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DEPARTMENT OF DEFENSE

JOINT SERVICE SPECIFICATION GUIDE

AIR SYSTEM

AMSC FSC 15GP

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FOREWORD

JSSG Release Notice

This specification guide supports the Acquisition Reform initiative and is predicated on a performance based business environment approach to product development. As such, it is intended to be used in the preparation of performance specifications. It is one of a set of specification guides. This is the initial release of this guide. In that sense, this document will continue to be improved as the development effort is accomplished.

1. During the 1970's, the Department of Defense (DoD) and the Defense Science Board (DSB) investigated the cost of DoD acquisition development programs. DoD results were reported in a 1975 memorandum from the Deputy Secretary of Defense, which cited the blanket application and unbounded subtiering of development specifications and standards as a major cost driver. The DSB investigation concluded that, rather than specifying functional needs, the documents dictated design solutions. It also noted that blanket application of layer upon layer of design specifications actually represented a bottom-up versus a top-down process, which not only failed to develop systems responsive to user operational needs but also inhibited technical growth. As a result of these findings, DoD directed that policies be established to require tailored application of development specifications on all new system acquisitions. The June 1994 memorandum from the Secretary of Defense regarding “Specifications & Standards - A New Way of Doing Business,” further emphasized these policies.

2. Joint Service Specification Guides are generic documents intended to provide a best starting point for tailoring a specification for specific development program applications. Furthermore, they are intended for common use among the services. This not only facilitates joint programs but also provides industry a single, consistent approach to defining requirements.

3. A Joint Service Specification Guide itself never goes on contract. It is, as its title reads, a guide. It is the tailored derivative of the specification guide, with its program-peculiar system identification number, that becomes part of the system definition and, in the case of specifications intended for contractual application, part of the acquisition package.

4. Joint Service Specification Guides state generic performance parameters with the definitive portions of the requirements left blank. Specification guides provide a one-to-one correlation of section 3 performance requirements to section 4 verifications. They include guidance sections to assist the document user in tailoring the specification requirements and verifications for program-specific applications. The guidance sections provide, for each requirement and associated verification, rationale for including the requirement, guidance to assist in filling in the blanks and tailoring, and experiences related to the requirements and verifications in the form of lessons learned.

5. About this document:

   a. This Joint Service Specification Guide is intended to assist Government and contractor personnel in developing a system specification tailored to an acquisition development program. To tailor the document to the specific application, the applicable requirements must be selected and the blanks within

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those requirements filled in appropriately for the system being developed. For each of the requirements selected, the associated verifications are examined and tailored as needed.

b. The fundamental objectives of this document are to provide consistent organization and content guidance for describing system requirements as translated from validated needs. System requirements must be

- meaningful in terms of meeting user operational needs;
- performance-based and avoid specifying the design;
- measurable during design, development, and verification;
- achievable in terms of performance, cost, and schedule; and
- complete in the context of the system life cycle and in treating system products and processes.

c. The systems engineering approach is emphasized to ensure the system is the complete, integrated, and balanced solution to customer needs, and accounts for all inputs and outputs. The up-front integration of requirements defined in the context of the system life cycle helps ensure a complete system definition and enables a disciplined top-down flow of requirements to lower-tier specifications.

d. The unique features of this document that help to satisfy operational requirements include

- specifying in section 3 the scenarios and mission descriptions against which the system performance requirements are defined, for both peacetime and wartime operations;
- expressing performance requirements for the system in technically based, quantitative, user-oriented terms;
- defining all internal and external interfaces with other systems, subsystems, equipment, operations, training, deployment environments, etc., for peacetime and wartime operations; and
- requiring incremental verifications in section 4 at program milestones to confirm progressive compliance with section 3 requirements.

e. This Joint Service Specification Guide (JSSG), in conjunction with its companion JSSGs, is intended for use by Government and industry program teams as guidance in developing program-unique specifications. This document may not be placed on contract.

f. The complete set of JSSGs establish a common framework to be used by Government-industry program teams in the aviation sector for developing program-unique requirements documents for air systems, air vehicles, and major subsystems. Each JSSG contains a compilation of candidate references, generically stated requirements, verifications, and associated rationale, guidance, and lessons learned for program team consideration. The JSSGs identify typical requirements for a variety of aviation roles and missions. By design, the JSSG sample requirements are written as generic templates, with

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blanks that need to be completed in order to make the requirements meaningful. Similarly, the sample incremental verifications indicate the level of verification expected at each program milestone. In this document, additional guidance is available for developing verification criteria appropriate to the associated requirement. Program teams need to review the rationale, guidance, and lessons learned found in the JSSG handbook (Part II) to (1) determine which requirements are relevant to their program; and (2) fill in the blanks with appropriate, program-specific requirements and verifications.

g. This specification guide is organized in two parts. Part I is a template for developing the program-unique performance specification. As a generic document, it contains requirement statements for the full range of aviation sector applications. It requires tailoring to form the program-unique specification. Tailoring involves selecting the essential requirements and deleting nonapplicable requirements. In addition, where blanks exist in the selected requirements, these blanks must be filled in appropriately to form a complete set of program-unique specification requirements to meet program objectives. Part II of this document is a handbook, which provides the rationale, guidance, and lessons learned relative to each requirement statement in Part I. The section 4 verifications must be tailored to reflect an understanding of (1) the system solution; (2) the identified program-specific milestones and the associated level of maturity expected to be achieved at those milestones; (3) the approach to be used in the design and verification of the required products and processes; and (4) criteria to be used in establishing satisfaction of the requirements. The rationale, guidance, and lessons learned, although written to be generic in nature, document what has been successful in past programs and practices. They should not be interpreted to limit new practices, processes, methodologies, or tools.

6. At the time of release, this document is a work in progress. Special attention has been focused on performance requirements and solid rationale and guidance for each of those requirements. As a result, most of the verification information is still in work and will be supplied at a later date. Expect this document to be periodically updated over the next 12 months as the verification information is completed and comments/concerns from potential document users are received and evaluated.

7. This specification guide has not been specifically reviewed to assure that the requirements, verifications, and their guidance are adequate for application to rotary wing or unmanned air vehicles.

8. Drafts of verification information are available to United States Department of Defense, National Aeronautics and Space Administration, and Federal Aviation Administration employees from the document point of contact (POC). Organizations having contracts with the Department of Defense may request drafts of verification information through their Government program office. Draft information is not available to foreign requesters. If you would like to share your thoughts, comments, and concerns or would like to obtain the current document status, contact the document POC, Donald Sedor, at sedordj@asc-en.wpafb.af.mil.

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JOINT SERVICE SPECIFICATION GUIDE

AIR SYSTEM

SPECIFICATION TEMPLATE

(Part I)

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1. SCOPE

1.1 Scope.

This specification establishes the overall requirements, and the associated verification criteria, for the ___(1)___ system.

1.2 System.

The air system specification characterizes the system in terms of technical requirements, which are engineered to become design solutions that provide the needed capability throughout the system's life cycle. Specification developers must keep in mind that, while a system specification focuses on the capabilities expected in products for use in specific environments, systems engineering accounts for the system's entire life cycle, encompassing all of the people, products, and processes involved (including hardware, software, facilities, data, materials, services, and techniques).

> Specification: A description of the essential technical requirements for items, materials, and services that includes the verification criteria for determining whether these requirements are met. A specification supports the acquisition and life cycle management of the item, material, and service described.

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2. APPLICABLE DOCUMENTS

2.1 General.

The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of the specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks.

The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS), and supplement thereto, cited in the solicitation.

SPECIFICATIONS

Department of Defense

Document Number	Document Title
______________________	______________________________________
______________________	______________________________________

STANDARDS

Department of Defense

Document Number	Document Title
______________________	______________________________________
______________________	______________________________________

HANDBOOKS

Department of Defense

Document Number	Document Title
______________________	______________________________________
______________________	______________________________________

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(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Defense Automation and Production Service (DAPS), 700 Robbins Avenue, Bldg 4D, Philadelphia PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications.

The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues are those in effect on the date of the solicitation.

Document Number	Document Title
____________________	__________________________________
____________________	__________________________________

(Copies of specifications, standards, handbooks, drawings, publications, and Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.3 Non-Government publications.

The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the document that are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

Non-Government Standards Organization Name(s)

Document Number	Document Title
____________________	__________________________________
____________________	__________________________________

Application for copies should be addressed to (name and address of the source).

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Document tiering.

When the air system specification is directly referenced in the contract, it is a first-tier specification and is applicable. Documents referenced in the (first-tier) specification are applicable as follows:

a. Second Tier - All documents directly referenced in the first-tier specification are only applicable to the extent specified.

b. Lower Tier - All documents directly referenced in second- or lower-tier documents are for guidance only, unless otherwise directed by the contract.

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Control of document tiering has become a primary way of controlling contractual applicability of referenced documents. Care must be taken to ensure that each referenced document is appropriately applicable in first-tier references (including those references cited in the contract, which themselves would become first-tier references and, thus, their second tier would become contractually applicable as well).

Note that this guidance is aimed primarily at controlling applicable documents when a system specification, derived from this JSSG, is cited in the contract. During production phase, there are additional considerations as well. For example, specifications and standards listed on engineering drawings are to be considered first-tier references (see Dr. Perry's memorandum on "Specifications and Standards - a New Way of Doing Business" dated 29 June 1994). In a Performance Based Business Environment context, this option is primarily applicable to the Build-to-Print (BTP) and Modified Build-to-Print (MBTP) business practices when the drawings are directly cited in the contract. See the Performance Based Product Definition Guide for additional information about BTP and MBTP practices.

Exceptions to tiering applicability are generally defined by DoD policy. For example, in the Perry Memo previously cited, the direction on tiering of specifications and standards includes, "Approval of exceptions may only be made by the Head of the Departmental or Agency Standards Improvement Office and the Director, Naval Nuclear Propulsion for specifications and drawings used in nuclear propulsion plants in accordance with Pub. L. 98-525 (42 U.S.C. ß7158 Note)."

2.5 Order of precedence.

In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. PERFORMANCE REQUIREMENTS

3.1 Operations.

3.1.1 Roles and missions.

The system shall perform as needed to conduct the roles and missions within the scenarios and conditions stipulated in table 3.1.1-I.

TABLE 3.1.1-I. Air system roles and missions.

ID	Scenario	Role	Mission	Vignette	Mission/ Vignette Mix	Peace/ War	Threat	Basing Location	Time	Remarks

3.1.2 Organization.

The system shall perform as specified in this document when the operational elements of the system are employed in the organizational units described in table 3.1.2-II.

TABLE 3.1.2-II. Organizational units.

Unit	Air Vehicle Quantity	Conditions	Remarks

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3.1.3 Deployment and mobilization.

The system shall be capable of being mobilized and deployed as described in table 3.1.3-I.

TABLE 3.1.3-I. Deployment and mobilization scenarios.

Role/ Mission	Peace/ War	Basing	Runway	Available Support Structure	Applicable Year(s)	Config-uration	Remarks

The system must be deployable, configured as defined in table 3.1.3-II, for the duration indicated and shall not require more than __(1)__ to deploy, excluding personnel. Deployment time for training exercises and wartime missions shall not exceed those indicated in table 3.1.3-II. Deployments with full capability and performance shall require not more than __(2)__ (or equivalents); __(3)__ air refueling. Deployment and mobilization requirements shall ___(4)____.

TABLE 3.1.3-II. Deployment configurations and durations.

Configuration	Personnel	Duration	Quantity	Remarks

3.1.4 Mission planning.

The system shall provide a mission planning capability that provides the operational mission data for use in, or for, the air vehicle. The mission planning function shall utilize the ___(1)___ as defined in ___(2)___. Mission planning includes ___(3)___ and replanning, and shall support the mission mix requirements stated elsewhere in this document.

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3.1.5 System usage.

3.1.5.1 Peacetime operations.

3.1.5.1.1 Training missions.

The system shall be capable of successfully conducting the training missions identified in table 3.1.5.1.1-I at ___(1)___ while sustaining a _____(2)___ mission capable rate for ____(3)____ missions for a ____(4)____.

TABLE 3.1.5.1.1-I. Training mission types.

Mission Type	Frequency	Conditions

3.1.5.1.2 Operational deployment.

The system shall be capable of deployment from __(1)___ to ____(2)_____ within ___(3)____ of notification; shall be capable of flying the missions indicated in _____(4)____ within ____(5)____ hours of arrival; and shall achieve a mission capable rate of ____(6)_____ within ____(7)_____ hours of arrival.

3.1.5.1.3 Operational missions in peacetime.

The system shall be capable of sustaining a sortie rate of ______(1)_____ sorties per day for the missions identified in table 3.1.5.1.3-I at the mission mix specified.

TABLE 3.1.5.1.3-I. Peacetime mission scenarios.

Mission	Percent Missions	# Alert A/C	Launch Readiness	Conditions

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3.1.5.1.4 Base escape.

______(1)____ aircraft out of _____(2)______ shall be capable of achieving a base escape separation distance of ______(3)______ within _____(4)____ of warning. These aircraft shall be capable of performing the _____(5)_____ mission. ______(6)____ aircraft out of the remaining ____(7) _____ aircraft shall be capable of achieving a base separation distance of ____(8)_____ within _____(9)____ of the initial warning. These aircraft shall be capable of performing the _____(10)_____ mission. Conditions for this mission are _____(11)_____.

3.1.5.2 Wartime operations.

3.1.5.2.1 Combat surge and sustained.

The system shall be capable of generating the sortie rates indicated in table 3.1.5.2.1-I, for roles and missions ____(1)____ and unit organization ____(2)____. Other overall conditions of operation include ____(3)____.

TABLE 3.1.5.2.1-I. Wartime mission scenarios.

	Surge				Sustained			
Mission	Sortie Rate	Percent of Missions	Days	Conditions	Sortie Rate	Percent of Missions	Days	Conditions

3.1.5.2.2 Air alert, loiter, surveillance.

For the ____(1)____ missions, the system shall be capable of maintaining ____(2)____ ____(3)____ stations/routes for __(4)___ days. Occupancy rates for the station/route shall be at least ___(5)___. ___(6)___ aircraft shall be maintained on the ground ready to launch on ___(7)___ notice to replace aircraft aborting the mission due to breaks. Conditions for the conduct of this mission are

a. Length of the operational day is _____(8)_____

b. Number of aircraft per flight is ______(9)____

c. Number of flights per station/route is _____(10)____

d. Size of the unit conducting the missions is _____(11)____

e. In-flight refueling allowed? _____(12)______

f. Flight abort rules are _______(13)_____

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3.1.5.2.3 Engagement from ground/deck basing.

For the ____(1)____ mission, a ___(2)__ ship flight shall be capable of launching, entering a lethal engagement envelope (target acquired, weapons locked, weapon Pk greater than or equal to __(3)___ percent of maximum weapon Pk) against ___(4)_____ targets, detected by ____(5)_______ source at a distance of ______(6)________ from the alert location before the targets can enter their lethal engagement envelope of _____(7)_______ against a friendly target located at ____(8)_______ relative to the alert location.

3.1.5.2.4 Engagement from loiter location.

For the ____(1)____ mission, a ___(2)__ ship flight shall be capable of exiting a loiter location, entering a lethal engagement envelope (target acquired, weapons locked, weapon Pk greater than or equal to __(3)___ percent of maximum weapon Pk) against ___(4)_____ targets, detected by ____(5)_______ source at a distance of ______(6)________ from the loiter location before the targets can enter their lethal engagement envelope of _____(7)_______ against a friendly target located at ____(8)_______ relative to the alert location.

3.1.5.3 General system utilization requirements.

3.1.5.3.1 Availability.

The system shall be able to conduct the missions in table 3.1.5.3.1-I within the availability, utilization, and conditions described therein.

TABLE 3.1.5.3.1-I. Mission availability, utilization, and conditions.

Mission	Utilization Rate	Availability	Conditions

3.1.5.4 Integrated combat turnaround (ICT) time.

For the _____(1)____ mission, the elapsed time required to conduct an ICT starting with a mission-capable aircraft shall not exceed __(2)__ when the vehicle is equipped with the assets and quantities identified in table 3.1.5.4-I. These requirements shall be met under __(3)__ conditions. Timing begins when __(4)___ and ends at pilot acceptance. Integrated combat turnaround time ___(5)____ includes time needed for general servicing, replacement of mission data, and replacement/replenishment, as appropriate, of needed fluids, gases, and agents.

The system shall meet all the stated requirements during __(6)__, using __(7)__ power and ___(8)___ shelters.

The above requirements shall be met for ___(9)____ ICTs. The system shall be capable of ____(10)____ simultaneous ICTs.

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TABLE 3.1.5.4-I. Items and quantities for integrated combat turnaround.

Item	Quantity at Start	Quantity at End	Remarks

3.1.6 System dependability.

3.1.6.1 Mission reliability.

Mission reliability, the ability to conduct and complete mission tasks once committed to a mission, shall be as shown in table 3.1.6.1-I for the missions and scenarios identified.

TABLE 3.1.6.1-I. Mission reliability.

Scenario	Mission	Mission Reliability

3.1.6.2 System survivability.

3.1.6.2.1 Mission and one-on-one survivability.

The air system shall meet or exceed the probability of survival specified in table 3.1.6.2.1-I for the missions, scenarios, vignettes, mission phases, and conditions shown.

TABLE 3.1.6.2.1-I. Mission survivability.

Mission	Scenario	Vignette	Mission Phases	Probability of Mission Survival	Conditions

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The one-on-one survivability of the air system shall meet or exceed the one-on-one probability of survival specified in table 3.1.6.2.1-II for the missions, scenarios, vignettes, mission phases, threats, and conditions shown.

TABLE 3.1.6.2.1-II. One-on-one survivability.

Mission	Scenario	Vignette	Mission Phase	Threat	Probability of Survival	Conditions

3.1.6.2.2 Parked aircraft and ground support survivability.

System items shall satisfy the survivability criteria identified in table 3.1.6.2.2-I.

TABLE 3.1.6.2.2-I. Ground survivability.

Item	Criteria	Conditions

3.1.7 System capabilities.

3.1.7.1 Mission lethality.

3.1.7.1.1 Air-to-air lethality.

The system shall achieve and sustain the anti-aircraft lethality as specified in table 3.1.7.1.1-I.

TABLE 3.1.7.1.1-I. Air-to-air lethality.

Mission	Scenario	Vignette	Mission Phase	Exchange Ratio	P(Kill)	Target Acquisition/ Cueing Condition	Config-uration	Conditions

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3.1.7.1.2 Air-to-surface lethality.

The system shall provide the lethality effectiveness index as specified in table 3.1.7.1.2-I.

TABLE 3.1.7.1.2-I. Air-to-surface lethality.

Mission	Scenario	Vignette	Mission Phase	Target	Effectiveness Index	Weapon Type & No.	Target Acquisition/ Cueing and Navigation Aides	Conditions

3.1.7.2 Cargo transport.

The system shall provide cargo delivery capability as defined in table 3.1.7.2-I.

TABLE 3.1.7.2-I. Cargo delivery.

Mission/ Scenario	Air Vehicles	Cargo Quantity	Distance	Basing		Delivery Rate	Operations Period	Reference
				T/O	Landing			

3.1.7.3 Reconnaissance/surveillance.

The system shall provide reconnaissance/surveillance capability as described in table 3.1.7.3-I for the conditions identified.

TABLE 3.1.7.3-I. Reconnaissance/surveillance capability.

Mission/ Scenario	Sensors	Coverage	Information Collection	Information Processing	Information Dissemination	Timeline	Conditions

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3.1.7.4 Aerial refueling (tanker).

The system shall be capable of transferring fuel to other platforms as specified in table 3.1.7.4-I.

TABLE 3.1.7.4-I. Tanker refueling capability.

Mission	Receiver and Flight Size	# Simultaneous Receivers	Off-Load per Receiver	Refuel Process Duration	# Off-Load Occurrences/ Tanker Sortie	Conditions

3.1.7.5 System reach.

The system shall provide the reach indicated in table 3.1.7.5-I for the mission and altitude regime stipulated.

TABLE 3.1.7.5-I. Reach.

Mission	Reach	Altitude Regime	Remarks

3.1.8 Reserve modes.

The system shall be capable of providing wartime reserve modes as indicated in table 3.1.8-I.

TABLE 3.1.8-I. Wartime reserve modes.

Function/Characteristic	Capability

3.1.9 Lower-tier mandated requirements.

The air system lower-tier mandated requirements shall be as specified in the following: __(1)__.

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3.2 Environment.

The system shall provide full, specified performance during and after experiencing the cumulative effects of the combination(s) of environments the system is expected to experience over its lifetime.

a. Natural Environment. The system shall satisfy the requirements specified herein throughout its service life during and after operation in and exposure to the following worldwide conditions _(1)__.

b. Induced Environment. The system shall satisfy the requirements specified herein throughout its service life during and after operation in and exposure to its intended functional environment. Specifically, the man-made (non-threat), induced environmental conditions in which the system and its components must function are ___(2)__. Man-made threat environments are addressed as part of the Vulnerability and Susceptibility requirements.

c. Limiting Environmental Conditions. The system shall satisfy the requirements specified herein throughout its service life, during and after operation in, and exposure to, the conditions in table 3.2-I, with exceptions as noted therein.

TABLE 3.2-I. Environmental conditions.

Absolute Environment Condition	Frequency	Duration	Requirement Exceptions During Operation	Remarks

3.3 System characteristics.

3.3.1 Force life-cycle management.

3.3.1.1 System architecture.

The system shall have a functionally based, open systems architecture.

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3.3.1.1.1 Growth.

The system shall have the capacity for the growth potential defined in table 3.3.1.1.1-I.

TABLE 3.3.1.1.1-I. Growth potential.

Capability	Growth Value	Conditions

3.3.1.1.2 Standard/common assets.

Where practicable, standard/common/nondevelopmental assets (commercial or military) shall be used in the system's design and construction where they satisfy the performance and design criteria for the system and are affordable in terms of life-cycle economics and logistics sustainment.

3.3.1.1.3 Interchangeability.

Parts, subassemblies, assemblies, and software having the same identification, independent of source of supply or manufacturer, shall be functionally and physically interchangeable.

3.3.1.2 System service life.

The air system shall provide the performance specified herein for __(1)__ years, given the system usage defined in 3.1.5 and the following life-cycle profile.

TABLE 3.3.1.2-I. Usage and conditions for determining service life.

Usage	Rate/Conditions
Wartime Operations	(# or % / type of operations)
Peacetime Operations	(# or % / type of operations)
Basing	(# or % ground operations/checkouts)
Testing/Checkouts	(# or %)
Transportation	(# shipments/abnormal conditions – exposure)
Storage	(# shipments/abnormal conditions – exposure)
Realistic Training (e.g., Red Flag, on-equipment training)	(# of occurrences and training conditions)

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3.3.1.3 Manpower and personnel.

The system shall be operated, maintained, and supported by not more than the numbers and classifications of personnel, exclusive of the student throughput populations as shown in table 3.3.1.3-I through table 3.3.1.3-V for the following force/operational structure conditions:

a. Number of flying organizational units is ____(1)____ with ____(2)___ air vehicles per unit;

b. Number of flying training units is ____(3)_____ with ____(4)____ air vehicles per unit;

c. Number of off-base support locations is ____(5)_____;

d. Other force/operational structure conditions include ______(6)_______; and

e. The maintenance concept as defined in paragraph _____(7)_____ of this specification.

TABLE 3.3.1.3-I. Student throughput populations (military officer).

Military Personnel (Officer)				
	Job Type (optional)	**Skill Level (optional)**	**Numbers**	**Conditions**
Operators				
Maintainer				
Support				
Training				

TABLE 3.3.1.3-II. Student throughput populations (warrant officer).

Military Personnel (Warrant Officer)				
	Job Type (optional)	**Skill Level (optional)**	**Numbers**	**Conditions**
Operators				
Maintainers				
Support				
Training				

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TABLE 3.3.1.3-III. Student throughput populations (enlisted).

Military Personnel (Enlisted)				
	Job Type (optional)	Skill Level (optional)	Numbers	Conditions
Operators				
Maintainers				
Support				
Training				

TABLE 3.3.1.3-IV. Student throughput populations (civilian).

Civilian Personnel				
	Job Type (optional)	Skill Level (optional)	Numbers	Conditions
Operators				
Maintainers				
Support				
Training				

TABLE 3.3.1.3-V. Student throughput populations (contract).

Contract Personnel				
	Job Type (optional)	Skill Level (optional)	Numbers	Conditions
Operators				
Maintainers				
Support				
Training				

3.3.1.4 Asset identification.

System assets that are repairable, replaceable, salvageable, or consumable shall be permanently identified by a method that is observable and recognizable throughout the life of the asset and that does not adversely affect the life and utility of the asset. The identification shall include ___(1)____.

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3.3.2 Diagnostics.

The system shall detect, isolate, and report loss or degradation of system functions. The system shall detect safety- and mission-critical failures, functionally isolate those failures, and, where practicable, provide the information needed (to the crew or other equipment) in time to preclude further uncontrolled degradation to safety, mission accomplishment, and survivability. The system shall detect and isolate failures to allow maintenance personnel to perform necessary maintenance to meet mission, logistics, and availability requirements. The system shall incorporate a hierarchy of diagnostic data and tolerancing across indentures of design to assure compatibility of tested parameters, test tolerances, ranges, sequences, interfaces, and techniques. The system shall further __(1)__.

3.3.3 Nuclear surety.

The system shall, to the extent specified herein, prevent nuclear weapons involved in accidents, incidents, or jettison from producing nuclear yield and shall prevent unauthorized and inadvertent prearming, arming, or releasing of nuclear weapons in normal and abnormal environments. Abnormal environments include ____(1)___. The probability of unauthorized or inadvertent prearming shall be not greater than __(2)__ . The probability of unauthorized or inadvertent arming shall be not greater than ___(3)__. The probability of unauthorized or inadvertent release or jettison shall be not greater than ___(4)__. The air system shall meet the following nuclear certification requirements: ___(5)___.

3.3.4 Electromagnetic environmental effects (E^3).

The system shall comply with the requirements of _(1)_ to achieve system electromagnetic compatibility (EMC) among all subsystems and equipment within the system and with environments resulting from electromagnetic effects external to the system.

3.3.5 System security.

The system shall deny access to sensitive assets, capabilities, and information by unauthorized parties or functions. The threat to the system's security is ____(1)_____.

3.3.6 System safety.

The air system, when performing the prescribed missions within the environments specified herein, shall have a cumulative risk hazard index (RHI) not greater than ____(1)_______ for all identified hazards with individual risk hazard index values greater than ___(2)___. The identified hazards, each of which is comprised of the expected frequency of the hazard occurrence and the consequent loss of said occurrence, do not include those attributable to acts of war, combat, civil unrest and disorder. Nor do they include acts of nature except as specifically identified in the environments and missions delineated herein. The cumulative risk hazard index shall be the sum of the products of the frequency of occurrence and the consequence associated with each of the identified hazards, where such product value shall be as defined in table 3.3.6-I.

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TABLE 3.3.6-I. Individual hazard risk indices.

	HAZARD FREQUENCY					
Hazard Consequence	___(F1)___	__(F2)___	___(F3)___	__(F4)___	__(F5)___	___(F6)___
____(C1)____						
____(C2)____						
____(C3)____						
____(C4)____						
____(C5)____						

Hazard Consequence. The following consequence definitions shall be used to quantify identified hazards:

C1: ____(C1D)____

C2: ____(C2D)____

C3: ____(C3D)____

C4: ____(C4D)____

C5: ____(C5D)____

Hazard Frequency. The following hazard frequency definitions shall be used to quantify identified hazards:

F1: ____(F1D)____

F2: ____(F**2**D)____

F3: ____(F3D)____

F4: ____(F4D)____

F5: ____(F5D)____

F6: ____(F6D)____

3.3.6.1 Air vehicle noncombat loss rate.

The average air vehicle loss rate shall be not greater than ___(1)___ per flight hour. This rate includes air vehicle losses resulting from ground and in-flight operations as well as material and design related losses. The average air vehicle loss rate for materials and design causes shall be not greater than ___(2)___ per flight hour.

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3.3.7 Stores and expendables lists.

3.3.7.1 Weapons.

The system shall be capable of employing the weapons listed in table 3.3.7.1-I.

TABLE 3.3.7.1-I. Weapons list.

Weapon Nomenclature	Variant Descriptors	Minimum Required Modes

3.3.7.2 Sensor pods.

The system shall be capable of employing the sensor pods listed in table 3.3.7.2-I.

TABLE 3.3.7.2-I. Sensor pod list.

Sensor Pod	Variant Descriptors	Minimum Required Modes

3.3.7.3 Cargo.

The system shall carry and deliver the cargo types listed in table 3.3.7.3-I.

TABLE 3.3.7.3-I. Cargo list.

Cargo Type	Cargo Descriptors

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3.3.7.4 Other stores.

The system shall be capable of employing the stores listed in table 3.3.7.4-I.

TABLE 3.3.7.4-I. Other stores list.

Store Nomenclature	Variant Descriptors	Minimum Required Modes

3.3.8 System usage information collection and retrieval.

The system shall be capable of collecting, storing and using real-time information on the use of the system and the conditions it experiences. For the item(s) identified, the functionality to be provided for operational, support, and other uses (such as accident investigations); the minimum information characteristics required; and the performance characteristics of that information shall be as specified in table 3.3.8-I. Additionally, special security provisions for the information/equipment, information/ equipment retrieval performance/characteristics (including compatibility requirements with infrastructure equipment and information processing systems) and any other relevant conditions shall be as specified in table 3.3.8-I.

TABLE 3.3.8-I. System usage information collection and retrieval.

Item	Functionality (Purpose)	Information Characteristics	Performance Characteristics	Security	Retrieval Performance/ Characteristics	Conditions

3.3.9 Human systems.

The air system shall be capable of meeting the requirements specified herein when operated by ______(1)______ and maintained by ______(2)______ in the environments specified in _____(3)______.

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3.4 Interfaces.

The system shall operate as a self-contained unit or in concert with same service forces, multi-national military forces, other service forces, and/or national assets as identified in the table below. The system shall meet the interface requirements identified in table 3.4-I.

TABLE 3.4-I. Interface requirement matrix.

Country, Organization, Service, Agency	Operational	Support	Training	C4ISR	Inter-operability*	Trans-portation	Mapping, Charting, and Geodesy

* Specification developers shall refer to the most recent version of JTA, Aviation Domain, for mandated interoperability requirements.

3.4.1 Support interfaces.

3.4.1.1 Supply support.

The system shall be compatible with the ____(1)____ supply support infrastructure.

3.4.1.2 Facility interfaces.

The system shall be capable of interfacing with the facilities identified in table 3.4.1.2-I.

TABLE 3.4.1.2-I. System/facility interfaces.

Facility	Functional Capability	Status	Facility Description (Compatibility Requirements)

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3.4.1.3 Common support equipment.

The system shall be capable of interfacing with the common support equipment identified in table 3.4.1.3-I.

TABLE 3.4.1.3-I. System/common support equipment interfaces.

Common Support Equipment	Functional Capability	Status	Common Support Equipment Description (Compatibility Requirements)

3.5 Manufacturing.

System products shall consistently provide performance that meets or exceeds the requirements stated herein throughout their usage modes and across intersystem and intrasystem interfaces.

3.6 Support.

The system shall provide the resources and peculiar infrastructure, as required, to restore and sustain the delivered performance of the air system elements when the system is operated and deployed as specified herein for the operational service life specified herein (see 3.3.1.2).

3.6.1 Maintenance concept.

The levels of maintenance for the air system shall be _____(1)____.

3.6.2 System capability and procedure information.

The system shall provide operators, maintainers, and trainers with relevant information regarding the capabilities and limitations of applicable portions of the system (equipment, procedures, and use). The information shall be provided in a form that enables realization of the full capabilities of the system in the environments and conditions of use of the equipment, procedures, and uses.

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3.6.3 Protective structures.

The system shall provide protection of assets from the conditions to which they are exposed as described in table 3.6.3-I.

TABLE 3.6.3-I. Protection of assets.

Asset	Condition	Capabilities

3.6.4 Packaging, handling, storage, and transportation (PHS&T).

System items shall be transportable by ____(1)___ modes of transportation in compliance with ____(2)____ for all assemblies, subassemblies, equipment, components and end items, including training and support equipment, except __(3)____. System items shall be capable of being packaged and shall be able to withstand ____(4)____ of storage of all assemblies, subassemblies, equipment, components and end items for worldwide shipments in accordance with ____(5)____.

3.7 Training.

3.7.1 Training capability.

The system shall provide the training necessary to ensure the personnel identified in tables 3.3.1.3-I, II, III, IV, & V have the knowledge, skills, and abilities to perform their operational, maintenance, support, training, and ___________ roles. Training rates shall support the demands for skilled people to accomplish unit start-up, personnel rotations, reassignment, attrition and other factors that affect the availability of skilled people to perform system tasks in order to fully exploit the performance of the system.

3.7.2 Training types.

Trained personnel shall be capable of operating and supporting the air system to the performance levels defined herein. The system shall be capable of providing the following training: ___(1)___.

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3.7.3 On-equipment training.

The system shall accommodate _____(1)_______ on-equipment training capabilities. On-equipment training includes utilization of the system assets solely, utilizing the system assets in combination with dedicated training assets, and/or incorporating embedded training features into system assets to accomplish the necessary system training.

System assets shall be available for on-equipment training subject to the constraints in table 3.7.3-I

TABLE 3.7.3-I. On-equipment training.

Equipment	Purpose of Training	Maximum Utilization

On-equipment training shall neither interfere with nor be detrimental to the availability of equipment and people necessary to support system availability, sortie generation, and other system utilization requirements, nor to the safe operation of the equipment.

Note: On-equipment training capabilities and use must be consistent with the system service life requirement (3.3.1.2).

3.8 Disposal.

The system and any portions of the system (components, parts, materials, etc.) shall provide for being permanently stored, salvaged, recovered, reused, recycled, demilitarized, and cannibalized, to the extent practicable. The system shall provide for the identification, isolation, and control of hazardous and radiological material to ensure personnel safety and environment protection.

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4. VERIFICATIONS

NOTE: Verification information relating to each specific requirement will be addressed in later revisions.

The verifications established in Section 4 for the requirements specified in Section 3 are intended to result in a progressive, in-process verification of design maturity that will be consistent with key milestones of the Government Engineering and Manufacturing Development program schedule. The Incremental verification matrix (table 4-I) provides a cross-reference between the requirements and the associated method and timing of the verification. Measurand is a parameter that is measured in order to verify a required system or end item feature or characteristic.

TABLE 4-I. Incremental verification matrix.

Requirement\Milestone	SRR/ SFR	PDR	CDR	FFR	SVR
3 Requirements					
3.1 Operations					
3.1.1 Roles & missions	A	A	A	None	A
3.1.2 Organization	IA	IA	AI	None	IA
3.1.3 Deployment & mobilization	A	A	A	None	A
3.1.4 Mission planning	A	A	A	None	A
3.1.5 System usage					
3.1.5.1 Peacetime operations					
*					
*					
*					
3.X.X.X	A	A	A	None	A
Note: Entries represent sample guidance for a representative portion of the section 3 requirements. Shaded cells identify section 3 paragraph titles that do not have associated verifications.					

Tables 4-II and 4-III describe the milestones and verification methods used in the above table. See 6.3.31 for definitions of the verification methods and 6.4 for definitions of the milestones.

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TABLE 4-II. Milestones.

Milestone	Description
SRR/SFR	System Requirements Review/ System Functional Review
PDR	Preliminary Design Review
CDR	Critical Design Review
FFR	First Flight Review
SVR	System Verification Review

TABLE 4-III. Verification methods for the Air System specification.

Method	Description
I	Inspection
A	Analysis
S	Simulation
D	Demonstration
T	Test

Verification format example:

Section 4.X.X.X Verification:

Requirement Elements	Measurand*	SRR/SFR	PDR	CDR	FFR	SVR

*Measurand: A parameter that is measured in order to verify a required system/end item feature or characteristic.

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5. PACKAGING

5.1 Packaging requirements.

Packaging requirements ____(1)____.

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful but is not mandatory.)

6.1 Intended use.

This Joint Service Specification Guide is intended to be tailored for the development of first-tier, program-unique performance specifications for DoD air systems.

6.2 Acquisition requirements.

Acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Issue of DoDISS to be cited in the solicitations, and if required, the specific issue of individual documents referenced (see 2.2.1, 2.2.2, and 2.3).

c. Packaging requirements (see section 5).

6.3 Definitions.

6.3.1 Asset.

Any item, service, or process, whether developmental, nondevelopmental, possessed, or procured. Frequently used interchangeably with "item."

6.3.2 Availability (Ao).

A measure of the degree to which an item is in the operable and committable state when the mission is called for at any random point in time. Availability is dependent on reliability, maintainability, and logistics supportability.

6.3.3 Battle damage assessment.

The timely and accurate estimate of damage resulting from the application of military force, either lethal or non-lethal, against a predetermined objective. Battle damage assessment can be applied to the employment of all types of weapon systems (air, ground, naval, and special forces weapon systems) throughout the range of military operations. Battle damage assessment is primarily an intelligence responsibility with required inputs and coordination from the operators. Battle damage assessment is composed of physical damage assessment, functional damage assessment, and target system assessment. Also called BDA. *(Joint Pub 1-02, 15 Apr 98)*

6.3.4 Computer resources.

System computer hardware, system computer software/firmware, and computer resources support subsystems.

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6.3.5 Evolutionary acquisition.

An adaptive and incremental strategy applicable to high technology and software intensive systems when requirements beyond a core capability can generally, but not specifically, be defined.

6.3.6 Full mission capable.

Material condition of an aircraft or training device indicating that it can perform all of its missions. Also called FMC. See also mission capable; partial mission capable; partial mission capable, maintenance; partial mission capable, supply. *(Joint Pub 1-02, 15 Apr 98)*

6.3.7 Growth.

The inclusion of physical and/or functional characteristics/provisions which enable expansion or extension of the system's capability with minimum disruption of the system design.

6.3.8 Imagery intelligence.

Intelligence derived from the exploitation of collection by visual photography, infrared sensors, lasers, electro-optics, and radar sensors such as synthetic aperture radar wherein images of objects are reproduced optically or electronically on film, electronic display devices, or other media. Also called IMINT. *(Joint Pub 1-02, 15 Apr 98)*

6.3.9 Intelligence.

1. The product resulting from the collection, processing, integration, analysis, evaluation, and interpretation of available information concerning foreign countries or areas.

2. Information and knowledge about an adversary obtained through observation, investigation, analysis, or understanding. *(Joint Pub 1-02, 15 Apr 98)*

6.3.10 Intelligence discipline.

A well defined area of intelligence collection, processing, exploitation, and reporting using a specific category of technical or human resources. There are five major disciplines: human intelligence, imagery intelligence, measurement and signature intelligence, signals intelligence (communications intelligence, electronic intelligence, and foreign instrumentation signals intelligence), and open-source intelligence. *(Joint Pub 1-02, 15 Apr 98)*

6.3.11 Interoperability.

1. 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. (DoD)

2. The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases. *(Joint Pub 1-02, 15 Apr 98)*

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6.3.12 Logistics supportability.

The degree to which planned logistics support [including test, measurement, and diagnostics equipment; spares and repair parts; technical data; support facilities; transportation requirements; training; manpower; and software support] allow meeting system availability and wartime usage requirements.

6.3.13 Measurand.

A parameter that is measured in order to verify a required system/end-item feature or characteristic.

6.3.14 Measurement and signature intelligence.

Scientific and technical intelligence obtained by quantitative and qualitative analysis of data (metric, angle, spatial, wavelength, time dependence, modulation, plasma, and hydromagnetic) derived from specific technical sensors for the purpose of identifying any distinctive features associated with the target. The detected feature may be either reflected or emitted. Also called MASINT. *(Joint Pub 1-02, 15 Apr 98)*

6.3.15 Mission capable.

Material condition of an aircraft indicating it can perform at least one and potentially all of its designated missions. Mission capable is further defined as the sum of full mission capable and partial mission capable. Also called MC. See also full mission capable; partial mission capable; partial mission capable, maintenance; partial mission capable, supply. *(Joint Pub 1-02, 15 Apr 98)*

6.3.16 Modularity.

A system composed of discrete elements, each of which is defined in sufficient completeness and detail such that selected element(s) can be replaced and/or modified in a competitive environment with minimal or no modifications to other system elements while maintaining equal or improved system performance and capability.

6.3.17 Near real time.

Pertaining to the timeliness of data or information which has been delayed by the time required for electronic communication and automatic data processing. This implies that there are no significant delays. *(Joint Pub 1-02, 15 Apr 98)*

6.3.18 Objective.

The goal or desired value (see Technical objectives).

6.3.19 Partial mission capable.

Material condition of an aircraft or training device indicating that it can perform at least one but not all of its missions. Also called PMC. See also full mission capable; mission capable; partial mission capable, maintenance; partial mission capable, supply. *(Joint Pub 1-02, 15 Apr 98)*

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6.3.20 Partial mission capable, maintenance.

Material condition of an aircraft or training device indicating that it can perform at least one but not all of its missions because of maintenance requirements existing on the inoperable subsystem(s). Also called PMCM. See also full mission capable; mission capable; partial mission capable; partial mission capable, supply. *(Joint Pub 1-02, 15 Apr 98)*

6.3.21 Partial mission capable, supply.

Material condition of an aircraft or training device indicating it can perform at least one but not all of its missions because maintenance required to clear the discrepancy cannot continue due to a supply shortage. Also called PMCS. See also full mission capable; mission capable; partial mission capable; partial mission capable, maintenance. *(Joint Pub 1-02, 15 Apr 98)*

6.3.22 Preplanned product improvement.

The conscious, considered strategy which involves deferring the development of necessary performance capabilities associated with elements having significant risks or delays so that the system can be fielded while the deferred element is developed in a parallel or subsequent effort. Provisions, interfaces, and accessibility are integrated into the system design so that the deferred element can be incorporated in a cost effective manner when available. The concept also applies to process improvements.

