_s reflects the percentage of on-hand assets capable of performing the task. The number of munitions on-hand normally excludes on-hand assets that are disassembled for storage and/or testing. For example, a disassembled munitions is not normally available munitions; once assembled and checked out, it becomes available. Equivalent definitions are used for theater-level A_s and force-level A_s.

$$A_s = \frac{\text{number of available munitions}}{\text{total munitions in inventory}}$$

A3.4.3.2. **Sortie Surge Weapons Generation (SSWG).** Sortie surge weapons generation is the number of operable munitions/missiles that can be assembled, delivered and loaded to meet wartime sortie requirements within a specified surge period under defined surge conditions. Thus, the measure is a rate. The aircraft type; quantities of personnel, aircraft, support equipment, munitions; and time constraints are based on operational requirements and should be established by the using command. Sortie surge weapons generation can be calculated through direct measurement but is normally estimated using a simulation model because of the lack of assets to conduct a representative generation during OT&E.

$$\text{SSWG} = \frac{\text{number of weapons assembled, delivered, and loaded}}{\text{specified surge time period}}$$

Attachment 4

MAINTAINABILITY MEASURES

A4.1. Introduction. This attachment provides a discussion of data collection for maintainability measures and general examples of maintainability measures.

A4.2. Discussion.

A4.2.1. Maintainability is the ability of an item to be retained in or restored to a specified condition (mission capable or partial mission capable) when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources at each prescribed level of maintenance and repair. Maintainability measures are based on time and critical failures that render a system inoperable (non-mission capable) per event.

A4.2.2. What data to collect:

A4.2.2.1. Critical failures that render a system "non-mission capable."

A4.2.2.2. Non-critical failures that render a system "partially mission capable."

A4.2.2.3. System or subsystem repair time in hours per event.

A4.2.2.4. System or subsystem operating hours.

A4.2.3. How to collect data:

A4.2.3.1. Note and record critical failures per system/subsystem.

A4.2.3.2. Note and record time-to-restore system/subsystem to operational status (mission capable or partial mission capable) per event.

A4.2.4. How to analyze data: Compare repair time per system/subsystem per event and note trend/outliers that may affect overall rating.

A4.3. General Example Measures.

A4.3.1. **Fix Rate (FR).** Percentage of broken systems (aircraft, satellite, etc) returned to operational status in a certain amount of time. For fighter aircraft, measurements are made at the 4-hour and 8-hour points. For other aircraft, measurements are taken at the 12-hour point. A broken aircraft is an aircraft that lands with an overall status of Code 3 (a grounding condition for which the aircraft is unable to meet at least one of its wartime missions). FR includes direct maintenance time and downtime associated with administrative and logistics delays.

$$\text{FR} = \frac{\text{number of aircraft fixed within "x" hours}}{\text{total number of broken aircraft}}$$

A4.3.2. **Time to Restore Function.** The time required, as the result of a critical failure, to restore a system to full operating status. It includes administrative and logistics delay times associated with restoring function following a critical failure. A typical metric is the MTTRF and is defined as

$$\text{MTTRF} = \frac{\text{total critical restore time}}{\text{number of critical failures}}$$

A4.3.3. **Repair Time.** Repair time is the on- and off-equipment corrective maintenance times in an operational environment. It includes all maintenance actions needed to correct a malfunction, including preparing for test, troubleshooting, removing and replacing components, repairing, adjusting, re-assembly, alignment, adjustment, and checkout. Repair time does not include maintenance, supply or administrative delays. MRT is a typical metric of repair time. Note that MRT differs from the contractual term MTTR in that MRT measures maintenance activities that occur in the operational environment.

$$\text{MRT} = \frac{\text{number of corrective repair hours}}{\text{number of corrective maintenance events}}$$

A4.3.4. **Downtime.** The elapsed clock-time between loss of mission-capable status and restoration of the system to mission-capable status. This downtime includes maintenance and supply response administrative delays, and actual on-equipment repair. In addition to the inherent repair and maintainability characteristics, downtime is affected by technical order availability and adequacy, support equipment capability and availability, supply levels, and manning. MDT is a typical downtime metric used to measure the average elapsed time between losing MC status and restoring the system to at least PMC status.