6.3.23 Real time.

Pertaining to the timeliness of data or information which has been delayed only by the time required for electronic communication. This implies that there are no noticeable delays. *(Joint Pub 1-02, 15 Apr 98)*

6.3.24 Reconnaissance.

A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy, or to secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. *(Joint Pub 1-02, 15 Apr 98)*

6.3.25 SEEK EAGLE (SE).

The Air Force certification program for determining safe carriage, employment and jettison limits, safe escape, and ballistics accuracy, when applicable, for all stores in specified loading configurations on United States Air Force and Foreign Military Sales (FMS) aircraft. SE includes compatibility analyses for fit, function, electromagnetic interface, flutter, loads, stability and control, and separation; stores loading procedures; ground and wind tunnel tests; and flight tests. The end product is source data for flight, delivery, loading manuals, and the weapon ballistics portion of the aircraft operational flight program. (AFI 63-104).

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6.3.26 Service life.

The period of time spanning from an asset's introduction into the inventory for operational use until it is consumed or disposed. The service life of a system typically exceeds the service lives of the assets that compose it.

6.3.27 Signals intelligence.

1. A category of intelligence comprising, either individually or in combination, all communications intelligence, electronics intelligence, and foreign instrumentation signals intelligence, however transmitted.
2. 2. Intelligence derived from communications, electronics, and foreign instrumentation signals. Also called SIGINT. *(Joint Pub 1-02, 15 Apr 98)*

6.3.28 Specification.

A description of the essential technical requirements for items, materials, and services that includes the verification criteria for determining whether these requirements are met. A specification supports the acquisition and life cycle management of the item, material, and service described.

6.3.29 Surveillance.

The systematic observation of aerospace, surface or subsurface areas, places, persons, or things, by visual, aural, electronic, photographic, or other means. *(Joint Pub 1-02, 15 Apr 98)*

6.3.30 Technical performance measurement (TPM).

The continuing verification of the degree of anticipated and actual achievement for technical parameters. Confirms progress and identifies deficiencies that might jeopardize meeting a system requirement. Assessed values falling outside established tolerances indicate a need for evaluation and corrective action (see figure 6.3-I).

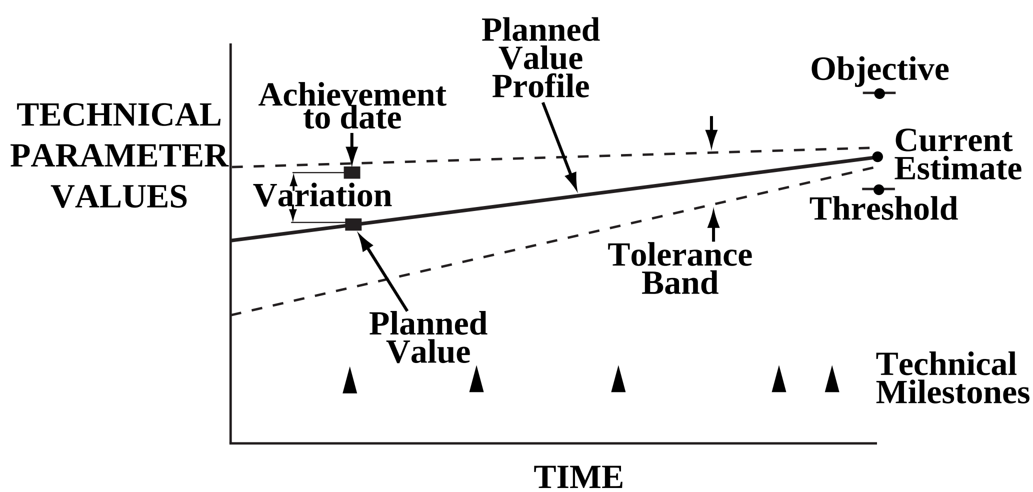

FIGURE 6.3-I. Example technical performance measurement profile.

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6.3.30.1 Achievement-to-date.

Present assessed value of the technical parameter.

6.3.30.2 Current estimate.

The technical parameter value predicted to be achieved by the end of the contract with remaining resources (including schedule and budget).

6.3.30.3 Objective.

The goal or desired value (see Technical objectives).

6.3.30.4 Planned value.

Technical parameter value based on the planned value profile.

6.3.30.5 Planned value profile.

Projected time-phased achievement of a technical parameter.

6.3.30.6 Technical milestone.

A point where a TPM evaluation is accomplished or reported.

6.3.30.7 Threshold.

The limiting acceptable value of a technical parameter.

6.3.30.8 Tolerance band.

Alert envelope around the planned value profile indicating allowed variation and projected estimating error.

6.3.30.9 Variation.

Difference between the planned value and the achievement-to-date value.

6.3.31 Verification definitions.

The verification methods are defined as follows.

6.3.31.1 Inspection/evaluation (I).

Examination of equipment, drawings, or documentation.

6.3.31.2 Analysis (A).

A method of verification that utilizes established technical or mathematical algorithms, charts, graphs, circuit diagrams, or other scientific principles and procedures.

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6.3.31.3 Simulation/modeling (S).

The process of conducting experiments with a model. Simulation may include the use of analog or digital devices, laboratory models, or "testbed" sites.

6.3.31.4 Demonstration (D).

A method which that generally utilizes, under specific scenarios, the actual operation, adjustment, or reconfiguration of items.

6.3.31.5 Test (T).

A method of verification that generally determines, quantitatively, the properties or elements of items, including functional operation, and involves the application of established scientific principles and procedures.

6.3.32 Wartime reserve modes.

Characteristics and operating procedures of sensor, communications, navigation aids, threat recognition, weapons, and countermeasures systems that will contribute to military effectiveness if unknown to or misunderstood by opposing commanders before they are used, but could be exploited or neutralized if known in advance. Wartime reserve modes are deliberately held in reserve for wartime or emergency use and seldom, if ever, applied or intercepted prior to such use. *(Joint Pub 1-02, 15 Apr 98)*

6.4 Verification by milestones.

The incremental verification approach is intended to accomplish several important objectives, ensuring that

a. system-level performance requirement is consistent with the requirement allocations made and implemented in lower-tier specifications/product definition documentation,

b. product design decisions support the allocated performance requirements, and

c. the system-level performance requirements are met.

To ensure that product design decisions support and properly allocate performance requirements, verification should be accomplished in iterations at appropriate program milestones. Ideally, iterative verifications, while accomplishing the same basic objective each time, are done with greater and greater fidelity and accuracy as designs mature and more detailed information becomes available. Some verifications may progress in method from inspection to analysis to simulation to test through successive milestones. Other verifications may call for using the same method (i.e., analysis) through each program milestone but requiring successively more insight into and fidelity in data and assumptions.

Requirements should be verified prior to each major system milestone to provide the greatest assurance that verification criteria are achieved. The milestones for a specific program may differ or be called by a different name. There may be more milestones or fewer. Milestone objectives may be different. These are all program choices. In all cases, program milestones must be defined. However, the verification criteria must be matched to the milestones selected and the milestone objectives.

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The following are typical milestones intended for use in the JSSGs:

a. System Requirements Review (SRR)/System Function Review (SFR) or equivalent

b. Preliminary Design Review (PDR) or equivalent

c. Critical Design Review (CDR) or equivalent

d. First Flight Review (FFR) or equivalent

e. System Verification Review (SVR) or equivalent

The key objectives of each milestone, applicable to specifications, are summarized below:

a. System Requirements Review (SRR)/System Functional Review (SFR) or equivalent. Confirm convergence on and achievability of system requirements and readiness to initiate preliminary design by confirming that

(1) system functional and performance requirements have converged and characterize a system for which one or more design approaches exist that satisfy established customer needs and requirements;

(2) the system's draft physical architecture and draft lower-level product performance requirements definition establish an initial assessment of, the adequacy, completeness, and achievability of functional and performance requirements, and quantification of cost, schedule, and risk;

(3) critical technologies for people, product, and process solutions have been verified at an acceptable level of risk for availability, achievability, needed performance, and readiness for transition;

(4) life cycle requirements for people, products and processes have been defined, within acceptable limits of certainty, that provide the encompassing essential functionality, capability, interfaces, and other requirements/ constraints; and

(5) preplanned product and process improvement and evolutionary acquisition requirements planning has been defined as required.

b. Preliminary Design Review (PDR) or equivalent. Confirm that the detailed design approach satisfies system requirements and the total system is ready for detailed design. PDR confirms that the process completely defines system requirements for design including that

(1) the system physical architecture is an integrated detailed design approach for people, products, and processes to satisfy requirements, including interoperability and interfaces;

(2) an audit trail from SRR is established with changes substantiated;

(3) available developmental test results support the system design approach;

(4) the product performance requirements are defined;

(5) sufficient detailed design has been accomplished to verify the completeness and achievability of defined requirements, and quantification of cost, schedule, and risk; and

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(6) preplanned product and process improvement and evolutionary acquisition requirements planning have been refined.

c. Critical Design Review (CDR) or equivalent. Confirm that the total system detailed design is complete, meets requirements, and that the total system is ready for manufacturing. CDR confirms that the process completely defines system design requirements including that

(1) the system physical architecture is an integrated detailed design for people, products, and processes to satisfy requirements, including interoperability and interfaces;

(2) an audit trail from PDR is established with changes substantiated, and product performance requirements are refined;

(3) product design definition and product manufacturing/fabrication and support definition for the system is defined;

(4) the system design compatibility with external interfaces has been established;

(5) developmental test results are consistent with system design and interface requirements and design constraints;

(6) critical system design and interface requirements and design constraints are supported by developmental test results; and

(7) preplanned product and process improvement and evolutionary acquisition requirements planning has been defined.

d. First Flight Review (FFR) or equivalent. Confirm that, prior to testing, system items, individually or in combination, demonstrate that

(1) the safety inherent in the test article(s) and the procedures and plans for its use have been evaluated as being safe;

(2) personnel involved in the testing are trained in both the objectives of the test(s) and the jobs they are responsible for accomplishing;

(3) the configuration control process necessary to support flight testing is established;

(4) planning for testing is complete, evaluated for adequacy and available to all applicable personnel;

(5) hazardous materials and procedures are defined and documented, and handling equipment, instructions, and special actions are defined and provided to affected personnel with warnings, instructions, and special training as appropriate;

(6) resources (people, equipment, and materials) needed to accomplish the testing are available and ready for the testing;

(7) the test article(s), equipment, facilities, and ranges (if applicable) are evaluated as ready for test; and

(8) documentation of evaluations, assessments, plans, procedures, training and other factors applicable to the tests is available, correlated, and complete.

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e. System Verification Review (SVR) or equivalent. Confirm that the total system is verified. SVR confirms the completion of all incremental accomplishments for system verification (e.g., Test Readiness Reviews, system Functional Configuration Audits) and confirms, within acceptable limits of certainty, that

(1) system verification procedures are complete and accurate (including verification by test and demonstration of critical parameters as well as key assumptions and methods used in verifications by analytic models and simulations);

(2) the system is confirmed to be ready for verification;

(3) verifications have been conducted in accordance with established procedures and are completed for people, products, and processes; and system processes are current, executable, and meet the need;

(4) an audit trail from CDR is established with changes substantiated and the system verified;

(5) the interface compatibility has been achieved;

(6) plans and procedures for downstream processes (production, training, support/sustainment, deployment/fielding, operations, and disposal) evaluated for adequacy; discrepancies resolved; and documentation and results incorporated in the system data base; and

(7) preplanned product and process improvement and evolutionary acquisition requirements and plans have been refined.

6.5 Specification tree.

The following list identifies the documents that comprise the top level of the specification tree for the air system.

Example

Level	Document
1	Air System Specification
2	Air Vehicle Specification
2	Training System Specification
2	Support System Specification
2	(Other Tier 2 Specification(s))

This section identifies the top three tiers of the specification tree. The complete tree of requirements documentation is normally the developing contractor's responsibility to develop. See the Integrated Performance Based Business Environment Guide and the Performance Based Product Definition Guide for additional information.

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A specification tree is a program-unique construct to organize the requirements flow-down into documentation that describes requirements for segments of the system and items that comprise the system. An air system specification is normally the top-tier document in the specification tree for system development. This is not intended to preclude the use of another document as the top-tier specification on a modification program such as using a tailored avionics specification for a radar upgrade. As always, significant insight and planning is necessary when constructing a set of requirements for the program. For example, how much of that radar upgrade needs to be verified in its installed environment (air vehicle) or how much of that requirements set is dependent on system environments, interfaces, and other factors such as impacts on support and training.

This Air System Joint Service Specification Guide (JSSG) has been developed in concert with seven other JSSGs with the assumption that, at some future point, a Weapon JSSG (used in those circumstances when the system being developed is a weapons system) will be developed and existing Air Force Guide Specifications (AFGS) for Training Systems and Support Systems will be converted to JSSGs. The nominal JSSG hierarchy depicted on figure 6.5-1 should not be construed as a program specification tree. While the JSSGs shown at tier 2 may represent program-unique specifications to be developed, those specification guides shown under the Air Vehicle at tier 3 may or may not have a resemblance to a program-specific specification architecture. These tier 3 JSSGs nominally communicate performance expectations for areas of air vehicle functionality. While they could exist in a program-specific form, some (or some portions) of these documents express functionality that would frequently be expressed as part of the functionality of the air vehicle. That is, in developing a program-specific air vehicle specification, portions of the tier 3 documents may be appropriately tailored and incorporated in an air vehicle specification. Additionally, the choices on how best to organize requirements are frequently driven by the organization of the program, risk, and complexity among other factors. For example, the use of integrated product teams may make it desirable to consolidate all requirements for avionics into a single specification even though some of the performance expectations are tier 2 (i.e., air vehicle requirements) and some tier 3 (e.g., radar requirements). This would enable making a single team accountable for the development and implementation of a given area of requirements. The organization of the Joint Service Specification Guide specification tree is intended to assist the program office in constructing appropriate sets of requirements, not in hindering factors such as teamwork, team accountability, or other mechanism used to organize requirements.

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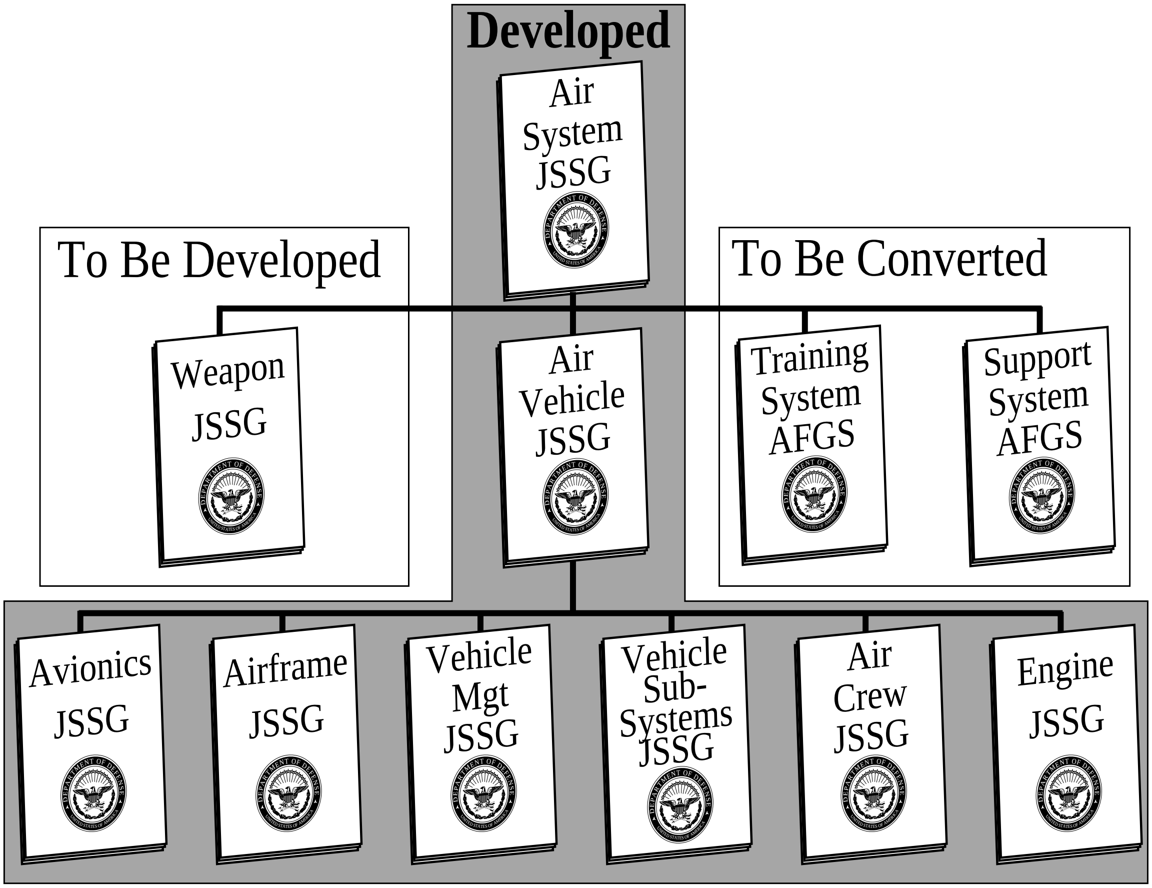

FIGURE 6.5-1. Joint Service Specification Guide specification tree.

6.6 Key word list.

acquisition reform
acquisition requirements
aerial refueling
aircraft
air vehicle
avionics
crew system
interface
interoperability
maintainability
operational concept
performance specification
reliability
service life
specification template
structures
subsystem

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support systems
survivability
system life cycle
systems engineering
tailorable specifiation
training system
verification
weapons

6.7 International interest.

Certain provisions of this document may be the subject of international standardization agreements. When change notice, revision, or cancellation of this document is proposed that will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

6.8 Responsible engineering office.

The DoD office responsible for development and technical maintenance of this Joint Service Specification Guide is ASC/ENS, Bldg. 560 (Area B), 2530 Loop Road West, Wright-Patterson AFB OH 45433-7101. Requests for additional information or assistance on this specification can be obtained from ASC/ENS: DSN 785-1799, commercial (937) 255-/1799, FAX (937) 255-5597. Address e-mail comments to D. Sedor (sedordj@asc-en.wpafb.af.mil). Any information relating to Government contracts must be obtained through the contracting officer for the program or project under consideration.

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JOINT SERVICE SPECIFICATION GUIDE

AIR SYSTEM

HANDBOOK

(Part II)

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1. SCOPE

1.1 Scope.

This specification establishes the overall requirements, and the associated verification criteria for the ___(1)___ system.

GUIDANCE (1.1)

Note that the scope and other material in sections 1, 2, and 6 are part of the template for use in developing a program-specific specification. Thus, the language used in these sections does not reflect that this document is a specification guide. This specification guide provides candidate requirements and verifications that are expected to be tailored for a specific program application.

Enter the name of the system in blank 1.

Include any additional language necessary to describe the scope of the system specification. The system specification is the basis for design, development, and fabrication of, or modification to, any equipment and software, as applicable for the system. In general, all programs have a system specification and the Government is responsible for defining all system-level, essential performance requirements in performance terms in the program-specific, system-level specification. This is true whether a specific development program is for the entire air system or an upgrade or modification to that system which only involves some portion of the system. The reason for defining the required performance at the system level is to attain the installed, operational capability needed by the war fighters. This may be difficult for common equipment intended for use in a number of different systems, because the installed performance will most likely be different in each system. In addition it is also likely that the initial program direction only requires initial integration for a limited number of systems. In this case, the installed performance for the initial systems should be defined, and the factors that influence installed performance should be identified and steps taken to ensure the design solution addresses future implementation. It may also be difficult for legacy systems where the development specifications have not been maintained sufficiently or have not been converted to performance based requirements. In every case, the Government must define all the interface requirements external to the development effort. In the case of a mod or upgrade, this would include all essential interfaces for new or modified equipment in addition to those external to the prime equipment (e.g. air vehicle, trainer, etc.). Government-defined requirements should be only in performance terms that do not restrict the potential design solutions that satisfy these requirements, with the exception of interoperability requirements.

1.2 System.

The air system specification characterizes the system in terms of technical requirements, which are engineered to become design solutions that provide the needed capability throughout the system's life cycle. Specification developers must keep in mind that, while a system specification focuses on the capabilities expected in products for use in specific environments, systems engineering accounts for the system's entire life cycle,

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encompassing all of the people, products, and processes involved (including hardware, software, facilities, data, materials, services, and techniques).

Specification. A description of the essential technical requirements for items, materials, and services that includes the verification criteria for determining whether these requirements are met. A specification supports the acquisition and life cycle management of the item, material, and service described.

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2. APPLICABLE DOCUMENTS

2.1 General.

The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of the specification, whether or not they are listed.

GUIDANCE (2)

When this specification guide is tailored for a particular program application, this section should include only those references cited in sections 3 and 4 of the resulting program specification. In addition, the specific applicable paragraph(s) should be cited where a document is referenced. For example, if a document is intended to be contractually binding, it is cited in section 3 or 4 to the extent that it is applicable and listed in section 2 under the appropriate subparagraph and category (see 2.4 for tiering implications). Section 2 of the tailored specification should not include documents cited only in sections 1, 2, 5, or 6.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks.

The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS), and supplement thereto, cited in the solicitation.

SPECIFICATIONS

Department of Defense

Document Number	Document Title
______________	______________
______________	______________

STANDARDS

Department of Defense

Document Number	Document Title
______________	______________
______________	______________

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HANDBOOKS

Department of Defense

Document Number	Document Title

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Defense Automation and Production Service (DAPS), 700 Robbins Avenue, Bldg 4D, Philadelphia PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications.

The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues are those in effect on the date of the solicitation.

Document Number	Document Title

(Copies of specifications, standards, handbooks, drawings, publications, and Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

GUIDANCE (2.2.2)

Other Government documents, drawings, and publications called out in the final specification are listed in this section. List only other Government documents, drawings, and publications called out in sections 3, 4, and 5 of the tailored program specification See appendix B for a cross-reference matrix showing the location of each document referenced.

2.3 Non-Government publications.

The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the document that are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

Non-Government Standards (NGS) Organization Name(s)

Document Number	Document Title

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Application for copies should be addressed to (insert the name and address of the source under the list of documents for each NGS body).

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

GUIDANCE (2.3)

Non-Government publications called out in the final specification are listed here. List only non-Government documents called out in sections 3, 4, and 5 of the tailored program specification. See appendix B for a cross-reference matrix showing the location of each document referenced.

2.4 Document tiering.

When the air system specification is directly referenced in the contract, it is a first-tier specification and is applicable. Documents referenced in the (first-tier) specification are applicable as follows:

a. Second Tier - All documents directly referenced in the first-tier specification are only applicable to the extent specified.

b. Lower Tier - All documents directly referenced in second- or lower-tier documents are for guidance only unless otherwise directed by the contract.

Control of document tiering has become a primary way of controlling contractual applicability of referenced documents. Care must be taken to ensure that each referenced document is appropriately applicable in first-tier references (including those references cited in the contract, which themselves would become first-tier references and, thus, their second tier would become contractually applicable as well).

Note that this guidance is aimed primarily at controlling applicable documents when a system specification, derived from this JSSG, is cited in the contract. During production phase, there are additional considerations as well. For example, specifications and standards listed on engineering drawings are to be considered first-tier references (see Dr. Perry's memorandum on "Specifications and Standards - a New Way of Doing Business" dated 29 June 1994). In a Performance Based Business Environment context, this option is primarily applicable to the Build-to-Print (BTP) and Modified Build-to-Print (MBTP) business practices when the drawings are directly cited in the contract. See the Performance Based Product Definition Guide for additional information about BTP and MBTP practices.

Exceptions to tiering applicability are generally defined by DoD policy. For example, in the Perry Memo previously cited, the direction on tiering of specifications and standards includes, "Approval of exceptions may only be made by the Head of the Departmental or Agency Standards Improvement Office and the Director, Naval Nuclear Propulsion for specifications and drawings used in nuclear propulsion plants in accordance with Pub. L. 98-525 (42 U.S.C. ß7158 Note)."

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2.5 Order of precedence.

In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

GUIDANCE (2.5)

This is the final paragraph of section 2 in all specifications. Copy verbatim.

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3. PERFORMANCE REQUIREMENTS

REQUIREMENT RATIONALE (3)

To Be Prepared

REQUIREMENT GUIDANCE (3)

In defining the requirements for an air system, there are a vast number factors to consider. This document addresses many of them, but it does not, and could not, address them all. In the development of this document, many comments were received that highlighted good practices as well as things to avoid. Other comments pointed out misperceptions of the role that a system specification plays in a development program. This section addresses some considerations to keep in mind as this document is used to develop a program–specific, system specification.

a. Role of a system specification

(1) A system specification documents the translation of the customer's (DoD, users) requirements for the life cycle of a system into an overarching set of technical requirements and their verifications.

a) A system specification is not a replication of the Operational Requirements Document. It is represents a translation of operational requirements (e.g., destroy moving enemy armor columns 300 miles beyond the forward line of our troops at night and under weather) into a set of technical requirements (including air vehicle sortie rate, survivability, lethality per air vehicle, reach, training required to do the jobs, etc.) and their verifications.

b) Air systems are developed to satisfy warfighter requirements. But the warfighter is not the only customer. The needs of all the customers must be satisfied including those of the trainer, supporter, etc.

(2) Every requirement to be defined and developed must be traceable (derivable) from a requirement in the system specification.

The highest requirement (i.e., cannot be shown to be traceable to any higher-tier requirement) that exists at any tier in the system architecture is a system requirement. This can result from an inability to define a more appropriate system requirement that would form the basis for determination of the lower-tier requirement. It can also be that the apparently lower-tier parameter is a system requirement or is the most appropriate choice for use as one. Failure to include the requirement in the system specification will likely result in missed interfaces and inadequate allocations.

Requirements are imposed by a number of sources. The warfighter may have developed an ORD that includes critical requirements specifically driving particular lower-tier parameters. Requirements could also originate as commitments to OSD, for example, in the Acquisition Program Baseline; and commitments to Congress, for example, in the Manpower Estimate Report. The ability to ensure that air vehicle, training, support, and other tier 2 specification

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impacts are adequately allocated is dependent upon the comprehensiveness of translating all externally imposed requirements into a system specification.

Depending on program-specific implementation, a system specification is developed from a viewpoint that all tier 2 requirements may be independently determined by the contractor and that the successful integration of those requirements yielding the requirements in the system specification will be considered acceptable. In other words, if the system specification can be satisfied by a blimp, then a blimp would be considered an acceptable solution.

b. Developing a system specification

In the current acquisition environment, be prepared to accept any air vehicle specification, training specification, and support specification that, individually, contains feasible and affordable requirements, has adequate verifications, and that, in combination, satisfies the requirements and verifications in the system specification. If those documents are not acceptable (but they satisfy requirements), then the system specification is probably inadequate. This does not imply that lower-tier requirements should be included in the system specification. Rather, it means all the system requirements and verifications that are necessary have been included and are appropriate and complete.

When describing the mission sequence, include as many parameters as possible. Consider planning, sortie generation, survivability, target acquisition, weapon delivery, etc., and not merely the ideal scenarios and conditions. The operations section of this document has been ordered to assist in accomplishing this.   Keep in mind that ideal weapon delivery conditions (e.g., fly straight and level at the optimum altitude to obtain the best weapon accuracy and density over targets) are not necessarily survivable. Likewise, ideal survivability conditions (e.g., hug the ground or fly really high and fast) are not necessarily useful for target acquisition and weapon delivery.

A key value of air systems is their flexibility. Some critical parameters that give air systems their value are not captured by the typical or average conditions communicated by a nominal mission sequence. For example, sortie rate is very useful for productivity and the overall job to be done. A derivative of sortie rate can be the maximumallowed turnaround time. This will not necessarily capture real operational conditions to which that the system must be capable of responding (for example, that a threat attack occurred during an aircraft recovery cycle, or that only limited air assets are available in theater to counter a surprise attack, or that real demands for sorties occur at unpredictable tempos). Thus, it may be necessary to specify a more stringent turnaround time as well (see the integrated combat turnaround time requirement). On the other hand, do not try to capture every conceivable possibility as a requirement in the specification. Conditions that occur some fraction of a percent of the time can be significant design (and cost) drivers. The question, “is this an amenity or is this mission essential” must continually be addressed. Early trade-off studies that examine the costs, benefits, and risks of such capabilities are essential in establishing a suitable set of system requirements. The customers (warfighter, supporter, trainer, etc.) are vital members of the team developing the specification. Developers (both Government and contractor) use their expertise in design impacts (and associated cost, schedule, and risk impacts) along with the warfighter’s, supporter’s, and trainer’s expertise in what is important for them

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to do their jobs in defining a reasonable set of system characteristics. The selected set of characteristics must enable solid solutions that provide flexibility for innovation, cost savings, and alternative capabilities expected from lower-tier items.

Air systems are now developed that may be around for many decades. Do not expect to capture every possible use. Select requirements for application that provide adequate "design to" points. It will not be possible to translate every possible nuance of an operational requirement, nor will it be possible to foresee exactly how the system will be used twenty years from now. However, a nominal set of conditions must be established. Sometimes, a reasonable estimate is far better than no estimate at all. For example, the service life of an air system is generally estimated to be twenty years or longer. But clearly, we do not know what the peacetime flying hour program will be for training. Specify a reasonable number. Training in air vehicles consumes engine cycles (a durability/system integrity issue). Ignoring it will result in the wrong answer. A reasonable estimate will provide a far better (and significant) "design-to" point.

REQUIREMENT LESSONS LEARNED (3)

To Be Prepared

3.1 Operations.

This is a paragraph header facilitating document organization.

REQUIREMENT RATIONALE (3.1)

The Operations section of the Air System JSSG translates typical warfighter requirements into system-specific characteristics needed to effectively accomplish military tasks in the mission element documented in the Mission Needs Statement (MNS) and elaborated on in the Operational Requirements Document (ORD). More specifically, it deals with those requirements directly bearing on the successful accomplishment of mission objectives and tasks in peacetime and wartime environments, planned or expected.

REQUIREMENT GUIDANCE (3.1)

The operations section is organized into a nominal mission sequence, preceded by a description of roles, missions and unit organization, and followed by other operational characteristics that may be determined to be essential to full operational success. The organization of these requirements is consistent with the definition of system effectiveness as a function of the systems availability for use, dependability in use, and capability as used. A system's availability for use has been predominantly expressed in terms of its utilization, typically as a sortie rate. System dependability describes a system's ability to consistently conduct a given job or task. It has been characterized in terms of mission reliability and survivability. System capability describes a system's ability to execute the primary mission task, such as the destruction of targets or reconnaissance of a given area.

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REQUIREMENT LESSONS LEARNED (3.1)

To Be Prepared

3.1.1 Roles and missions.

The system shall perform as needed to conduct the roles and missions within the scenarios and conditions stipulated in table 3.1.1-I.

TABLE 3.1.1-I. Air system roles and missions.

ID	Scenario	Role	Mission	Vignette	Mission/ Vignette Mix	Peace/ War	Threat	Basing Location	Time	Remarks

REQUIREMENT RATIONALE (3.1.1)

This section defines the roles and missions against which system requirements are defined. Roles and mission need to address a complete representation of what the system is expected to do. These would include peacetime operations, wartime operations and conditions other than war. While it may be impossible to predict with certainty all the conditions that a system might be called upon to perform, the descriptions provided need to be suitable for establishing a requirements/design point for system definition and be a sufficient representation for life cycle requirements and management. Without this definition of the stressing elements, the performance requirements are incomplete and the context for the allocated parameters cannot be established. In addition, wartime and peacetime deployment locations, as well as other required information, are provided as a basis from which to derive infrastructure and some environment requirements.

REQUIREMENT GUIDANCE (3.1.1)

Including thorough scenario, threat, and basing location information in a table may not be feasible. If not, cite appropriate reference documents or provide the information in paragraph form.

Guidance for completing table 3.1.1-I follows:

> ID: This requirement (and table) is referenced from numerous locations in the document. A unique identifier (even a line number) will assist document users in unambiguously locating the appropriate reference.

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Roles: Enter the general description of the task to be accomplished. For example, air to air, air to ground, aerial refueling, and training would be valid entries.

Mission: Identify the mission (e.g., combat air patrol or tanker support) to be conducted and a mission description. The description includes a top-level (generic) mission profile identifying reference points (e.g., loiter reference points, orbit location(s) reference points, profile/speed/altitude change reference points etc). Depending on the operational requirements and their translation into a system specific specification, the profile(s) could be as simple as “launch, climb, cruise to within XX miles of the FLOT, dash in to target area, deliver weapons, dash out from target area, cruise to descend point, descend, land.” It could also be a bit more complex, identifying some minimum speed conditions and/or altitude bands; for example, “launch, climb to medium altitude (with a definition of this altitude range), cruise to within XX miles of the FLOT, dash at mach XX or better in to the target area, deliver weapons at medium altitude supersonically (or leave it blank), etc. The intent is to provide sufficient information to scope the mission. The more specific the profile, the more constrained the resulting air vehicle solution would be. Provide sufficient latitude. Do not specify what is not necessary to meet operational requirements. Focus on the objective, not on the air vehicle characteristics that may satisfy the objective. The profile should be refined (specific speeds and altitudes) along with specific aircraft capabilities in the air vehicle specification. Missions address those planned or expected in peacetime conditions, wartime conditions, and conditions other than war. A reference to 3.1.7, System Reach, would also be appropriate.

Vignette: A vignette (sometimes referred to as a mini-scenario) can be viewed as a single mission portion of a campaign. It is a two-sided situation that encompasses system employment conditions. It describes starting and ending conditions, the numbers of systems involved, their tactics and operating conditions, the targets and their location, the relationships between systems, natural environment factors (including weather conditions and terrain), operational environment conditions (including dust and smoke) and any other operationally significant factors. It must be sufficiently broad to assess the interactions between like air vehicles in the flight and accommodate the interactions with systems external to the flight. Each vignette needed in the definition of the system, should be incorporated into the descriptions and conditions defined in 3.1.1, Roles and Missions. A vignette can also have a variety of associated conditions that describe specific characteristics of air vehicle operations to be conducted. Note that a vignette used to explore candidate system definitions at the start of Product Definition Phase is substantively different from that used in a system specification. At the start of Product Definition/Risk Reduction Phase, the focus is on defining a system solution. The system specification represents that system solution. Thus the vignettes used in the system specification reflect the air vehicle and operational concepts needed.

A mission may have multiple vignettes. To minimize ambiguity, repeat the mission and other information on a new row in the table) for each vignette.

Some specific survivability conditions (see 3.1.6.2.1, Mission and One-on-One Survivability) to include in the vignettes are the overall threat distribution and density. For example, assume that the mission involves a single air vehicle

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penetrating enemy airspace at low altitude. Further, assume that the air vehicle would enter the engagement envelope of only ten threat systems out of the one-hundred threat systems in the overall scenario. The vignette must be sufficiently encompassing to ensure that the air vehicle's threat detection capabilities are not limited to just the ten threat systems that are engaging it, but also the other ninety in the scenario. That is, the air vehicle's survival capability may be strongly influenced by its ability to assess the entire environment and focus pertinent survival equipment and operating modes on the ten percent that reflect the danger to this mission.

Mission/Vignette Mix: Enter the percentage of each mission/vignette type expected for the specified role and mission. This is the percentage of missions expected to be flown for the indicated mission.

Scenario: Separate data may be needed for each unique scenario. A system may have more than one role or mission in a given scenario (or vice versa). Generally, a system must be capable of performing effectively in multiple scenarios. For example, peacetime training and wartime conflicts constitute 2 scenarios. Training conducted by dedicated training assets will be a different scenario than training conducted by operational units. Scenario information is not limited to beddowns and locations. Operational factors such as decision processes, rules of engagement and mission tasking can also be scenario dependent. Be sure to provide complete information.

Peace/War: If the scenarios, roles, and missions identified are valid during peacetime, conditions other than war, and wartime, enter "all"; otherwise, indicate "peacetime," "conditions other than war," or "wartime," as appropriate.

Threat: This requirement constrains the system to being effective in a threat environment. The various elements of the subsystems may encounter different threats. The threat(s) against the system are found in an intelligence community validated threat description document. DoD 5000.2 refers to the threat description document as System Threat Assessment Report (STAR). The table or text in the system specification would describe the threat tactics for the defined threat and establish the threat environment in which the total system must provide the specified performance. The campaign and engagement simulations used in design and verification of parameters should include the appropriate representation of the threat as described in the threat documents. The recommended method for specifying threat information is to attach a threat appendix (or create and reference a separate document) that defines threat characteristics and engagement rules in sufficient detail to serve as a basis for establishing conditions for lower-tier requirements, design, and system verification. This extension of the STAR should have an endorsement by the user's intelligence community that the suggested implementation is consistent with the STAR and with tactics and doctrine of the enemy. The STAR extension should be the basis for all simulations and analyses. Threat data needs to include target and other information necessary to support assessment and verification of the requirements in the specification. For example, target vulnerability information to support lethality assessments; air defense numbers, locations, and capabilities to support survivability assessments and verifications; etc.

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Basing Location: Any characteristics of particular locations in the scenarios should be clearly identified.

Time: Enter the time frame in this column. Valid entries are 2000, 2010 etc.

Remarks: Enter any additional information that does not fall into the categories defined by the column titles but is necessary to further identify system constraints.

REQUIREMENT LESSONS LEARNED (3.1.1)

To Be Prepared

3.1.2 Organization.

The system shall perform as specified in this document when the operational elements of the system are employed in the organizational units described in table 3.1.2-II.

TABLE 3.1.2-II. Organizational units.

Unit	Air Vehicle Quantity	Conditions	Remarks

REQUIREMENT RATIONALE (3.1.2)

This paragraph requires the operational elements of the system to provide the specified performance when operating in the quantity of aircraft per operating unit planned for the system. The quantities and locations prescribe requirements for the second-tier support and training elements. The intended organization of equipment provides the employment basis for mission operations and defines the bounds for application of support and maintenance assets. For example, collocation of assets may reveal dependencies that more closely capture actual use conditions. As a result, conditions may be uncovered that are both operational and support drivers and impact the further definition and design of the system.

REQUIREMENT GUIDANCE (3.1.2)

For composite squadrons or wings, identify the planned wing structure including support infrastructure.

Guidance for completing table 3.1.2-II follows:

Unit: Identify the type of organizational unit. Examples include squadron(s), wing(s), flight, etc.

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Air Vehicle Quantity: Identify the types and quantity of different air vehicles in the squadron, wing and flight. If these vary for different composite structures, use the next column to explain.

Conditions: The conditions column is used to explain the variations in the numbers of air vehicles under different scenarios. For example, if the composite wing structure varies for different scenarios, then there would be a separate entry for each, and the conditions column would specify when the numbers apply.

Remarks: Use where further constraints or clarifications are necessary.

NOTE: If tabular presentation of this information is unwieldy, it may be more practical to present the information textually.

REQUIREMENT LESSONS LEARNED (3.1.2)

To Be Prepared

3.1.3 Deployment and mobilization.

The system shall be capable of being mobilized and deployed as described in table 3.1.3-I.

TABLE 3.1.3-I. Deployment and mobilization scenarios.

Role/ Mission	Peace/ War	Basing	Runway	Available Support Structure	Applicable Year(s)	Config-uration	Remarks

The system must be deployable, configured as defined in table 3.1.3-II, for the duration indicated and shall not require more than ___(1)___ to deploy, excluding personnel. Deployment time for training exercises and wartime missions shall not exceed those indicated in table 3.1.3-II. Deployments with full capability and performance shall require not more than ___(2)___ (or equivalents); ___(3)___ air refueling. Deployment and mobilization requirements shall ___(4)___.

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TABLE 3.1.3-II. Deployment configurations and durations.

Configuration	Personnel	Duration	Quantity	Remarks

REQUIREMENT RATIONALE (3.1.3)

The locations in which the system is deployed (both peacetime and wartime) provide bounds on the infrastructure and environment in which the prescribed performance is required. Without this definition of the infrastructure and stressing elements, the performance requirements are incomplete and the context for the allocated parameters cannot be established. Additionally, identification of deployment requirements provides critical requirements on the allowed size of the support package, including supplies, available for use for the durations specified.

REQUIREMENT GUIDANCE (3.1.3)

Guidance for completing table 3.1.3-I follows:

Role/Mission: Identify the role and mission to be performed. This should match one of the roles and missions identified in 3.1.1.

Peace/War: If the deployment identified is valid during peacetime, conditions other than war, and wartime, enter "all"; otherwise, indicate "peacetime," "conditions other than war," or "wartime," as appropriate.

Basing*: Main Operating Bases (MOBs), Remote Operating Bases (ROBs), aircraft carriers, amphibious ship, and air capable ship, either within or outside CONUS.

Runway*: Runway surface length and strength for the air vehicle and other system assets.

Available Support Structure*: If the user needs to employ the system only at prepared and prestocked locations, this should be clearly explained. If the locations are differently stocked for MOB, ROB, and carrier, or CONUS and non-CONUS sites, identify the differences in this column.

Applicable Year(s): Identifies the years in which the requirements apply. Some requirements/conditions, such as basing type, weapons/stores (i.e., configuration), transport aircraft, etc., change over time, which can result in either a more or less stringent requirement. They can also stress different aspects of the system solution.

Configuration: Air vehicle configuration (or identifier) to link to the appropriate row in table 3.1.3-II.

Remarks: Provide additional information as needed.

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*The Basing, Runway, and Available Support Structure information should be supplemented, to the extent appropriate, with more definitive information concerning the specifics of the bed down locations. Bed down results in the first use of the system in its new home or normal peacetime operational environment. These requirements will differ from those resulting from deployments and mobilizations that occur after bed down. Note that some of the resulting requirements may more appropriately capture in the Interface section (3.4).

The ability of the system to be fully operational under either scenario depends on the physical and functional characteristics of the site, camp, post, station, or commercial facility, and hence the available infrastructure, selected by the user. This infrastructure becomes a part of the environment from which the total system is defined. Using any existing and planned additions to infrastructure enables systems developers to minimize the amount of new or system-unique equipment needed for achieving a total system capability.

The following are some common basing characteristics (or functions) that need to be considered when staging or basing any system from any site. One set of characteristics should be identified for each site listed. The infrastructure of each base should be well known and should be documented by base civil engineering. Base civil engineering should also have information on planned work to be done to improve facilities (e.g., MILCON).

Functions/Characteristics

Subcharacteristics/Attributes

a. Launch/landing

b. Geographical position

c. Surface mechanical conditions-launch

d. Surface mechanical conditions-landing

e. Storage

f. Size: volume, area

g. Floor mech conditions

    (1) composition

    (2) tensile strength/load factor

    (3) tiedowns

    (4) servicing points

h. Transport/handling

i. Towing system

j. Safe/protect systems/equipment

k. Emergency–fire fighting--system

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l. Lifting/load support systems

m. Materials handling (463L)

n. Servicing

o. Power, Electric

   (1) Hydraulic

   (2) Pneumatic

p. Conditioned air

q. Compressed gas

r. Consumables

   (1) Coolants

   (2) Cleaning mixtures

   (3) Oil

   (4) Water

   (5) Cryogenic liquid

   (6) Fuels

s. Information

t. Maintenance

u. Mechanical systems

v. Adjustment/alignment systems

w. Electronic systems

x. Repair

y. Test equipment

z. Ancillary

   (1) Stands, platforms, docks, etc.

   (2) Aids

   (3) Maintenance management

   (4) Data collection

   (5) Air crew, maintainer debrief

   (6) Tech data delivery

   (7) Supply system management

aa. Diagnostics

bb. Manpower (see 3.3.1.3)

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cc. Personnel (see 3.3.1.3)

dd. Training (see 3.7)

ee. Liaison

ff. Commanders: base, wing, squadron

gg. Key support structure managers (including police/fire protection, security, hospitals, training facilities, utilities, etc.)

hh. Tenants

ii. Community

jj. Security

kk. Command, control, communications, and computer

ll. Information

mm. Personnel

nn. System

oo. Operations

Blank 1 should be expressed in hours, days, weeks, months, or years and should be consistent with time specified in the ORD. In blank 2, identify the number and aircraft type(s) required to deploy a squadron (usually) of air vehicles and support infrastructure. Indicate in blank 3 if the requirement is to be met with/without air refueling. Indicate in blank 4 if the deployment and mobilization requirements vary by configuration or location. Adjust as necessary to reflect actual deployment conditions. For example, if the deployment is conducted by transport aircraft or ship, the airborne refueling requirement should be deleted.

Guidance for completing table 3.1.3-II follows:

Configuration: Characterize the deployment in terms of air vehicle configuration.

Personnel: Identify skill types and quantities available for the deployment, as they may be different for some situations.

Duration: State how long the deployment will exist without resupply (usually stated in days).

Quantity: State the number of air vehicles to be deployed.

Remarks: Provide additional information as needed.

REQUIREMENT LESSONS LEARNED (3.1.3)

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3.1.4 Mission planning.

The system shall provide a mission planning capability that provides the operational mission data for use in, or for, the air vehicle. The mission planning function shall utilize the ___(1)___ as defined in ___(2)___. Mission planning includes ___(3)___ and replanning, and shall support the mission mix requirements stated elsewhere in this document.

REQUIREMENT RATIONALE (3.1.4)

Modern air systems employ a variety of management information systems and networked resources to accomplish mission planning. Mission planning includes weight and balance, armament selection and programming, menu selection sequencing, navigation waypoints, threat advising, threat avoidance, etc. This requirement affects support structure and training requirements and, hence, provides the top-level requirement for mission planning.

REQUIREMENT GUIDANCE (3.1.4)

If the ORD or PMD directs the use of a particular Mission Planning System (MPS) or stipulates an interface to a particular MPS, identify the MPS in blank 1 and the specification and applicable ICD in blank 2. Completely identify the documents and their exact date in blank 2. If there is a requirement for in-flight planning, so indicate in blank 3.

If there is no directed solution, delete the sentence containing blanks 1 and 2.

Note: if the mission planning capability is not developed as part of the system, then this requirement should be an interface requirement.

REQUIREMENT LESSONS LEARNED (3.1.4)

To Be Prepared

3.1.5 System usage.

This is a paragraph header facilitating document organization.

REQUIREMENT RATIONALE (3.1.5)

Fundamentally, system usage addresses the question, “are aircraft available in sufficient numbers to accomplish assigned missions to the degree tasked?” Critical measures of system usage are mission dependent and may include the fraction of the aircraft available to perform a given mission, the number of sorties expected from each aircraft per day for a given duration, or other parameters as appropriate. Those missions vary as a function of the readiness state of the force and the function the system is intended to perform in that state for those missions. Thus, there are different measures for nominal peacetime conditions and wartime conditions. However, even in peacetime conditions there are operational missions to be performed (as opposed to simply training). Thus, some parameters may need to be addressed in both states. For example, airlift aircraft perform operational roles in both peacetime and wartime. Some

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of the missions they perform are different and some the same, but the mission expectations can be different for what is basically the same mission in addition to differences in the tempo of operations and availability of maintenance personnel.

REQUIREMENT GUIDANCE (3.1.5)

While the requirements in the following subparagraphs are nominally grouped into peacetime and wartime conditions - the intent of the grouping is to communicate force readiness conditions. Select requirements appropriate to the missions the aircraft is intended to perform and adjust the conditions as necessary to reflect the force readiness state expected. Based on the specific missions to be conducted, it may be prudent to adapt a mission from one state or another to best reflect the specific mission of the aircraft. Some missions under peacetime actually fall in the transition period from nominal peacetime conditions to wartime conditions.

Caution: It may be possible to select nearly all of the requirements for certain aircraft types and conditions. Select only those requirements essential to satisfy life cycle requirements and tailor those requirements as needed to reflect operational requirements. Some requirements may not be drivers in the sense that risks are acceptable to accept the consequences of not specifying a given requirement (i.e., the warfighter/developer is willing to accept the fallout capability that the system provides). Keep in mind, an aircraft usage profile is needed to establish durability characteristics of the design. Thus, for example, the peacetime mission capable rate may not be a driving factor in satisfying an operational requirement, but the resulting usage rate is important in constructing a life cycle profile of aircraft use.

Many of the requirements in this section have been expressed in terms of system utilization, typically as a sortie rate. Other parameters, such as schedule effectiveness, alert rate, launch rate, and so forth can be used to express availability. However, a system integrity approach relies heavily on developing a utilization profile for the system. Such an approach is necessary and cannot be built by using requirements that do not include a measure of system utilization.

The system usage section contains, in 3.1.5.1 Peacetime operations, 3.1.5.2 Wartime operations, and 3.1.5.3 General system utilization requirements, and their associated subparagraphs, multiple different ways of describing system utilization requirements. The intent is to provide flexibility in expressing requirements since not all systems or usage conditions are best characterized by a uniform usage description. Care must be taken to avoid redundantly specifying the same requirement. It is possible, when using the requirement candidates provided, to over specify requirements for a given condition and mission (for example, use of sortie rate in one requirement and availability in another). The objective of providing these candidate requirements is to assist in the definition of a good set of requirements for a system. Their inclusion in this document is not a suggestion that all such alternatives be specified.

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3.1.5.1 Peacetime operations.

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REQUIREMENT RATIONALE (3.1.5.1)

Peacetime operations of the system reflect the capability of the system to provide training; to be capable of deploying from a nominal stateside location to a combat location; to perform other operational missions such as transport, refueling and surveillance in peacetime conditions; and to move aircraft (very expensive articles) from potential hostile locations (whether the hostile in question is threat, terrorist, or the natural environment) to a safe location.

3.1.5.1.1 Training missions.

The system shall be capable of successfully conducting the training missions identified in table 3.1.5.1.1-I at ___(1)___ while sustaining a _____(2)___ mission capable rate for ____(3)____ missions for a ____(4)____.

TABLE 3.1.5.1.1-I. Training mission types.

Mission Type	Frequency	Conditions

REQUIREMENT RATIONALE (3.1.5.1.1)

Establish that the system is available to the extent needed for training. The requirement can be constructed to provide latitude between in aircraft training versus other training mechanisms such as simulators.

REQUIREMENT GUIDANCE (3.1.5.1.1)

This requirement may need to be repeated if there is a need to reflect differences in training and utilization between training conducted by dedicated training assets and training conducted within operational units.

Suggested alternatives for blank 1:

a. “an average utilization rate per aircraft per month of XX,” where XX reflects the planned flying hour program. Any additional training needed would be conducted by other methods.

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b. “an average utilization rate per aircraft per month not to exceed YY and not less than ZZ,” where YY reflects the maximum average utilization and ZZ reflects the minimum average utilization.

This requirement provides some minimum amount of training/proficiency is conducted by flying the aircraft with an upper limit on utilization. It provides latitude to enable greater trade space between in aircraft versus in simulator training. It would be expected that the utilization rate would be established after trade studies between simulator versus training missions are completed and requirements established in lower-tier specifications. Note that maintenance training is impacted along with air crew training, so that as the utilization rate per aircraft decreases, supplemental training for maintenance crews may need to increase.

Guidance for blank 2:

a. Blank 1 requires successful sorties. Thus, as long as the sorties can be conducted, it may be deemed preferable to delete the MCR requirement and let it float. However, the implications are, that for a sufficiently low utilization rate in a sufficiently large unit, it could be possible to conduct all required training missions with a small fraction of the unit. This might not be acceptable or operationally prudent. However, there are other requirements (deployment) that can provide the bounding conditions to ensure that aircraft are available. A key factor to consider in the use (or non-use) of a particular MCR value is whether or not the unit doing the training is also conducting operational missions. If so, explicit linkages between the training requirement and the peacetime operational requirement will be needed. Or a composite requirement may need to be constructed that reflects mission mix and utilization rates across the set of the training and operational missions conducted by the unit.

b. Mission capable rate is the percent of aircraft capable of performing at least one and potentially all of its designated missions. Mission capable is the sum of fully mission capable and partial mission capable.

Guidance for blank 3:

If a percent is entered in blank 2, then a mission list needs to be provided in blank 3. This mission list could be “all designated missions” but would normally be limited to the training mission(s) and other designated missions to be performed from the basing location from which the training is conducted.

Guidance for blank 4

Specify the type of unit (e.g. squadron, wing etc.) and its size, or reference 3.1.2, which defines unit organization, as appropriate.

In table 3.1.5.1.1-I, identify the training mission type in the column “Mission Type” (which should correlate to one or more of the missions identified in 3.1.1, Roles and Missions), establish the percentage of the training missions for this type, and define the reference conditions for the mission. Conditions include (but are not limited to)

a. operating environment(s)

b. the mix between day, night and in-weather sorties;

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c. maintenance shifts employed such as two, eight hour shifts;

d. ground rules such as mission flight size and impacts if one of the air vehicles in the flight needs to abort the mission.

e. definition of the configuration

f. aircraft staging rules which can, for example, define that some number of aircraft are maintained in a ready (i.e., ready to conduct this mission) state in the event that an aircraft assigned to conduct the mission is forced to abort (e.g., in-flight failure of mission-essential equipment).

Cite the references either here, in a separate document, or someplace else in the specification. The conditions should contain a reference to 3.1.1, which defines roles and missions.

REQUIREMENT LESSONS LEARNED (3.1.5.1.1)

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3.1.5.1.2 Operational deployment.

The system shall be capable of deployment from ____(1)___ to ____(2)_____ within ___(3)____ of notification; shall be capable of flying the missions indicated in _____(4)____ within ____(5)____ hours of arrival; and shall achieve a mission capable rate of ____(6)_____ within ____(7)_____ hours of arrival.

REQUIREMENT RATIONALE (3.1.5.1.2)

The system needs to have a capability of transitioning between nominal peacetime and nominal wartime conditions. Paragraph 3.1.1 defines the operational roles and missions. Paragraph 3.1.2 defines the organizational structure and 3.1.3 identifies the nominal requirements for deployment. This paragraph describes the transition between the nominal peacetime and wartime conditions.

REQUIREMENT GUIDANCE (3.1.5.1.2)

Blank 1 identifies the nominal location from which the deployment would occur. For example, CONUS locations

Blank 2 identifies the nominal location of wartime operations. For example, Southwest Asia locations

Blank 3 identifies the time available from notification until when the deployment starts. This may be specified in terms of days (for example, 2 days) or weeks (for example, 1 week).

Blank 4 provides a reference to the type of missions that must be conducted within some specified period after arrival. This may be a reference to one or more of the missions identified in 3.1.1.

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Blank 5 identifies the amount of time the aircraft have from arrival until they are expected to be flying “operational” missions.

Blank 6 identifies that mission capable rate to be achieved and the missions to which it apples. Mission capable rate is the percent of aircraft capable of performing at least one and potentially all of its designated missions. Mission capable is the sum of fully mission capable and partial mission capable. This is a nominal rate that reflects a ramp up to a fully operational rate.

Blank 7 identifies the amount of time the unit has to achieve the mission capable rate.

REQUIREMENT LESSONS LEARNED (3.1.5.1.2)

To Be Prepared

3.1.5.1.3 Operational missions in peacetime.

The system shall be capable of sustaining a sortie rate of ______(1)_____ sorties per day for the missions identified in table 3.1.5.1.3-I at the mission mix specified.

TABLE 3.1.5.1.3-I. Peacetime mission scenarios.

Mission	Percent Missions	# Alert A/C	Launch Readiness	Conditions

REQUIREMENT RATIONALE (3.1.5.1.3)

This paragraph addresses the requirements to conduct operational missions in a peacetime environment. Nominally, when aircraft deploy the unit shifts from a peacetime to an operational tempo. Many aircraft, however, have operational roles that they fulfill in peacetime although possibly not at the same tempo as in wartime. Nominally, the requirements for this mission are in addition to any requirements for training missions identified in 3.1.5.1.1.

REQUIREMENT GUIDANCE (3.1.5.1.3)

Depending on the aircraft and the roles it is intended to perform, it is possible that some “peacetime operational” missions also serve a training function. Thus some merging and harmonization of requirements between 3.1.5.1.1 and this paragraph may be needed. It is recommended, however, that missions conducted solely for training be contained in 3.1.5.1.1. There will be a need to establish an aircraft life cycle utilization profile and, for example, repeated maneuvers conducted during dedicated training flights can stress the aircraft in different ways than the addition of some training tasks during

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other missions. Note that, consistent with the concept of peacetime operations, the sortie rate expected from the system assumes a steady state condition that can be sustained indefinitely.

Blank 1: Specify the sustained sortie rate to be achieved.

Table 3.1.5.1.3-I:

Mission: Identify the mission(s) to be performed. This should include a reference to 3.1.1 for mission specifics.

Percent Missions: If the system is intended to provide sorties over multiple different missions, enter the percentage of total missions for each mission to be performed. If there is only a single mission to be performed, enter 100 percent

Alert Aircraft: Specify the number of aircraft to be maintained in alert status in the event of a mission abort by the aircraft conducting the missions.

Launch Readiness: Specify the amount of time allowed from notification of an abort until the alert aircraft are launched (i.e., sorties in the air).

Conditions. Specify the conditions for both operations and support including environmental factors. Operations conditions include factors such as the flight size, mission specific parameters such as air refueling, and length of the operational day. Support factors include parameters such as maintenance availability for example 2 maintenance shifts per day at 8 hours per shift.

REQUIREMENT LESSONS LEARNED (3.1.5.1.3)

To Be Prepared

3.1.5.1.4 Base escape.

______(1)____ aircraft out of _____(2)______ shall be capable of achieving a base escape separation distance of ______(3)______ within _____(4)____ of warning. These aircraft shall be capable of performing the _____(5)_____ mission. ______(6)____ aircraft out of the remaining ____(7) _____ aircraft shall be capable of achieving a base separation distance of ____(8)_____ within _____(9)____ of the initial warning. These aircraft shall be capable of performing the _____(10)_____ mission. Conditions for this mission are _____(11)_____.

REQUIREMENT RATIONALE (3.1.5.1.4)

The applicability and need for this requirement must be carefully considered. The degree of its utility was greater during heightened tensions between the United States and the former Soviet Union. Derivatives of the base escape mission are, however, also applicable to conditions such as relocation of aircraft away from severe weather conditions or, in concept, to potential actions that threaten base security. It may be preferable to accept a fallout capability. If it is desired to specify multiple conditions (for example, a base escape requirement and a weather escape requirement) this paragraph should be repeated and tailored for the specific conditions required.

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REQUIREMENT GUIDANCE (3.1.5.1.4)

The requirements in this paragraph are tied to the organizational structure specified in 3.1.2.

Blanks 1-5 generally apply to aircraft on alert status or maintained in a high degree of launch readiness.

Blank 1: Specify the number of aircraft that must clear the base area promptly.

Blank 2: Specify the number of aircraft in the unit that are maintained in alert status and in a mission capable (near mission capable) condition that are expected to clear the base area promptly.

Blank 3: Specify the separation distance that must be attained.

Blank 4: Specify the amount of time to launch all the aircraft identified in blank 1 and for those aircraft to achieve the separation distance identified in blank 3.

Blank 5: This requirement is applicable only if the aircraft are to be launched with the capability to perform the stated mission. This requirement must be correlated with a mission identified in 3.1.1.

Blanks 6-10 generally apply to the remaining aircraft in the unit. These aircraft may be mission capable or not, as appropriate.

Blank 6: Specify the number of remaining aircraft that must clear the base area.

Blank 7: Specify the number of remaining aircraft in the unit (for example, if the unit size were 24 aircraft and if blank 1 were 8, blank 7 would be 16).

Blank 8: Specify the separation distance that must be attained (This requirement is provided if, for example, the separation distance is different than for the first set of aircraft).

Blank 9: Specify the amount of time allowed from first notification until this set of aircraft is expected to reach the separation distance specified in blank 8.

Blank 10: This requirement is applicable only if the aircraft are to be launched with the capability to perform the stated mission. This requirement must be correlated with a mission identified in 3.1.1.

Blank 11: Specify any mission and support conditions applicable. For example, has a heightened increase in readiness been instigated and aircraft are undergoing accelerated maintenance to maximize the number of aircraft available for launch. Also identify conditions such as threat and weather environments, conditions for taxi and takeoff, etc.

REQUIREMENT LESSONS LEARNED (3.1.5.1.4)

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3.1.5.2 Wartime operations.

REQUIREMENT RATIONALE (3.1.5.2)

Wartime operations of the system reflect the capability of the system to provide the sorties needed to satisfy its intended function in combat conditions. Combat conditions pose additional stress on sortie generation. For example, bases may be under attack, air and maintenance crews may be operating with additional protective equipment such as chem-bio gear, additional maintenance tasks may be needed such as battle damage repair or aircraft decontamination. Some types of missions are driven by productivity demands such as air-to-surface attack. Other types of missions (such as point defense) are driven by the need to maintain high degrees of launch readiness with a sudden pulse in sortie generation given an event occurs.

Additionally, there are two states of sortie generation that are typically drivers on a unit's ability to provide mission capable aircraft. Surge combat typically represents a state where the maximum sortie generation rate possible is needed. Basically, this is a state that reflects time critical demands for aircraft and a greater need for missions than there are aircraft available. In surge combat conditions, maintenance actions (such as phased inspections) are frequently deferred. The focus of maintenance activity is on fixing breaks and turning mission capable aircraft. In sustained combat, there is a protracted period of hostility. Some mission types may still be operating on a launch readiness basis. Others are typically operating to a productivity demand. During sustained combat operations, maintenance actions are typically not deferred. Phased inspections and preventative maintenance actions are conducted. Our experience is that sustained combat conditions drive maintenance manpower requirements.

REQUIREMENT GUIDANCE (3.1.5.2)

The following paragraphs contain a variety of different performance parameters to describe the requirements for system usage. Some systems may be performing multiple missions. For example, close air support and interdiction. These missions place different demands on the system. It may be necessary to construct a set of composite requirements by repeating various individual requirements and "missionizing" them. When constructing a system usage requirement across different missions, the relative frequency of each mission will need to be established. Some aircraft may be conducting the same mission from two different locations with different support structures; for example, conduct of battlefield interdiction from a Main Operating Base and from a forward deployed, remote operating base. These two scenarios will likely have different expectations. As such, the requirement would be repeated for the different expectations and differing support asset availability.

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3.1.5.2.1 Combat surge and sustained.

The system shall be capable of generating the sortie rates indicated in table 3.1.5.2.1-I, for roles and missions ___(1)____ and unit organization _____(2)_____. Other overall conditions of operation include _____(3)_____.

TABLE 3.1.5.2.1-I. Wartime mission scenarios.

	Surge				Sustained			
Mission	**Sortie Rate**	**Percent Missions**	**Days**	**Conditions**	**Sortie Rate**	**Percent Missions**	**Days**	**Conditions**

REQUIREMENT RATIONALE (3.1.5.2.1)

This paragraph addresses the requirements to generate operational missions in a combat environment. Surge combat conditions stress factors such as air vehicle turnaround time, break rates and fix rates. Sustained combat stresses maintenance ability to maintain combat capable aircraft for long durations. Frequently issues such as people, supply and parts availability become critical. While surge combat stresses the air and maintenance crews over short durations, sustained combat stresses crews over long duration with the additional tasks necessary to keep aircraft functioning. Such tasks include phased inspections and preventive maintenance. When operations are conducted over protracted periods, the maintenance, parts and supply states at the end of a surge period become significant factors in addressing the ability to maintain a sustained sortie rate.

REQUIREMENT GUIDANCE (3.1.5.2.1)

This requirement must be carefully crafted to reflect the conditions expected. Nominally expectations would be that intense combat tempos would be characteristic of the initial phase of combat operations followed by a protracted period of less intense operations. While this is the assumption used in designing table 3.1.5.2.1-I, this is not always the case and the table will need to be appropriately configured for the appropriate situation(s) needed to communicate performance expectations. It will likely not be possible, or useful, to account for all possible situations. The objective is to communicate a reasonably robust set of performance expectations and conditions of operation in order to establish an appropriate “design to” point.

Depending on the variety of conditions that need to be described, it may be preferable to communicate these requirements as a series of paragraphs rather than attempting to define all the performance expectations and conditions in a single requirement paragraph.

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Blank 1: Specify the role and mission to be conducted. This could be done by referencing a line in table 3.1.1-I of paragraph 3.1.1, which defines the roles and missions of operation. Note that most of the content of 3.1.1 is critical to defining the conditions of operation. It may be necessary to completely identify the role and mission at this point to eliminate ambiguity. A hypothetical example for filling in this blank could be "air to surface attack, battlefield air interdiction, Southwest Asia 2020 scenario, in wartime conditions, operating from main operating bases."

Blank 2: Specify the organization to be used. This could be done by referencing a line in table 3.1.2-I of paragraph 3.1.2. Similarly, it may be necessary to utilize some (or all) of the content of a line in that table to reduce ambiguity.

Blank 3: Identify those other conditions of operation impacting the entire requirement. Such conditions could include information dealing with factors such as

a. Combat stress conditions. For example, airbase or ship under attack (the threat description under the roles and missions section should include a vignette or mini-scenario that describes these conditions, which could include runway attack, asset attack, chemical/biological attack or some combination). It may be useful to replicate the requirements set to specify a set of benign conditions (i.e., no externally induced combat stress conditions) to address the basic capability of the system and a set of combat stress conditions. Such factors tend to identify the differences in expectations in air dominance vs. non air dominance situations. Other combat stress factors could include whether or not battle damage repair is to be considered.

b. Supply factors such as are these expectations based only on the organic assets or do they include depot repair of items (and if so, what is the nominal depot repair rate including transportation times to and from the theater of operations if appropriate). Additionally, do the expectations reflect replenishment spares in excess of the WRSK?

Note that the inclusion of specific information in blank 3 has a number of positive attributes. The more closely realistic conditions are portrayed, the better specific supporting parameters can be defined. The drawback is the tendency to lock in on isolated operational points that may not occur. For example, when operating in a chemical/biological environment, we might expect a lower sortie generation capability than in benign conditions. If such is the case, there would likely be a greater demand on chemical/biological equipment and supply requirements, which is a good thing to identify. However, if this were the only condition examined, we would expect a lower demand on parts and other material than would be needed in a lower stress (e.g., air dominance) situation. To characterize the system's capabilities completely, it will be necessary to define expectations with and without combat stress.

Table 3.1.5.2.1-I is portrayed in two parts under the assumption that a period of combat surge conditions will be followed by a period of combat sustained conditions. If expectations are only for combat surge conditions, delete the combat sustained portions of the table. If expectations are only for combat sustained conditions, delete the combat surge portions of the table. For some types of air systems, there may be no difference in the expectations. However, if there are differences in the conditions of operation, it may still be necessary to have a two component table (e.g., the sortie generation expectation

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may be flat across a long period of combat but the conditions of depot resupply and/or spare replenishment may be different).

Mission: Identify the mission(s) to be performed. This should include a reference to 3.1.1 for mission specifics.

Surge:

a. Sortie Rate: Enter the sortie rate expected for the unit and conditions identified.

b. Percent Missions: If the system is intended to provide sorties over multiple different missions, enter the percentage of total missions for each mission to be performed. If there is only a single mission to be performed, enter 100 percent.

c. Days: Identify either the combat days (e.g., days 1-5) or duration (e.g., 5).

d. Conditions: Specify the conditions for both operations and support. Operations conditions include factors such as the flight size, mission specific parameters such as weather conditions, battle damage expectations, and length of the operational day. Support factors include parameters such as maintenance availability for example 2 maintenance shifts per day at 12 hours per shift, and any additional assets available for battle damage repair. Note that in surge combat conditions maintenance days are typically longer than for sustained combat. Phased/preventive maintenance is not always conducted. Crew rest can become an issue.

Sustained:

a. Sortie Rate: Enter the sortie rate expected for the unit and conditions identified

b. Percent Missions: If the system is intended to provide sorties over multiple different missions, enter the percentage of total missions for each mission to be performed. If there is only a single mission to be performed, enter 100 percent

c. Days: Identify either the combat days (e.g., Days 6-50) or duration (e.g., 45)

d. Conditions: Specify the conditions for both operations and support. Operations conditions include factors such as the flight size, mission specific parameters such as weather conditions, battle damage expectations, and length of the operational day. Support factors include parameters such as maintenance availability for example 3 maintenance shifts per day at 8 hours per shift, phased maintenance intervals, and any additional assets available for battle damage repair.

REQUIREMENT LESSONS LEARNED (3.1.5.2.1)

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3.1.5.2.2 Air alert, loiter, surveillance.

For the ____(1)____ missions, the system shall be capable of maintaining ____(2)____ ____(3)____ stations/routes for __(4)___ days. Occupancy rates for the station/route shall be at least ___(5)___. ___(6)___ aircraft shall be maintained on the ground ready to launch on ___(7)___ notice to replace aircraft aborting the mission due to breaks. Conditions for the conduct of this mission are

a. Length of the operational day is _____(8)_____

b. Number of aircraft per flight is ______(9)____

c. Number of flights per station/route is _____(10)____

d. Size of the unit conducting the missions is _____(11)____

e. In-flight refueling allowed? _____(12)______

f. Flight abort rules are _______(13)_____

REQUIREMENT RATIONALE (3.1.5.2.2)

This requirement can be used in a wide variety of circumstances. It can pertain to maintaining air defense/air dominance over the battlefield to prevent hostile intrusion from air assets. It can be used for surveillance missions. It can be used as a means of "forward" deploying aircraft, such as close air support assets to enable a more rapid response to ground actions. This requirement establishes a presence to rapidly react to hostile actions as far forward as deemed necessary.

REQUIREMENT GUIDANCE (3.1.5.2.2)

This requirement, as written, is scenario dependent. Replicate it, to the extent needed, to address the scenario dependencies. For example, operations in one scenario may dictate 4 air vehicles/flight others 2 air vehicles/flight. Some scenarios may include in-flight refueling, others may not. Frequently the intensity of air operations and the distances to the loiter location are the driving factors for the differences between scenarios.

Blank 1: Identify the missions to which this requirement applies. This should relate to, and cross-reference, a role and mission in 3.1.1 to provide the necessary situational and other data bearing on the requirement.

Blank 2: Identify the number of stations/routes that need to be maintained.

Blank 3: Identify the type of station/route. Examples are air alert, loiter and surveillance.

Blank 4: Identify the duration that this activity continues, for example, 1 week.

Blank 5: Identify the occupancy rate for the station/route. This allows for in-flight breaks (consistent with mission reliabilities specified elsewhere) and the launch readiness of

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replacement aircraft with some allowance for covering the distance between the base the station location.

Blank 6: Identify the number of aircraft maintained in launch readiness.

Blank 7: The amount of time from notification to launch until the air vehicle is in the air.

Blank 8: Identify the length of the operating day, for example 24 hours.

Blank 9: Identify the number of aircraft in a flight. For a surveillance mission conducted by an AWACS this might be 1. For a combat air patrol mission, this might be two.

Blank 10: Identify the number of flights assigned to each station/route.

Blank 11: Identify the size of the unit conducting the mission, for example a 24 aircraft squadron.

Blank 12: Identify whether or not aerial refueling is allowed.

Blank 13: Identify the flight abort rules. For example, for a flight size of two air vehicles, if one aborts due to a mission-critical failure, does the other aircraft abort the mission as well?

REQUIREMENT LESSONS LEARNED (3.1.5.2.2)

To Be Prepared

3.1.5.2.3 Engagement from ground/deck basing.

For the ____(1)____ mission, a ___(2)__ ship flight shall be capable of launching, entering a lethal engagement envelope (target acquired, weapons locked, weapon Pk greater than or equal to __(3)___ percent of maximum weapon Pk) against ___(4)_____ targets, detected by ____(5)_______ source at a distance of ______(6)________ from the alert location before the targets can enter their lethal engagement envelope of _____(7)_______ against a friendly target located at ____(8)_______ relative to the alert location.

REQUIREMENT RATIONALE (3.1.5.2.3)

This requirement is intended to address those missions for which aircraft are launch ready and awaiting a specific event to occur to initiate engagement of a target. Such occurrences could be driven by notification of a high value, hostile asset being targeted. The target can in principle, be either airborne or be ground based. This mission stresses the ability of the aircraft to rapidly launch and engage. This is not strictly an availability requirement since it also involves aircraft engagement capabilities. The concept behind the requirement involves situations where, for example, a small number of aircraft out an air combat unit are held back in a ready state to provide point defense. This could also apply to air-to-surface missions where a small number of aircraft are held back in launch readiness with a predetermined ordnance load to be able to rapidly react to time critical targets. In terms of stressing availability, this requirement is more effective when the

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type of situation described in the requirement is part of a set of situations a larger unit (such as a squadron or a wing) is expected to be able to execute.

REQUIREMENT GUIDANCE (3.1.5.2.3)

Blank 1: Identify the missions to which this requirement applies. This should relate to, and cross reference, a role and mission in 3.1.1 to provide the necessary situational and other data bearing on the requirement.

Blank 2: Number of aircraft in the flight.

Blank 3: This requirement is intended to provide an envelope for weapon release.

Blank 4: The type of target being attacked. It may be a single target or a target array.

Blank 5: The source of the information. Criteria should address the timeliness of the information and whether or not in-flight updates will be available. Reference to the C4ISR portion of the interfaces section (3.4) should be included.

Blank 6: The relative location of the target from the alert location at the time of detection.

Blank 7: If the target is mobile and lethal, the intent is to engage the target prior to the target being able to release ordnance at a friendly.

Blank 8: The location of the friendly being protected.

Some high value targets are not lethal in themselves. Other targets are lethal, but the requirement may be to destroy the hostile even after it releases weapons. In these circumstances, tailor the requirement statement to remove blanks 6 and 7.

REQUIREMENT LESSONS LEARNED (3.1.5.2.3)

To Be Prepared

3.1.5.2.4 Engagement from loiter location.

For the ____(1)____ mission, a ___(2)__ ship flight shall be capable of exiting a loiter location, entering a lethal engagement envelope (target acquired, weapons locked, weapon Pk greater than or equal to __(3)___ percent of maximum weapon Pk) against ___(4)_____ targets, detected by ____(5)_______ source at a distance of ______(6)________ from the loiter location before the targets can enter their lethal engagement envelope of _____(7)_______ against a friendly target located at ____(8)_______ relative to the alert location.

REQUIREMENT RATIONALE (3.1.5.2.4)

This requirement is intended to address those missions for which aircraft are in the air, frequently in a loiter or combat air patrol, location and awaiting a specific event to occur to initiate engagement of a target. Such occurrences could be driven by notification of a high value, hostile asset being targeted. The target can in principle, be either airborne or be ground based. Missions can include missions such as defense of an airborne

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platform by its escorts (e.g., AWACS or E2C defense); intercept of incoming hostiles from a combat air patrol station; or ground attack of time sensitive hostile forces from a forward loiter location. This mission stresses the ability of the aircraft to rapidly engage while already in the air. This is not strictly an availability requirement since it also involves aircraft engagement capabilities. The concept behind the requirement involves situations where, for example, a number of aircraft from an air combat unit are already airborne and ready to provide point defense. This could also apply to air-to-surface missions where a number of aircraft are maintained in a holding orbit with a predetermined ordnance load to be able to rapidly react to time critical targets. In terms of stressing availability, this requirement is more effective when the type of situation described in the requirement is part of a set of situations a larger unit (such as a squadron or a wing) is expected to be able to execute.

REQUIREMENT GUIDANCE (3.1.5.2.4)

Blank 1: Identify the missions to which this requirement applies. This should relate to, and cross reference, a role and mission in 3.1.1 to provide the necessary situations and other data bearing on the requirement.

Blank 2: Number of aircraft in the flight.

Blank 3: This requirement is intended to provide an envelope for weapon release.

Blank 4: The type of target being attacked. It may be a single target or a target array.

Blank 5: The source of the information. Criteria should address the timeliness of the information and whether or not in-flight updates will be available. Reference to the C4ISR portion of the interfaces section (3.4) should be included.

Blank 6: The relative location of the target from the airborne location at the time of detection.

Blank 7: If the target is mobile and lethal, the intent is to engage the target prior to the target being able to release ordnance at a friendly.

Blank 8: The location of the friendly being protected.

Some high value targets are not lethal in themselves. Other targets are, but the requirement may be to destroy the hostile even after it releases weapons. In these circumstances tailor the requirement statement to remove blanks 6 and 7.

REQUIREMENT LESSONS LEARNED (3.1.5.2.4)

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3.1.5.3 General system utilization requirements.

REQUIREMENT RATIONALE (3.1.5.3)

For some systems, and missions, the generic description of characteristics expected has no specific dependency on the peacetime/wartime state. The values required, however, may be very different. This section of the system usage requirements is used to communicate those requirements whose generic description is similar across peacetime, wartime, and conditions other than war.

3.1.5.3.1 Availability.

The system shall be able to conduct the missions in table 3.1.5.3.1-I within the availability, utilization, and conditions described therein.

TABLE 3.1.5.3.1-I. Mission availability, utilization, and conditions.

Mission	Utilization Rate	Availability	Conditions

REQUIREMENT RATIONALE (3.1.5.3.1)

Establish that the system is available to conduct the missions indicated. This requirement is particularly useful for those systems developed to conduct missions that are long endurance and may or may not have a daily demand on a per air vehicle basis. This requirement can be used in characterizing cargo/transport, bomber, reconnaissance, or other long-endurance missions.

For some systems and missions, it is possible that a sortie rate or other requirement from 3.1.5.1 and 3.1.5.2 could have been used as well for the same mission. Specification developers are encouraged not to pick two different sets of parameters for the same mission, scenario, and other conditions.

However, tailoring the requirements can lead to some useful characterizations. For example, assume a nonstressful or only moderately stressful sustained sortie rate. Artificially increasing the sortie rate beyond what is needed simply to capture the need to ensure some number of air vehicles are available on short notice places additional (and artificial) demands on the maintenance system resulting in excessive allocated requirements and more expensive solutions. Thus, it may be appropriate to require a sortie rate (or some other utilization parameter) in combination with keeping some number of aircraft in a ready to launch status.

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REQUIREMENT GUIDANCE (3.1.5.3.1)

The availability expected will vary with the utilization rate demanded. This will normally be a function of the expected state of readiness, which varies as a function of peacetime, wartime, and conditions other than war. For some systems, there may be little, if any difference. Where there are differences for the same mission, add lines in the table. Fill in table 3.1.5.3-I as follows:

Mission: Identify the mission to be conducted. An explicit reference to 3.1.1 will be necessary to characterize the conditions.

Utilization Rate: For the mission and its associated operating conditions, identify the expected utilization rate. This is frequently expressed as flight hours/sorties expended or missions attempted per system during a specific interval of calendar time.

Availability: The scope of this parameter will vary depending on the system being developed. For example, some systems (for example, reconnaissance systems) may depend on a ground station. That is, both the air vehicle and the ground station need to be functioning properly for the system to be available. Sometimes a ground station will be developed in concert with the air vehicle and sometimes an existing ground station will be utilized. The preferred approach would be to use the combined readiness of both the air vehicle and the ground station if both are developed as part of the system. If an existing ground station will be utilized either the combined availability or just the air vehicles availability can be used. The advantage of using the combined availability lies in ensuring that the air vehicle is available when the ground station is available. In other words, it is a timing issue. Great care must be taken to ensure that, for an existing ground station, the availability of the combined assets does not exceed that of the already developed ground station.

Availability (Ao) is a measure of the degree to which an item is in the operable and committable state when the mission is called for at any random point in time. Availability is dependent on reliability, maintainability, and logistics supportability (the degree to which planned logistics support [including test, measurement, and diagnostics equipment; spares and repair parts; technical data; support facilities; transportation requirements; training; manpower; and software support] allow meeting system availability and wartime usage requirements). Frequently, the measure used for peacetime conditions is mission capable rate and for wartime, utilization rate. Since the intent of this requirement is to capture missions being conducted while maintaining a given level of capability, both parameters are needed.

Conditions: Fully describe the conditions and assumptions used in crafting the other requirements. Conditions include whether availability measures flight availability (that is, is the measure that of a single air vehicle or is it the measure of a flight of two or more air vehicles needed to perform a given mission). Other conditions include whether ground station availability is a factor in the availability described in those circumstances when a ground station is essential for the conduct of a mission (e.g., a ground control station for a remotely piloted air vehicle). If so, a description of the ground station will be necessary as well as its critical operating characteristics (e.g., its availability). Where an existing ground

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station is identified, a reference to the appropriate interfaces in 3.4 (such as C4ISR) will be necessary.

REQUIREMENT LESSONS LEARNED (3.1.5.3.1)

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3.1.5.4 Integrated combat turnaround (ICT) time.

For the _____(1)____ mission, the elapsed time required to conduct an ICT starting with a mission-capable aircraft shall not exceed __(2)___ when the vehicle is equipped with the assets and quantities identified in table 3.1.5.4-I. These requirements shall be met under __(3)___ conditions. Timing begins when __(4)___ and ends at pilot acceptance. Integrated combat turnaround time ___(5)____ includes time needed for general servicing, replacement of mission data, and replacement/replenishment, as appropriate, of needed fluids, gases, and agents.

The system shall meet all the stated requirements during __(6)__, using __(7)__ power and __(8)___ shelters.

The above requirements shall be met for ___(9)___ ICTs. The system shall be capable of _____(10)_____ simultaneous ICTs.

TABLE 3.1.5.4-I. Items and quantities for integrated combat turnaround.

Item	Quantity at Start	Quantity at End	Remarks

REQUIREMENT RATIONALE (3.1.5.4)

The ability to return an air vehicle to mission readiness is a critical factor for combat air vehicle, especially fighter aircraft. This requirement establishes the maximum time it will take the system to fully arm and ready a combat air vehicle for another mission immediately after it has returned to base from a previous mission.

Sortie rate requirements can be used to help bound a time allowed for turning a combat air vehicle around based on nominal conditions (average rates, squadron or larger size pool of air vehicles to draw from, etc.). They do not, in themselves assure that all critical system capabilities are achieved. Five, ten or thirty day average sortie rates do not communicate that there are critical conditions that demand air power immediately, not in xx hours. For example, if a twelve-hour operating day and a 3-sortie-per-day requirement is used to set the turnaround requirement, the required time would be 5 hours assuming a one hour mission duration. Such a fallout capability may be unacceptable for some types of systems and operating conditions especially for lead

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elements deployed to counter "surprise" hostile actions and in high intensity combat situations. At the same time, this requirement can be a significant design (and cost) driver. It should not be applied arbitrarily. The most operationally flexible time is near-instant turnaround, which is clearly unachievable and prohibitively expensive. The objectives in establishing this requirement should be determining what is desired, assessing the design and cost impacts, and then examining excursions that relax various portions of the requirement. Then, assess conditions to determine the costs and effectiveness of the alternatives, and select the most reasonable (satisfies the warfighter and is affordable) alternative requirement/conditions.