$$\text{MDT} = \frac{\text{NMC time}}{\text{number of downing events}}$$

A4.3.5. Time Between Maintenance Events. The time between on-equipment, corrective events including inherent, induced, no-defect, and preventive maintenance actions. A typical metric is the mean time between maintenance events (MTBME). Divide the total number of life units (for example, operating hours, flight hours, rounds) by the total number of maintenance (base level) events for a specific period of time. A maintenance event is composed of one or more maintenance actions.

A4.3.6. **Time Between Removals.** A measure of the system reliability parameter related to demand for logistic support. A typical metric is the mean time between removals (MTBR), which is the total number of system life units divided by the total number of items removed from that system during a stated period of time. This term is defined to exclude removals performed to facilitate other maintenance and removals for TCTO.

A4.3.7. **MMH/LU.** For aircraft systems, this measure is usually based on FHs, i.e., MMH/FH. Maintenance data collection systems allow tracking by inherent malfunctions, induced malfunctions, no-defect events, total corrective events, support general maintenance, preventative maintenance, product improvement and the sum of all categories.

A4.4. Integrated Diagnostics Measures. The following are a sampling of possible integrated diagnostics measures. Consider others for the particular system under test. The percentage measures could be stated as probabilities in requirements documents. Test measures and metrics should match the requirements documents.

A4.4.1. **Percent BIT Fault Detection (Pfd**). The proportion of the number of faults detected by the system BIT to the total number of faults experienced by the system, expressed as a percentage.

$$P_{fd} = \frac{\text{number of correct detections}}{\text{total number of faults experienced}} \times 100$$

A4.4.2. **Percent BIT Fault Isolation (P_{fi}).** The proportion of detected faults that were unambiguously isolated to a single replaceable unit or other rule identified in the procurement specification (e.g., to a group of 3 or less replaceable units), expressed as a percentage. Clearly define "fault isolation."

$$P_{fi} = \frac{\text{number of correct fault isolations}}{\text{number of correct detections}} \times 100$$

A4.4.3. **Percent BIT False Alarms (P_{fa}).** The proportion of the number of faults that cannot be confirmed upon investigation to the total number of fault indications, expressed as a percentage. This measure is an indication of how frequently the diagnostics indicate a fault exists when in fact the system is functional. This area is particularly troublesome, since the system false alarms may be either improper indications of faults that do not exist or faults that did exist but were transient in nature. Identifying which situation exits is most difficult for complex systems.

$$P_{fa} = \frac{\text{number of BIT faults that cannot be confirmed upon investigation}}{\text{total number of BIT fault indications}} \times 100$$

A4.4.4. **Percent Cannot Duplicate (P_{cnd}).** The proportion of fault detections that result in a CND to the total number of maintenance events (excluding manually generated CND), expressed as a percentage.

$$P_{cnd} = \frac{\text{number of fault detections that result in a CND}}{\text{total number of maintenance events}} \times 100$$

A4.4.5. **Percent Retest Okay (P_{rtok}).** The proportion of LRUs/SRU that retest okay (RTOK) at the intermediate level to the total number of LRUs/SRUs tested at that level, expressed as a percentage.

$$P_{rtok} = \frac{\text{total number of LRUs/SRUs that RTOK at the intermediate level}}{\text{total number of LRUs/SRUs tested at the intermediate level}} \times 100$$

A4.4.6. **Time to Fault Locate.** The time required to locate faults. Mean time to fault locate (MTTFL) is a typical metric. MTTFL is the total amount of time required to locate faults divided by the total number of faults.

$$\text{MTTFL} = \frac{\text{total time to locate faults}}{\text{total number of faults}}$$

A4.4.7. **Time Between False Alarms.** The time in life units (e.g., operating hours, flight hours, cycles) between indicated (detected) faults where no fault could be confirmed (i.e., false alarm). Possible metrics for this measure include the minimum and mean times. An example metric is mean operating hours between false alarms (MOHBFA). The formula for MOHBFA is

$$\text{MOHBFA} = \frac{\text{total operating hours}}{\text{total number of false alarms}}$$

Another alternative is a FAR, which is the reciprocal of a mean time and indicates the number of false alarms per life unit.

$$\text{FAR} = \frac{\text{total number of false alarms}}{\text{total life units}}$$

Attachment 5

LOGISTICS MEASURES

A5.1. Introduction. This attachment provides a discussion of logistics measures considerations and general logistics measures.