REQUIREMENT GUIDANCE (3.1.5.4)

The requirement must state all conditions under which the turn-around time is to be demonstrated. Table 3.1.5.4-I may be expanded to identify different sets of equipment available for different turns. For example, Mark 84 bombs, laser guided bombs, ammunition, pallets, etc. Nominally, table 3.1.5.4-I identifies an item to be replenished (fuel, 20mm ammunition etc.), the quantity of that item on-board the air vehicle at the start of the combat turn, and the quantity of that item on-board the air vehicle at the end of the combat turn. Note that, for some items (e.g., air-to-air missiles), it may be appropriate to specify a number but for other items (e.g., fuel, 20mm ammunition) it will probably be more appropriate to specify a percentage (e.g., fuel quantity at start of 20 percent internal fuel - quantity at end of 100 percent internal fuel), since the absolute values are high depending on the actual design. In the remarks column, identify any restrictions or limitations on what equipment and people may be used, as well as other limiting conditions and factors.

In blank 1 enter the mission and organization. A reference to the pertinent content of 3.1.1 and 3.1.2 should also be included.

In blank 2 enter the maximum allowable turn-around time. This time is usually expressed in minutes.

In blank 3, enter the environmental including the chemical and biological factors under which the performance is to be satisfied. Sometimes different performance numbers are specified under different environmental conditions. A reference to program-specific source material can be used provided that material is intended for contractual application.

Blank 4 must state the conditions when the clock starts.

Blank 5 states whether general servicing and replacement of fluids, gases, agents, and mission data must be accomplished within the required time. Suggested approach is to delete blank 5 if the actions are to be part of the turnaround and must be completed within the time specified in blank 2. If such tasks are not included, recommend filling blank 5 with "does not."

The portion of the air system to which the ICT applies must be clearly defined. It is also necessary to specify limitations on simultaneous actions in blank 6. For example, is refueling and engine operating an allowed condition? If an APU or external power source is permitted, these conditions must be clearly stated in blank 7, as well as whether any or all actions are to take place within a shelter (blank 8).

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For fighter aircraft, there are two different sets of conditions under which times may be specified. For blank 9 indicate to what conditions the performance numbers apply. A hot ICT is one in which refueling is performed with aircraft propulsion engine(s) operating (provides an instantaneous taxi capability). A cold ICT is one in which refueling is performed with the Auxiliary Power Unit (APU) and aircraft propulsion engine(s) not operating. If both conditions are significant and the time (i.e., blank 1) is different for each condition, then this requirement will need the following adjustments:

a. Repeat the requirement if quantities, crews, or support equipment is different; or

b. Delete the last sentence ("The above requirements _______...."), and use language such as "XX minutes for a Hot ICT and YY minutes for a Cold ICT" in blank 1 when the remaining conditions (i.e., blanks) have the same content for either ICT condition.

Blank 10 defines the number of simultaneous ICTs that the organization (identified in blank 1) must be capable of conducting.

REQUIREMENT LESSONS LEARNED (3.1.5.4)

To Be Prepared

3.1.6 System dependability.

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3.1.6.1 Mission reliability.

Mission reliability, the ability to conduct and complete mission tasks once committed to a mission, shall be as shown in table 3.1.6.1-I for the missions and scenarios identified.

TABLE 3.1.6.1-I. Mission reliability.

Scenario	Mission	Mission Reliability

REQUIREMENT RATIONALE (3.1.6.1)

Mission reliability (the ability of a system to complete its planned mission or function) is a critical factor in mission planning and accomplishment. It captures the ability of the system to maintain mission capability from commitment of the air vehicle to the mission until the completion of the mission tasks. Typically, completion of the mission tasks includes the delivery of weapons on assigned targets, completion of surveillance of assigned areas, delivery of cargo to intended locations, and maintaining offensive or defensive presence for a given duration or mission such as combat air patrol or air

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escort. Mission reliability is a direct input into mission planning systems to determine how many aircraft are needed to achieve a given level of destruction, or cargo delivery, or defense of airspace. For many air vehicle types, missions, and employment tactics, mission reliability of a single air vehicle may be a determining factor in whether the other flight elements continue the mission. In other words, if one aircraft aborts, others may be forced to abort depending employment conditions (such as single ship, two ship, multi-ship employment), tactics, and requirements for multi-air vehicle cooperation.

For some types of systems/missions, mission reliability is a measure of the air vehicle, air vehicle operations and other elements such as a remotely piloted air vehicle and its ground station. For example, when the control station of a remotely piloted vehicle breaks, the mission cannot be completed. This situation can be further complicated if there are multiple ground stations, each with a given capacity that may be able to take over control of in-flight vehicles in the event that one of the ground stations breaks. Other systems may depend on ground stations for information processing and dissemination and the cooperative capabilities of both may be mission essential.

Mission reliability drives equipment reliability at lower levels of the system architecture including requirements for inherent reliability and redundancy.

REQUIREMENT GUIDANCE (3.1.6.1)

There are three basic choices in the selection of a parameter to use for mission reliability.

a. Mean Time Between Critical Failures (MTBCF). The average time between failures, which prevents a system from performing its primary function. This is a useful parameter to characterize, but in the context of a system specification it is not a good choice. In concept, specific mission durations will not be established until specific mission profiles are established. This includes a complete representation of the mission including air vehicle-weapon combination impacts on target acquisition, target acquisition profile, delivery profile, speeds throughout all the profiles, and other related parameters. Such definition will not be available until the air vehicle specification, and possibly lower-tier specifications, are finalized including associated timelines. It is a good parameter for assessments, but not a good choice in setting a requirement. Additionally there are ambiguity problems in characterizing this parameter when mission-critical systems are redundant. For example, when two (or more) items capable of performing the same function are incorporated in the design and the air vehicle will not be committed to the mission unless both are operating and one fails in-bound to the target. The mission would not be aborted but the air vehicle will be considered to have a mission-critical failure.

b. Break Rate (BR). The percent of time an aircraft will return from an assigned mission with one or more previously working systems or subsystems on the mission-essential subsystems list (MESL) inoperable. While this is an important parameter, it is a poor choice for a system specification. Break Rate impacts are already addressed by inclusion of sortie rate requirements. Break Rate provides no insight on when the break occurred (for example in-bound versus out-bound) or whether the break occurred in a redundant system. It may be useful in assessments, but is not an appropriate choice for a system specification requirement.

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c. Operational System Reliability (OSR). The probability that a given system initially in mission capable status will successfully complete its designated mission or function. This is the parameter of choice for a system specification. The intent of this section is to define the system requirements impacting mission success. OSR feeds the mission planning system, avoids ambiguity in mission success determination, allows redundancy in mission-critical subsystems as a possible solution; and handles cooperative reliability conditions (such as air vehicles that rely on a successfully operating ground station).

While operational system reliability is the most appropriate choice for use in a system specification, this choice should not imply that the other parameters are unimportant. For example, preliminary assessments of break rates will be needed to set the sortie generation requirements and to confirm they can be feasibly achieved. There will need to be trade studies both before and after the system specification is established on the costs of redundancy, maintainability, and reliability. The concern here is to capture the best parameter to satisfy the warfighter and to provide our contractors with sufficient latitude to define and design a solution. Of the three parameters, operational system reliability does this the best.

Since mission reliability captures the ability to maintain mission capability, identification of scenarios and missions become critical factors in ascertaining what air vehicle functions are essential. As development progresses, mission-essential subsystems will be identified. The development of the mission reliability requirement requires an understanding and definition of the employment and deployment conditions of the system for all identified missions at worldwide locations in intended operating environments. Mission reliability is mission dependent. Thus, degradation of any subsystem below minimum acceptable performance results in a lack of mission reliability. Such an occurrence can be compensated for via subsystem redundancy and/or redundancy of critical items within the subsystem.

The scenarios and missions have been defined elsewhere in this system specification guide (3.1.1). A reference to the scenario and mission information is sufficient in the “scenario” and “mission” columns. Use multiple rows for each scenario and mission combination. Ensure that the mission column (either explicitly or in the referenced paragraph) provides sufficient ground rules on air vehicle employment. Mission reliability is specified for the air vehicle or air vehicle and “other element” combination. Flight reliability should not be used. However, it must be evaluated in determining what the mission reliability should be. Thus, if we expect (in the case of a fighter aircraft) that both aircraft either operate together or abort together and the requirement is that the two ship will remain mission capable 98 percent of the time, then the mission reliability for a single air vehicle would need to be specified as “0.99.” Note, again, that parameters such as “mean time between mission-critical failures” are not recommended. Such duration dependent parameters can be useful when specific mission durations are known. However, use of duration independent parameters is preferred in the system specification to allow greater latitude in defining air vehicle requirements. Some knowledge of the mission duration will, however, be needed in defining the appropriate mission reliability to specify.

Specifying mission reliability for an air vehicle is preferred. Remotely piloted vehicles (RPV) are a special case. If the controlling station (either air, ground, or ship based) has already been developed, specifying the mission reliability for the RPV (i.e., the air vehicle) is preferred. If the controlling station is being developed along with the RPV

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there are options depending on the capability expected from the controlling station. For example, if there is one controlling station for each RPV, then specifying mission reliability for the combination of the controlling station and RPV would provide the greatest latitude in decomposing the mission reliability and allocating it to appropriate equipment. If the controlling station controls multiple RPVs or another control station can assume control of the RPV in the event of a control station failure, then specifying the mission reliability of both the control station and the RPV may be the preferred approach. If the mission reliability includes both the RPV and the controlling station, this fact must be noted in the mission column (along with the mission reliability expected) and sufficient information (such as employment ground rules etc.) must be available in the description of the mission referenced.

REQUIREMENT LESSONS LEARNED (3.1.6.1)

Mission reliability is a critical factor to ascertain the amount of resources required for a given job. Force sizes are decreasing. Achieving high productivity from the force is necessary. There have been circumstances when more aircraft are assigned to missions and operated than are actually needed to accomplish mission tasks simply to ensure that enough aircraft arrive in the combat area with the capability to conduct those tasks. Over-assigning aircraft to missions to compensate for low mission reliability must be avoided.

3.1.6.2 System survivability.

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3.1.6.2.1 Mission and one-on-one survivability.

The air system shall meet or exceed the probability of survival specified in table 3.1.6.2.1-I for the missions, scenarios, vignettes, mission phases, and conditions shown.

TABLE 3.1.6.2.1-I. Mission survivability.

Mission	Scenario	Vignette	Mission Phases	Probability of Mission Survival	Conditions

The one-on-one survivability of the air system shall meet or exceed the one-on-one probability of survival specified in table 3.1.6.2.1-II for the missions, scenarios, vignettes, mission phases, threats, and conditions shown.

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TABLE 3.1.6.2.1-II. One-on-one survivability.

Mission	Scenario	Vignette	Mission Phase	Threat	Probability of Survival	Conditions

REQUIREMENT RATIONALE (3.1.6.2.1)

The system must be survivable in threat environments. Lack of survivability erodes a force's capability to continue operations. Loss rates that may seem small for single missions become staggeringly large when viewed over time. For example, at three sorties per day for 10 days, less than 74 percent of the aircraft would be expected to remain at an average of one loss per hundred sorties and less than 55 percent at an average of two losses per hundred sorties. Increase the productivity demand to four sorties per day and the remaining force is reduced to less than 67 percent at the end of ten days for an average of one loss per hundred sorties and to less than 45 percent at the end of ten days for an average of two losses per hundred sorties. This is simple arithmetic ($P_s^{Sr * t}$ where Ps is the single sortie probability of survival, Sr is the sortie rate and t is the number of days). Over time we would expect a force experiencing such losses to take actions such as lethal suppression, tactics changes, and so forth to avoid such undesirable circumstances. At the same time, we do not necessarily expect a system to be self-survivable to the extent that it has no reliance on other systems. However the actions a force can take are dependent on the inherent survivability of each system that compose that force. One alternative is, of course, to avoid the fight. That is not why we build combat aircraft.

Probability of survival is a useful measure that captures critical system requirements and also provides design flexibility. It allows trade-offs for and impacts specific characteristics such as mission planning systems (ability to avoid the threat); communications (ability to share threat information between air vehicles in a flight or with external systems); training; observables; vulnerability; maneuver; speed; altitude; countermeasures effectiveness (including expendables capacity); and balances between target acquisition and weapon delivery effectiveness versus survivability in a hostile environment. The associated parameter (see requirement guidance provided below) of probability of survivable damage provides critical criteria for lower-level trade-offs regarding hardening versus threat avoidance. Further it is coupled with battle damage repair requirements to provided maintenance capability criteria.

Mission survivability is complex and often argumentative. This requirement is structured to preclude the need for campaign assessments (which should serve as the basis for establishing the requirement initially). Campaign assessments involve very complex interactions between force elements. While these are necessary factors that must be addressed, the complexity of those interactions often precludes direct, verifiable assessments. Frequently the debate deals with the capabilities of supporting assets

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such as jammers, escorts, and other elements necessary to the successful application of air power and the relative success of friendly forces in achieving air superiority or air dominance and the rate at which that may (or may not) occur. While such factors are absolutely crucial, they have a tendency to “swamp” the characteristics of the system being developed. The purpose of this requirement is to isolate survivability characteristics to the system being developed.

This requirement is structured in two parts. The first part encompasses the mission. Mission survivability can be viewed as an integration of one-on-one situations into the one-on-few, one-on many, few-on-one, few-on-few and many-on-many situations that comprise the execution of the mission from a survivability perspective. The second part encompasses the one-on-one survivability for a particular mission phase that can be directly related to testable system characteristics. (Note: This is not intended to imply that all characteristics be tested in all situations. Testing all possible conditions against all possible threats can be cost prohibitive.)

REQUIREMENT GUIDANCE (3.1.6.2.1)

In structuring and defining this requirement, the specification developer needs to consider what is to be achieved in terms of characteristics to be developed. Top-level considerations include

a. What are the trade-offs between speed, altitude, observables, countermeasures, mission planning and maneuver? And, what is the magnitude and mix in the air vehicle of these characteristics? System requirements should enable an air vehicle definition that quantifies the degree of observability, the degree of countermeasures and so forth. This requirement must contain sufficient information to enable that definition.

b. What are the interactions among air vehicles in a flight that contribute to survivability?

c. What external systems (e.g., jammers, escorts, etc) are employed to help the system being developed survive and in what ways do they contribute?

d. What operational factors are employed and how do these impact the conditions of measurement?

The requirement should be structured to enable a build-up to mission survivability from the one-on-one survivability characteristics. This provides a mechanism to address mission factors (e.g., size of the expendables package, cooperative tactics, etc.) and one-on-one conditions that can be verified at higher fidelity (test and/or high fidelity simulations).

For some air vehicle types, exposure to threat environments will be infrequent. Consider the nuclear bomber force. It has yet to be used to conduct its primary mission. Its value as a deterrent is a function of the bomber’s survivability and capability. Cargo/transport aircraft may not be frequently called upon to transport troops, supplies and equipment into hostile territory. But if they do, what are the consequences of lack of survival? Similarly with tankers. The need for and degree of inherent survivability is driven by the consequences of failing to achieve required mission and force objectives and the costs involved in achieving that survivability.

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Although this specification guide deals with the survivability of the system being developed, the inherent survivability required is dependent on the use (or lack of use) of other force elements that can contribute to survivability. In setting system specific survivability requirements, those other force elements need to be taken into account.

Requirement Guidance for table 3.1.6.2.1-I

Mission and Scenario: Identify the mission being conducted and the scenario in which it is conducted. This should include a reference to 3.1.1, Roles and missions.

Vignette: A vignette (sometimes referred to as a mini-scenario) can be viewed as a single mission portion of a campaign. It is a two-sided situation that encompasses system employment conditions. It describes starting and ending conditions, the numbers of systems involved, their tactics and operating conditions, the targets and their location, the relationships between systems, natural environment factors (including weather conditions and terrain), operational environment conditions (including dust and smoke), and any other operationally significant factors. It must be sufficiently broad to assess the interactions between like air vehicles in the flight and accommodate the interactions with systems external to the flight. Each vignette needed in the definition of the system, should be incorporated into the descriptions and conditions defined in 3.1.1, Roles and missions. A vignette can also have a variety of associated conditions that describe specific characteristics of air vehicle operations to be conducted. Note that a vignette used to explore candidate system definitions at the start of Product Definition Phase is substantively different from that used in a system specification. At the start of Product Definition Risk Reduction Phase the focus is on defining a system solution. The system specification represents that system solution. Thus the vignettes used in the system specification reflect the air vehicle and operational concepts needed.

Some specific survivability conditions to reflect in the vignettes include the overall threat distribution and density. For example, assume that the mission involved a single air vehicle penetrating enemy airspace at low altitude. Further assume that the air vehicle would enter the engagement envelope of only ten threat systems out of the one-hundred threat systems in the overall scenario. The vignette must be sufficiently encompassing to ensure that the air vehicle's threat detection capabilities are not limited to just the ten threat systems that are engaging it, but also the other ninety in the scenario. That is, the air vehicle's survival capability may be strongly influenced by its ability to assess the entire environment and focus pertinent survival equipment and operating modes on the ten percent that reflect the danger to this mission.

Mission Phases: Identify the mission phases, and appropriate operating modes, for the air vehicles in the vignette. Phases can include (but are not limited to): launch, cruise, initiate penetration altitude and speed, long-range target area acquisition, ingress to terminal area acquisition point, terminal area target acquisition, ingress to target area, target acquisition/weapon delivery, repeat target acquisition/weapon delivery as needed, proceed to next target, target acquisition/weapon delivery, egress. Mission phases should lay out the mission from end-to-end to accommodate the tactics employed to successfully accomplish the intended purpose of the mission. The intent is not to specify mission survival for each mission phase, rather it is to define the conditions that impact survivability. For example, there may not be an end-game survivability concern from launch to the cruise point, however, depending on threat capabilities and air vehicle

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characteristics, that phase of the mission may provide warning of in-bound activity that impacts threat readiness state.

Probability of Mission Survival: Define the survival probability required and the kill category. The probability of mission survival used depends on a large number of factors, all of which must be properly integrated. Factors include (but are not limited to):

Air crew – air vehicle interface: Threat environments impose both stress and workload factors that have been shown historically to significantly influence survivability. For example, a pilot's ability to effectively assess and react to threat warning information while conducting other mission tasks (such as navigation, target acquisition, and weapon delivery). Situation awareness is also a contributor to survivability provided such information is presented to air crews in an effective manner. The importance of such factors can be driven by the threat environment. Combat environments pose stressing demands to process (by machine and by the human) and effectively utilize real-time information from friendly sources: for example, information sharing between air vehicles in the flight; information distributed from external sources, such as AWACS; and "information" received from threat sources such as acquisition and tracking radars.

Mechanisms used to achieve survivability include the following:

Countermeasures (ECM effectiveness, expendables effectiveness and quantity), threat avoidance, observables, vulnerability reduction, maneuver, speed, altitude, etc.

Number of weapon delivery passes

Lethal self-protection

Tactics used both autonomously and cooperatively

Effectiveness and fidelity of combat training.

Threat density, capability and readiness states

Kill categories

There are a number of categories of "aircraft kill" that indicate varying levels of damage. The selection of the category to use is dependent on the mission to be accomplished, the capabilities expected from the system as a whole, and can even depend on the number of systems being procured (for example, there may be a need to ensure that key, high value/high cost assets that are only procured in limited quantities are more damage tolerant).

In terms of impacting the overall system capability, there are three basic aircraft kill levels. An attrition kill indicates that the air vehicle is lost to the inventory. That is, the air vehicle has either been shot down or that damage is too expensive to repair. A mission abort kill indicates that the air vehicle is unable to complete its mission but is capable of being repaired. A mission availability kill indicates that an aircraft can complete its mission but requires repair before being usable for another mission. There are others as well, for example, there is a forced landing kill normally used for helicopters that indicates that damage forces the helicopter to land and repair is required prior to resuming flight. Within the kill categories there are also kill levels. For example, within attrition kill, categories include (but are not limited to)

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KK kill, which indicates immediate destruction of the air vehicle

K kill, which indicates the air vehicle falls out of manned control within 30 seconds of being damaged

A kill, which indicates the air vehicle falls out of manned control within 5 minutes of being damaged

B kill, which indicates the air vehicle falls out of manned control within 30 minutes.

The kill categories to use can depend on the objectives of the system. Typically, an attrition kill category is always used since it directly impacts the future sustainability of the force. However, from a mission effectiveness perspective, a mission abort kill is also a key factor. Mission abort kills are also important for those systems designed to do high value, time-critical jobs that occur infrequently and where back-up systems are not normally available. From a maintenance perspective, damaged air vehicles impose additional burdens on sortie generation, thus mission availability kill can also be a valuable measure.

Selection of kill levels within a category is also important. For example, specifying KK kill as the only probability of survival category results in not accounting for loses that occur within minutes of the damage. In trying to best represent the capabilities expected from the system being developed, it may be appropriate to specify some capabilities directly and, for the purposes of integrating survival characteristics with other system requirements and parameters, to ensure that other characteristics are verified to the extent needed. Other system capabilities use survivability information as data. For example, a mission planning capability might use both an attrition kill and a mission abort kill as inputs.

The specification developer needs to realize that there is a large difference between what needs to be specified versus what needs to be calculated. Additionally, there are a number of survivability conditions and criteria that are important but difficult to quantify and even harder to specify. For example, air vehicles that are damaged tend not to survive as well as those that are not damaged.

A robust survivability/vulnerability and sortie generation analysis prior to selecting specification requirements cannot be understated. It is essential to know and understand what is important to the missions being conducted. Additionally, every parameter specified in this area potentially has significant design consequences. Ensure that all the critical requirements and conditions are specified. However, it will not be prudent to specify every parameter and condition that could be specified.

While all applicable categories and levels are of value, it is more appropriate to control the critical ones and verify others (to the extent needed) in concert with other requirements. It is essential to require what is necessary. Air vehicle (and other lower-tier) requirements and design criteria are driven by the choices made in the system specification.

Consider two alternatives to meeting an arbitrary probability of survival. One alternative achieves its attrition kill criteria by not being shot at but it is soft (high vulnerability). The other meets the same criteria by being able to withstand a lot of damage (low vulnerability). Both lose the same number of aircraft per mission but the low vulnerability

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air vehicle requires a lot of battle damage repair capability. Which alternative provides better combat effectiveness? Is the second alternative (low vulnerability) an acceptable solution? If it is, use of A or B kill criteria with the provision for XX percent survivable air crew in the event of loss may be sufficient. If the second alternative is not acceptable, then criteria relating to damage tolerance will also be necessary.

Damage tolerance requirements can be communicated by mission availability kill, an acceptable damage to loss rate, or a probability of survivable damage. Consider mission availability kill versus damage-to-loss rate as a candidate requirement to specify. For example, assume that an arbitrary attrition kill criterion is selected with an acceptable probability of survival of .98. Suppose, at that level of survival, that we would be willing to accept a .04 probability of a returning aircraft not being mission available due to damage. Is this the same as specifying a damage-to-loss rate of two? On the surface it is. But what if the designer delivered an aircraft that yielded a .99 probability of survival? Would .04 probability of a returning aircraft not being mission available due to damage be acceptable (i.e., a damage-to-loss rate of 4)? Clearly it would not be if damage-to-loss rate were specified. The designer did a good job by beating the survivability requirement. If the requirement stipulates a 0.04 probability of a returning aircraft not being mission available due to damage, do not burden the designer with a damage-to-loss rate.

Damage tolerance criteria also has levels. An aircraft could be damaged and not fixable within days (or weeks). Thus, if mission availability kill is used, a time interval also needs to be specified (e.g., 0.96 probability of aircraft being mission capable within XX hours). This poses another problem, what if it takes longer? Is it considered an attrition kill? That is, using mission availability kill criteria can introduce ambiguity. Consider using a probability of survivable damage as a factor and let the rate of fixing (or not fixing) the damage be controlled by the aircraft battle damage repair requirement. Another alternative is, of course, to let this be a fallout capability at the risk of having unlimited damage. That is, if the designer delivered 0.98 probability of survival against an attrition kill category, are we willing to accept a solution that allows damage to all the surviving aircraft?

Thus the requirement under mission probability of survival could be stated as

"___(1)___ probability of survival using ___(2)___ kill criteria with ____(3)___ percent survivable air crew in the event of loss and ____(4)____ probability of survivable damage. Where (1) is the acceptable attrition kill level, (2) is the attrition kill criteria (e.g., A or B), (3) is the percent of air crews that must survive the attrition kill, (4) is the probability of survivable damage."

<u>Candidate kill category considerations</u>:

Fighter/Attack class air vehicle: Consider using A or B kill criteria with a provision for XX percent survivable air crew in the event of a loss. We expect surviving aircraft to recover and fly another mission. Thus repairable damage is also important.

Bomber: For tactical missions, criteria for fighter/attack class aircraft could be appropriate. For strategic missions, both A or B kill criteria and mission abort kill criteria would be significant.

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Tanker: Is the tanker intended to go in harm's way or is the intent to protect the aircraft in specific circumstances? If there is a threat and the concept of operations does not provide for back-up or alternative tanker capability, a mission abort kill can result in loss of the aircraft to be refueled.

Cargo/Transport: This class of air vehicles poses a significant problem in criteria and condition selection. For example, we would frequently expect some capability to operate in forward areas near the battle area. Additionally, these air vehicles also conduct air drop missions for troops, supplies and equipment. They are relatively few in number and high cost. Is the survivability requirement just to protect the air vehicle? What about the cargo?

Conditions: Define the operating conditions that may impact survivability. Such factors typically include ECM discipline; expendables usage; cooperative capabilities and tactics between air vehicles in a flight; mission planning factors including engagement and avoidance characterization; and so forth.

Requirement Guidance for table 3.1.6.2.1-II

Mission, Scenario, Vignette: Identify the mission being conducted, the scenario in which it is conducted, and the vignette that describes aircraft employment and other conditions. These are used to provide traceability between the one-on-one requirements and the mission survivability. If the mission survivability portion of this requirement is not used or specific one-on-one situations are being specified that are not encompassed within the mission survivability requirement, see the descriptions for table 3.1.6.2.1-I.

Mission Phases: Identify the mission phase to be used in the one-on-one assessment. Mission phases are frequently associated with specific potions of a mission profile. For example, the one-on-one probability of survival will likely be different for an air vehicle during terrain following during ingress, performing a pop-up maneuver for stand-off target acquisition, or doing low-level/pop-up and dive/stand-off weapon delivery.

Threat: Identify the threat system. Threats can include aircraft as well as ground based defenses.

Probability of Survival: Define the one-on-one survival probability required and kill category. The conditions and factors described for table 3.1.6.2.1-I are generally applicable here expect for damage tolerance. At the mission level, probability of survivable damage provides a maximum allowed frequency of occurrence and drives survival parameters related to denying threats an effective weapon launch capability (do not compensate by specifying a minimum probability of survivable damage at the mission level). This may not be sufficient if the air vehicle must also be hard (i.e., low vulnerability). One-on-one survivability deals with probability of survival given an engagement. Denial of an effective threat weapon launch capability may shrink engagement envelopes and does impact one-on-one survivability. However, what happens when an effective threat weapon launch occurs? Does the aircraft need to be able to take damage and survive? If not, then define the one-on-one probability of survival and appropriate kill level against each threat expected. But if the aircraft must survive some level of damage, then damage tolerance criteria must also be specified to provide a minimum acceptable level of damage tolerance. There are a variety of ways this can be specified, such as

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No mission impairment damage due to hits from YY weapons (sometimes used for small arms)

No mission impairment damage due to XX size fragments at velocities from YY to ZZ (sometimes used for fragmentation warheads)

Probability of kill given a hit less than XX (sometimes used for anti-aircraft artillery and rapid fire guns)

Probability of collateral damage less than (this can be expressed in a variety of ways but frequently we do not want the air vehicle to be destroyed because of a hit in the fuel tank, or we want to contain damage to the impacted item such as preventing a hit in the engine from throwing engine parts/fragments into an adjacent engine).

Thus, the requirement under one-on-one probability of survival against the threat identified could be stated as follows:

> "___(1)___ probability of survival using ___(2)___ kill criteria with ____(3)___ percent survivable air crew in the even of loss and ____(4)____ damage tolerance. Where (1) is the acceptable attrition kill level, (2) is the attrition kill criteria (e.g., A or B), (3) is the percent of air crews that must survive the attrition kill, (4) is an expression of the damage tolerance capability expected."

Conditions: Define the operating conditions that may impact survivability. Such factors typically include ECM discipline; expendables usage; tactics; mission planning factors including engagement and avoidance characterization; uncertainty of threat locations; and so forth.

REQUIREMENT LESSONS LEARNED (3.1.6.2.1)

Combat aircraft take hits. Hits cause damage. Some types of damage result in aircraft loses. Survivable damage drives maintenance. We prefer aircraft to return from missions even if damaged. Avoiding threats is safest, but is not always consistent with mission objectives.

Often neglected, realistic and effective training is a critical factor in achieving a survivable system. Making the right decisions at the speed of combat is often the determining factor in whether a system survives or not. For example, timing of a maneuver to avoid a missile. This is not a trivial problem, especially when multiple threats are present. Additionally, air crews must fully understand (and be confident in) air vehicle capabilities. For example, does a missile-dodging maneuver put the air crew/air vehicle at greater risk than relying on and exploiting other capabilities of the air vehicle. This ability is not realized by peacetime flying conditions. Historical information indicates that pilots who have combat experience are more survivable than those without such experience. That is one of the purposes of the Red Flag exercises. However, operational exercises conducted by the warfighters must not be the rationale for lack of attention to training in development. They should be looked upon as further refinement of air crew capabilities, as opposed to the basis for those capabilities.

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3.1.6.2.2 Parked aircraft and ground support survivability.

System items shall satisfy the survivability criteria identified in table 3.1.6.2.2-I.

TABLE 3.1.6.2.2-I. Ground survivability.

Item	Criteria	Conditions

REQUIREMENT RATIONALE (3.1.6.2.2)

Losing an air vehicle at a basing location is just as significant as an in-flight loss. Losses of key support assets may have as big an impact on system productivity as air vehicle losses.

Often neglected, air vehicles are vulnerable when based and have no capability to defend themselves, avoid the threat, or employ countermeasures. Their capability to survive is based on specific attention to basing survivability issues addressed during development, plus whatever elements of the basing infrastructure they can utilize.

Survivability of supporting assets is not frequently considered. However, preventing air vehicles from flying by damage or destruction of system specific support assets can degrade productivity to a greater extent than air vehicle break rates.

REQUIREMENT GUIDANCE (3.1.6.2.2)

There are a number of mechanisms that can be used to improve parked aircraft and ground support survivability. Some of may become infrastructure issues such as having hardened shelters. Some may be a combination of infrastructure and system specific issues such as camouflaging support equipment, not all of which will be system peculiar. Others are system specific but may require infrastructure support, for example, it may be necessary to have revetments for systems capable of operating from forward areas. Still others may be system unique such as decoys, camouflage, and so forth.

In general, survivability of assets on the ground can be improved from nominal conditions by a variety of techniques including redundancy of key support assets, deception such as decoys, avoidance such as camouflage, concealment, reconstitution (repair of damaged assets), dispersal, and hardening. Adequate levels of survivability are determined by analysis of threat operations and the capability of the threat.

There are a number of ways of specifying survivability of assets on the ground. First, a “weight of attack” and “frequency of attack” condition can be specified along with an

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acceptable level of degradation in sortie generation capacity and recovery time. This is generally a starting point to address the impacts to the system, however resolution of these impacts may not solely be a system specific problem. Resolution of the survivability problems may be an infrastructure and/or air base operations issue that does not fall under the scope of the system being developed. For example, more and better hardened air vehicle shelters or air bases that afford better dispersal characteristics may solve the problem. Such solutions are, however, not frequently within the program scope of the system being developed. There are, however, actions that can be taken and appropriate requirements specified. The following information represents some of the characteristics that can be specified for many types of air systems. The requirements selected for use are dependent on system expectations and scope of development.

Guidance for table 3.1.6.2.2-I

Chemical/Biological Attack

Item: Air System

Criteria: Acceptable level of degradation of sortie generation capability due to chemical/biological attacks and a maximum recovery time (including decontamination) back to full sortie generation capability

Conditions: Description of the chemical/biological threat, weight of the attack and attack frequency. This should include a reference to Roles and missions (3.1.1) and Organization (3.1.2). The chemical/biological threat must be fully defined in the threat section (Roles and missions paragraph)

Conventional vulnerability

Item: air vehicle (or support equipment)

Criteria: Survivable damage for blast fragmentation warheads detonating at distances in excess of XX meters

Conditions: Describe the threat ordnance (or provide a reference to the location of the description)

Conventional vulnerability

Item: air vehicle (or support equipment)

Criteria: Survivable damage from small arms fire

Conditions: Specify the threat weapons

Conventional vulnerability

Item: air vehicle (or support equipment)

Criteria: Survivable damage from indirect fire weapons (e.g., artillery, mortars etc., normally survivability against direct fire weapons such as tanks is not used)

Conditions: Identify the weapons and payload (e.g., HE rounds, cluster munitions, etc.)

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Deception (deny acquisition)

Item: air vehicle (or support equipment)

Criteria: Decrease threat ability to acquire the item to XX

Conditions: Describe threat target acquisition capabilities and characteristics

Single Point Failures

Item: system support structure

Criteria: Damage or loss of any item of support shall result in _____ capability to generate sorties (note: this can be structured in a variety of ways including, “no degradation in” or a “ percent acceptable degradation in” etc.)

Conditions: Specify pertinent conditions and constraints.

Runway denial

Item: Air vehicle

Criteria: The air system shall be capable of launching combat sorties within XX (specify a time interval) of attacks on air base surfaces given a critical field length (typically the maximum of the take-off and landing distance) of YY feet is available. (Note that repair of runways, taxiways etc. is frequently a combined capability of both the system being developed and specialized, non-system-peculiar runway repair assets.)

Conditions: Specify conditions such as the nature of the attack, which can include anti-personnel munitions, and weight of the attack. Identify the non-system-peculiar assets available for air base recovery and their capabilities.

REQUIREMENT LESSONS LEARNED (3.1.6.2.2)

To Be Prepared

3.1.7 System capabilities.

3.1.7.1 Mission lethality.

This is a paragraph header facilitating document organization.

3.1.7.1.1 Air-to-air lethality.

The system shall achieve and sustain the anti-aircraft lethality as specified in table 3.1.7.1.1-I.

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TABLE 3.1.7.1.1-I. Air-to-air lethality.

Mission	Scenario	Vignette	Mission Phase	Exchange Ratio	P(Kill)	Target Acquisition/ Cueing Condition	Config-uration	Conditions

REQUIREMENT RATIONALE (3.1.7.1.1)

This requirement establishes the lethality of the system in the air-to-air role and is a measure of the system's ability to execute its intended function. It integrates both the aircraft and weapon performance thus addressing the aircraft's ability to achieve effective delivery conditions for the weapon. It also incorporates impacts for systems cued from external sources. Depending on the specific set of conditions specified, this requirement can be used to reflect options ranging from a single weapon to the entire payload. Note that, at the system level, this requirement integrates navigation, target acquisition (including detection, identification, classification, assessment, lock-on etc) and weapon delivery capabilities. Defining this performance and the conditions under which the system must perform allows the prime contractor to allocate lower-tier performance requirements.

REQUIREMENT GUIDANCE (3.1.7.1.1)

Table 3.1.7.1.1-I will likely contain a number of entries to capture required system capabilities. For example, its scope should address one-on-one situations that enable verification of much of the capabilities needed to satisfy the requirement via high fidelity methods (for example, test or test "validated" methods. This then provides a link to few-on-few engagement situations.

Guidance for completing table 3.1.7.1.1-I follows:

Mission, Scenario, and Vignette: Identify the mission being conducted, the scenario in which it is conducted, and the vignette that establishes the conditions. This should include a reference to 3.1.1, Roles and missions.

For this requirement, a vignette could be as simple as the initial conditions for a one-on-one situation. A key point to remember is that, for an air combat aircraft, this requirement could be the "sizing" requirement on the capabilities expected from the system's target acquisition sensor(s).

Mission Phases: Identify the mission phases, and appropriate operating modes, for the air vehicles in the vignette. Phases can include (but are not limited to) launch, cruise, initiate penetration altitude and speed, long-range target area acquisition, ingress to

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terminal area acquisition point, terminal area target acquisition, ingress to target area, target acquisition/weapon delivery, repeat target acquisition/weapon delivery as needed, proceed to next target, target acquisition/weapon delivery, egress. Mission phases should lay out the mission from end-to-end to accommodate the tactics employed to successfully accomplish the intended purpose of the mission.

Exchange Ratio: Enter the minimum required exchange ratio against the threat aircraft for the stipulated conditions and P_k capability.

P(Kill): The Probability of Kill (P_k). Specify in this entry the minimum required probability that a threat aircraft will be killed.

Probability of kill refers not only to endgame effects, but to all of the following: the probability of detecting the target, the probability of acquiring the target, the probability of identifying the target, the probability of classifying the target (if necessary), the probability of locking on to the target, the probability of providing guidance to launched weapons, and finally the endgame kill probability. Although the meaning of this measure seems apparent, it is not. Several different degrees of kill have been defined and accepted by DoD. Ambiguity in the meaning of the P_k parameter will likely lead to incorrect requirements during development of the lower-tier specifications. Therefore, carefully select and identify the appropriate kill criteria and ensure the P_k definition(s) are included in the Definitions section of the system specification.

Target Acquisition/Cueing Condition: At a minimum, “Autonomous” should be selected as a condition. Other conditions can include “in-flight cooperative” and external systems. When external systems are identified, a reference to the C4ISR Interface requirements should also be identified. Identification requirements (or identification state) and their relationship to the rules of engagement should also be included. For example, few-on-few vignettes will not typically stress target identification. Target identification can be achieved autonomously, cooperatively among air vehicles in a flight, externally, or situationally. If external or situational criteria are used, any additional criteria that are to be applied prior to weapon release need to be identified. Situational criteria is used to describe identification by observing where a potential target is (deep inside enemy territory), what it is doing (flying in formation with thousands of other unknowns and they are coming our way, shooting at the other aircraft in the flight, etc.), or other analogous conditions/situations.

Configuration: Identify the combat configuration of the air vehicle. If the decision on weapons carriage (type and numbers) has already been determined, identify the appropriate loadouts. If the developing contractor has latitude to define the carriage capability, use a generic description (e.g., “full air combat weapons load”). Similarly, if other stores (such as expendables) have already been determined these can be identified along with a reference to one of the paragraphs and entries under 3.3.7, Stores and expendables lists.

Conditions: Enter those conditions under which the system must achieve the specified lethality (i.e., "Night"). Ensure that the specification thoroughly defines the meaning of each condition stipulated. Also, since the lethality requirement can change significantly under different conditions, expect to make multiple entries for the same threat aircraft. For example, the exchange ratio requirement against a MiG-29 may be higher for night, in poor weather conditions, than for daytime, in clear conditions. For this situation, make

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two MiG-29 entries, because each entry affects the development of lower-tier specification requirements.

For systems on air-to-ground missions that require an air combat self-defense capability, identify whether external stores are allowed to be jettisoned or whether they must be retained. For air combat systems, identify whether external fuel tanks (if carried) are jettisoned prior to combat. Air combat conditions typically include rules of engagement. Additionally, limitations could be placed on the amount of ordnance to use (e.g., no gun firing, 50 percent of gun ammunition allowed, 2 air-to-air missile firings allowed, etc.)

In addition to light level or weather conditions, the entry in the conditions column should include any critical constraints, including engagement scenario, environment, weapons, or any other parameter necessary to establish the required anti-aircraft lethality of the system. Engagement scenarios (i.e., blue and red force sizes, tactics, command, control, communications, basing, support system, etc.) are particularly important considerations if the using command identifies them, either in the ORD or by other means, as critical constraints.

REQUIREMENT LESSONS LEARNED (3.1.7.1.1)

To Be Prepared

3.1.7.1.2 Air-to-surface lethality.

The system shall provide the lethality effectiveness index as specified in table 3.1.7.1.2-I.

TABLE 3.1.7.1.2-I. Air-to-surface lethality.

Mission	Scenario	Vignette	Mission Phase	Target	Effectiveness Index	Weapon Type & No.	Target Acquisition/ Cueing and Navigation Aides	Conditions

REQUIREMENT RATIONALE (3.1.7.1.2)

This requirement establishes the air-to-surface lethality of the system. Note that, at the system level, lethality includes target acquisition (including detection, identification, classification if appropriate, lock-on, etc) and navigation capability. This requirement provides the fundamental reason why air-to-surface systems are developed and procured. Lethality is mission and scenario dependent due to terrain, basing, weather and other factors. Air-to-surface systems are called upon to attack a wide variety of

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targets, both fixed and mobile, using a wide array of munitions. It will likely not be necessary to specify requirements for each and every target type an air-to-surface system may be called upon to attack with all the different choices of weapons available. But even a limited set can be large. The stressing conditions should be specified with sufficient coverage of other conditions to ensure that the system is designed with the needed flexibility. For example, only a few conditions may be necessary for "dumb bomb" attacks against fixed targets. Since point targets (air base hangar) stress different delivery capabilities than area targets (such as air base runways) some subset should be selected that ensure acceptable design criteria. Precision guided munition attacks against fixed targets might also be limited to a small set of conditions. However, lethality is coupled with survivability in that optimal weapon delivery (and target acquisition) does not often directly equate with survivable conditions. And, for example, there may be operational flexibility requirements that are to be met. For example, ability to exploit a hole in the air defense coverage may drive certain weapon delivery capabilities to exploit a survival sanctuary. Additionally, some weapons that may be required, have their own set of characteristics that drive delivery conditions. Mobile targets frequently provide more stressing situations than fixed targets, both in terms of target acquisition capability, but also due to their frequently vast numbers, small sizes, and differences in how they are arrayed. Defining this capability and the conditions under which the system must perform allows the prime contractor to allocate lower-tier performance requirements.

REQUIREMENT GUIDANCE (3.1.7.1.2)

Surface attack lethality requirements for an air system cannot be stipulated merely by identifying the target set. The lethality of a system against any target set is highly dependent on the type of weapon or weapons used, the number of weapons used during each attack, the system accuracy, and the conditions under which the weapon system attacks the target.

Table 3.1.7.1.2-I defines the system surface attack lethality performance. Accuracy is not included in the table. Although accuracy plays a large role in determining lethality, accuracy is best derived from the system lethality and other system requirements. The following paragraphs provide additional instructions on the use of this table.

Complete table 3.1.7.1.2-I using the following guidance:

Mission, Scenario, Vignette: Identify the mission being conducted, the scenario in which it is conducted, and the vignette that sets the conditions. This should include a reference to 3.1.1, Roles and missions.

Mission Phases: Identify the mission phases, and appropriate operating modes, for the air vehicles in the vignette. Phases can include (but are not limited to) long-range target area acquisition, ingress to terminal area acquisition point, terminal area target acquisition, ingress to target area, target acquisition/weapon delivery, repeat target acquisition/weapon delivery as needed, proceed to next target, target acquisition/weapon delivery.

Target: If not included in the vignette, enter a precise description of the surface target(s), keeping in mind that any ambiguity will likely result in incorrect requirements in the lower-tier specifications. Some targets are single objects, such as a T-72 tank. Other

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targets are a combination of objects, such as a column of T-72 tanks. These "complex" targets usually require more descriptive information (e.g., spacing). Other details, for instance, whether the target is stationary or hardened, are critical in defining the target with sufficient detail to allow proper flow-down to lower-tier performance requirements.

Effectiveness Index: Enter the appropriate effectiveness index. For point targets, enter the minimum required single pass (or single firing event) Probability of Kill for each expected target, weapon, and condition combination. For area targets, enter the minimum number of expected kills or minimum fractional kill criteria. Although the meaning of these measures may seem apparent, they are not. Several different degrees of kill are often available for each type of target. Therefore, it is important to carefully select and identify the appropriate kill criteria and ensure they are included in the Definitions section (6.xx) of the system specification. Ambiguity in the meaning of the effectiveness index chosen will likely lead to incorrect requirements during development of the lower-tier specifications.

Weapon Type & No.: Enter the type and number of each weapon that will be used during a single pass or single firing event. For example, this entry may be 12 Mk-82 LDGP.

Target Acquisition/Cueing and Navigation Aides: Identify external, in-flight cooperative, and autonomous conditions for target acquisition. For external target acquisition/cueing systems, identify the location accuracy and in-flight update capability available from the external platform. For external navigation aides, identify the location accuracy available. When external systems are identified, a reference to the C4ISR Interface requirements should also be identified. Also included should be errors introduced (or passed on) by the mission planning capability/system.

Conditions: Enter all of the conditions under which the system must achieve the specified lethality. Carefully describe the conditions, such as light level, weather, or any other pertinent constraints. Also, since the lethality requirement can change significantly under different conditions, expect to make multiple entries for the same target. For example, the Expected Kills requirement for a column of T-72 tanks with 50 meter spacing traveling at 25 mph may be lower for night, in poor weather conditions than for day, in clear conditions. For this situation, make two T-72 tank column entries, because each entry affects the development of lower-tier specification requirements. In addition to light level or weather conditions, the entry in the conditions column should include any critical constraints, including engagement scenario, environment, weapons, or any other parameter necessary to establish the required surface attack lethality of the system. Engagement scenarios (i.e., blue and red force sizes, tactics, command, control, communications, etc.) are particularly important considerations if the using command identifies them, either through the ORD or by other means, as critical constraints.

Additional location information can be critical for attack of mobile targets. For example, sometimes air-to-surface attacks are cued from external sources. Mobile targets change location. Thus factors such as “timely arrival” can have a significant bearing on the air-to-surface lethality. A recommended approach is to provide both conditions that include this factor and conditions that do not include this factor. When including this factor, the age of the information of the cued location and target location uncertainty should also be defined. Such factors can drive target acquisition capability requirements as well as other air vehicle performance requirements, such as speed.

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Finally, the conditions should specifically relate to a mission phase in the Mission and One-on-One survivability requirements identified in 3.1.6.2.1 and mission profile in 3.1.1 Roles and missions. Any additional conditions or constraints on weapon delivery profile should also be defined. This will help ensure that weapon delivery conditions, and resulting lethality, is consistent with the survivability requirements.

REQUIREMENT LESSONS LEARNED (3.1.7.1.2)

To Be Prepared

3.1.7.2 Cargo transport.

The system shall provide cargo delivery capability as defined in table 3.1.7.2-I.

TABLE 3.1.7.2-I. Cargo delivery.

Mission/ Scenario	Air Vehicles	Cargo Quantity	Distance	Basing T/O Landing	Delivery Rate	Operations Period	Reference

REQUIREMENT RATIONALE (3.1.7.2)

This paragraph establishes the cargo delivery requirements for the system. This is the top-tier capacity/rate requirement and is linked to the cargo interface requirements that establish dimensions, weights etc. This requirement describes the installed performance characteristics that link ground/shipboard cargo handling (load and unload) capability, with system availability, the "cube" requirements of the cargo to be delivered, and the rate at which cargo must be transported over a given distance for a specified operational period. This requirement is a critical design constraint and must be defined so that lower-tier requirements are properly derived.

REQUIREMENT GUIDANCE (3.1.7.2)

Use as many entries in the table as needed to describe the critical delivery requirements for the system. The explicit linking of this requirement to the cargo interface requirement provides flexibility in specifying generic loadouts (e.g., this can be reduced to a metric tons-kilometer rate requirement) to specific loadouts. It is essential that explicit matches be defined between each line in this table to the cargo interface requirements via the "Reference" column in table 3.1.7.2-I. This process would allow the following requirement: "Not more than 24 aircraft shall be capable of delivering 1 unit of cargo 7000 kilometers per 10 days over a sustained operating period of 60 days," where 1 unit of cargo is defined in entry XYZ in paragraph 3.3.7.3, which could be the cubic volume

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description of the personnel and equipment of an armored division. This would also allow the following requirement: "Not more than 8 aircraft shall be capable of delivering 120 metric tons of cargo 7000 kilometers in 2 days for a sustained operating period of 30 days," with cargo as defined in paragraph 3.3.7.3, which could be the cube description of some aggregate of generic form of supply.

Guidance for completing table 3.1.7.2-I:

Mission/Scenario: Identify the mission being conducted and the scenario in which it is conducted. This should include a reference to 3.1.1, Roles and missions.

Air Vehicles: Enter the number of aircraft available to achieve the cargo capability. This is the total pool of aircraft available and would (for example) include some fraction of the aircraft that are down for repair.

Cargo Quantity: Enter the number of units of cargo that the system must deliver (this is keyed to the corresponding cell in the "Reference" column).

Distance: Enter the distance in kilometers that the system transports the cargo.

Basing: Identify the basing for Take-off (T/O) and Landing. Basing descriptions can include basing type (main operating base, forward operating base, unimproved area, ship/ship type etc.). Frequently characteristics such as load capacity number or california bearing ratio and "runway" length will also need to be identified.

Delivery Rate: Specify the time (including load and unload time) in which the system must deliver the cargo specified in blank 2, for the distance specified in blank 3 with the cargo description identified via blank 6.

Operations Period: Define the sustained operating period for which the system must deliver cargo at the amount and rate specified in "Cargo Quantity," "Distance," "Delivery Rate," and "Reference" within number of aircraft identified available in "Air Vehicles." The time units should be either in days, weeks, or months.

Reference: Identify the specific reference that defines what the unit of cargo means in "Cargo Quantity." This could be the cargo interface requirement provided in 3.3.7.3 or it could be a separate document that provides the information described in 3.3.7.3.

REQUIREMENT LESSONS LEARNED (3.1.7.2)

Rapid retasking of moving cargo on and off naval vessels at sea places unique constraints on cargo interface design.

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3.1.7.3 Reconnaissance/surveillance.

The system shall provide reconnaissance/surveillance capability as described in table 3.1.7.3-I for the conditions identified.

TABLE 3.1.7.3-I. Reconnaissance/surveillance capability.

Mission/ Scenario	Sensors	Coverage	Information Collection	Information Processing	Information Dissemination	Timeline	Conditions

REQUIREMENT RATIONALE (3.1.7.3)

Reconnaissance and Surveillance are two functions that provide information for intelligence. Intelligence is

a. The product resulting from the collection, processing, integration, analysis, evaluation, and interpretation of available information concerning foreign countries or areas.

b. Information and knowledge about an adversary obtained through observation, investigation, analysis, or understanding.

Extracts from Air Force Doctrine Document 1:

> Intelligence, surveillance, and reconnaissance must operate together, enabling commanders to preserve forces, achieve economies, and accomplish campaign objectives. They are integral to gaining and maintaining information superiority.
>
> Intelligence provides clear, brief, relevant, and timely analysis on foreign capabilities and intentions for planning and conducting military operations. The overall objective of intelligence is to enable commanders and combat forces to "know the enemy" and operate smarter. It helps commanders across the range of military operations by collecting, analyzing, fusing, tailoring, and disseminating intelligence to the right place at the right time for key decision making. Intelligence provides indications of enemy intentions and guides decisions on how, when, and where to engage enemy forces to achieve the commander's objectives. It assists in combat assessment through munitions effects assessment and bomb damage assessment.
>
> Surveillance is the function of systematically observing air, space, surface, or subsurface areas, places, persons, or things, by visual, aural, electronic, photographic, or other means. Surveillance is a continuing process, not oriented to a specific "target." In response to the requirements of military forces, surveillance must be designed to provide warning of enemy initiatives and threats and to detect changes in enemy activities. Air- and space-based surveillance assets exploit elevation to detect enemy initiatives at long range.

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Reconnaissance complements surveillance in obtaining, by visual observation or other detection methods, specific information about the activities and resources of an enemy or potential enemy; or in securing data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. Reconnaissance generally has a time constraint associated with the tasking. Collection capabilities, including airborne and space-based systems that are manned and unmanned, and their associated support systems, are tailored to provide the flexibility, responsiveness, versatility, and mobility required by the strenuous demands of fluid, global taskings. Intelligence critical to the prosecution of current combat operations is evaluated and transmitted in near real time to those elements having a need for that information. Reconnaissance forces possess multiple and diverse capabilities. Because these capabilities are valuable across all levels of war, their specific employment at any one level should consider possible effects on other levels.

REQUIREMENT GUIDANCE (3.1.7.3)

The requirements imposed by this paragraph are primarily intended for those missions whose primary function is reconnaissance/surveillance. In concept, the requirements could be adapted to missions that have a secondary or tertiary reconnaissance/surveillance function. Examples of missions with secondary or tertiary functions could be air-to-air or air-to-surface combat missions that require battle damage assessments (such as gun camera or bomb impact imagery) or a record of radar warning receiver information coupled with spatial location of the air vehicle. These requirements may be better communicated via 3.3.10, regarding system usage information collection and retrieval.

An air system may be developed that just provides reconnaissance or just surveillance or a combination of reconnaissance and/or surveillance and intelligence. In establishing air system requirements for reconnaissance/surveillance and associated intelligence requirements (if any) it is necessary to examine the disciplines of intelligence.

Intelligence discipline. A well defined area of intelligence collection, processing, exploitation, and reporting using a specific category of technical or human resources. There are five major disciplines: human intelligence, imagery intelligence, measurement and signature intelligence, signals intelligence (communications intelligence, electronic intelligence, and foreign instrumentation signals intelligence), and open-source intelligence.

Air systems can potentially contribute to three of these disciplines.

Imagery intelligence. Intelligence derived from the exploitation of collection by visual photography, infrared sensors, lasers, electro-optics, and radar sensors such as synthetic aperture radar wherein images of objects are reproduced optically or electronically on film, electronic display devices, or other media. Also called IMINT.

Measurement and signature intelligence. Scientific and technical intelligence obtained by quantitative and qualitative analysis of data (metric, angle, spatial, wavelength, time dependence, modulation, plasma, and hydromagnetic) derived from specific technical sensors for the purpose of identifying any distinctive

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features associated with the target. The detected feature may be either reflected or emitted. Also called MASINT.

Signals intelligence. 1. A category of intelligence comprising, either individually or in combination, all communications intelligence, electronics intelligence, and foreign instrumentation signals intelligence, however transmitted. 2. Intelligence derived from communications, electronics, and foreign instrumentation signals. Also called SIGINT.

An air system may need to be capable of information collection supporting IMINT or MASINT or SIGINT or some combination of the three. It could be required that it will need to be capable of all three at the same time. Alternatively, it may only need to be capable of performing one or two of the collection functions. Finally, it may need to have a modular capability that enables it to perform any one of the required capabilities with the collection capability changing from sortie to sortie. Thus, it is essential that the missions in 3.1.1, Roles and missions, be appropriately identified to allow correlation of other system requirements with the capabilities required here.

Guidance for filling in the table 3.1.7.3-I

Mission/Scenario: Identify the mission being conducted and the scenario in which it is conducted. This should include a reference to 3.1.1, Roles and missions. Mission designators that include descriptors identifying the type of information (IMINT, MASINT, and/or SIGINT) can be useful.

Sensors: Enter wording that describes whether the system will use onboard sensing devices, external or separate sensors, or a combination of both. Suggested wording for specifying the appropriate choice is "onboard" or "onboard and external." If external sensors are used, they must be identified and a reference to the appropriate interface in 3.4, Interfaces (particularly the C4ISR interfaces) should be included. Additionally, if the system is required to use one or more existing sensors, identify the sensor and reference the appropriate sensor information in 3.3.7.2, Sensor pods. Be very clear in this paragraph so that the contractor can easily determine what capabilities they need to develop and what capabilities they need to integrate. It is possible that the system will use external sensors and one or more sensors identified in 3.3.7.2 and still need to develop one or more other sensors to provide the required information collection capability.

Coverage: Enter information describing coverage conditions. Coverage conditions include

a. Standoff characteristics: The air vehicle may over-fly or standoff from the area over which it is collecting information (enter “over-fly” or “standoff”). Also provide the altitude and maximum slant range to a detectable target/feature/event.

b. Conditions of coverage: The conditions and constraints necessary to establish each collection requirement. Entries may include day, night, weather conditions, speed, and time over area.

c. Frequency of coverage: The frequency with which the coverage area must be observed. Examples of valid entries are "Continuous" or "Twice a day."

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d. Sustainment period: The length of time that coverage must be sustained. An example of a valid entry is "1 month."

e. Per Sortie Coverage Area: The number of square kilometers of area that must be observed for the conditions, frequency, and sustained period stipulated.

Information Collection: Enter information detailing the information collection requirements. Information collection requirements may include the following (Note: a system developed to conduct reconnaissance and/or surveillance may have significant avionics capability requirements at the system level. The system specification for such a system may reflect a tailored hybrid of the Air System JSSG and the Avionics JSSG with additional avionics detail at lower levels of the specification tree):

a. Detectable characteristic: Detectable characteristics depend on the type of information being collected (see above definitions for IMINT, MASINT, and SIGINT).

   The detection characteristic and performance value for the conditions, coverage area, altitudes and standoff ranges identified. These entries should describe the type of operational targets that must be detected and identified by the system. Examples would be "troops," "tank column," or "parked aircraft." If further descriptive information is pertinent, such as type, number, and spacing, then provide these details as well.

   Entries can also describe a generic size requirement if no target details are desired or available. In such a situation, an example of a valid entry would be "2 square meter object" or a minimum resolvable temperature. Additionally, the detectable characteristic may not be an object; a signal and a sensitivity may be more appropriate. Add range information if multiple sensitivity points need to be specified or if the operating slant range does not adequately describe the range (or is not pertinent) for detection (for example, resolve a delta temperature of X degrees at Y kilometers slant range).

   Requirements for detection, identification, and classification (i.e., a vehicle is there, the vehicle is a tank, the tank is a T-62) may also be appropriate (or more appropriate to use for some types of systems than other types descriptions – for example, “the system must be capable of classifying tanks at 200 km).

b. Accuracy (or fidelity) of characteristic measurement: Define the accuracy (uncertainty) of the measurement device as it impacts the characteristic being measured.

c. Instantaneous coverage area: Describe the directional attributes and/or ground swath coverage.

d. Instantaneous capacity: How much information (of the type of information being collected) must the system be able to handle at the same time (e.g., pulses/sec). For some systems this is not applicable (e.g., in photo-recon missions this may be the same as the instantaneous coverage area).

e. Storage capacity: How much information must be collected and stored.

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Information Processing: Define the processed outputs (a complete list of final outputs includes all intermediate outputs for which there is a user of that information) in terms of the processing functions expected. For example, “correlation of emitter signals, with GPS and on-board air vehicle location information, and terrain maps to provide a current emitter beddown.” Include processing accuracy requirements, if any.

Information Dissemination: Define who the outputs go to and how often those outputs are to be provided. Characteristics of dissemination can deal with a wide variety of factors such as “secure transmission of reconnaissance data to XX kilometers.” Dissemination characteristics can include point-to-point, point-to-multiple point or broadcast capabilities. This requirement can be quite complex if the platform also serves as a command and control platform (e.g., an AWACS) and dissemination would include segmenting information into meaningful portions and the transmission of that information with tasking to other assets.

Dissemination characteristics could be as simple as, “a roll of film extracted from the air vehicle at the end of a sortie.” Dissemination characteristics are also driven by who will be using the information. The system may need to be capable of multiple types of characteristics to accommodate the different levels needed by the end users of the information such as a pilot, a mission planner, a controller, or a force commander (at varying levels).

Timeline: Define all applicable timelines. Some systems may collect information and pass it on. Some systems may collect and process information and then pass it on. Some systems may collect information and pass it on and still perform processing then pass on the processed results. Time lines may be real time (pertaining to the timeliness of data or information that has been delayed only by the time required for electronic communication. This implies that there are no noticeable delays.), near real time (pertaining to the timeliness of data or information that has been delayed by the time required for electronic communication and automatic data processing. This implies that there are no significant delays), or delayed (defines the maximum allowed time delay).

REQUIREMENT LESSONS LEARNED (3.1.7.3)

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3.1.7.4 Aerial refueling (tanker).

The system shall be capable of transferring fuel to other platforms as specified in table 3.1.7.4-I.

TABLE 3.1.7.4-I. Tanker refueling capability.

Mission	Receiver and Flight Size	# Simultaneous Receivers	Off-Load per Receiver	Refuel Process Duration	# Off-Load Occurrences/ Tanker Sortie	Conditions

REQUIREMENT RATIONALE (3.1.7.4)

If the air system includes an air vehicle that is to function as a tanker to aerially refuel receiver air vehicles, this role and the associated mission(s) should be identified, as they will impact air vehicle and aerial refueling subsystem design performance requirements.

Aerial refueling is valuable to air operations. It expands employment options available to commanders by increasing the range, payload, and flexibility of air forces.

Air Force conventional air refueling assets are employed in five basic modes of operation:

a. Support of the nuclear Single Integrated Operation Plan,

b. Support of long-range, conventional strategic attack missions,

c. Deployment of air assets to a theater,

d. Support of an airlift line of communication or airbridge, and

e. Support of combat and combat support aircraft operating in theater.

REQUIREMENT GUIDANCE (3.1.7.4)

While this requirement has been structured to assist document users in constructing a requirement for refueling capability for air vehicles not solely designed as a tanker, it will require tailoring to characterize this condition.

Guidance for table 3.1.7.4-I

Mission/Scenario: Identify the mission being conducted and the scenario in which it is conducted. This should include a reference to 3.1.1, Roles and missions.

Receiver: Identify the receiver air vehicle and the number of air vehicles in the flight to be refueled. Reference the appropriate portion of the Interface section (3.4) for each air vehicle identified. Reference to specific air vehicle type is preferred over just specifying

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a receptacle interface since refueling compatibility (including airflows around air vehicles) must be established. If multiple air vehicle types must be refueled on the same mission identify both types and add appropriate information in the conditions column. For a single mission, use a separate line for each air vehicle type to be refueled on that mission. Do not rely on the interface section to convey pertinent information (such as, if there is a requirement to refuel two different aircraft types on the same mission that require different fuel types). Add such information to the conditions column.

Simultaneous Receivers: If there is an explicit need or capability to require multiple simultaneous hook-ups to receivers, identify the number. If not, this number will become a fallout of the time allowed for refueling, and the off-load per receiver and number of air vehicles to be refueled requirements.

Off-load Per Receiver: Specify the amount of fuel that must be off-loaded to each receiver aircraft.

Refuel Process Duration: Specify the amount of time allowed for the refueling process for the entire flight. Identify both the starting and ending conditions.

Off-Load Occurrences per Tanker Sortie: Specify the number of times per tanker sortie that this refueling condition occurs. In conjunction with the off-load per receiver and number of air vehicles per flight, this will size the total off-load capacity per tanker. Note: this is total off-load capacity per mission (an installed performance requirement).

Conditions: Identify any special conditions. This includes natural environmental factors (lighting, turbulence, wind, etc.), air speed and altitude ranges (if necessary), conditions for multiple fuel types, angle-of-attack maximums and minimums, and other factors necessary to fully communicate the condition of performance.

REQUIREMENT LESSONS LEARNED (3.1.7.4)

To Be Prepared

3.1.7.5 System reach.

The system shall provide the reach indicated in table 3.1.7.5-I for the mission and altitude regime stipulated.

TABLE 3.1.7.5-I. Reach.

Mission	Reach	Altitude Regime	Remarks

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REQUIREMENT RATIONALE (3.1.7.5)

System reach characterizes the distance/time for which the system must maintain flight worthiness and mission reliability while deploying to an operating location or conducting a given mission. Normally it is derived from target base coverage requirements, departure and arrival locations, operational presence requirements, and other factors which demand that air vehicles (supported or unsupported by external assets such as tankers) have an endurance measured in terms of distance and/or time. Note that this requirement may result in lower-tier requirements to provide crew rest and provisioning capabilities for systems that have particularly long durations.

REQUIREMENT GUIDANCE (3.1.7.5)

To complete table 3.1.7.5-I, use the following guidance:

Mission: List all missions (see 3.1.1, Roles and missions), including training missions, as required, to satisfy the ORD. Do not reference the ORD.

Reach: Enter the required distance for the various missions and the type of distance (e.g., radius, unrefueled range, etc.). It may be necessary to describe a combination (e.g., a refueled range and an unrefueled range or a refueled range and an unrefueled radius). The mission profiles in 3.1.1 should identify aerial refueling points.

> For some systems or missions, this may be better described as a time duration or a combination of distance and duration. For example, the distance between an AWACS base and its orbit location is an important factor, but the distance it travels while in orbit is not the critical specification factor, but the required time on orbit is.
>
> For some systems, such as cargo/transport systems, additional information may be necessary. Some types of transport missions involve multiple take-offs and landings similar to a commercial bus. These circumstances will need to be defined as well as if and what type of servicing is permitted at each stop. A few examples for this situation could be
>
> total distance of 6000km with 5 stops, no servicing; or
>
> total distance of 8000km with 5 stops, no servicing except refueling; or
>
> total distance of 8000km with 5 stops, general servicing and refueling allowed

Altitude Regime: Generally the low and high altitude flight envelope for the air vehicle will be the same for all missions. Both the lowest altitude above ground level and the highest full performance altitude for the specific mission should be defined.

Remarks: Provide any necessary clarification.

REQUIREMENT LESSONS LEARNED (3.1.7.5)

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3.1.8 Reserve modes.

The system shall be capable of providing wartime reserve modes as indicated in table 3.1.8-I.

TABLE 3.1.8-I. Wartime reserve modes.

Function/Characteristic	Capability

REQUIREMENT RATIONALE (3.1.8)

Wartime reserve modes are characteristics and operating procedures of sensor, communications, navigation aids, threat recognition, weapons, and countermeasures systems that will contribute to military effectiveness if unknown to or misunderstood by opposing commanders before they are used, but could be exploited or neutralized if known in advance. Wartime reserve modes are deliberately held in reserve for wartime or emergency use and seldom, if ever, applied or intercepted prior to such use.

REQUIREMENT GUIDANCE (3.1.8)

Wartime reserve modes are determined via three primary sources:

a. They can be directed, for example in the Operational Requirements Document or program direction.

b. They may interface driven (either directed or derived).

c. They may be the result of translating operational (or other) requirements into system specific capabilities. That is, during concept exploration and program definition phases, capabilities are identified that are consistent with and support achievement of warfighter requirements but should be held in reserve for wartime use to prevent exploitation by an adversary.

Fill in table 3.1.8-I as follows:

<u>Function/Characteristic</u>: Identify the function or characteristic for which a wartime reserve mode capability is required.

> When a function is identified be as explicit as possible to provide limiting guidance to the extent required. For example, consider the difference between "communication" and "intra-flight communication." The first would require that all communications throughout the system (including communications in training and support) be afforded the capability defined. The second would limit the capability to just communications between the air vehicles in a flight. Rather than specifying all communication, identify each type to the extent required by

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using separate entries in the table (e.g., "intra-flight communication" could be one entry, "communication with AWACS" could be another, and so forth).

When a characteristic is identified, specificity is also important. One dilemma with characteristics is they tend to be associated with specific solutions. This may be unavoidable where characteristics are associated with specific parameters the warfighter has deemed important and with characteristics/ capabilities associated with an interfacing item. Characteristics should be tied to a specific requirement in the system specification or, if appropriate, an attachment to it.

Capability: Describe the capability required. For example, if multiple reserve modes for intra-flight communication are needed, define what is expected. For example, "3 channels" and the characteristics of those channels such as whether or not they need to be secure and what constitutes "secure" such as encryption or other mechanism. It will likely be necessary to describe capabilities for characteristics in more specific terms than is necessary for a function. For example, the capability for secure intra-flight communication could be expressed in terms of denial of reception of an emission, interpretation of the content, etc. To the extent practicable, provide functional descriptions and performance requirements and avoid the use of specific solutions.

REQUIREMENT LESSONS LEARNED (3.1.8)

To Be Prepared

3.1.9 Lower-tier mandated requirements.

The air system lower-tier mandated requirements shall be as specified in the following: __(1)__.

REQUIREMENT RATIONALE (3.1.9)

This paragraph accommodates those circumstances where system technical characteristics have been deemed essential by the operational requirements proponent and incorporated in the operational requirements document. Requirements included in this section are typically derived from system specification requirements and included in lower-tier specifications, but instead, have been identified as crucial system characteristics. Sources of such requirements include the Operational Requirements Document (ORD), the Program Management Directive (PMD), and the Acquisition Decision Memorandum (ADM) to name a few. Including these requirements in the System Specification is necessary to ensure that all lower-tier requirements can be traced to controlling requirements contained in the system specification.

REQUIREMENT GUIDANCE (3.1.9)

This requirement is typically completed by the Government program office, sometimes in concert with potential contractors. Include any performance requirements mandated by the sources listed in the rationale paragraph above, but do not include interface requirements. Provide a paragraph number for each separate requirement.

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REQUIREMENT LESSONS LEARNED (3.1.9)

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3.2 Environment.

The system shall provide full, specified performance during and after experiencing the cumulative effects of the combination(s) of environments the system is expected to experience over its lifetime.

a. Natural Environment. The system shall satisfy the requirements specified herein throughout its service life during and after operation in, and exposure to, the following worldwide conditions __(1)__.

b. Induced Environment. The system shall satisfy the requirements specified herein throughout its service life during and after operation in and exposure to its intended functional environment. Specifically, the man-made (non-threat), induced environmental conditions in which the system and its components must function are __(2)__. Man-made threat environments are addressed as part of the Vulnerability and Susceptibility requirements.

c. Limiting Environmental Conditions. The system shall satisfy the requirements specified herein throughout its service, life during and after operation in, and exposure to, the conditions in table 3.2-I, with exceptions as noted therein.

TABLE 3.2-I. Environmental conditions.

Absolute Environment Condition	**Frequency**	**Duration**	**Requirement Exceptions During Operation**	**Remarks**

REQUIREMENT RATIONALE (3.2)

The environments in which the system must perform can affect the overall performance (e.g., the effect of weather on sensor range). The internal and external environmental conditions to which the system is exposed, both while operating and not operating, impose stresses on the system leading to failure. These environments, along with the design usage data established in 3.1, and its associated subparagraphs, are used to establish the specific design duty cycles for each element of the system. This requirement provides the environmental boundaries in which the system is expected to meet full specified system performance and provides the necessary information when combined with the usage data of 3.1, and its associated subparagraphs, for designing integrity into the system at all levels.

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REQUIREMENT GUIDANCE (3.2)

Typically, the platform or host vehicle environmental data are documented in environmental control documents (ECDs) or similar technical documentation. If the program requires the system equipment to be installed or used on more than one host system, requirements from each system should be included. The service life of the system is defined in 3.3.1.2.

The technical documentation discussed above, which defines the environmental conditions for the system, should not be put under formal Government control until after completion of the SVR, or later. This allows the contractor to refine the environmental conditions throughout the design as more details are obtained, and to make the necessary changes to the system design without requesting Government approval and specification changes. This technical documentation, under formal Government control at the completion of the program, is used as the initial environmental definition documentation for future system updates.

Constraints on the combination of environments must meet the test of reasonableness. That is, the combination must be one that may be encountered during actual employment and not a combination that is contrived. For example, requiring an immersion test while simultaneously freezing the test article (e.g., an electronic jammer) and then requiring it to perform satisfactorily would not normally be considered reasonable, would be inconsistent with intended usage, and is too detailed for a system specification. On the other hand, expecting an aircraft to perform its mission after exposure to deicing chemicals while parked in a freezing rain would be reasonable.

Blank 1: The prime contractor for a system item is usually responsible for the specific environmental data for the item. It is reasonable to expect that the prime contractor will work with their subcontractors to determine or estimate the expected natural and induced environmental conditions as those conditions are propagated within the system. The Government must provide the overall set of environmental conditions for system operation. In the system specification, the natural environment (blank 1) can be handled by identification/description of geographic areas and seasons. For example, winter carrier operations in the North Atlantic, or summer basing in Southwest Asia deserts (Saudi Arabia), or year-round operations from any CONUS air base.

Blank 2: The functional environment of the system is further subject to induced environmental effects, such as the man-made phenomena of vibration, shock, electromagnetic interference (EMI), adjacent heating and cooling, acidic/corrosive atmosphere (e.g., acid rain), chemicals, and other contaminants (blank 2). Of particular interest is the achievement of electromagnetic compatibility (EMC) among subsystems and equipment during all functional operating modes, and while individually or collectively operated, as well as with like platforms, other systems, and the external electromagnetic environment. Attention to expected operating environments is essential, such as shipboard conditions associated with electromagnetic emissions, and power-on testing of mission systems (such as radar). In addition to the Air Vehicle, the support and training equipment operated in their respective functional environments also shall be electromagnetically compatible.

The induced environments should be characterized for both steady-state and transient conditions for each critical point in the life cycle environmental profile and/or flight

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envelope. Particular attention should be directed at transient conditions, power cycling, vibration, and thermal stresses that occur on start-up, dwell, cycling, and shutdown. Similarly, the environments associated with manufacturing, training, maintenance (at all levels), transportation, and handling need to be identified since they all can impact the life and reliability of the system.

Table 3.2-I:

There are some environmental conditions (natural, induced, and combinations) that the system will experience and must be capable of withstanding while sustaining full (or some minimum level) performance that are not adequately characterized by seasonal information. These limiting environmental conditions are captured in table 3.2-I. Examples of such limiting environmental conditions include full performance at –65^{o}F; safe launch, recovery, and on-deck maneuvering in sea state 3; ability to withstand XX MPH winds while parked in an exposed state at an air base; and other such factors impact the system design. Also, the frequency (for example, as occurrences per year) and duration (for example, minutes or hours for high winds, days/weeks/months for temperature extremes etc) of such limiting conditions need to be identified. Some of these conditions may reasonably be expected to degrade the system's ability to meet requirements during exposure. If so, enter the minimum expectations as an exception during operation. If exceptions are permitted, care should be taken to ensure that: reasonable impacts are identified, and the exception is only for the duration of the condition. The reason this requirement is framed in this manner may be illustrated by a simple example. Suppose that the system must be capable of operating in exceptionally cold temperature. It may be reasonable to allow some relaxation in the integrated combat turnaround time. However, it may not be reasonable to allow a relaxation after the limiting environmental condition has terminated, nor would it likely be reasonable to allow a decreased lethality while the condition is occurring. The remarks column can be used for a variety of purposes. It may communicate special considerations. Additionally, it can identify a condition simply as a withstand condition. For example, in the case of high winds, the requirement could simply be to withstand the wind with no expectations that sorties will be generated.

REQUIREMENT LESSONS LEARNED (3.2)

Many of the environments are based on the missions, scenarios, mission mix and mission profiles established in 3.1.1. Any changes to these may result in changes to the environments. Understanding the design environment early in the development phase will help eliminate excessive redesign and the potential program delays.

3.3 System characteristics.

This is a paragraph header facilitating document organization.

REQUIREMENT RATIONALE (3.3)

System characteristics are performance-based definition and design parameters that apply across the system. Some of these may be translated from the Operational Requirements Document. Others are driven by factors such as DoD policy, force structure, infrastructure, life cycle requirements and commonality.

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3.3.1 Force life-cycle management.

This is a paragraph header facilitating document organization.

3.3.1.1 System architecture.

The system shall have a functionally based, open systems architecture.

REQUIREMENT RATIONALE (3.3.1.1)

Include this requirement to ensure the system architecture (functionally and physically, i.e., requirements, design, and design implementation) is flexible, robust, and in concert with the characteristics of open systems. The system architecture includes the hardware, software, and other elements (such as services, materials etc.) for all system elements/subsystems. A flexible, robust architecture can have significant benefits over the life cycle of the system. It enables the system to be more readily and affordably modified for repair; provides for increased capability (growth); allows interchanging of obsolete parts and minimizes its impact; allows for incorporation of new technologies; promotes simplicity; enables cost-effective production, support, and training; and enables reprocurement of technology evolved replacement parts. This requirement is intended to achieve the features of open systems that are being advocated within DoD and industry. A key objective in achieving a system that is life cycle maintainable, modifiable, and that accommodates technology insertion as a natural course of business rather than simply in terms of new development is achieving an open system.

REQUIREMENT GUIDANCE (3.3.1.1)

Most concern over how the system architecture is defined or developed deals with potential life-cycle management issues. The desire is to have a system flexible and robust so it can easily and affordably be modified, if necessary, to incorporate additional capability, new technology, or replace failed, worn or obsolete parts. The requirement is stated in general terms, describing the overarching characteristics (i.e., functionally based and open systems) needed to achieve the intended purpose or end result. If more specific characteristics or features are known or can be defined for a system component (i.e. level of functional partitioning, modularity, software complexity, etc.), provide the more definitive requirement. This paragraph also provides an umbrella requirement under which other, more detailed system architecture requirements would be defined.

An enabling characteristic of open systems is a comprehensive, performance based product definition. This approach is where the performance, key product characteristics (including interfaces) and product acceptance criteria are defined/specified; but flexibility is given to change the design and/or manufacturing processes as long as the key product characteristics continue to be met. As long as the physical form and fit of the design changes meet the installation requirements, the functional performance of the system resulting from design changes is maintained/unaffected, and the interfaces to other system assets, items, components, modules, etc. are preserved, flexibility can be granted to the designer on the details of the design and components used as well as the specific manufacturing processes employed. This flexibility promotes cost effective system modifications, technology insertion, reduces impacts of obsolescent parts, and many of the other advantages realized from an open system architecture. There are two

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key features of an open system, widely used interface standards and modularity (partitioning). When selecting interface standards, preference should be given first to widely used, consensus commercial standards. Next in order would be selection of widely used consensus proprietary or military standards. For additional information, see http://www.acq.osd.mil/. Modularity is defined as follows:

> Modularity. A system composed of discrete elements, each of which is defined in sufficient completeness and detail such that selected element(s) can be replaced and/or modified in a competitive environment with minimal or no modifications to other system elements while maintaining equal or improved system performance and capability.

For hardware, characteristics of an open system architecture would include functional partitioning where functions are organized, minimized, and isolated into discrete modules. Interfaces among modules (intra-system) would be defined, well documented, and controlled. Modules should be as simple as practical and excessive part counts should be avoided. Interactive design tools and simulations should be utilized to evaluate functional partitioning and interfaces, conduct alternative design trades, and achieve a robust and flexible system design and architecture.

For software, modules that are too complex impact both the development and support phases of an air system. While the number of source lines of code has often been used to capture this characteristic, it is a poor indicator of complexity. Software complexity is a significant driver in testing (and support). There is no definitive relationship between software complexity and size. While one would expect complexity to increase with size, large modules can be less complex than small modules. Thus, if there is a need to control complexity, it should be controlled directly via a complexity metric rather than through module size. There are a number of ways complexity can be measured such as cyclomatic complexity, module design complexity, integration complexity, object integration complexity, actual complexity, realizable complexity, essential complexity, and data complexity. Complexity could be specified as an integer in accordance with guidance concerning McCabe's Cyclomatic complexity. The original limit suggested by McCabe for cyclomatic complexity was 10. While there is evidence to support this, some highly capable organizations with modern tools, comprehensive test plans, software walk throughs, highly experienced staff etc, have succeeded with software complexity metrics of 15. If there is a need to control complexity, keep in mind that the target support organization may not be the same as the developing organization, and lower complexity criteria may be more suitable for the system life cycle. Complexity could be specified statistically. For example, a normal distribution with an appropriate standard deviation could be specified. In this case, the language would read, "A _______ percentage of the modules may exceed _______ using the ______ complexity metric." This would permit some modules to exceed the specified value but not all. This subject is treated in standard software engineering text books. The *National Institute of Standards and Technology (NIST) Publication 500-235*, "Structured Testing: A Testing Methodology Using the Cyclomatic Metric," dated September 1996, is another source for guidance on this subject.

Key to the development and life cycle maintenance of a system is the availability of a complete description of the system and capture of the rationale and decisions that resulted in the system architecture. Guidance on characteristics of the information expected is contained in the Performance Based Product Definition Guide.

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REQUIREMENT LESSONS LEARNED (3.3.1.1)

System data is the product of a development program. System data has the same life cycle as the products it supports and describes. System data is essential to the production, modification, support, remanufacturing, operation, training, deployment and disposal of the system. We have been faced with (at least) three types of critical shortfalls resulting from an inadequate system description and rationale for that description.

a. Failure to properly and completely develop and maintain the performance and product characteristics for each item has resulted in significant expenditures in time and money to reverse-engineer item capabilities when suppliers can no longer be obtained for technologically obsolete parts.

b. Failure to properly and completely develop and maintain the performance and product characteristics for each item has severely limited technology insertion, required additional efforts (e.g., value engineering) to “reconstruct” the information, and limited access to the commercial marketplace for items of equivalent capability.

c. Failure to capture the decisions and rationale, along with supporting information, has resulted in program delays and implementation of additional developments. Once the knowledge is lost regarding why something was done, there is no ability for timely problem solving when development difficulties are experienced in related (and dependent) areas. Some programs are pushed to the point of nonexecutability because loss of the knowledge inhibits examination of alternative requirements or realization that conditions upon which the original requirements (and resulting solutions) are based no longer exist. Such factors have impacted both the original development and follow-on modification efforts.

3.3.1.1.1 Growth.

The system shall have the capacity for the growth potential defined in table 3.3.1.1.1-I.

TABLE 3.3.1.1.1-I. Growth potential.

Capability	Growth Value	Conditions

REQUIREMENT RATIONALE (3.3.1.1.1)

Historically, military air systems incur numerous changes, upgrades, and modifications over their service life. System modifications are required for many reasons (correction of deficiencies, performance upgrades, technology insertion, parts obsolescence, etc.) and can canvass a wide degree of changes (from basic software modifications to complete redesigns). This requirement is intended to incorporate growth provisions in the

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system's design that would enable the system to accommodate some level of change and modification without continually requiring major, expensive redesigns.

> Growth. The inclusion of physical and/or functional characteristics/provisions that enable expansion or extension of the system's capability with minimum disruption of the system design.

REQUIREMENT GUIDANCE (3.3.1.1.1)

Include this requirement to ensure the system has flexibility and growth provisions to accommodate required changes. Although the specific or exact changes or modifications that will be incurred by the system over its life, can not be defined at the time of the system's initial development, historical precedence indicates that system changes are inevitable. Design approaches should be taken to define the system architecture in a way that provides growth capacity to make undefined future changes easier and less costly to implement. Recognizing that some changes, upgrades, and modifications may require major redesigns, the requirement should be defined consistent with a portion of the system's service life. The requirement is stated in general terms, describing the overall characteristics desired to achieve the intended purpose or end result. If more specific characteristics or features are known or can be defined (i.e. the percent of growth capacity, amount of growth memory, number of spare pins, etc.), provide the more definitive requirement.

Computer resources and software are particularly sensitive to growth capacity to promote supportability and mitigate impacts of change over the system's life. Computer processing capability is advancing at a high rate enabling dramatic improvements in system functionality. This technology evolution needs to be planned for and accommodated in the system design. Software by nature is continually modified and expanded. In fact, history shows that there is typically a significant growth in the software during a system's development phase. However, growth requirements focus on "post-development" changes. That is, the baseline design should incorporate the capacities needed during development plus the required growth provisions. The system computer resources design needs to incorporate the necessary additional memory, processing capability and input/output capacity to improve or extend the specified system or system component operations and/or performance without major modifications to the system.

Defining growth provisions necessitates anticipation of both planned and unplanned requirements. Planned requirements typically address preplanned product improvement (P^3I) and evolutionary acquisition approaches.