A5.2. Test Considerations for Integrated Logistics Support (ILS) Elements. Historically, an evaluation of logistics supportability has been based on a qualitative assessment of each of the elements of ILS. However, some of the elements are better addressed under a different operational suitability area. Key elements that should be evaluated under logistics supportability are supply support (spares and repair parts), support equipment for all levels of maintenance, and planned support facilities. Comparison of operational test data with ILS planning factors is a good approach to evaluating logistics supportability. Planning, test methodology, data requirements and evaluation considerations for support equipment, supply support, facilities and maintenance planning are below.

A5.2.1. **Support Equipment (SE).**

A5.2.1.1. **Planning Considerations.** SE can be divided into two classes: major and non-major. Major equipment usually includes such items as avionics systems, automatic test stations, or newly designed complex support equipment. Non-major equipment usually includes such items as non-powered support equipment, hand tools, and support equipment that is already in the inventory. Normally, only a few major types of equipment, such as avionics test stations, will have quantitative requirements listed in the maintenance concept or other program documentation.

A5.2.1.2. **Test Methodology Considerations.** The SE methodology should parallel that used for the prime equipment. Because support equipment is part of the total system, collecting suitability data for RAM, etc., for support equipment applies as well. Selection of support equipment measures will depend on the complexity and purpose of the equipment.

A5.2.1.3. **Data Requirement Considerations.** Data are collected using either automated or manual systems. IMDS, SEDS and Micro-OMNIVORE described in Chapter 13 all have the capability to capture RAM data on support equipment. Manual logs containing maintainer comments, completed questionnaires, test team developed forms may also help provide a comprehensive evaluation.

A5.2.1.4. **Evaluation Considerations.** When evaluating support equipment, compare what is procured and available at each maintenance level to actual needs. Identify support equipment deficiencies requiring enhancement or optimization. A model may be used to simulate time demands on support equipment, e.g., to estimate failed item arrival rates, support equipment waiting times, and turnaround times. If the number of arrivals is low (i.e., reliability is high), a two-level maintenance capability is appropriate. If the number of arrivals is long and support equipment availability, inadequate, additional system quantities may be needed. The intent is to evaluate each facet of system operation and maintenance to verify that the proper type and quantity of support equipment are available at the right location.

A5.2.2. **Supply Support.**

A5.2.2.1. **Planning Considerations.** Maintaining operational readiness under diverse conditions of military use depends directly on the right supplies being available when and where they are needed. Supply support can be divided into six basic activities:

A5.2.2.1.1. Provide consumption and failure rate data to supply provider's in order to update provisioning factors.

A5.2.2.1.2. Compare test data with provisioning data to identify items that appear to be under- or over-provisioned.

A5.2.2.1.3. Review ISSL, bench stock, MRSP, or in-place readiness spares package (IRSP) listings and compare them with test results to identify items that appear to be under or over expected requirements.

A5.2.2.1.4. Review supply planning decisions and compare them with test experience. **NOTE:** This process is an ongoing and should continue throughout OT&E.

A5.2.2.1.5. Measure the performance of the supply support system and identify deficient areas. Example measures are requisition fill rates, PMCS, and NMCS.

A5.2.2.1.6. Review level of repair decisions.