> Preplanned Product Improvement. The conscious, considered strategy that involves deferring the development of necessary performance capabilities associated with elements having significant risks or delays so that the system can be fielded while the deferred element is developed in a parallel or subsequent effort. Provisions, interfaces, and accessibility are integrated into the system design so that the deferred element can be incorporated in a cost effective manner when available. The concept also applies to process improvements.

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Evolutionary Acquisition. An adaptive and incremental strategy applicable to high technology and software intensive systems when requirements beyond a core capability can generally, but not specifically, be defined.

Unplanned requirements can involve examinations of historical information on mission growth potential; historical use of the class of air vehicle being developed (For example, air combat fighters are frequently reroled as air-to-surface air vehicles. Redesigning/ redeveloping structure and adding "hard points" can be prohibitively expensive but can be realized at modest costs and penalties during the original development.); applying just in case provisions that are inexpensive to implement in design and construction, but expensive to implement in already built articles (for example, adding additional wire(s) for power or information transfer during initial construction, or providing additional capacity for power and cooling); examination of potential impact of mission relevant technologies that are promising but are not ready for transition; and so forth.

Regardless of why growth capability may be needed, a well thought out plan should be constructed with reasonable estimates of the costs, benefits, and penalties identified.

Filling in the table:

Capability: Define the capability for which a growth design allowance is needed. To the extent possible, describe the capability functionally. For example, sensor fusion processing, unused volume, target data information storage capacity, additional capabilities or functionality (e.g., air-to-surface), provisions for weight growth, power distribution, etc.

Growth Value: Define the magnitude needed. Identify whether this is growth capacity to extend the functional capability or whether this is a growth capacity for incorporation of new functionality. For example, avionics cooling of XXXX BTUs, growth memory of YY MB, growth volume of 5 cubic feet, hard points for air-to-surface ordnance, unused power cable to "growth" equipment bays, etc.

Conditions: Define any conditions necessary for the envisioned application of the requirement. For example, if the requirement is for 5 cubic feet of volume it would be desirable to identify the minimum contiguous volumes necessary (such as 1 cubic foot). If allowances are being provided for preplanned improvements, a location may also be necessary, such as 2 cubic feet at the forward, bottom portion of the fuselage.

REQUIREMENT LESSONS LEARNED (3.3.1.1.1)

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3.3.1.1.2 Standard/common assets.

Where practicable, standard/common/nondevelopmental assets (commercial or military) shall be used in the system's design and construction where they satisfy the performance and design criteria for the system and are affordable in terms of life-cycle economics and logistics sustainment.

REQUIREMENT RATIONALE (3.3.1.1.2)

> Asset. Any item, service, or process whether developmental, nondevelopment, possessed, or procured. Frequently used interchangeably with "item."

The intent is to lower development, production, support, supply, and maintenance costs by minimizing the number of unique items, components, and parts. Standard/Common assets should includes other elements of the system/subsystem (i.e. operating environments, software languages, development tools, test facilities and infrastructure, etc.) in addition to the specific components and parts that make up the system/subsystem's physical configurations. Lowering the unique items, components, and parts count will lessen development costs and schedule impacts. Using common items, components, and parts will minimize the number of special tools required for maintenance, the number of items, components, and parts stocked in the supply channels, the workload in the maintenance shops.

REQUIREMENT GUIDANCE (3.3.1.1.2)

The objective of the requirement is to preclude developing new assets when existing assets are available, affordable and meet the requirements. We may not want the prime contractor to develop a unique radio, hydraulic actuator, or oxygen regulator when a common item in use in other air systems can be used instead. Similarly, we do not want to develop a new service (such as freight delivery) when existing services are available, satisfy the requirements and are affordable. An important criterion is the life-cycle economic impacts. Too often, standardization occurs only after an item is fully mature as demonstrated by long term use. As a result, standardization decisions occur late in the "technology life cycle" of an item with the part becoming obsolescent either because of the benefits of newer technology alternatives or because of scare manufacturing sources for old items. Standardizing on items for a system should focus, where possible, on items early in their technology life cycle.

Likewise in the computer resource area, it would not be cost effective to have to support multiple processor/software languages. Use of multiple programming languages should be avoided. Unless there are specific Program requirements, the programming language should be selected as part of the design process, with the objective of being capable of performing all the functional requirements, being efficient, easily modified, and cost effective. If there is a requirement to specify a specific programming language, then state the requirement as such: "Newly developed system computer software shall be programmed in the _______ Programming language." DoD historically prefers the use of the Ada programming language if it is cost effective.

Also, experience indicates that designing and supporting large, complex air systems with diverse development/support tools (especially software tools) results in a severely fragmented systems engineering process and inevitably results in severe integration and

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test problems whose solution is often a complete and total redesign. Development/ support tools (i.e. the Computer Resource Support System) shall include all facilities, hardware, and software required to design, develop, test, integrate, and support the system and should be common to the extent possible and be cost effective. Tools include operating systems, computer/processors, software compilers, editors, assemblers, linkers' debuggers, configuration management tools, environment simulators, system integration labs, anechoic chambers, etc.

REQUIREMENT LESSONS LEARNED (3.3.1.1.2)

To Be Prepared

3.3.1.1.3 Interchangeability.

Parts, subassemblies, assemblies, and software having the same identification, independent of source of supply or manufacturer, shall be functionally and physically interchangeable.

REQUIREMENT RATIONALE (3.3.1.1.3)

It is essential that parts, subassemblies, assemblies, and software with the same identification be interchangeable, maintaining the key product characteristics and associated tolerances of the original item. This reduces logistic support requirements, minimizes maintenance/repair problems, minimizes assembly problems during production, and assure that performance and operability are not compromised.

REQUIREMENT GUIDANCE (3.3.1.1.3)

This requirement generally applies to all situations and should be included in the system specification. The requirement may be tailored to address specific items if deemed necessary.

REQUIREMENT LESSONS LEARNED (3.3.1.1.3)

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3.3.1.2 System service life.

The air system shall provide the performance specified herein for __(1)__ years, given the system usage defined in 3.1.5 and the following life-cycle profile.

TABLE 3.3.1.2-I. Usage and conditions for determining service life.

Usage	Rate/Conditions
Wartime Operations	**(# or % / type of operations)**
Peacetime Operations	**(# or % / type of operations)**
Basing	**(# or % ground operations/checkouts)**
Testing/Checkouts	**(# or %)**
Transportation	**(# shipments/abnormal conditions – exposure)**
Storage	**(# shipments/abnormal conditions – exposure)**
Realistic Training (e.g., Red Flag, on-equipment training)	**(# of occurrences and training conditions)**

REQUIREMENT RATIONALE (3.3.1.2)

> Service life. The period of time spanning from an asset's introduction into the inventory for operational use until it is consumed or disposed. The service life of a system typically exceeds the service lives of the assets that compose it.

Ongoing assessments of current and projected threats against defense capabilities result in a definition of mission needs that includes operational life. The system service life requirement is directly determined by these mission needs and defines how long the system is projected to be needed. Since exact system utilization and service life is not known at the time of initial development, this requirement provides a reasonable design point or definition based on the best estimate or projection of the system's service life and utilization. The requirement is allocated to system elements to ensure that all elements provide the necessary utility for the required duration. This information forms the basis for design loads/stress criteria and the integrity program. While the system may last for the specified duration, the parts of the system may be upgraded, repaired or replaced. The objective is to establish an overall requirement for the system and then to allocate, to the individual assets, appropriate criteria for their servicable life.

The servicable life for individual assets should be based on life-cycle trades including technology cycle time, reliability, repairability, durability, and so forth. It may be more cost-effective to replace a part, component, assembly, etc., than to design each item to match the system service life requirement. Each type of equipment typically has a different critical parameter that best characterizes its service life. For example, structural lifetime is typically expressed in hours, engines in cycles, and so forth. Table 3.3.1.2-I

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illustrates some of the critical parameters the may be used to characterize lower-level parameters.

REQUIREMENT GUIDANCE (3.3.1.2)

System service life defines how long a system is intended to be in service based on the manner in which the system is expected to be used. It establishes a reasonable design point since the precise or exact length of service and utilization for the system is not known that far in the future. It is, however, an important parameter for the designer and can drive specific design parameters like structural strength, parts/component selection, reliability, maintenance/sustainability concepts, manufacturing techniques, etc. Blank 1 should define the specific service life or the desired duration the system is to be in operation and is likely expressed in number of years. Table 3.3.1.2-I should provide an estimated life-cycle profile describing the anticipated number and mix of operations/missions already defined in 3.1.5 in addition to any other factors that would impact the system over its life. Operations for both peacetime and wartime might be expressed in terms of the number or percentage each mission type described in 3.1.5 would be flown over the system's life. Basing should include ground operations like taxiing, alert stationing, number of power-up cycles, etc. Transportation should include the number of anticipated trips; storage should include the time or percentage spent in storage over the system's life; and for both, any abnormal environment and exposure conditions should be defined. Realistic training should reflect planned/anticipated frequencies, conditions, and environments. For example, the number of "Red Flag" operations for each unit of the force. Note that realistic combat and other on-equipment training (see 3.7.3) has been observed to "consume" significant amounts of the service life of the assets involved. If the system is envisioned to be used in any other manner than what is defined in 3.1.5, like dedicated testing (flight or ground), then define those system utilization(s) as well. These parameters will typically be established by the using service and included in the basic program directives. If no guidance is provided, a requirements allocation process using mission needs, threat projections, and/or historical data from previous systems may be used. For the USAF, AFI 63-1001 assigns the operational command the responsibility to establish the service life for all aircraft systems.

REQUIREMENT LESSONS LEARNED (3.3.1.2)

The service life specified in the contract is, in all likelihood, not the actual service life the system will experience. Changes over time in usage, threat driven upgrades, technology evolution, etc. will have significant impact on a system's actual service life. However, as previously stated, this requirement is important since it serves as a reasonable target design point for the designer. Every attempt should be made to define the desired length of service the user wants from the system and to think through all of the conditions that would impact that length of service.

An aircraft initially designed for high altitude operation may require life-extending structural modifications if the mission is changed to include high speed, low altitude penetration in response to changing threats.

A particular fighter aircraft required structural modification to maintain specified service life when it was learned the actual operational usage was more severe than the design

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spectrum. Additional modifications were also required to compensate for manufacturing-induced flaws.

An armed rotorcraft vehicle was specified with a design durability service life of the airframe of 10,000 hours, a minimum depot inspection interval of 3000 flight hours, and a safe life of all dynamic components of at least 4500 flight hours when using the design usage spectrum.

3.3.1.3 Manpower and personnel.

The system shall be operated, maintained, and supported by not more than the numbers and classifications of personnel, exclusive of the student throughput populations as shown in table 3.3.1.3-I through table 3.3.1.3-V for the following force/operational structure conditions:

a. Number of flying organizational units is ____(1)____ with ____(2)___ air vehicles per unit;

b. Number of flying training units is ____(3)_____ with ____(4)____ air vehicles per unit;

c. Number of off-base support locations is ____(5)_____;

d. Other force/operational structure conditions include ______(6)_______; and

e. The maintenance concept as defined in paragraph _____(7)_____ of this specification.

TABLE 3.3.1.3-I. Student throughput populations (military officer).

Military Personnel (Officer)				
	Job Type (optional)	**Skill Level (optional)**	**Numbers**	**Conditions**
Operators				
Maintainers				
Support				
Training				

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TABLE3.3.1.3-II. Student throughput populations (warrant officer).

Military Personnel (Warrant Officer)				
	Job Type (optional)	Skill Level (optional)	Numbers	Conditions
Operators				
Maintainers				
Support				
Training				

TABLE 3.3.1.3-III. Student throughput populations (enlisted).

Military Personnel (Enlisted)				
	Job Type (optional)	Skill Level (optional)	Numbers	Conditions
Operators				
Maintainers				
Support				
Training				

TABLE 3.3.1.3-IV. Student throughput populations (civilian).

Civilian Personnel				
	Job Type (optional)	Skill Level (optional)	Numbers	Conditions
Operators				
Maintainers				
Support				
Training				

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TABLE 3.3.1.3-V. Student throughput populations (contract).

Contract Personnel				
	Job Type (optional)	**Skill Level (optional)**	**Numbers**	**Conditions**
Operators				
Maintainers				
Support				
Training				

REQUIREMENT RATIONALE (3.3.1.3)

This requirement defines the maximum quantities and quality of personnel required to operate, maintain, support and provide training for the system upon full operational deployment. Manpower refers to the numbers of military and civilian (including contract personnel) and the Air Force Specialty Codes (AFSCs) needed to operate, maintain, and support the functional requirements and mission of the system. Personnel refers to the type of individual (i.e., job type) and the degree of skill required to operate, maintain, and support the functional requirements and mission of the system.

There are three external “agents” driving this requirement. The first is congressional reporting requirement (Title 10, United States Code, Section 2434, Independent cost estimates; operational manpower requirements). This simply states that the Secretary of Defense shall prescribe regulations that require that the manpower estimate include an estimate of the total number of personnel required to operate, maintain, and support the program upon full operational deployment and to train personnel to carry out those activities.

The second is implementation of this requirement by DoD 5000.2-R, paragraph 3.5.

> “The manpower estimate shall report the total number of personnel needed to operate, maintain, support, and provide training for the program upon full operational deployment. It shall report the number of military (officer, warrant officer, and enlisted), DoD civilian, and contract manpower requirements for each fiscal year of the program beginning with initial fielding and ending with full operational deployment. A separate estimate shall be provided for each Component (for joint programs) and separately for the Active, Reserve, and National Guard forces.” (Note the difference between a specification requirement “full operational deployment” and a programming requirement “for each fiscal year of the program beginning with initial fielding and ending with full operational deployment.”)

The third is implementation of the DoD regulation by service. For example, the Air Force estimate breaks the maintenance grouping into organizational and intermediate maintenance. The support grouping into depot maintenance, central logistics support,

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program office, and associated base operating system manpower for each element. The current service regulations should be reviewed and assessed prior to establishing the manpower requirements in the system specification. These should be carefully examined to determine what are the actual (and appropriate) requirements to specify versus what are reporting/planning factors used in apportioning manpower.

When establishing a manpower requirement, an examination must be conducted to ascertain the basis for the requirement. In some cases, the driving factor may be monetary, in other cases it is driven by broader force structure personnel constraints, in other cases it may be driven by a need to manage military skills populations. Where possible, the developing contractor should be given the maximum latitude in describing the specific skills needed subject to the constraints established by this requirement.

Manpower and personnel (M&P) requirements must be identified for an acquisition program to proceed beyond program initiation and are necessary to determine affordability in terms of military end-strength and civilian work years (see DoD 5000.2-R, para. 3.5.2). M&P requirements must specify the limitations the work force imposes on the system and conversely, any limitations the system imposes on the work force. This is especially critical when new personnel skill mixes are required to operate, maintain and support systems employing new technologies with increased operational complexity.

As of the date of this document, a query has been submitted to DoD to ascertain the rationale behind the expected content of table 3.3.1.3-V Contract Personnel. In circumstances where contract personnel are used to supplement the organic workforce, basically in a person for person sense, or when there is a need for constant/continual access to various capabilities only available via contract, the rationale for this part of the requirement is clear. However, when support or training is procured as a service (e.g., contracted logistics support) the rationale for such a requirement is not evident. However, reporting of contractor manpower in the Manpower Estimate Report (MER) is required by public law (Title 10, United States Code, Section 2434). This item should be clarified in later revisions to this specification guide. Until that time, suggest program offices request clarification of this particular item should they need to establish a manpower requirement for their program (typically prior to the Milestone II decision) and elect to employ this requirement in a contract system specification.

REQUIREMENT GUIDANCE (3.3.1.3)

When a manpower requirement is established, the conditions for that requirement are critical. Blanks 1 through 6 describe some (but likely not all) of the conditions that impact the requirement. Ideally, the manpower requirement would scale with the actual number of air vehicles fielded. This is not strictly achievable for a variety of reasons, including

a. Manning is integer based. That is, it is based upon an integer number of crews consisting of fixed numbers of people. Changing the size of the organizational unit will not necessarily change the numbers of maintenance crews needed or the size of a crew. Additionally, each organizational unit has a staff to manage the maintenance activity.

b. Centralized intermediate repair facilities are sometimes used to consolidate maintenance efforts in a region. Changing the number of air vehicles

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(organizational units) served by such a facility may impact the number of crews needed simultaneously (and thus impact manning), but there is still a need for a staff to manage the maintenance activity. Such facilities (similar to depots) offer economy-of-scale manpower savings (e.g., if a crew is needed to fix broken engines, but insufficient breaks occur to keep the crew busy, consolidating engine repair at an intermediate facility enables more efficient workload-to-manpower management).

Maintenance and training may be accomplished by a) only the Government; b) only contract personnel; or c) some mix of the two.

Filling in the blanks

Blank 1 describes the number of operational units of a size identified in blank 2. It may be necessary to replicate this entry for each different size unit to be fielded. For example, squadron size may vary and the number of squadrons per wing may vary. This will impact the number of crews available to a squadron or wing (based on the maintenance concept) and the number and sizes of the maintenance staff at the organizational level.

Blanks 3 and 4 characterize information similar to operational units, however the staffing of a dedicated training unit is frequently different from an operational unit.

Blank 5 identifies the number of off-base maintenance locations. These normally fall into two categories: centralized intermediate repair facilities and depots. Centralized intermediate repair facilities may not be applicable to every program. If such facilities are needed, they should be identified in the support concept. Both entries induce certain manpower requirements that are part of the total manpower required. It is important to remember that every organizational entity consumes manpower just to perform necessary functions (security, safety, etc.) that go beyond the fundamental mission of the organization (i.e., fix broken items). Note this is a limiting condition. Our objective should be to minimize the number of such locations to realize manpower savings.

Blank 6 defines any other critical conditions that are factors in the manpower requirement.

Blank 7 identifies the paragraph detailing the maintenance concept for the system. In this specification guide, it is 3.6.

Filling in the tables

Maintenance and training may be accomplished by only the Government; only contract personnel; or some mix of the two. Prior to establishing the content of the tables,

a. Analyze and conduct trade-offs on the ramifications of alternative sources of manning;

b. Work with the operational user to ensure that a mutual understanding exists between trading military and DoD civilian workforce with contracted workforce;

c. Establish the costs and benefits of each alternative approach;

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d. Determine where there is latitude in specifying the manpower breakout.

Fill in the columns of each applicable table as follows:

Job Type: List the job type only when absolutely essential. Eliminating this column provides the developer with the latitude to optimize manpower allocations. Job types can include all specialties associated with the system and are not limited to just the air crew and maintenance crew members and may or may not correspond to an existing AFSC. Examples of job titles include Aircraft Commander, Maintenance Engine Run Technician, Simulator Technician, Computer Analyst, etc. Where possible, limit the number of entries. In some cases, it may not be necessary to have a job type category. These become more critical when specific job types are being managed in a force structure sense and where there is a requirement to consolidate jobs.

Skill Level: Enter the highest level of proficiency or ranking required to satisfy job performance requirements. For air crew members (operators of the system), this may be a knowledge and skill-coded proficiency level (i.e., 4b, 2a, etc.). For maintenance crew members, this may be a technical status (i.e., level 3, level 5, etc.). For support members, such as a computer analyst, it may be a “trade designation” (e.g., Novice, Journeyman, Senior, etc.). The need for this category will be driven by two factors. The first factors deals with the degree to which skill levels (as well as job types) are managed in a force structure sense. The second factor addresses “ceilings” to preclude unrealistic expectations on force composition/maintainer capability (basically, it is unrealistic to expect that the system will be maintained by “all PhD” crews). It is preferable to establish some basic constraints to preclude unreasonable demands on personnel proficiency and provide the developer with the maximum latitude to determining appropriate skill levels, being specific only when it is essential to do so.

Numbers: Enter the maximum number of personnel allowed. If job types and skill levels are included enter the numbers for each job type, for each skill level.

Conditions: Define any conditions bearing on the requirement. For example, it may not be necessary to specify numbers by job type and skill level. It may be sufficient to define a set of jobs, some reasonable maximums on various skill levels and let the contractor determine the proper allocation. Additional conditions could include factors such as whether new/unique job types/skill codes are allowed, constraints on the selection of job types and skill levels, etc.

REQUIREMENT LESSONS LEARNED (3.3.1.3)

To Be Prepared

3.3.1.4 Asset identification.

System assets that are repairable, replaceable, salvageable, or consumable shall be permanently identified by a method that is observable and recognizable throughout the life of the asset and that does not adversely affect the life and utility of the asset. The identification shall include ___(1)____.

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REQUIREMENT RATIONALE (3.3.1.4)

Identification markings are necessary on any system item (hardware, software, ...), component, and part that is designated for replacement, repair, and/or salvage. Identification markings should not be required on items, components, or parts that would not be replaced, repaired, and/or salvaged. For example, resistors on a board would not be required to have identification markings if replacement, repair, and/or salvage were at the board level only. Identification markings also facilitate maintenance, modification, spares procurement, logistic supply systems, deficiency reporting, and configuration management. Marking system items, components, and parts by serial number (or other identifiers) enables rapid identification of specific items and provides pertinent information to the personnel required to support the system.

REQUIREMENT GUIDANCE (3.3.1.4)

In the blank, include required identification method or information content such as National Stock Number (NSN), serial number, CAGE code, manufacturer's part number, etc.. For example, it may be required to include as part of the markings, a notice that an item, component, or part is subject to warranty and the period or conditions of that warranty. MIL-STD-130 can be consulted for additional guidance on this requirement. Identification can be implemented by any method that meets the requirement for the given asset. Such methods could include electronic, bar code, etching/engraving, etc.

REQUIREMENT LESSONS LEARNED (3.3.1.4)

To Be Prepared

3.3.2 Diagnostics.

The system shall detect, isolate, and report loss or degradation of system functions. The system shall detect safety- and mission-critical failures, functionally isolate those failures, and, where practicable, provide the information needed (to the crew or other equipment) in time to preclude further uncontrolled degradation to safety, mission accomplishment, and survivability. The system shall detect and isolate failures to allow maintenance personnel to perform necessary maintenance to meet mission, logistics, and availability requirements. The system shall incorporate a hierarchy of diagnostic data and tolerancing across indentures of design to assure compatibility of tested parameters, test tolerances, ranges, sequences, interfaces, and techniques. The system shall further ___(1)___.

REQUIREMENT RATIONALE (3.3.2)

Diagnostic information regarding the status of a system is needed for a variety of reasons. There are safety, mission, and maintenance decisions that must be made, all of which require timely and accurate knowledge of the system condition. Further, it is necessary to ensure that information tested/reported at one level of the system's architecture is consistent with information reported at lower levels (e.g., on-board diagnostics results is consistent with results reported by off-board test equipment).

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REQUIREMENT GUIDANCE (3.3.2)

Blank 1 should list applicable diagnostic methods that are available for use in meeting diagnostic requirements at this and the following design levels. This could include a variety of embedded test methods, portable diagnostic aids, manual troubleshooting, or an Automatic Test System (ATS). This allows the contractor complete flexibility to study a variety of combinations of the available diagnostic methods and arrive at an optimum mix.

Blank 1 should also contain any additional limitations, restrictions, or requirements for the Diagnostic system. These may include, but are not limited to, the following:

a. Any mandated requirement, such as the use of a particular Automatic Test System (ATS).

b. The need to support rapid reconfiguration of mission software to enable graceful degradation when mission hardware failures occur.

c. Compatibility with the appropriate service maintenance data system (e.g., REMIS, 3M, IMDS, etc.)

REQUIREMENT LESSONS LEARNED (3.3.2)

To Be Prepared

3.3.3 Nuclear surety.

The system shall, to the extent specified herein, prevent nuclear weapons involved in accidents, incidents, or jettison from producing nuclear yield and shall prevent unauthorized and inadvertent prearming, arming, or releasing of nuclear weapons in normal and abnormal environments. Abnormal environments include ____(1)___. The probability of unauthorized or inadvertent prearming shall be not greater than __(2)__ . The probability of unauthorized or inadvertent arming shall be not greater than ___(3)__. The probability of unauthorized or inadvertent release or jettison shall be not greater than ___(4)__. The air system shall meet the following nuclear certification requirements: ___(5)___.

REQUIREMENT RATIONALE (3.3.3)

Department of Defense (DoD) Directive 3150.2, Safety Studies and Reviews of Nuclear Weapons Systems, requires that all systems that employ, transport or handle nuclear weapon incorporate special safety provisions to prevent the unauthorized and/or inadvertent activation of nuclear weapons in both normal and abnormal environments. *Air Force Instruction 91-101, Air Force Nuclear Weapons Surety Program*, establishes Air Force Policy and delineates responsibilities for the implementing and executing a comprehensive nuclear surety program. The other Services may have similar policy and guidance documents.

Nuclear surety, which includes nuclear safety and nuclear security, involves a formal process resulting in Nuclear Certification. The analyses, design studies, and tests associated with the verification of the requirements stated above are the heart of the

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nuclear certification process. Even though this is a performance-based specification, experience has shown that design philosophies have gained acceptance by the Nuclear Surety community and should be utilized to the maximum extent possible to assure timely certification. Due to the special and critical nature associated with the handling, control, and release of nuclear weapons, time proven, top-level, design concept requirements contained in DoD, Air Force, and other service directives, regulations, and instructions should be use in lower-tier specifications. As an example, requirements such as those shown below should be selectively used where appropriate in lower-tier specifications:

Two-man control

Separation of the functions of prearming, arming, launching, and release

All aircraft and missiles shall have a nuclear consent function

Safety studies and analyses over the years have resulted in a set of design rules that have proven effective and supportive of the quantitative values that would be included in the blanks shown in the requirements paragraph above. MIL-HDBK-1822, Nuclear Certification of Weapon Systems, Subsystems, and Associated Facilities and Equipment describes the nuclear certification process and provides detail guidance and criteria on how to obtain nuclear certification.

REQUIREMENT GUIDANCE (3.3.3)

The primary goals of nuclear weapons systems surety are to protect people and property and to conserve nuclear weapons as a national resource by protecting them against all risks and threats inherent in their operational environment. Because of their destructive power and the consequences of an unauthorized or inadvertent detonation of the nuclear or high explosive materials, nuclear weapons and nuclear weapon systems must be designed to incorporate specific design features and capabilities consistent with the surety requirements dictated by its operational environment and intended use.

The requirements in this paragraph are applicable to new and modified systems that carry and employ nuclear weapons in the form of gravity release and/or air-launched missiles. New or modified systems that handle, transport, test and/or store nuclear weapons are also governed by these requirements. From a system perspective, these requirements must be appropriately allocated to the air vehicle and its critical functions and components, ground handling and transportation equipment, support equipment, test equipment, mission planning systems, training systems, facilities, and data.

In developing requirements for this section, the systems engineer should consult the following documents or sources for information, direction, and top-level operational requirements:

a. Program Management Directive

b. Mission Need Statement

c. Operational Requirements Document

d. Operational Plan Data Document

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e. Stockpile-to-Target Sequence

f. Military Characteristics Document

g. Other valuable reference documents include the following:

DoD Dir 3150.2	Safety Studies and Reviews of Nuclear Weapons Systems
MIL-HDBK-1822	Nuclear Certification of Weapon Systems, Subsystems and Associated Facilities and Equipment
AFPD 91-1	Nuclear Weapons and Systems Surety
AFI 91-101	Air Force Nuclear Weapons Surety Program
AFI 91-102	Air Force Weapon System Safety Studies, Operational Safety Reviews, and Safety Rules
AFI 91-103	Air Force Nuclear Safety Certification Program
AFI 91-107	Design, Evaluation, Troubleshooting, and Maintenance Criteria for Nuclear Weapon Systems
AFI 91-108	Air Force Nuclear Weapons Intrinsic Radiation Safety Program

Additional assistance can be obtained from AFMC/SE, San Antonio Air Logistic Center, Nuclear Weapons Integration Division (SA-ALC/NWI), and the Directorate of Nuclear Surety, Headquarters Air Force Safety Agency (HQ AFSA). Recognize that the handbooks, instructions, etc. mentioned above are all Air Force documents. Similar documents and associated criteria published by the other services should be used as appropriate.

Care must be exercised when dealing with legacy systems. Many legacy weapons do not have the latest safety features incorporated, so requirements at all levels must be tailored to accommodate both modern and older nuclear weapons while still meeting the fundamental tenets of nuclear surety. For modification to legacy platforms, the latest nuclear surety criteria is only mandatory for that portion of the system being modified to accommodate the new weapon or to improve operational employment of existing weapons. The key word here is "mandatory." It may be prudent and overall more cost effective upgrade the entire system to the new requirements. This is a study that the system engineer should conduct before the requirements and design approach are finalized.

Blank 1: Specify what is meant by abnormal environment. Several of the reference documents define abnormal environment as follows:

> Abnormal environment – An environment outside the levels specified for normal environment described in the stockpile-to-target sequence document. In an abnormal environment, the nuclear weapon or nuclear weapon system is not expected to retain full operational reliability.

For the system engineer tasked with developing this requirement, the definition for abnormal environment presented above is not very definitive. Generally, abnormal environments are conditions such as fire, aircraft crash landing, violent forms of nature (earthquakes, tornadoes, floods, etc.), accidents, etc. A review of the stockpile-to-target

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sequence document along with discussions with the nuclear weapons community and the user should provide a good summary of expected abnormal environments.

Blank 2: Specify the numerical value for the probability of unauthorized or inadvertent prearming. MIL-STD-1822 and AFI 91-107 are good sources for obtaining acceptable values for this parameter.

Blank 3: Specify the numerical value for the probability for unauthorized or inadvertent arming. MIL-STD-1822 and AFI 91-107 are good sources for obtaining acceptable values for this parameter.

Blank 4: Specify the numerical value for the probability for unauthorized or inadvertent release or jettison. MIL-STD-1822 and AFI 91-107 are good sources for obtaining acceptable values for this parameter.

Depending up the situation, there may be other performance parameters that should be specified in this section to cover critical nuclear surety issues. The list of source and reference documents shown above can help determine if there should be additional parameters.

Blank 5: Specify the criteria for Nuclear Certification. A logical solution would be to reference MIL-HDBK-1822, but current procurement guidelines does not permit the reference of a MIL Handbook as a requirements document. In all fairness, referencing MIL-STD-1822 is not a good idea. The handbook is written to cover a wide variety of situations and needs to be tailored significantly to focus on the specific system covered by this specification. Also, MIL-STD-1822 goes into too much detail requiring further tailoring to be applicable to the specific program under development. It is suggested that the system engineer develop a specific set of nuclear certification criteria to be referenced in blank 5 and included as an attachment to the subject Air System Specification. MIL-HDBK-1822, AFPD 91-1, and AFI 91-101 provide sufficient guidance to develop this criteria.

Identify in the system security paragraph(s), any special security requirements for nuclear surety. The security paragraph in this Air System Specification Guide is 3.3.5.

REQUIREMENT LESSONS LEARNED (3.3.3)

To Be Prepared

3.3.4 Electromagnetic environmental effects (E^3).

The system shall comply with the requirements of __(1)__ to achieve system electromagnetic compatibility (EMC) among all subsystems and equipment within the system and with environments resulting from electromagnetic effects external to the system.

REQUIREMENT RATIONALE (3.3.4)

Imposition of E^3 requirements is necessary to ensure the system is electromagnetically compatible with itself and other systems with which it is intended to work. Subsystems and equipment in the system must work with each other within the internal

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electromagnetic environment which both the system equipment itself and external environments (such as lightning, radio frequency (RF) fields, and electromagnetic pulse (EMP)) may create. A flow down of the external environment stresses to the lower-tier specifications using transfer functions is necessary to allow tailoring of the subsystems and equipment requirements. Structural designs and materials affect electrical bonding, grounding techniques, electrostatic charging, and the electromagnetic interference (EMI) requirements that will be imposed on all subsystems and equipment. High levels of electromagnetic radiation can pose hazards to personnel, fuels, and electro-explosive devices and should be addressed with safety, design, and mission impact in mind. All of these requirements need to consider life cycle aspects of maintaining the E^3 protection.

REQUIREMENT GUIDANCE (3.3.4)

Blank 1 should be completed with MIL-STD-464 or alternative source of E^3 requirements. Requirements areas that need to be addressed are margins; intra-system EMC; inter-system EMC; lightning; EMP; subsystem and equipment EMI; electrostatic charge control; electromagnetic radiation hazards to personnel, fuel, and ordnance; life cycle, E^3 hardness; electrical bonding; external grounds; TEMPEST, emission control (EMCON); and electronic protection (EP). Depending on the approach selected, the information in the blank should be expanded to include tailoring of MIL-STD-464 (such as appropriate external inter-system environments and service unique requirements) or the alternative source for the particular system. Whichever approach is used, MIL-STD-464 should be consulted to ensure that requirements are adequately addressed and for the extensive rationale, guidance, and lessons learned contained in the standard. Mission success depends on the ability of all subsystems and equipment that are intended to operate concurrently within the system to do so successfully and on the ability of the subsystems and equipment to operate with the external environments.

REQUIREMENT LESSONS LEARNED (3.3.4)

Emphasis on systems engineering aspects of E^3 system design is important. In the past, the electromagnetic effects area was often viewed as a test and fix effort with little influence on the actual design at the system level. With the proper performance of electronics playing a more important role for safety and mission completion and the extensive use of composite materials in the system structure, it is essential that the response of the system to electromagnetic stresses be analyzed and understood. MIL-STD-464 contains detailed lessons learned information.

Antenna-to-antenna compatibility problems have been common on aircraft. Receivers have been degraded from radiation from other antennas due to common operating frequencies, harmonics of transmit frequencies, amplified thermal noise, and spurious outputs. Achieving RF compatibility requires careful strategic planning of the placement of antennas and operation of RF subsystems. Involved personnel require detailed technical knowledge of the operating characteristics of subsystems. An RF compatibility effort needs to be established early in the program. Early analysis should be accomplished to estimate antenna-to-antenna isolation.

EMI requirements at subsystem and equipment level (radar, support equipment, etc.) are an important key to successful design and need to include controls on (1) emission levels, that is, interference conducted or radiated from the equipment on electrical interfaces and (2) resistance to susceptibility, that is, undesirable responses from

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external fields and conducted interference. Subsystems and equipment are generally designed to the requirements of MIL-STD-461D. These requirements are tailored based on the transfer functions from the external environments to the internal stresses.

The types of requirements, placement of limits, and applicable frequency ranges in MIL-STD-461D are based on lessons learned from past programs. MIL-STD-461D includes an appendix to explain the rationale for the requirements and to provide guidance in tailoring the requirements. There had been a great deal of misunderstanding and confusion in the past regarding MIL-STD-461 requirements. The DoD issued MIL-STD-461D in January 1993, after extensive revision effort by a tri-service working group. The document is coordinated and approved for use by all the services. MIL-STD-461D contains default baseline levels for requirements suitable for many applications. Tailoring is encouraged.

Electrical bonding is often one of the first areas reviewed for adequacy when a electromagnetic compatibility problem develops at the aircraft level. Some problems have been fixed simply by improving the bonding. The actual need for a certain level of bonding is dependent on a number of issues including shielding topology, type of circuit interfaces, and ground referencing of circuits to the avionics and equipment enclosures.

3.3.5 System security.

The system shall deny access to sensitive assets, capabilities, and information by unauthorized parties or functions. The threat to the system's security is ____(1)_____.

REQUIREMENT RATIONALE (3.3.5)

This system security requirement is directed at negating the security threats to a completed, deployed air system while that system is in an operational environment. The objective is to preclude compromise, exploitation, sabotage, and intentional damage and destruction. The premise of this requirement is that these objectives can be achieved by denying access.

REQUIREMENTS GUIDANCE (3.3.5)

Blank 1: Define, or identify the source document, of the multi-discipline counter-intelligence threat supplied by the appropriate DoD component counterintelligence analysis center.

The security requirement can be expanded given sufficient attention prior to putting the system specification on contract. For example, acquisition systems protection is the overall concept of protecting the program's essential program information, technologies, and/or systems (EPITS) from compromise and inadvertent loss from the establishment of the Mission Needs Statement (MNS) to demilitarization. By establishing basic criteria on the EPITS, system vulnerabilities, and countermeasures, design features can be devised and incorporated into the system to reduce the costs and burdens of security operations after deployment.

If the EPITS are sufficiently defined prior to development of the program system specification, the following can be used to expand this requirement.

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The EPITS, security vulnerabilities, and functional countermeasures are identified in table 3.3.5-I.

TABLE 3.3.5-I. EPITS, security vulnerabilities, and functional countermeasures.

EPITS	Security Vulnerability

Essential Program Information, Technologies, and/or Systems (EPITS). The critical elements of the system that make it unique and valuable to U.S. defense forces. Those items that, if compromised, would cause a degradation of combat effectiveness, decrease the combat-effective lifetime, or allow a foreign activity to clone, kill, or neutralize the U.S. system. Those pieces of information or technology that provide the essential capability to be protected.

Security Vulnerability. The susceptibility of the system to the security threats in a given environment. Vulnerabilities possessed by the system's EPITS are based upon

a. How the EPITS are stored, maintained, or transmitted (e.g., electronic media, blueprints, training materials, facsimile, or modem)

b. How the EPITS are used (e.g., bench testing or field testing)

c. What emanations, exploitable signals, or signatures (electronic or acoustic) are generated by the EPITS or reveal them (e.g., telemetry, acoustic, or radiant energy)

d. Where the EPITS are located (e.g., program office, test site, contractor, or vendor)

e. What types of OPSEC indicators or observables are generated by program or system functions, actions, and operations involving EPITS

At the system level, the EPITS could be expressed by identifying the functions needing protection and the sensitivity of the information or technology to be protected. Some functions that may be included are mission-critical functions and classified components and data. There may be other functions unique to the system that should also be included. Generally, physical, electronic, and software threats are applicable. Within each of these broad threat groups are sub-groups, such as sabotage, espionage, and so forth. In a System Program Office, the collocated Acquisition Security representative or the Acquisition Security home office can assist in the identification process. Other organizations will have a comparable group that can provide assistance.

Significant threats exist when individuals have the opportunity to place or design a vulnerability into the system that could create an operational deficiency. As an example,

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software programs that sabotage the firing system could be installed during a system's development by disgruntled employees.

Operational physical protection requirements of the system will usually be defined by the warfighter (in the case of aircraft by Priority A, B, and C or other protective measures). This affords a certain level of security, but there may be subsystems or components that require a level of security beyond that provided for the system. As an example, consider classified unit identification data that is stored in computer software. An attack aircraft that runs a high risk of being captured in enemy territory represents one level of threat. A command and control aircraft that never leaves friendly airspace but whose crew requires access to the data to perform its mission represents a different level of threat. The disgruntled airman doing maintenance work on the flight line represents another.

All mission-critical functions will be identified and ranked through the life-cycle of the air system to include; the system/subsystem/ components, ground support equipment, system support, depot support/facilities, personnel, training, information, computer, communications, and operational security requirements as applicable, at the various locations to include manufacturing and test sites. The most realistic threats and associated air system vulnerabilities will be identified.

It may also be appropriate to identify specific countermeasures that represent the solutions to correct design deficiencies. While this may be vital, it is still important to describe them generically, if possible, to provide the developing contractor latitude in the final design solution. Countermeasures are the culmination of the risk management process. That is, once the threats and vulnerabilities are identified, the risk is analyzed and if considered significant, countermeasures are applied. There are a myriad of approaches to this. Everything from accepting the risk and doing nothing (applying no countermeasures) to spending a significant amount of money and time on one or several countermeasures. This is all decided in the analysis/trade-off process, always keeping in mind the importance of what is being protected and how critical it actually is.

Security measures (hardware, firmware, software, procedures, etc.) must be accredited and certified by appropriate Risk Acceptance Authority (RAA) and Designated Approval Authority (DAA) prior to its use. Each service has an agency to help with certification and accreditation, such as AFWIC. Often, the phrase Certification Official, is used in place of RAA and DAA. Usually, system security engineering requirements are accredited and certified, but the DAA or RAA will indicate what requirements need to be specified.

REQUIREMENTS LESSONS LEARNED (3.3.5)

The reprogramming flight line capability on the air vehicle enhances operational readiness but brings security more vividly into the picture. A previously unclassified function may now need security procedures and techniques to be included in the overall function design. An example is digital flight controls. Although the control laws may be unclassified, the effects of sabotage or inadvertently altered programs could have a catastrophic effect on the air vehicle. Thus, trusted software bases and accountability procedures may be warranted.

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3.3.6 System safety.

The air system, when performing the prescribed missions within the environments specified herein, shall have a cumulative risk hazard index (RHI) not greater than ____(1)________ for all identified hazards with individual risk hazard index values greater than ____(2)___. The identified hazards, each of which is comprised of the expected frequency of the hazard occurrence and the consequent loss of said occurrence, do not include those attributable to acts of war, combat, civil unrest and disorder. Nor do they include acts of nature except as specifically identified in the environments and missions delineated herein. The cumulative risk hazard index shall be the sum of the products of the frequency of occurrence and the consequence associated with each of the identified hazards, where such product value shall be as defined in table 3.3.6-I.

TABLE 3.3.6-I. Individual hazard risk indices.

	Hazard Frequency					
Hazard Consequence	___(F1)___	___(F2)___	___(F3)___	___(F4)___	___(F5)___	___(F6)___
____(C1)____						
____(C2)____						
____(C3)____						
____(C4)____						
____(C5)____						

Hazard Consequence. The following consequence definitions shall be used to quantify identified hazards:

C1: ____(C1D)____
C2: ____(C2D)____
C3: ____(C3D)____
C4: ____(C4D)____
C5: ____(C5D)____

Hazard Frequency. The following hazard frequency definitions shall be used to quantify identified hazards:

F1: ____(F1D)____
F2: ____(F2D)____
F3: ____(F3D)____
F4: ____(F4D)____
F5: ____(F5D)____
F6: ____(F6D)____

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REQUIREMENT RATIONALE (3.3.6)

This requirement establishes the overall air system safety requirement.