A5.2.2.2. **Test Methodology Considerations.** The test methodology is based either on an investigation of the supply support planned for critical supply items or on the total provisioning process. Consider factors such as complexity, cost, criticality and failure rates in selecting candidate supply items. As a rule, quantitative evaluation criteria are appropriate for supply only during FOT&E. Until then, the supply support system is either the responsibility of the contractor or is in the initial buildup stage for organic Air Force support. The methodology can also be based on obtaining primary evaluation criteria such as PMCB NMCB (both denotes maintenance and supply). Additional considerations are:

A5.2.2.2.1. Compare component level reliability metrics (e.g., MTBM, MTBD) and base-level repair capability (e.g., NRTS) to those used in the provisioning process. Although this comparison may not in itself mean an item has been under- or over-provisioned, it will help identify candidates for further T&E. Such factors as anticipated reliability improvements, improved technical data and increased base-level repair capability should be considered before determining that a component is under- or over-provisioned.

A5.2.2.2.2. Identify potential supply problems caused by top PMCS, NMCS and/or cannibalization items.

A5.2.2.3. **Data Requirement Considerations.** Use data from the reliability and availability evaluation plus data from the provisioning agency. If the data for this requirement should come from the contractor, the test planner should ensure the requirements from which the data are obtained are included in the development contract. Other required data will include such items as the ISSL, MRSP, IRSP and bench stock listings. The provisioning activity or the prime ALC normally develops and provides these data.

A5.2.2.4. **Evaluation Considerations.** When evaluating supply support, compare key supply parameters against criteria stated in the capabilities requirement document. Identify the components that are under-provisioned. Review and assess the MRSP, ISSL, IRSP and bench stock listing, to support mission requirements. Review and assess the RLA and the resulting source, maintainability and recovery (SMR) codes. If possible, conduct a random statistical sample of provisioned items to draw conclusions about the overall provisioning plans. Model the supply support capability to arrive at an optimum balance between a stock-out situation and the proper level of inventory. One way to accomplish this is to use the planned supply support capability in the model and note the effect on other system parameters such as availability. The other way is to use an unrestricted supply capability and determine the amount of supply used. Then, compare this amount to the planned supply support. **NOTE:** Stock-out conditions promote cannibalization of parts and/or the necessity of initiating high-priority orders from the supplier. Both options are costly and impact base operations, since using commands must now pay for this support. Supply support capability may differ between items of high value or cost and the more common spares. For high-value items, greater emphasis is placed on replacement factors and usage rates. For other items, the economic order principle applies. This principle equates the cost to order spares with the cost to hold to arrive at an optimum or economic order quantity.

A5.2.3. **Facilities.**

A5.2.3.1. **Planning Considerations.** Base maintenance facility plans on engineering, operational, and maintenance requirements. The test team should monitor all maintenance activities to identify any facility requirement that has not been satisfied, use AFI 32-1024, Standard Facility Requirements as a guide. Close coordination with the prime ALC and using command is important. The test team should review all applicable facilities plans to ensure facilities requirements are properly stated. Such items as heavy maintenance docks, work areas, storage requirements, wash rack and test cell requirements are of interest.

A5.2.3.2. **Test Methodology Considerations.** The test methodology for facilities may cover site activation activities by working with the site activation task force (SATAF). On programs not employing a SATAF, evaluators may work with the prime civil engineering activity responsible for facility survey and planning. Review the base and MAJCOM facilities program plans. AFI 32-1024, Standard Facility Requirements, computations may be used when applicable. Quantitative inputs for these computations should come from the results of the reliability, maintainability and manpower evaluation areas. Monitor and review periodically maintenance activities in light of facilities requirements to identify and report any unique requirements, new facilities, additions or modifications needed to support the system.

A5.2.3.3. **Data Requirement Considerations.** Data requirements for facilities will typically include the contractor's facilities program plan, base and MAJCOM facilities program plan, minutes of site activation conference, meetings and working groups, and results of facility evaluation questionnaire.

A5.2.3.4. **Evaluation Considerations.** The facilities evaluation may include review of programmed facilities requirements in light of test experience and review of activities to

identify any unique, new or altered facilities requirements, which have not been previously identified or programmed.

A5.2.4. **Maintenance Planning.**

A5.2.4.1. **Planning Considerations.** Maintenance planning assesses the adequacy of each significant maintenance task required to support the weapon system. Specifically, it is the assessment of the planning for all the activity required to achieve, restore or maintain the operational capability of the system or equipment. MOSs for this area will be the subjective assessments (backed up by qualitative and quantitative data from the other evaluation areas) of the acceptability of maintenance and logistics planning to provide the required support.

A5.2.4.2. **Test Methodology Considerations.** The test methodology is based on:

A5.2.4.2.1. Comparison of logistics factors used to compute the RLA and SMR codes with conditions actually being experienced or projected for the mature environment.

A5.2.4.2.2. Comparison of key programmed suitability performance parameters with those actually experienced or projected and planning actions being taken to adjust or accommodate differences. Consider such factors as RAM performance, ID capability, supply provisioning, technical data adequacy, and support equipment suitability.

A5.2.4.2.3. Changes in the maintenance concepts and appropriate adjustments or changes in maintenance planning.

A5.2.4.2.4. Review of all suitability problems and the adequacy of maintenance planning to overcome or compensate for those problems, when applicable.

A5.2.4.3. **Data Requirement Considerations.** Data for the maintenance planning evaluation will typically come from the other suitability evaluation areas. If ICS will occur until the system reaches IOC, obtain and review the transition plan to organic maintenance.

A5.2.4.4. **Evaluation Considerations.** Design the evaluation of maintenance planning to identify areas where maintenance planning is not acceptable to support the required level of mission performance and to make appropriate recommendations. The following are suggested areas:

A5.2.4.4.1. The ability of the maintenance planning to result in the necessary actions and support to ensure the system or equipment attains required operational capability.

A5.2.4.4.2. The realism of criteria for repair times, RAM characteristics, support equipment requirements, maintenance skills, and facilities requirements.

A5.2.4.4.3. An evaluation of whether or not the most efficient and economical repair levels have been established. **NOTE:** AFOTEC is required to report upon the system's suitability for two-level maintenance.

A5.2.4.4.4. The scope and completeness of transition plans designed to facilitate transfer of logistics support from contract to organic capabilities.

A5.2.4.4.5. For CLS, provisions for documentation, source code, and skills levels may be assessed to identify potential hardware or software problem areas that could affect system support, configuration management or mission performance.

A5.3. Data Collection Before and During Test.

A5.3.1. Suitability evaluators should review logistics and readiness portions of the capabilities requirement document for consistency with the program office's LCMP. In addition, there may be other plans such as the RAM plan, test and support equipment plan, supply support plan, technical data plan, facilities plan and computer resources plan. Also, if the system is under development by more than one contractor (or in competition), OT&E suitability evaluators should anticipate reviewing separate plans from each contractual effort. Collectively, these plans will indicate what data needs to be captured during test. Data should be simple to collect and maintained in logbooks or existing data systems.

A5.3.2. M&S may be used to analyze the ability of the system to meet some operational requirements within the planned level of support. M&S is useful in overcoming limitations or differences between the planned operational support and support available during OT&E. Use of M&S should be explained in the TEMP, verified, validated and accredited prior to use for OT&E purposes.

A5.3.3. Derive specific quantitative measures for HM/HS, CBR contamination and BDR from the requirements document, if possible. They are typically related to the timeliness of performing HM/HS, CBR contamination and/or BDR procedures. Other measures may relate to ratings on particular questions addressed on the HM/HS questionnaire and other questionnaires contained in the *AFOTEC Questionnaire Guide*.

A5.4. Data Analyses after Test.

A5.4.1. Quantitative measures related to logistics supportability include:

A5.4.1.1. **Not Mission Capable Supply.** The rate at which an item cannot perform any of its wartime missions due to lack of parts.

A5.4.1.2. **Downtime.** This is the logistics supportability component of readiness (availability). (See Figures 2.1., 2.2. and 2.3. for depictions of downtime.) A typical metric of downtime is MDT. MDT equals the sum of the mean maintenance time, the mean ADT and the mean LDT. The delay times can include time required to hire and train personnel, provision for supply or repair parts, transport repair parts to a repair facility, etc.