REQUIREMENT GUIDANCE (3.3.6)

Define the consequence and frequency criteria specified in table 3.3.6-I, to be appropriate to the extent and nature of the air system. Completion of the blanks in 3.3.6 will require determination of the acceptable loss by assessment of the cost of consequent losses resulting from hazards involved in the peacetime operation of the air system that can be tolerated. Such loss must be considered in the context of the effectiveness of said air system with respect to countering the threat to which the system responds. Given this assessment, the total acceptable loss less a subjective, semi-quantitative margin to account for all of the hazards (identified and not identified) that belong to the set of hazards of lesser consequence and frequency set in the value of blank 2 of 3.3.6 becomes the value of blank 1. The requirement is set in the context of the size of the operating fleet identified in blank 3.

Constructing table 3.3.6-I:

Table 3.3.6-I is a derivative of the content of similar tables in MIL-STD-882. Both the Hazard Consequences and Hazard Frequencies can be tailored as needed for a given program.

<u>Hazard Consequence</u>

For each row under the “Hazard Consequence” heading, identify a consequence criteria identifier. Suggested identifiers are

Blank C1: Catastrophic

Blank C2: Critical

Blank C3: Significant

Blank C4: Marginal

Blank C5: Negligible

Each of these identifiers will need to be defined. Definitions should include dollar criteria (financial consequence of a hazard occurrence), a human criteria (human consequence of a hazard occurrence, and environmental criteria (environmental consequence of hazard occurrence). Suggested criteria are

Catastrophic:

a. Dollar: loss of a capital asset or damage thereto and resources in excess of one million dollars (production acquisition value).

b. Human: injury to the public or the operator resulting in death or permanent disability.

c. Environmental: irreversible severe environmental damage that violates law or regulation.

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d. Combined (blank C1D): consequences shall be considered as any event that leads to loss of a capital asset or damage thereto and resources in excess of one million dollars (production acquisition value) or injury to the public or the operator resulting in death or permanent disability or irreversible severe environmental damage that violates law or regulation.

Critical:

a. Dollar: capital equipment or resource loss or damage of less than one million dollars but more than $250,000.

b. Human: one or more injuries that result in partial disability.

c. Environmental: reversible environmental damage causing a violation of law or regulation.

d. Combined (blank C2D): consequences include those that result in capital equipment or resource loss or damage of less than one million dollars but more than $250,000 and/or resulting in one or more injuries that result in partial disability or reversible environmental damage causing a violation of law or regulation.

Significant:

a. Dollar: capital equipment and resource loss or damage of less than $250,000 and more than $100,000.

b. Human: personal injury, or injuries, resulting in temporary partial or complete disability of greater than fifteen (15) days.

c. Environmental: mitigable environmental damage causing a violation of law or regulation.

d. Combined (blank C3D): consequences include those that result in capital equipment and resource loss or damage of less than $250,000 and more than $100,000 or personal injury, or injuries, resulting in temporary partial or complete disability of greater than fifteen (15) days or mitigable environmental damage causing a violation of law or regulation.

Marginal:

a. Dollar: capital equipment and resource loss or damage of less than $100,000 and more than $10,000.

b. Human: personal injury, or injuries, resulting in temporary disability of less than fifteen (15) days and more than one (1) lost day.

c. Environmental: mitigable environmental damage without violation of law or regulation where restoration activities can be accomplished.

d. Combined (blank C4D): consequences include those that result in capital equipment and resource loss or damage of less than $100,000 and more than

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$10,000 or personal injury, or injuries, resulting in temporary disability of less than fifteen (15) days and more than one (1) lost day or mitigable environmental damage without violation of law or regulation where restoration activities can be accomplished.

Negligible:

a. Dollar: capital equipment and resource loss or damage of less than $10,000.

b. Human: personal injury, or injuries, resulting in first aid requirements and one (1) or less days lost to disability.

c. Environmental: minimal environmental damage not violating law or regulation.

d. Combined (Blank C5D): consequences include those that result in capital equipment and resource loss or damage of less than $10,000 and personal injury, or injuries, resulting in first aid requirements and one (1) or less days lost to disability or minimal environmental damage not violating law or regulation.

Hazard Frequency

There are two options for hazard frequency, either a probability of occurrence or rate is used. The safety community normally uses a probability of occurrence. If an absolute rate is used (for example, in the context of 10 occurrences per year) then an operating fleet size condition will need to be included in the requirement such as, "For the purposes of this requirement, the operating fleet size shall be assumed to be ________."

Suggested identifiers for the row beneath "Hazard Frequency" are

Blank F1: Frequent

Blank F2: Probable

Blank F3: Occasional

Blank F4: Unlikely

Blank F5: Remote

Blank F6: Improbable

Each of these identifiers will need to be defined. An understanding of individual events and likely impacts across the fleet will be needed. Further, these can be directly applied to the service life (see 3.3.1.2) of the items.

Frequent:

Blank F1D: includes all hazards likely to occur often in the life of an item with a probability of occurrence greater than 0.1 in that life for an air system operated in accordance with the operational scenarios and missions as defined herein.

Probable:

Blank F2D: includes all hazards that will occur several times in the life of an item with a probability of occurrence less that 0.1 but greater than 0.01 in that life for an air system operated in accordance with the operational scenarios and missions as defined herein.

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Occasional:

Blank F3D: includes all hazards that are likely to occur some time in the life of an item with a probability of occurrence less than 0.01 but greater than 0.001 in that life for an air system operated in accordance with the operational scenarios and missions defined herein.

Unlikely:

Blank F4D: includes all hazards that are unlikely but possible to occur in the life of an item with a probability of occurrence less than 0.001 but greater than 0.0001 for an air system operated in accordance with the operational scenarios and missions defined herein.

Remote:

Blank F5D: includes all hazards that are unlikely but possible to occur in the life of an item with a probability of occurrence less than 0.0001 but greater than 0.000001 for an air system operated in accordance with the operational scenarios and missions defined herein.

Improbable:

Blank F6D: includes all hazards that are so unlikely it can be assumed occurrence may not be experienced with a probability of occurrence less than 0.000001 in that life for an air system operated in accordance with the operational scenarios and missions defined herein.

Example of consequence and frequency weighted categories for risk indices table:

TABLE 3.3.6-II. Individual hazard risk indices – weights assigned.

	Hazard Frequency					
Hazard Consequence (Weight)	**Frequent (6)**	**Probable (5)**	**Occasional (4)**	**Unlikely (3)**	**Remote (2)**	**Improbable (1)**
Catastrophic (5)	**6 X 5 =30**					
Critical (4)						
Significant (3)						
Marginal (2)						
Negligible (1)						

Each category of hazard consequence and frequency is assigned a weight. The product of row weight times column weight provides a quantifiable measure that can be verified.

A filled-in example of the table and definitions follows.

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TABLE 3.3.6-III. Individual hazard risk indices - filled-in example.

	Hazard Frequency					
Hazard Consequence	**Frequent**	**Probable**	**Occasional**	**Unlikely**	**Remote**	**Improbable**
Catastrophic	30	25	20	15	10	5
Critical	24	20	16	12	8	4
Significant	18	15	12	9	6	3
Marginal	12	10	8	6	4	2
Negligible	6	5	4	3	2	1

Hazard Consequence. The following consequence definitions will be used to quantify identified hazards:

Catastrophic consequences shall be considered as any event that leads to loss of a capital asset or damage thereto and resources in excess of one million dollars (production acquisition value) or injury to the public or the operator resulting in death or permanent disability or irreversible severe environmental damage that violates law or regulation.

Critical consequences include those that result in capital equipment or resource loss or damage of less than one million dollars but more than $250,000 and/or resulting in one or more injuries that result in partial disability or reversible environmental damage causing a violation of law or regulation.

Significant consequences include those that result in capital equipment and resource loss or damage of less than $250,000 and more than $100,000 or personal injury, or injuries, resulting in temporary partial or complete disability of greater than fifteen (15) days or mitigable environmental damage causing a violation of law or regulation.

Marginal consequences include those that result in capital equipment and resource loss or damage of less than $100,000 and more than $10,000 or personal injury, or injuries, resulting in temporary disability of less than fifteen (15) days and more than one (1) lost day or mitigable environmental damage without violation of law or regulation where restoration activities can be accomplished.

Negligible consequences include those that result in capital equipment and resource loss or damage of less than $10,000 and personal injury, or injuries, resulting in first aid requirements and one (1) or less days lost to disability or minimal environmental damage not violating law or regulation.

Hazard Frequency. The following frequency of hazard definitions will be used to quantify identified hazards:

Frequent includes all hazards that are likely to occur often in the life of an item with a probability of occurrence greater than 0.1 in that life for an air system operated in accordance with the operational scenarios and missions as defined herein.

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Probable includes all hazards that will occur several times in the life of an item with a probability of occurrence less that 0.1 but greater than 0.01 in that life for an air system operated in accordance with the operational scenarios and missions as defined herein.

Occasional includes all hazards that are likely to occur some time in the life of an item with a probability of occurrence less than 0.01 but greater than 0.001 in that life for an air system operated in accordance with the operational scenarios and missions defined herein.

Unlikely includes all hazards that are unlikely but possible to occur in the life of an item with a probability of occurrence less than 0.001 but greater than 0.0001 for an air system operated in accordance with the operational scenarios and missions defined herein.

Remote includes all hazards that are unlikely but possible to occur in the life of an item with a probability of occurrence less than 0.0001 but greater than 0.000001 for an air system operated in accordance with the operational scenarios and missions defined herein.

Improbable includes all hazards that are so unlikely it can be assumed occurrence may not be experienced with a probability of occurrence less than 0.000001 in that life for an air system operated in accordance with the operational scenarios and missions defined herein.

For example, using the example table 3.3.6-I as a basis, all hazards with a risk hazard index greater than 12, arbitrarily set as the value of blank 2 in this example, would be accumulated and established as the value of blank 1. This value (for blank 1) may be established as 100 hazards of average risk hazard index of 20 resulting in a specification value of 2000 in blank 1 for the air system.

Controlling air vehicle losses:

An air vehicle loss is a catastrophic event (capital asset in excess of $1M). The acceptable level of risk is generally measured in terms of losses per hundred thousand flying hours. Using an arbitrary planning factor of 5/100000hrs (the warfighters or force planners should make this estimate for the particular system), an average mission duration of 1 hour, a peacetime flying hour program of 20 missions/month, a service life of 20 years, and an operating fleet size of 500 air vehicles, “planned” losses would have approximately .21 probability of occurrence. This meets the criteria for “frequent” with a resulting risk hazard index of 30. A potential problem is that regardless of how high the acceptable risk factor gets, the hazard score never exceeds 30 for any given hazard. It may be prudent to also specify an acceptable loss rate for air vehicles.

REQUIREMENT LESSONS LEARNED (3.3.6)

Operators and maintainers of air systems must be capable of performing their job effectively in exceedingly challenging (i.e., stressful) environments. It is the developer’s responsibility to provide those operators and maintainers with equipment that is inherently safe and not rely on warnings, indicators, or additional training to achieve acceptably safe operating states. While this may not always be practicable, equipment operator intervention should be minimized, if not eliminated. To effect this, the system design practice(s) to preclude hazards should be in accordance with the following order of precedence:

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a. Eliminate hazards through design.

b. If a hazard cannot be eliminated, reduce mishap risk through the use of protective safety features or devices.

c. Incorporation of detection and warning capability to alert personnel of the hazard.

d. Incorporation of special procedures, including personnel protective equipment, and training.

3.3.6.1 Air vehicle noncombat loss rate.

The average air vehicle loss rate shall be not greater than ___(1)___ per flight hour. This rate includes air vehicle losses resulting from ground and in-flight operations as well as material and design related losses. The average air vehicle loss rate for materials and design causes shall be not greater than ___(2)___ per flight hour.

REQUIREMENT RATIONALE (3.3.6.1)

This requirement establishes the system loss rate per operating hour. Air vehicle loss rate is a key factor in determining the fleet buy size.

REQUIREMENT GUIDANCE (3.3.6.1)

Air vehicle losses due to noncombat causes are generally related to the type missions in which the air vehicle is intended to fly and, as a result, for which training is lacking. Planning factors generally reflect both the mission and number of engines. The warfighter and/or the service force planning organization can be an appropriate source of data. An air vehicle loss is any loss that is not economical to repair. Historical data and planning factors for air vehicle loss rate can be obtained from the Air Force Safety Center.

REQUIREMENT LESSONS LEARNED (3.3.6.1)

In past aircraft programs, a typical loss rate has been $6x10^{-5}$ per flight hour (blank 1). Losses due to material and design problems typically are $3x10^{-5}$ per flight hour (blank 2). These figures may be used as guidelines in determining system safety performance.

3.3.7 Stores and expendables lists.

This is a paragraph header facilitating document organization.

3.3.7.1 Weapons.

The system shall be capable of employing the weapons listed in table 3.3.7.1-I.

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TABLE 3.3.7.1-I. Weapons list.

Weapon Nomenclature	Variant Descriptors	Minimum Required Modes

REQUIREMENT RATIONALE (3.3.7.1)

This paragraph is used to identify the weapons that are part of the system.

REQUIREMENT GUIDANCE (3.3.7.1)

Complete the columns of the table as follows:

Weapon Nomenclature: List all of the weapons that the system must employ.

Variant Descriptor: Include any variant specific information that is pertinent.

Minimum Required Modes: Enter the weapon modes that must be employed by the system. If all available weapon modes must be employed, indicate by entering "All."

REQUIREMENT LESSONS LEARNED (3.3.7.1)

To Be Prepared

3.3.7.2 Sensor pods.

The system shall be capable of employing the sensor pods listed in table 3.3.7.2-I.

TABLE 3.3.7.2-I. Sensor pod list.

Sensor Pod	**Variant Descriptors**	**Minimum Required Modes**

REQUIREMENT RATIONALE (3.3.7.2)

This paragraph is used to identify the sensor pods that are part of the system.

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REQUIREMENT GUIDANCE (3.3.7.2)

Complete the columns of the table as follows:

Sensor Pod Nomenclature: List all of the sensor pods that the system must employ.

Variant Descriptor: Include any variant specific information that is pertinent.

REQUIREMENT LESSONS LEARNED (3.3.7.2)

To Be Prepared

3.3.7.3 Cargo.

The system shall carry and deliver the cargo types listed in table 3.3.7.3-I.

TABLE 3.3.7.3-I. Cargo list.

Cargo Type	Cargo Descriptors

REQUIREMENT RATIONALE (3.3.7.3)

This paragraph is used to identify the types of cargo that must be delivered by the system.

REQUIREMENT GUIDANCE (3.3.7.3)

Complete the columns of the table as follows:

Cargo List: List all of the types of cargo that the system must deliver.

Cargo Descriptor: Provide the necessary descriptive detail to further identify the cargo types. This information can include pallet sizes, weights, volume, etc.

REQUIREMENT LESSONS LEARNED (3.3.7.3)

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3.3.7.4 Other stores.

The system shall be capable of employing the stores listed in table 3.3.7.4-I.

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TABLE 3.3.7.4-I. Other stores list.

Store Nomenclature	Variant Descriptors	Minimum Required Modes

REQUIREMENT RATIONALE (3.3.7.4)

This paragraph is identifies stores, other than weapons, stores, and cargo, that are part of the system.

REQUIREMENT GUIDANCE (3.3.7.4)

Complete the columns of the table as follows:

Store Nomenclature: List all of the stores, other than those listed in 3.3.7.3.1 through 3.3.7.3.3, that are part of the system.

Variant Descriptor: Include any variant specific information that is pertinent.

REQUIREMENT LESSONS LEARNED (3.3.7.4)

To Be Prepared

3.3.8 System usage information collection and retrieval.

The system shall be capable of collecting, storing and using real-time information on the use of the system and the conditions it experiences. For the item(s) identified, the functionality to be provided for operational, support, and other uses (such as accident investigations); the minimum information characteristics required; and the performance characteristics of that information shall be as specified in table 3.3.8-I. Additionally, special security provisions for the information/equipment, information/equipment retrieval performance/characteristics (including compatibility requirements with infrastructure equipment and information processing systems) and any other relevant conditions shall be as specified in table 3.3.8-I.

TABLE 3.3.8-I. System usage information collection and retrieval.

Item	Functionality (Purpose)	Information Characteristics	Performance Characteristics	Security	Retrieval Performance/ Characteristics	Conditions

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REQUIREMENT RATIONALE (3.3.8)

System usage information can be used for a wide variety of operational, support, and other purposes. These purposes may reflect

a. Information collected to support air operations such as battle damage assessment (e.g, "gun camera" or bomb impact video) and threats encountered to support planning of future missions.

b. Information collected to provide accurate data on environments experienced by the system to assist in redressing aging, stress, strain, thermal and other impacts that effect the reliability/durability of the item. Usage information can also be used to provide maintainers with sufficient information to ascertain the cause of equipment degradation and the operability of items to enable rapid maintenance actions and minimize equipment downtime.

c. Information collected on flight conditions and flight critical equipment operating states to enable identification of accident sources during mishap investigations. Sufficient information to ascertain the cause of the problem may enable corrective actions to preclude future flight mishaps.

Application of this requirement might result in a flight data recorder (or other such mechanism), a gun camera, a fatigue monitoring system, etc.

REQUIREMENT GUIDANCE (3.3.8)

Fill out table 3.3.8-I as follows: (Note: most the guidance relates to air vehicles since they provide easy examples; however, if there is a requirement to generate and store usage history information, application to other equipment such as flight simulators and high value/specialized/complex support equipment can be included as well.)

<u>Item</u>: Identify the item that must have the capability to collect and store usage information. Typically, this will be the "Air Vehicle" however, complex, costly, and/or safety critical items may be included as well (for example, a flight simulator). Enter the item as many times as needed to fully capture the information needed and its purpose. For example, "Air Vehicle" may be entered a number of times including for mishap investigations and for durability of big ticket, critical items such as aircraft structures.

<u>Functionality (purpose)</u>: Define the functionality to be obtained. This may also be expressed as the purpose (or reason why) the information is to be collected. It can be simply stated and is intended to provide a scope for the information for the information needed. Examples could be "Battle damage assessment," "monitor mission-critical subsystem performance," "identify threat locations for mission planning," "support accident cause determination."

<u>Information characteristics</u>: This parameter is optional. Use it to specify the minimum information characteristics needed. If used, it should either be complete or include a statement such as "and other relevant information." Sometimes, our historical experience provides considerable knowledge on what is important to accomplish various functions (such as accident investigations). Other times, it is preferable to rely on the functionality and performance characteristics. Care is needed. Information

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characteristics coupled with the functionality and performance characteristics can lead to additional capabilities (and expense) that may not be needed. For example, is it essential that threat location be established to a given accuracy or do we just want the information collected by a radar warning receiver at accuracies necessary for the system to meet its other requirements. Specify the type of information needed. For example, "operating state of flight critical equipment and flight operating conditions" may be needed to ascertain the cause of a mishap. Observed performance (such as "g-force" history) may be necessary for continuous assessment of system integrity. Encountered threat characteristics can be stored for future mission planning use.

Performance characteristics: Performance characteristics should address the capacity of the information to be stored, the frequency at which it is stored, the volatility of the information (see below), and other information such as accuracy. The performance characteristics can introduce additional capabilities, such as sensors, into the system. For example, "full weapon flight tracking from launch to flight termination plus 5 seconds on permanent media capable of 10 X enlargement without apparent image degradation" may communicate to some that a motion picture camera with high resolution film is necessary.

Volatility characteristics: Describes the storage performance for the information and how long it needs to be retained. It may be necessary to subcategorize the information parameter and express the volatility for each subcategory. Further, it may be necessary to break out conditions for volatility. For example, if the information is "flight conditions and operating status and states of flight critical items" with a functionality of "ascertain cause of mishap" for an air vehicle, cockpit voice information may only be needed for the last XX minutes of flight, but the operating states and status of flight critical equipment may be needed for the last YY minutes of flight. It may be required to retain all the information for a given set of information for the duration of the entire mission. Another condition to consider is where does the event occur. For example, if the mishap were to occur over threat territory, the volatility parameter can include a condition that this recorded information be erased on operator command. This can be used, in general, to protect sensitive information.

Security: Identify any special security requirements for information storage and retrieval for each condition of storage and retrieval experienced. Normally, the security requirements will be dictated by the information (and may be covered elsewhere in the specification). Other times, due to the type of performance required, additional equipment/capabilities will be necessary. For example, suppose it is desirable to generate and store the characteristics of encountered threats. There may need to be once set of security requirements for the information storage device itself, another for how the information is used in-flight, and still another if the information is to be passed to other air vehicles or equipment during the conduct of the mission.

Retrieval performance/characteristics: This parameter covers a wide range of possibilities. For example, if the operating performance of on-board equipment were being collected to ascertain the experienced equipment performance (i.e., for system integrity purposes), the retrieval characteristics may include maintenance data collection systems. If the information is related to mishap analyses, there may be multiple entries that address retrieval of a crash survivable storage device (visual, aural, and/or electromagnetic signals, beacons) as well as the retrieval of the information itself (which may include data formats and/or equipment interfaces). If information is to be passed

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from the air vehicle to an external receiver, identify the receiver and appropriate characteristics of the physical and functional interface. Where possible use performance terminology ("crash survivable and locatable") and/or identify the interface ("compatible with the XXX maintenance data collection system") with a reference to the appropriate interface in 3.2, Interfaces)

Conditions: Identify any conditions impacting the requirement. For example, collecting and storing information comes at a cost. Some types of information may not be needed from every item built and cost can be avoided by not instrumenting every item. For example, if stress profiles are needed from every air vehicle, enter "every vehicle." If they are needed from a fraction of the aircraft to be built (such as from every other air vehicle) enter that fraction. Use whichever numeric designation makes the most sense.

REQUIREMENT LESSONS LEARNED (3.3.8)

To Be Prepared

3.3.9 Human systems.

The air system shall be capable of meeting the requirements specified herein when operated by _______(1)______ and maintained by ______(2)_______ in the environments specified in _____(3)________.

REQUIREMENT RATIONALE (3.3.9)

Both the populations (including population characteristics) and operating environments/ conditions for crews operating and maintaining the system must be established to enable the definition and design of a system that can perform its intended functions. This affects the placement of components (size ranges), the weight of components (strength range of population), the education level to which technical manuals are written, endurance capabilities, crew accommodations, and so forth that must be designed into system products and services.

REQUIREMENT GUIDANCE (3.3.9)

Blanks 1 and 2 should define the anticipated operator and maintainer populations. Population characteristics include anthropometric with special attention to requirements, limitations, or allowances for physical attributes not normally characterized (for example, unusual expectations for human endurance, strength, etc.) as well as capabilities/attributes that can be characterized and selected from an allowed population that will limit/expand design options. Other pertinent population requirements/characteristics may include educational level. Blank 3 should define the anticipated environments in which the air system will be operated and maintained. These include the threat environments (see 3.1.1 Roles and missions), the natural and induced environments (see para 3.2 Environment) that can be handled by reference. Additional human operating environments should be specified here including, for example, acceptable crew environment requirements such as a "shirt sleeve" environments and self-contained crew rest/accommodation environments.

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Human engineering performance requirements are necessary to achieve mission success through integration of the human into the system, subsystem, equipment, facility and to achieve effectiveness, simplicity, efficiency, reliability, and safety of system operation, training, and maintenance. These areas shall include environment, anthropometry, maintainability, and operability. Environment considers life support and emergency escape/egress for the operator as well as protection for both the operator and maintainer. Anthropometry includes body size ranging for both operator and maintainer. Maintainability covers the ability of the maintainer to work effectively and efficiently to provide an operable system. Operability includes controls and displays and their interaction to enable the operator to perform the intended mission.

REQUIREMENTS LESSONS LEARNED (3.3.9)

To Be Prepared

3.4 Interfaces.

The system shall operate as a self-contained unit or in concert with same service forces, multi-national military forces, other service forces, and/or national assets as identified in the table below. The system shall meet the interface requirements identified in table 3.4-I.

TABLE 3.4-I. Interface requirement matrix.

Country, Organization, Service, Agency	Operational	Support	Training	C4ISR	Inter-operability*	Trans-portation	Mapping, Charting, and Geodesy

*Specification developers shall refer to the most recent version of JTA, Aviation Domain, for mandated interoperability requirements.

REQUIREMENT RATIONALE (3.4)

Air systems may operate in concert with same service forces, multi-national military forces, other service forces, and/or national assets. In such situations it is crucial that the system operate successfully with the respective operational systems, support equipment, training systems, C4ISR assets, mission planning systems and data, encryption information/codes and other assets or services required to deploy and operate.

REQUIREMENT GUIDANCE (3.4)

A system's interfaces include assets and processes that the system must operate with in order to achieve its requirements. For example, in supporting a system there are

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interfaces not only to "common" support equipment that are selected for use and deployed with the unit but also to the support process(es) that may include transportation of malfunctioning items to and from the depot or other location/agency responsible for the repair/refurbishment of the items. While we may expect a system to operate successfully in combat for some period of time utilizing resources from the spares kit deployed with the unit, sustaining operations beyond that point requires infrastructure, or other, support and transportation assets to maintain the flow of parts, consumables and expendables. The developing contractor may not be responsible for services provided by the military infrastructure, such services may impose additional constraints on successful operations. For example, consider a situation in which spares can be transported within constraints imposed by operational deployment requirements, but planned transportation assets beyond the initial deployment are limited. Inability to move broken items between an operating location and a designated repair location may be a driving factor in the reliability and maintainability of the system. That is, the design solution may be different for a system assumed to have an unlimited source of supply than for one whose supply pipeline is limited. In order to effectively impact the solution, the interface requirements and constraints must be defined. Where (and how) the system being developed directly fits within the overall architecture of the force provides a definition of the boundary conditions (interfaces) needed for successful operations, support, training, and so forth. While the developing contractor may not be responsible for the other assets and services, these may impose requirements and constraints that impact the solution.

The table format is intended to provide a single reference point from which interface areas can be identified and correlated to specific requirements. In the "Country, Organization, Service, Agency" column of the table enter the appropriate countries, organizations, services or agencies for which interface requirements exist. Examples of valid entries: "NATO," "Mexico," "CIA," "Israel," etc.

In the proper table cell, enter a letter or some other designator to identify a specific requirement. It is possible that a cell may have more than one and may have several designators.

An example of the table is shown below

Country, Organization, Service, Agency	**Operational**	**Support**	**Training**	**C4ISR**	**Inter-operability**	**Trans-portation**	**Mapping, Charting, and Geodesy Support**
NATO		a		b, c			

The meaning of each column header follows:

<u>Operational</u>: Include requirements to use, or integrate with, other operational assets. Examples would include the type of ship for carrier operations and other systems that

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designate/guide weapons launched from an air vehicle (such as one helicopter guiding a weapon launched from another) or vice versa.

Support: Include any requirement to use support equipment other than that developed as part of the system. This includes support equipment from other services, NATO, or other nations. The specific requirement should identify the level of use of these other support systems. For instance, a system may be required to use existing NATO refueling and weapon loading equipment.

Training: This area refers to any requirement to use other than Air Force training systems, however if interface requirements to Air Force training assets are not included in the Training Section of this document, those requirements should be identified here. Valid training interface requirements include identifying foreign pilots/operators that must be trained, as well as other service or nation training that must be used

C4ISR: Refers to Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance requirements. This area refers to a large interface area and will likely include a large number of specific requirements. The system specification shall include a system description, employment concept (including targeting, battle damage assessment, and bomb impact assessment requirements), operational support requirements (including C4ISR, testing, and training), interoperability and connectivity characteristics, management, and scheduling concerns.

Interoperability: Refers to 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 and to the condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. Examples of achieving some degree of interoperability would include the ability of US air combat fighters to employ allied weapons, or ability to use fuels and lubricants that allied forces use at their bases.

> The DoD Joint Technical Architecture (JTA) is a key piece of DoD's overall strategy to achieve a seamless flow of information quickly among DoD's sensors, processing and command centers, and shooters. System specification developers evaluate JTA standards and guidelines and establish program-specific information interface requirements to achieve the interoperability needed for quick, seamless information flow across the DoD warfighter battlespace.

Mapping, Charting, and Geodesy Support: Refers to cartographic materials, digital topographic data, and geodetic data needed for system employment. Where possible, Defense Mapping Agency standard military data should be used.

Transportation: This requirement should define the methods intended for use in transportation of various elements of the air system.

Below the table, list the specific requirement associated with the identifier. Examples are provided below:

a. The system shall be capable of exploiting existing support equipment and facilities at all NATO member main operating bases as available and necessary to accomplish its roles and missions.

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b. The system shall include communication modes and frequencies as necessary to operate with the forces of the Mexico.

c. The system shall be capable of communicating with all US Navy aircraft, ships, and installations in both secure and unsecured modes.

The column headers identify typical areas of interface, but may not include all interface areas. If an interface area is identified that is not included in the table, include as many additional columns as necessary to capture all interface needs.

It may be preferable to express the interface requirements differently. For example, by breaking out individual paragraphs for each class of interface (e.g., a support paragraph, a C4ISR paragraph etc.) or breaking out individual paragraphs for each interfacing item or service. Item-by-item paragraphs are useful when the interface deals with a limited, but specific, set of operating modes/conditions. The choice of format for the program-specific system specification should be driven by the need to communicate the requirements completely and to ensure that all the elements of the interface are appropriately verified.

REQUIREMENT LESSONS LEARNED (3.4)

To Be Prepared

3.4.1 Support interfaces.

This is a paragraph header facilitating document organization.

3.4.1.1 Supply support.

The system shall be compatible with the ____(1)____ supply support infrastructure.

REQUIREMENT RATIONALE (3.4.1.1)

The supply support function addresses all management actions, procedures, and techniques used to determine requirements to acquire, catalog, receive, store, transfer, issue, and dispose of secondary items, including provisioning for initial support as well as replenishment supply support. This includes identification of the functional and physical interfaces between the air system and all support system elements. The clear determination and execution of system supply support requirements is required for affordable system sustainment because the proliferation of unique supply items increases life cycle costs and puts unacceptable additional demands upon the supply system.

REQUIREMENT GUIDANCE (3.4.1.1)

Supply support requirements include any requirements that must be imposed to make the air system compatible with the existing supply system in order to minimize the costs of operations and maintenance. All interfaces between the air system and the support system must be identified. Detailed quantitative interfaces are described in lower-tier specifications and Interface Control Documents (ICDs). Supply support requirements

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should identify interface requirements between the air system and the total support system. Items to address include

a. Design to minimize demands on the supply system (i.e., reduce life cycle cost) by use of modular designs, on-condition repair concepts, reduction of secondary failures, and an appropriate balance between on- and off-equipment maintenance.

b. Introduction of a new item into the supply system and method of supply/resupply of all items shall not require development of additional supply systems or reporting procedures.

The supply support infrastructure is getting more complex with the increase in use of commercial items and services in DoD systems. In blank 1, describe the supply support infrastructure. Suggested wording includes “organic,” “contracted,” “commercial,” or “combination of ...” with appropriate clarifying information.

REQUIREMENT LESSONS LEARNED (3.4.1.1)

To Be Prepared

3.4.1.2 Facility interfaces.

The system shall be capable of interfacing with the facilities identified in table 3.4.1.2-I.

TABLE 3.4.1.2-I. System/facility interfaces.

Facility	Functional Capability	Status	Facility Description (Compatibility Requirements)

REQUIREMENT RATIONALE (3.4.1.2)

Facilities include all permanent or semi-permanent real property assets required to support the air system consistent with the operational and support concept. Facilities would include a structure, building, utility system, or pavement and underlying ground at a testing, training, operating or support location.

Facilities can either be system specific, in which case their requirements are typically defined in the support system segment (or lower), or are a part of the infrastructure with which that the system must be compatible. In the case of infrastructure, facilities can represent existing assets or they can be planned/in-development assets. For example, if a new air vehicle needs to be housed in a hangar, an existing hangar (for example a TAB-V) might be suitable; or, if the air vehicle is unusually large or demanding of a

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special environment, a new type of hangar might be defined, designed, and built. Typically, permanent structures are not part of an air vehicle development program even if they are deemed necessary for proper maintenance, training, and use. Permanent structures are normally handled as military construction items and become part of the infrastructure. In the case of existing structures (e.g., the TAB-V shelter), a requirement to house an air vehicle imposes strict dimensional (and other) restrictions on the design of the air vehicle. If a new type of shelter were to be needed, the air vehicle developer would be constrained to work with the shelter developer to ensure that interface compatibility is achieved.

REQUIREMENT GUIDANCE (3.4.1.2)

Table 3.4.1.2-I is filled in as follows:

Facility: Identify the facility, preferably with its appropriate nomenclature.

Functional Capability: Identify the functionality realized by the system when using the facility (e.g., if the facility were an air vehicle shelter the functionality could include protection of the air vehicle and crews from the natural and threat environments).

Status: Identify whether this is an “Existing” facility with fixed interface requirements or a “Planned” facility for which interface compatibility must be defined.

Facility Description: Where possible, reference to an Interface Description or other documentation that appropriately characterizes the facility should be used. In cases of a planned facility, it may be necessary to provide the characteristics here. For example,

Size/dimensions

Type

Environmental Control (e.g., humidity, temp)

Environmental Impact

Life Expectancy

Access (e.g., size of hangar door)

Interface Requirements with installed equipment (e.g., power supply, hazardous materials capture and disposal)

Demilitarization/Disposal

Special Access Required/Classified Material Capability

REQUIREMENTS LESSONS LEARNED (3.4.1.2)

To Be Prepared

3.4.1.3 Common support equipment.

The system shall be capable of interfacing with the common support equipment identified in table 3.4.1.3-I.

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TABLE 3.4.1.3-I. System/common support equipment interfaces.

Common Support Equipment	Functional Capability	Status	Common Support Equipment Description (Compatibility Requirements)

REQUIREMENT RATIONALE (3.4.1.3)

The SE requirement maximizes system support while minimizing costs. This is accomplished by making the right SE available at the right time with a complete support structure. Common support equipment further mitigates costs by enabling multiple air vehicle systems to use the same item. This is particularly valuable when space is constrained (for example on an aircraft carrier) or when multiple types of air vehicles are bedded down at the same location.

REQUIREMENT GUIDANCE (3.4.1.3)

Table 3.4.1.3-I is filled in as follows:

Common Support Equipment: Identify the common support equipment, preferably with its appropriate nomenclature.

Functional Capability: Identify the functionality realized by the system when using the common support equipment (e.g., refueling or weapons loader).

Status: Identify whether this is an existing common support equipment with fixed interface requirements or a planned common support equipment, for which interface compatibility must be defined.

Common Support Equipment Description: Where possible, reference to an interface description or other documentation that appropriately characterizes the common support equipment should be used. In cases of planned common support equipment, it may be necessary to provide the characteristics here. For example,

Deployability of SE

Calibration

R,M&A of SE

Physical Characteristics (weight, size, etc.)

Environmental Operating Conditions

Logistics Support of SE

Interoperability

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REQUIREMENTS LESSONS LEARNED (3.4.1.3)

To Be Prepared

3.5 Manufacturing.

System products shall consistently provide performance that meets or exceeds the requirements stated herein throughout their usage modes and across intersystem and intrasystem interfaces.

REQUIREMENT RATIONALE (3.5)

Due to the critical nature of the functions they perform, air systems need to provide performance that warfighters can depend on. In other words, these systems need to work as expected when pressed into service. In order to achieve this predictable performance, it is important that each subsystem and individual part making up the system reliably performs its distinct function in concert with the rest of the system and related systems with which they interface. For example, consistent performance must be achieved from the radar, the air vehicle with which it interfaces, the support equipment used to maintain it, the people by whom it is maintained, and the training of the operators and maintainers. Performance must not only be achieved by the product, but also across its interfaces with other assets, both internal and external to the system; e.g., the interfaces to maintenance relies on both product to product and product to process interfaces.

As the need for greater performance of new systems has contributed to system complexity, the potential has increased for problems to arise. The result is that after-the-fact verifications of product do not provide the needed assurance of conformance to requirements, increasing the need for tools, practices, and management systems that will assure that key pieces of systems meet their individual performance requirements, including those related to interfaces. This is best accomplished by beginning with an understanding of system products -- the outputs of manufacturing processes -- and the effect each has on overall system performance.

Focusing on expected performance of the outputs of manufacturing processes enables the identification of those product characteristics that have the most influence on overall system performance. In order to communicate these important features of the process outputs to those who can influence their outcome, they should be separately identified through the use of a term such as "key product characteristic." This permits efforts in design, manufacturing, support, training, etc., to be placed where they will have the most influence on system performance. In other words, the focus should be on the key characteristics of the product rather than with all its characteristics (again, this provides consistency with the current performance based business environment).

After identifying key product characteristics, this requirement is intended to drive toward identification of the processes that most influence the outcome of the key characteristics (key processes) and the individual process parameters that most affect process performance. These key parameters should be measured and controlled to assure the process outputs will meet the requirements that will ultimately ensure system performance requirements are met. Variability reduction efforts should also focus on key

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characteristics and parameters because these provide the greatest opportunity to improve system performance.

As described, this requirement can have a significant influence in design and manufacturing (for example, variability reduction) in ensuring we do not export lack of discipline in system definition and development to the warfighter. While this has frequently been characterized as a manufacturing problem, manufacturing is simply the first place problems typically surface in this area. Fundamentally, the problem often originates in definition and design (design criteria inconsistent with manufacturing process capabilities, definition of product characteristics that do not adequately integrate support and training criteria, etc.). What needs to occur is for manufacturing process capabilities to be understood by both manufacturing and design personnel, and designs should consider these capabilities. The output of the design processes should be robust design -- i.e., the design of a system such that its performance is insensitive to variations during its manufacturing, or in its operational environment (including maintenance, transportation, and storage), and the system continues to perform acceptably throughout its life-cycle despite component drift or aging. When robustness cannot be achieved in a product design that will meet warfighter needs, variability reduction efforts should be used, as needed, to improve current manufacturing processes and/or to develop new processes.

REQUIREMENT GUIDANCE (3.5)

This requirement is generally applicable to any system. The requirement may be expanded to include design performance requirements that address robust design. Process variability reduction should also be considered as a useful tool in a continuous improvement environment to further improve system performance, reduce costs, etc.

REQUIREMENT LESSONS LEARNED (3.5)

The focus of efforts intended to assure consistent, predictable performance for a given product once relied heavily on acceptance test procedures -- after-the-fact verifications to try to test quality into systems. However, despite these efforts, history is replete with instances of development programs that experienced severe problems in production. Under these past practices, development was primarily oriented to the demonstration of product performance with little attention to the ability to consistently and predictably produce the required product characteristics in a cost-effective manner. In many cases, the product designs were completed and then turned over to manufacturing, who attempted to optimize the production implementation within existing plant capabilities. Little or no effort had been made during development to address producibility as part of the design process. In addition, process control is not a norm within the current aerospace industry. In many cases, therefore, process capability is not known, let alone matched to product requirements. Mismatches between design limits and process capabilities are discovered too late -- in real time under the pressure of delivery schedules. Resulting design or process changes are generally sub-optimal.

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3.6 Support.

The system shall provide the resources and peculiar infrastructure, as required, to restore and sustain the delivered performance of the air system elements when the system is operated and deployed as specified herein for the operational service life specified herein (see 3.3.1.2).

REQUIREMENT RATIONALE (3.6)

This paragraph provides a top-level support requirement. It addresses the two key elements of the support function: to fix what is broken and to maintain the originally delivered performance of the air system.

REQUIREMENT GUIDANCE (3.6)

Based on the amount of work done prior to application of the system specification on contract, additional elaboration may be appropriate on topics such as source of support (organic, contracted, combined), and so forth.

REQUIREMENT LESSONS LEARNED (3.6)

To Be Prepared

3.6.1 Maintenance concept.

The levels of maintenance for the air system shall be _____(1)____.

REQUIREMENT RATIONALE (3.6.1)

This paragraph provides a minimum top-level requirement for the system's maintenance concept. Based on the amount of work done prior to application of the system specification on contract, additional elaboration may be appropriate on topics such as maintenance-phasing, depot and regional repair centers and so forth.

REQUIREMENT GUIDANCE (3.6.1)

Blank 1 will normally identify the levels of maintenance allowed. Descriptions such as "2-level" or "3-level" can be ambiguous. Phrases such as "on-aircraft," "base-level off-aircraft," "regional repair," and "depot repair" should be used in appropriate combinations to communicate the needed concept. This information can be further clarified by identifying the source (organic, contracted, etc) for the maintenance. Additionally, this information can be communicated in a table format since the maintenance concept for the air vehicle may be different than the maintenance concepts for training systems or support equipment. For example,

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TABLE 3.6.1-I. Maintenance.

Equipment	Maintenance Concept	Remarks
Air Vehicle	• On-Aircraft • Depot Repair	Two depots (one in ______ that services engines from ______ and one in ______ that services engines from ______)
Training Systems	• Contracted, On-simulator repair • OEM "depot" repair	
Etc.		

Based on the amount of work done prior to application of the system specification on contract, elaboration may be appropriate on topics such as maintenance-phasing, depot and regional repair centers, use of preventive, time directed, and run-to-failure maintenance and so forth.

For example,

> Preventive and time-directed maintenance concepts, supplemented as necessary with functionality tracking/assessment and periodic inspections, shall be the basis for sustaining the delivered performance characteristics of mission and safety critical elements.