A5.4.1.3. **Number of Spares Required.** Self-explanatory.

A5.4.1.4. **Percentage of Assets in Local Supply.** The number of assets in local supply divided by the number of assets required.

A5.4.1.5. **Fill Rates.** The rate at which supply is filled. It may be limited to critical items of supply.

A5.4.1.6. **Availability (e. g., PMCS, NMCB).** Indicates effects of supply support.

A5.4.1.7. NRTS rates, condemnation rates, bench-check serviceable rates, CND rates, cannibalization rates, and their causes.

A5.4.1.8. Time delay for awaiting parts to repair components.

A5.4.1.9. Average repair days (indicates the average number of days it takes to repair an item, excluding time waiting for parts).

A5.4.1.10. MTBD.

A5.4.2. **Measures Based on Responses to Various Questionnaires.** Logistics supportability questionnaires are contained in the *AFOTEC Questionnaire Guide*.

A5.4.2.1. **Support Equipment Attributes.** The following are attributes to consider.

A5.4.2.1.1. Support equipment reliability, maintainability, availability, HF, safety and compatibility.

A5.4.2.1.2. Support equipment suitability for mobility, deployment and bare-base operations, as appropriate.

A5.4.2.1.3. Ease or difficulty of operation.

A5.4.2.1.4. Effectiveness in performing troubleshooting and diagnostic functions.

A5.4.2.1.5. Susceptibility to damage, contamination or corrosion.

A5.4.2.1.6. Quantity of units needed versus authorized.

A5.4.2.1.7. Other ILS elements' capability to support the support equipment such as technical data and supply support (for the support equipment).

A5.4.2.2. **Supply Support Attributes.** The following are attributes to consider.

A5.4.2.2.1. Economic Order Quantity (EOQ). EOQ is expressed as the square root of (2CpD/Ch), where Cp is the average ordering cost, Ch is the cost of carrying the item in inventory (usually equal to 25 percent of the item price), and D is the annual item demand.

A5.4.2.2.2. Component logistics reliability and criticality.

A5.4.2.2.3. ISSL, MRSP, IRSP and bench stock listing acceptability.

A5.4.2.2.4. Inadequacies in technical data or support equipment, which impact supply support.

A5.4.2.2.5. SMR or equivalent coding.

A5.4.2.3. **Facility Attributes.** The following are attributes to consider.

A5.4.2.3.1. Programmed and forecast UR.

A5.4.2.3.2. Number of systems and units per squadron or wing.

A5.4.2.3.3. Test measurement diagnostic equipment and support equipment authorizations per squadron or wing.

A5.4.2.3.4. Wash rack, phase inspection dock, fuel cell and similar requirements.

A5.4.2.3.5. Munitions storage requirements.

A5.4.2.4. **Maintenance Planning Attributes.** The following are attributes to consider.

A5.4.2.4.1. The ability to effectively and efficiently support the weapon system.

A5.4.2.4.2. The suitability of repair-level decisions and the ID concept.

A5.4.2.4.3. The use of organic, ICS CLS resources for organizational-, intermediate-, and depot-level hardware and/or software support.

A5.4.2.4.4. Requirements for utilities, security, environmental control, war readiness materiel storage, forward operating location and deployment, and hazardous materials handling and disposal.

A5.4.2.4.5. Maintenance manpower authorizations.

A5.4.2.4.6. The validity of the assumptions upon which the maintenance concept/plan was based.

A5.4.2.4.7. Review of any existing MAJCOM Logistics Composite Model (LCOM) studies.

A5.4.2.5. The use of questionnaires to evaluate logistics supportability is encouraged. The *AFOTEC Questionnaire Guide*, contains the standard questionnaires for use by test teams. Automated tools are available from A-9I to capture questionnaire data and analyze them for test reporting purposes. A-9I will provide the test team with a copy of the automated questionnaire tools and will provide training in the use of the tools.