Examples of preventive maintenance are lubrication, or removing parts to perform some action such as removing deposits and then reinstalling the same part.

Time directed maintenance is the removal of functioning equipment and installing a new unit; as an example, aircraft engines are removed and replaced based on number of cycles, operating hours, etc., prior to a failure occurrence.

Functionality tracking (for example from an on-vehicle health monitoring system) is useful for those items that provide a performance response that can be recorded during actual use of the item (e.g., power from a power supply). Inspections are necessary for those items that do not provide such as response (e.g., structure).

Run-to-failure maintenance is efficient when failures will not cause human hazard or additional equipment damage and maintenance costs are relatively high

The system maintenance planning process develops and implements the maintenance concept to satisfy the desired user system operational employment and deployment requirements, and defines the related system or equipment maintenance technical requirements and design parameters. The developed maintenance plan also prescribes maintenance actions, intervals, and locations (including levels of repair and organizational responsibility for maintenance activities). The systems maintenance

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planning addresses technical data, equipment, facilities, spares, and repair parts for each significant item of the system, as well as personnel numbers and skills (see also 3.3.1.3). The maintenance planning process must address the flexible sustainment approach to effective system support. This includes key system quantitative reliability and maintainability attributes, the life/application cycle of the technology, relative cost values, total life-cycle cost, and system life-cycle management.

REQUIREMENT LESSONS LEARNED (3.6.1)

To Be Prepared

3.6.2 System capability and procedure information.

The system shall provide operators, maintainers, and trainers with relevant information regarding the capabilities and limitations of applicable portions of the system (equipment, procedures, and use). The information shall be provided in a form that enables realization of the full capabilities of the system in the environments and conditions of use of the equipment, procedures, and uses.

REQUIREMENT RATIONALE (3.6.2)

System capability and procedure information is normally provided in the form of technical orders/technical manuals (TOs/TMs). System capability and procedure information supports operation and maintenance of the system (air vehicle, associated ground stations and support equipment) by trained personnel. The instructions (whether contained on electronic or paper media) must be appropriate for each intended level of operation or maintenance. The operations and maintenance instructions must be interoperable with all interfacing prime mission and support equipment (SE) hardware and software. System capability and procedure information is normally developed and delivered in a digital format that is compatible with the Air Force integrated digital environment (IDE) and the digital data format selected for on- and off-equipment diagnostic data capture and recording. For system life-cycle management, supportability/sustainment analyses, and spare support, the proposed maintenance data collection system must be interoperable with digital format of operation and maintenance system capability and procedure information.

REQUIREMENT GUIDANCE (3.6.2)

Operation and maintenance instructions must be interoperable with all interfacing systems and support equipment as well as the Air Force IDE. System capability and procedure information development includes a) definition of the level at which they will be used (field, intermediate or depot); b) interfaces with other systems and equipment at each defined level; c) description of the digital data formats for creation and maintenance, delivery, presentation and archiving; and d) maintenance data collection system interface for each defined level. The resulting TOs/TMs are the only approved method for disseminating operation and maintenance information for centrally procured and managed air systems or equipment for use by organic personnel. The use of TO/TM instructions is mandatory. TO/TM format and content requirements are imposed by Technical Manual Specifications and Standards (TMSS) to make the air system interoperable with existing military or commercial TOs/TMs and support equipment to

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minimize operation, maintenance and sustainment costs. All interfaces between the air system and the TOs/TMs must be identified. Detailed qualitative and quantitative interfaces should be described in lower-tier specifications and interface control document (ICDs).

REQUIREMENTS LESSONS LEARNED (3.6.2)

System capability and procedure information is verified against production assets and delivered concurrently with fielding of the system to support organic operation, troubleshooting, repair, and maintenance of the system to meet the mission requirements. The resulting TOs/TMs are one of the most costly products purchased for support of the air system or equipment. While this is always recognized at some point in every program, planning for development, verification and delivery of TO/TM products is often poorly scheduled or integrated with system development and operational evaluation tasks. As a result, accuracy of TO/TM data may be poor and interface data may be improperly defined, requiring extensive correction and reverification. These factors increase the risk of successful program execution and will prevent Operational Safety, Suitability, and Effectiveness (OSS&E) Certification. Early development and use of TOs/TMs can assist in successful development of acceptance test procedures (ATPs) and support equipment hardware and software. These (and the system integrated diagnostics philosophy and capability) should all be developed concurrently. Past experience with serial development has led to operation and maintenance errors, incompatible software, rejection of good equipment, unacceptable rates of serviceable unit removal (retest OK – RTOK), and costly redesign. The ongoing transition from paper TOs/TMs to electronic maintenance aids and data systems must be carefully addressed in TO/TM and sustainment planning. Electronic formats for both prime system equipment, maintenance data collection and analysis systems, and SE must be interoperable. Finally, when procuring commercial technical data/manuals, compatibility with all of the above issues must be considered.

3.6.3 Protective structures.

The system shall provide protection of assets from the conditions to which they are exposed as described in table 3.6.3-I.

TABLE 3.6.3-I. Protection of assets.

Asset	Condition	Capabilities

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REQUIREMENT RATIONALE (3.6.3)

Many types of high value assets (e.g., people) have a low tolerance to continued exposure to adverse conditions (e.g., low temperatures, chemical/biological environment). Protective structures can mitigate the impacts of adverse conditions and improve overall combat effectiveness.

REQUIREMENT GUIDANCE (3.6.3)

In table 3.6.3-I

Asset: Identify the asset to be protected. For example, people, high explosives, consumables, air vehicles, etc.

Condition: Identify the condition that is the source of adverse effects. For example, "Arctic temperatures (^{o}C) and high winds (km/hr)," "chemical/biological environment (agent/density/duration)," "sand storm (wind speed and particulate density)," etc. The environments are based on the content specified in 3.2.

Capabilities: Define the required capabilities of the structure. For example, "environmentally controlled crew rest and mess capability," or "isolated decontamination and environmentally controlled crew rest capability," or "environmentally controlled air vehicle maintenance area," or "deployable air vehicle shelter."

REQUIREMENTS LESSONS LEARNED (3.6.3)

To Be Prepared

3.6.4 Packaging, handling, storage, and transportation (PHS&T).

System items shall be transportable by ____(1)___ modes of transportation in compliance with ____(2)____ for all assemblies, subassemblies, equipment, components and end items, including training and support equipment, except __(3)____. System items shall be capable of being packaged and shall be able to withstand ____(4)____ of storage of all assemblies, subassemblies, equipment, components and end items for worldwide shipments in accordance with ____(5)____.

REQUIREMENT RATIONALE (3.6.4)

This is required to minimize the cost of operation and maintenance and ensure supportability.

REQUIREMENT GUIDANCE (3.6.4)

PHS&T concept is developed during the design of deliverable equipment and included in follow-on contracts. Design requirements are based on; existing PHS&T capabilities and equipment, anticipated availability of handling and transportation equipment, anticipated storage conditions, and any other pertinent factors. Special considerations such as packaging and transportation of hazardous materials, electrostatic discharge items, and any item requiring special containers or special handling and transportation equipment

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shall be minimized. Availability of existing specialized containers or designs is determined through the DOD Container Design Retrieval System prior to designing new containers. If a transportability problem item, as defined in MIL-STD-1366, is identified, the material developer submits a Transportability Report in compliance with the applicable data item.

Blank 1: Identify the modes of transportation (e.g., rail, air transport, truck, etc.)

Blank 2: Incorporate the tailored provisions of MIL-STD-1366, Transportability Criteria. If the entire document is to be applied, simply cite the document.

Blank 3: Identify known exceptions

Blank 4: Identify the duration of storage, for example 5 years. This entry must be consistent with information specified on storage in the service life requirement, 3.3.1.2.

Blank 5: Incorporate the tailored provisions of MIL-STD-2073/1, DOD Standard Practice for Military Packaging. If the entire document is to be applied, simply cite the document.

REQUIREMENTS LESSONS LEARNED (3.6.4)

The existing Lessons Learned (see DOD Defense Acquisition Deskbook) are a source to help the procuring activities to make decisions about PHS&T concept application for a given program.

3.7 Training.

This is a paragraph header facilitating document organization.

3.7.1 Training capability.

The system shall provide the training necessary to ensure the personnel identified in tables 3.3.1.3-I, II, III, IV, & V have the knowledge, skills, and abilities to perform their operational, maintenance, support, training, and ___________ roles. Training rates shall support the demands for skilled people to accomplish unit start-up, personnel rotations, reassignment, attrition and other factors that affect the availability of skilled people to perform system tasks in order to fully exploit the performance of the system.

REQUIREMENT RATIONALE (3.7.1)

Trained personnel are critical for the successful employment of the air system. This introductory paragraph ties manpower requirements identified within the specification to the performance expectations of the system, thus providing the basis for partitioning and establishing more specific training system requirements.

REQUIREMENT GUIDANCE (3.7.1)

In the blank, identify any additional system roles that require trained personnel.

Most air system specifications include some mention of training requirements, however, many times such requirements are allocated directly to a trainer development

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specification with little thought given to how the entire air system can be employed to maximize training. When a need arises for support equipment, mission planning systems or aircraft systems to provide some function to the training system through an interface or in support of a curriculum, it is usually captured in a coincidental manner rather than a systematic analysis and consideration of the entire air system. This paragraph, along with its subordinate paragraphs, is the launching point for allocating training system requirements to all tier 2 specifications (or segments), including Training System, Support System, and Air Vehicle.

Therefore, ensure the personnel identified in the tables of 3.3.1.3 are complete to meet the performance defined in the spec and they adequately support the genesis of a sufficient training program. Should there be no manpower or personnel requirements defined elsewhere in the specification, then this paragraph should specify the number and, if appropriate, roles of Officer, Enlisted and Civilian specialties to be assigned to the air system.

REQUIREMENT LESSONS LEARNED (3.7.1)

To Be Prepared

3.7.2 Training types.

Trained personnel shall be capable of operating and supporting the air system to the performance levels defined herein. The system shall be capable of providing the following training: ___(1)___.

REQUIREMENT RATIONALE (3.7.2)

The scope of the training program is established through the type of system specific training defined here. System specific training requirements, at a top-level, serve to structure overall training expectations providing a departure point for establishing more detailed training curricula and equipment.

REQUIREMENT GUIDANCE (3.7.2)

In blank 1, identify the types of training to be used, such as

a. Initial Qualification: The training necessary to provide personnel the capability to safely operate, maintain and support the system.

b. Qualification: Training necessary to prepare personnel for deploying the system in the operational environment.

c. Continuation: Training to maintain the skills obtained during initial and unit training.

d. Mission Rehearsal: Training to practice specific operational plans.

e. Train the Trainer: The training necessary to qualify an initial cadre of personnel to provide training to the system operators, maintainers and supporters.

f. etc.

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REQUIREMENT LESSONS LEARNED (3.7.2)

To Be Prepared

3.7.3 On-equipment training.

The system shall accommodate _____(1)_______ on-equipment training capabilities. On-equipment training includes utilization of the system assets solely, utilizing the system assets in combination with dedicated training assets, and/or incorporating embedded training features into system assets to accomplish the necessary system training.

System assets shall be available for on-equipment training subject to the constraints in table 3.7.3-I.

TABLE 3.7.3-I. On-equipment training.

Equipment	Purpose of Training	Maximum Utilization

On-equipment training shall neither interfere with nor be detrimental to the availability of equipment and people necessary to support system availability, sortie generation, and other system utilization requirements, nor to the safe operation of the equipment.

Note: On-equipment training capabilities and use must be consistent with the system service life requirement (3.3.1.2).

REQUIREMENT RATIONALE (3.7.3)

On-equipment training capabilities can enhance operations and support training and accommodate concurrency of training devices, which, in turn, facilitates the accomplishment of specific training objectives. If all training were to be allocated to the tier 2 Training System Specification only, then it would be unnecessary to specify training requirements at the system level in this specification. However, it is typically advantageous to allocate training requirements throughout the entire system, since air vehicles and support systems may both present opportunities for efficient, effective and affordable training for both air crews and maintenance personnel. This paragraph addresses requirements for including specific capabilities into operational, support and training equipment. For example, a requirement that the air vehicle also serve as a simulator for maintenance training. A requirement for an air vehicle to have embedded capabilities for instrumented air combat training (ACMI).

This paragraph also identifies specific limitations on the time available for on-equipment training.

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REQUIREMENT GUIDANCE (3.7.3)

Using system assets for on-equipment training purposes necessitates careful consideration of the costs, penalties, and benefits incurred by such use. For example, using an operational air vehicle for maintenance training makes it unavailable for missions, consumes service life (e.g., wear and tear on fasteners and connectors as well as use of on-board power systems), and can result in induced failures requiring maintenance. At the same time, maintenance crews would have more time working on the real articles with increased proficiencies (e.g., reduced time to diagnose and rectify failures) an expected result. These types of trade-offs are conducted prior to establishing the system specification for an EMD contract to arrive at a cost-effective set of system requirements for on-equipment training.

Blank 1: Use this blank to specify the level of on-equipment training that is allowable in the system. There are nominally three conditions in which an asset can be used for on-equipment training.

a. The equipment could be made available just for practice. For example, use of an air vehicle to enable crews to “practice” removal and replacement of subsystems. The equipment itself would include no specific training features.

b. Some features to assist training could be incorporated. For example, an air vehicle could be “programmed” to simulate a given type of failure to enable a maintenance crew to train in both diagnosis and rectification of a given problem.

c. A training capability could be incorporated in system assets. For example, it may be deemed appropriate to embed mission rehearsal training in the air vehicle.

A wide range of specifics is possible; for example,

a. Specify any known mandated on-equipment and/or embedded training features here. For example, if engine reliability were high enough to preclude maintenance crews from staying current on removal/replacement of engines, then a requirement for on-equipment training (removal/replacement of good engines) may be appropriate. Also, a possible requirement for the air vehicle is to be able to simulate a failure for maintenance training purposes. While specific training requirements may not be known up front, it should be possible to define some basic and vital embedded features necessary to incorporate in the system requirements, for example OFP hooks/portability to simulators, support equipment training modes, mission planning system compatibility with simulator database generation systems, etc. Also, constraints to embedded training features can be included in this paragraph. If there are multiple on-equipment training requirements, a table format may better suited.

b. If no specific on-equipment training features are known but they are allowable or encouraged, due to life-cycle economics, then incorporate a generic or general statement. For example, “The system shall accommodate life-cycle economic on-equipment training features…”

c. If there are cases where no on-equipment or embedded training features are allowable, then so state here and delete the remainder of the requirement

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Table 3.7.3-I

Table 3.7.3-I can be used to constrain the amount of time system equipment can be used for training purposes.

Equipment: Enter the type of equipment such as “air vehicle,” “system peculiar support equipment,” “training devices,” etc.

Purpose of Training: Define the types of embedded training that are being constrained. For example, if the type of equipment is “air vehicle,” it may be prudent to constrain its use as a training device for “maintenance training.”

Maximum Utilization: Define the maximum percent of time that the equipment can be used for that training. The sum of the values for any given type of equipment would be the maximum allowed use of that item for on-equipment training purposes.

An example could be as follows:

TABLE 3.7.3-II. On-equipment training table example.

Equipment	Purpose of Training	Maximum Utilization
Air Vehicle	Maintenance Training	25%
Air Vehicle	Mission Rehearsal	10%
System Peculiar Support Equipment	Failure Simulation	30%
Training Devices	Train the Trainer	50%

This requirement should drive specific allocations in the tier 2 Air Vehicle and/or Support System specifications. Also, if on-equipment and/or embedded training features are utilized, impact on sortie generation, utilization, reliability, maintenance, and service life may be impacted and would need to be accommodated in the overall system design.

REQUIREMENT LESSONS LEARNED (3.7.3)

There are examples of training features embedded in air systems. Some are used interactively while in an operative mode, such as simulated threats that are connected into the avionics of the MH-53J IDAS/MATT and activated during flying training. Others are no more than "hooks" programmed into operational flight programs (OFPs) that allow use of the OFP in flight simulators, which is the case for the F-15 and the B-1B. A training-specific computer program transformed the electronic system test set for ALCMs & SRAMs into a training system for avionics technicians.

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3.8 Disposal.

The system and any portions of the system (components, parts, materials, etc.) shall provide for being permanently stored, salvaged, recovered, reused, recycled, demilitarized, and cannibalized, to the extent practicable. The system shall provide for the identification, isolation, and control of hazardous and radiological material to ensure personnel safety and environment protection.

REQUIREMENT RATIONALE (3.8)

Disposal encompasses the disposition of products and by-products that are no longer needed, no longer useful, no longer fit for use, the short and long term impact to the environment and health hazards to humans and animals as well as recycling, material recovery, salvage for reutilization, and demilitarization across the life cycle.

Certain portions of systems (normally either weapons [guns, bombs, explosive, etc.] or classified material) require demilitarization prior to resale or disposal. Other portions of the system require special handling to protect the environment or personnel safety. From some portions, strategic or precious materials can be recovered. Some portions can be recovered or salvaged for reuse. The objective of this requirement is to provide the basis for economical disposal of system assets.

> Demilitarization. The disposal resources, processes, procedures, design considerations, and methods necessary to ensure that military-peculiar attributes of system assets (such as explosives, whether in warheads or employed to effect performance of an item) can be deactivated (rendered harmless) or otherwise disposed of in an environmentally responsible manner.

REQUIREMENT GUIDANCE (3.8)

The degree to which the disposal aspects of the system need to be “designed in” is dependent on costs, benefits, and risks. The cost-benefit of ensuring that precious metals can be recovered from integrated circuit leads may be questionable, but the manpower and equipment costs to remove hazardous and radiological materials can be mitigated by smart design choices. Similarly, the risks involved in simply “throwing away” explosive and related materials outweigh the alternatives.

This requirement may be amplified in a number of ways. For example, a table identifying specific materials to be precluded from use in the system’s design or criteria to be used in defining quantities and thresholds for recovery of precious and strategic materials.

REQUIREMENT LESSONS LEARNED (3.8)

To Be Prepared

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4. VERIFICATIONS

NOTE: Verification information relating to each specific requirement will be addressed in later revisions.

The verifications established in section 4 for the requirements specified in section 3 are intended to result in a progressive, in-process verification of design maturity that will be consistent with key milestones of the Government Engineering and Manufacturing Development program schedule. The Incremental verification matrix (table 4-I) provides a cross-reference between the requirements and the associated method and timing of the verification. Measurand is a parameter that is measured in order to verify a required system or end item feature or characteristic.

TABLE 4-I. Incremental verification matrix.

Requirement \ Milestone	SRR/ SFR	PDR	CDR	FFR	SVR
3 Requirements					
3.1 Operations					
3.1.1 Roles & missions	A	A	A	*None*	A
3.1.2 Organization	IA	IA	AI	*None*	IA
3.1.3 Deployment & mobilization	A	A	A	*None*	A
3.1.4 Mission planning	A	A	A	*None*	A
3.1.5 System usage					
3.1.5.1 Peacetime operations					
*					
*					
*					
3.X.X.X	A	A	A	*None*	A

Note: Entries represent sample guidance for a representative portion of the section 3 requirements. Shaded cells identify section 3 paragraph titles that do not have associated verifications.

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The specification states the method to be employed in verifying that product performance complies with specified levels at the conclusion of the development effort. Incremental verification is intended to establish that the product design is maturing according to the plan profile established by the program as shown on figure 4-1 and that the required performance will be achieved at full maturity. As the product design matures, the fidelity of the incremental verifications improve and the uncertainty in the completed products performance decreases. Incremental verification methods and timing must not be defined or imposed in the performance specification, Rather, they are defined through other tools in the developer's toolbox. These tools include the statement of work, the Integrated Master Plan (IMP) or equivalent program management planning tool, the Test Evaluation Master Plan (TEMP) or verification plan, The Program Master Plan (PMP), and associated contract/program management processes. Acceptance criteria and supporting data should be documented in these tools, allowing effective evaluation of system performance maturity throughout the development program.

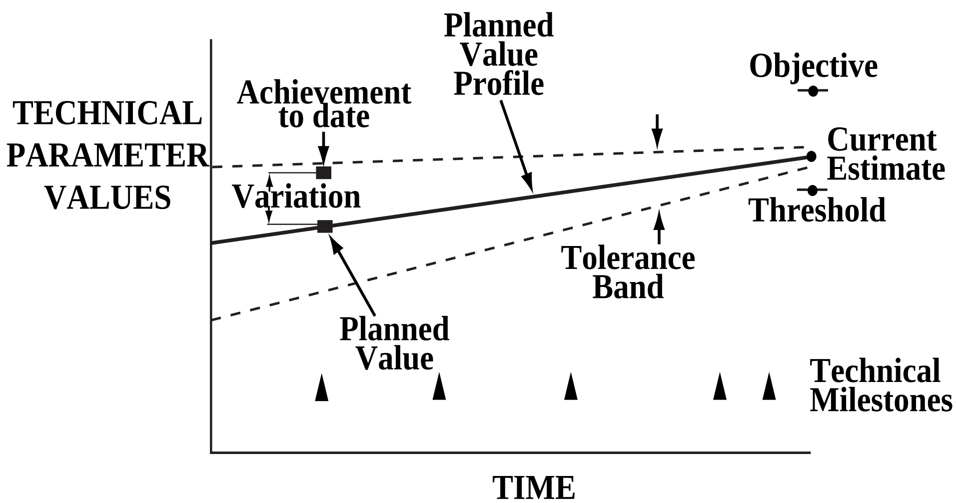

FIGURE 4-1. Example incremental verification profile.

Verification of compliance to requirements for complex systems constitutes a significant element of the development cost. As such, the procuring agency should solicit innovative, cost-effective verification methods from potential developers during source selection.

Tables 4-II and 4-III describe the milestones and verification methods used in table 4-I. See 6.3.31 for definitions of the verification methods and 6.4 for milestone definitions.

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TABLE 4-II. Milestones.

Milestone	Description
SRR/SFR	System Requirements Review/ System Functional Review
PDR	Preliminary Design Review
CDR	Critical Design Review
FFR	First Flight Review
SVR	System Verification Review

TABLE 4-III. Verification methods for the Air System specification.

Method	Description
I	Inspection
A	Analysis
S	Simulation
D	Demonstration
T	Test

Verification format example:

Section 4.X.X.X Verification:

Requirement Elements	Measurand	**SRR/SFR**	**PDR**	**CDR**	**FFR**	**SVR**

Verification Example- A single verification example in accordance with JSSG Integration Team Decision Paper 04 is included in the tier 2 Air Vehicle Specification Guide. The Terrain following/terrain avoidance requirement at tier 2 has been used to develop the JSSG verification process. This process will be used in developing representative verification examples that reflect the relationship of the tier 1 requirements as flowed down to tier 2.

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5. PACKAGING

5.1 Packaging requirements.

Packaging requirements ____(1)____.

REQUIREMENT RATIONALE (5)

Packaging requirements are specified in the contract or order. Normally, packaging items are not procured in a system-level specification, since

a. A system specification is functionally based and designsolution independent. As a result, neither product acceptance criteria nor acceptance test procedures are typically generated for the system specification.

b. Procurement of items requiring delivery (and as a result, packaging) are normally done against item specification.

c. A system specification governs development, including modifications and requalification.

If packaging is required, then a standard requirement (see guidance) is used.

REQUIREMENT GUIDANCE (5)

If packaging of an item is required, fill in blank 1 as follows:

> For acquisition purposes, the packaging requirements shall be as specified in the contract or order. When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

REQUIREMENT LESSONS LEARNED (5)

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful but is not mandatory.)

6.1 Intended use.

This Joint Service Specification Guide is intended to be tailored for the development of first-tier, program-unique performance specifications for DoD air systems.

6.2 Acquisition requirements.

Acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Issue of DoDISS to be cited in the solicitations, and if required, the specific issue of individual documents referenced (see 2.2.1, 2.2.2, and 2.3).

c. Packaging requirements (see section 5).

6.3 Definitions.

6.3.1 Asset.

Any item, service, or process, whether developmental, nondevelopmental, possessed, or procured. Frequently used interchangeably with “item.”

6.3.2 Availability (Ao).

A measure of the degree to which an item is in the operable and committable state when the mission is called for at any random point in time. Availability is dependent on reliability, maintainability, and logistics supportability.

6.3.3 Battle damage assessment.

The timely and accurate estimate of damage resulting from the application of military force, either lethal or non-lethal, against a predetermined objective. Battle damage assessment can be applied to the employment of all types of weapon systems (air, ground, naval, and special forces weapon systems) throughout the range of military operations. Battle damage assessment is primarily an intelligence responsibility with required inputs and coordination from the operators. Battle damage assessment is composed of physical damage assessment, functional damage assessment, and target system assessment. Also called BDA. *(Joint Pub 1-02, 15 Apr 98)*

6.3.4 Computer resources.

System computer hardware, system computer software/firmware, and computer resources support subsystems.

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6.3.5 Evolutionary acquisition.

An adaptive and incremental strategy applicable to high technology and software intensive systems when requirements beyond a core capability can generally, but not specifically, be defined.

6.3.6 Full mission capable.

Material condition of an aircraft or training device indicating that it can perform all of its missions. Also called FMC. See also mission capable; partial mission capable; partial mission capable, maintenance; partial mission capable, supply. *(Joint Pub 1-02, 15 Apr 98)*

6.3.7 Growth.

The inclusion of physical and/or functional characteristics/provisions that enable expansion or extension of the system's capability with minimum disruption of the system design.

6.3.8 Imagery intelligence.

Intelligence derived from the exploitation of collection by visual photography, infrared sensors, lasers, electro-optics, and radar sensors such as synthetic aperture radar wherein images of objects are reproduced optically or electronically on film, electronic display devices, or other media. Also called IMINT. *(Joint Pub 1-02, 15 Apr 98)*

6.3.9 Intelligence.

1. The product resulting from the collection, processing, integration, analysis, evaluation, and interpretation of available information concerning foreign countries or areas.

2. Information and knowledge about an adversary obtained through observation, investigation, analysis, or understanding. *(Joint Pub 1-02, 15 Apr 98)*

6.3.10 Intelligence discipline.

A well defined area of intelligence collection, processing, exploitation, and reporting using a specific category of technical or human resources. There are five major disciplines: human intelligence, imagery intelligence, measurement and signature intelligence, signals intelligence (communications intelligence, electronic intelligence, and foreign instrumentation signals intelligence), and open-source intelligence. *(Joint Pub 1-02, 15 Apr 98)*

6.3.11 Interoperability.

1. 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. (DOD)

2. The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases. *(Joint Pub 1-02, 15 Apr 98)*

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6.3.12 Logistics supportability.

The degree to which planned logistics support [including test, measurement, and diagnostics equipment; spares and repair parts; technical data; support facilities; transportation requirements; training; manpower; and software support] allow meeting system availability and wartime usage requirements.

6.3.13 Measurand.

A parameter that is measured in order to verify a required system/end-item feature or characteristic.

6.3.14 Measurement and signature intelligence.

Scientific and technical intelligence obtained by quantitative and qualitative analysis of data (metric, angle, spatial, wavelength, time dependence, modulation, plasma, and hydromagnetic) derived from specific technical sensors for the purpose of identifying any distinctive features associated with the target. The detected feature may be either reflected or emitted. Also called MASINT. *(Joint Pub 1-02, 15 Apr 98)*

6.3.15 Mission capable.

Material condition of an aircraft indicating it can perform at least one and potentially all of its designated missions. Mission capable is further defined as the sum of full mission capable and partial mission capable. Also called MC. See also full mission capable; partial mission capable; partial mission capable, maintenance; partial mission capable, supply. *(Joint Pub 1-02, 15 Apr 98)*

6.3.16 Modularity.

A system composed of discrete elements, each of which is defined in sufficient completeness and detail such that selected element(s) can be replaced and/or modified in a competitive environment with minimal or no modifications to other system elements while maintaining equal or improved system performance and capability.

6.3.17 Near real time.

Pertaining to the timeliness of data or information which has been delayed by the time required for electronic communication and automatic data processing. This implies that there are no significant delays. *(Joint Pub 1-02, 15 Apr 98)*

6.3.18 Objective.

The goal or desired value (see Technical objectives).

6.3.19 Partial mission capable.

Material condition of an aircraft or training device indicating that it can perform at least one but not all of its missions. Also called PMC. See also full mission capable; mission capable; partial mission capable, maintenance; partial mission capable, supply. *(Joint Pub 1-02, 15 Apr 98)*

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6.3.20 Partial mission capable, maintenance.

Material condition of an aircraft or training device indicating that it can perform at least one but not all of its missions because of maintenance requirements existing on the inoperable subsystem(s). Also called PMCM. See also full mission capable; mission capable; partial mission capable; partial mission capable, supply. *(Joint Pub 1-02, 15 Apr 98)*

6.3.21 Partial mission capable, supply.

Material condition of an aircraft or training device indicating it can perform at least one but not all of its missions because maintenance required to clear the discrepancy cannot continue due to a supply shortage. Also called PMCS. See also full mission capable; mission capable; partial mission capable; partial mission capable, maintenance. *(Joint Pub 1-02, 15 Apr 98)*

6.3.22 Preplanned product improvement.

The conscious, considered strategy which involves deferring the development of necessary performance capabilities associated with elements having significant risks or delays so that the system can be fielded while the deferred element is developed in a parallel or subsequent effort. Provisions, interfaces, and accessibility are integrated into the system design so that the deferred element can be incorporated in a cost effective manner when available. The concept also applies to process improvements.

6.3.23 Real time.

Pertaining to the timeliness of data or information which has been delayed only by the time required for electronic communication. This implies that there are no noticeable delays. *(Joint Pub 1-02, 15 Apr 98)*

6.3.24 Reconnaissance.

A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy, or to secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. *(Joint Pub 1-02, 15 Apr 98)*

6.3.25 SEEK EAGLE (SE).

The Air Force certification program for determining safe carriage, employment and jettison limits, safe escape, and ballistics accuracy, when applicable, for all stores in specified loading configurations on United States Air Force and Foreign Military Sales (FMS) aircraft. SE includes compatibility analyses for fit, function, electromagnetic interface, flutter, loads, stability and control, and separation; stores loading procedures; ground and wind tunnel tests; and flight tests. The end product is source data for flight, delivery, loading manuals, and the weapon ballistics portion of the aircraft Operational Flight Program. (*AFI 63-104*).

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6.3.26 Service life.

The period of time spanning from an asset's introduction into the inventory for operational use until it is consumed or disposed. The service life of a system typically exceeds the service lives of the assets that compose it.

6.3.27 Signals intelligence.

1. A category of intelligence comprising either individually or in combination all communications intelligence, electronics intelligence, and foreign instrumentation signals intelligence, however transmitted. 2. Intelligence derived from communications, electronics, and foreign instrumentation signals. Also called SIGINT. *(Joint Pub 1-02, 15 Apr 98)*

6.3.28 Specification.

A description of the essential technical requirements for items, materials, and services that includes the verification criteria for determining whether these requirements are met. A specification supports the acquisition and life cycle management of the item, material, and service described.

6.3.29 Surveillance.

The systematic observation of aerospace, surface or subsurface areas, places, persons, or things, by visual, aural, electronic, photographic, or other means. *(Joint Pub 1-02, 15 Apr 98)*

6.3.30 Technical performance measurement (TPM).

The continuing verification of the degree of anticipated and actual achievement for technical parameters. Confirms progress and identifies deficiencies that might jeopardize meeting a system requirement. Assessed values falling outside established tolerances indicate a need for evaluation and corrective action (see figure 6.3-I).

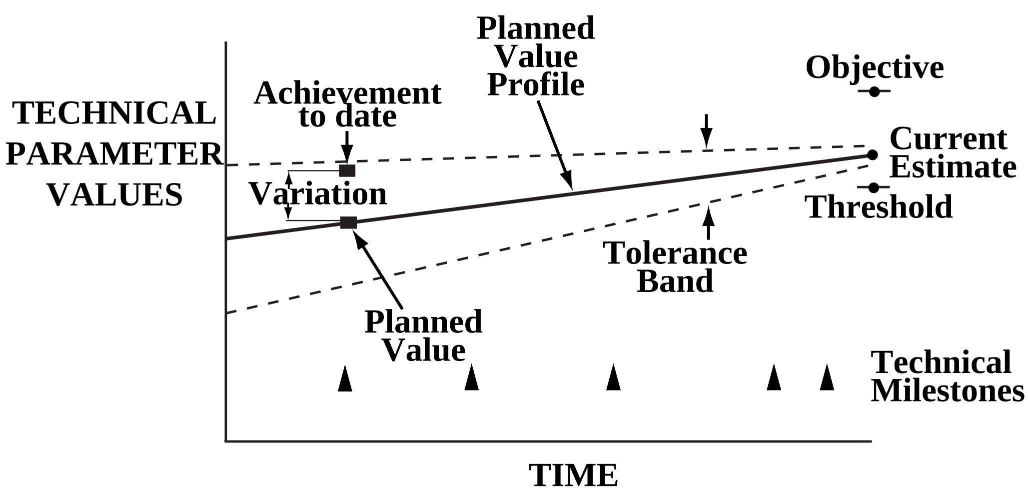

FIGURE 6.3-I. Example technical performance measurement profile.

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6.3.30.1 Achievement-to-date.

Present assessed value of the technical parameter.

6.3.30.2 Current estimate.

The technical parameter value predicted to be achieved by the end of the contract with remaining resources (including schedule and budget).

6.3.30.3 Objective.

The goal or desired value (see Technical objectives).

6.3.30.4 Planned value.

Technical parameter value based on the planned value profile.

6.3.30.5 Planned value profile.

Projected time-phased achievement of a technical parameter.

6.3.30.6 Technical milestone.

A point where a TPM evaluation is accomplished or reported.

6.3.30.7 Threshold.

The limiting acceptable value of a technical parameter.

6.3.30.8 Tolerance band.

Alert envelope around the planned value profile indicating allowed variation and projected estimating error.

6.3.30.9 Variation.

Difference between the planned value and the achievement-to-date value.

6.3.31 Verification definitions.

The verification methods are as follow.

6.3.31.1 Inspection/evaluation (I).

Examination of equipment, drawings, or documentation.

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6.3.31.2 Analysis (A).

A method of verification that utilizes established technical or mathematical algorithms, charts, graphs, circuit diagrams, or other scientific principles and procedures.

6.3.31.3 Simulation/modeling (S).

The process of conducting experiments with a model. Simulation may include the use of analog or digital devices, laboratory models, or "testbed" sites.

6.3.31.4 Demonstration (D).

A method whichthat generally utilizes, under specific scenarios, the actual operation, adjustment, or re-configuration of items.

6.3.31.5 Test (T).

A method of verification that generally determines, quantitatively, the properties or elements of items, including functional operation, and involves the application of established scientific principles and procedures.

6.3.32 Wartime reserve modes.

Characteristics and operating procedures of sensor, communications, navigation aids, threat recognition, weapons, and countermeasures systems that will contribute to military effectiveness if unknown to or misunderstood by opposing commanders before they are used, but could be exploited or neutralized if known in advance. Wartime reserve modes are deliberately held in reserve for wartime or emergency use and seldom, if ever, applied or intercepted prior to such use. *(Joint Pub 1-02, 15 Apr 98)*

6.4 Verification by milestones.

The incremental verification approach is intended to accomplish several important objectives, ensuring that

a. The system-level performance requirement is consistent with the requirement allocations made and implemented in lower-tier specifications/product definition documentation,

b. product design decisions support the allocated performance requirements, and

c. the system-level performance requirements are met.

To ensure that product design decisions support and properly allocate performance requirements, verification should be accomplished in iterations at appropriate program milestones. Ideally, iterative verifications, while accomplishing the same basic objective each time, are done with greater and greater fidelity and accuracy as designs mature and more detailed information becomes available. Some verifications may progress in method from inspection to analysis to simulation to test through successive milestones. Other verifications may call for using the same method (i.e., analysis) through each

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program milestone but requiring successively more insight into and fidelity in data and assumptions.

Requirements should be verified prior to each major system milestone to provide the greatest assurance that verification criteria are achieved. The milestones for a specific program may differ or be called by a different name. There may be more milestones or fewer. Milestone objectives may be different. These are all program choices. In all cases, program milestones must be defined. However, the verification criteria must be matched to the milestones selected and the milestone objectives.

The following are typical milestones intended for use in the JSSGs:

a. System Requirements Review (SRR)/System Function Review (SFR) or equivalent

b. Preliminary Design Review (PDR) or equivalent

c. Critical Design Review (CDR) or equivalent

d. First Flight Review (FFR) or equivalent

e. System Verification Review (SVR) or equivalent

The key objectives of each milestone, applicable to specifications, are summarized below:

a. <u>System Requirements Review (SRR)/System Functional Review (SFR</u>) or equivalent. Confirm convergence on and achievability of system requirements and readiness to initiate preliminary design by confirming that

   (1) system functional and performance requirements have converged and characterize a system for which one or more design approaches exist that satisfy established customer needs and requirements;

   (2) the system's draft physical architecture and draft lower-tier product performance requirements definition establish an initial assessment of, the adequacy, completeness, and achievability of functional and performance requirements, and quantification of cost, schedule, and risk;

   (3) critical technologies for people, product, and process solutions have been verified at an acceptable level of risk for availability, achievability, needed performance, and readiness for transition;

   (4) life cycle requirements for people, products and processes have been defined, within acceptable limits of certainty, that provide the encompassing essential functionality, capability, interfaces, and other requirements/ constraints; and

   (5) preplanned product and process improvement and evolutionary acquisition requirements planning has been defined as required;

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b. Preliminary Design Review (PDR) or equivalent. Confirm that the detailed design approach satisfies system requirements and the total system is ready for detailed design. PDR confirms that the process completely defined system requirements for design including that

(1) the system physical architecture is an integrated detailed design approach for people, products, and processes to satisfy requirements, including interoperability and interfaces;

(2) an audit trail from SRR is established with changes substantiated;

(3) available developmental test results support the system design approach;

(4) the product performance requirements are defined;

(5) sufficient detailed design has been accomplished to verify the completeness and achievability of defined requirements, and quantification of cost, schedule, and risk; and

(6) preplanned product and process improvement and evolutionary acquisition requirements planning have been refined.

c. Critical Design Review (CDR) or equivalent. Confirm that the total system detailed design is complete, meets requirements, and that the total system is ready for manufacturing. CDR confirms that the process completely defines system design requirements including that

(1) the system physical architecture is an integrated detailed design for people, products, and processes to satisfy requirements, including interoperability and interfaces;

(2) an audit trail from PDR is established with changes substantiated, and product performance requirements are refined;

(3) product design definition and product manufacturing/fabrication and support definition for the system is defined;

(4) the system design compatibility with external interfaces has been established;

(5) developmental test results are consistent with system design and interface requirements and design constraints;

(6) critical system design and interface requirements and design constraints are supported by developmental test results; and

(7) preplanned product and process improvement and evolutionary acquisition requirements planning has been defined.

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d. First Flight Review (FFR) or equivalent. Confirm that, prior to testing system items, individually or in combination, demonstrate that

(1) the safety inherent in the test article(s) and the procedures and plans for its use are evaluated as being safe;

(2) personnel involved in the testing are trained in both the objectives of the test(s) and the jobs they are responsible for accomplishing;

(3) the configuration control process necessary to support flight testing is established;

(4) planning for testing is complete, evaluated for adequacy and available to all applicable personnel;

(5) hazardous materials and procedures are defined and documented, and handling equipment, instructions and special actions are defined and provided to affected personnel with warnings, instructions, and special training as appropriate;

(6) resources (people, equipment, and materials) needed to accomplish the testing are available and ready for the testing;

(7) the test article(s), equipment, facilities, and ranges (if applicable) are evaluated as ready for test; and

(8) documentation of evaluations, assessments, plans, procedures, training and other factors applicable to the tests is available, correlated, and complete.

e. System Verification Review (SVR) or equivalent. Confirm that the total system is verified. SVR confirms the completion of all incremental accomplishments for system verification (e.g., Test Readiness Reviews, system Functional Configuration Audits) and confirms, within acceptable limits of certainty, that

(1) system verification procedures are complete and accurate (including verification by test and demonstration of critical parameters as well as key assumptions and methods used in verifications by analytic models and simulations);

(2) the system is confirmed to be ready for verification;

(3) verifications have been conducted in accordance with established procedures and are completed for people, products, and processes; and system processes are current, executable, and meet the need;

(4) an audit trail from CDR is established with changes substantiated and the system verified;

(5) the interface compatibility has been achieved;

(6) plans and procedures for downstream processes (production, training, support/sustainment, deployment/fielding, operations, and disposal) evaluated for adequacy; discrepancies resolved; and documentation and results incorporated in the system data base; and

(7) preplanned product and process improvement and evolutionary acquisition requirements and plans have been refined.

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6.5 Specification tree.

The following list identifies the documents that comprise the top tier of the specification tree for the air system.

Tier	Example Document
1	Air System Specification
2	Air Vehicle Specification
2	Training System Specification
2	Support System Specification
2	(Other Tier 2 Specification(s))

This section identifies the top tier of the specification tree. The complete tree of requirements documentation is normally the developing contractor's responsibility to develop. See the Integrated Performance Based Business Environment Guide and the Performance Based Product Definition Guide for additional information.

A specification tree is a program-unique construct to organize the requirements flow-down into documentation that describes requirements for segments of the system and items that comprise the system. An air system specification is normally the top-tier document in the specification tree for system development. This is not intended to preclude the use of another document as the top-tier specification on a modification program such as using a tailored avionics specification for a radar upgrade. As always, significant insight and planning is necessary when constructing a set of requirements for the program. For example, how much of that radar upgrade needs to be verified in its installed environment (air vehicle) or how much of that requirements set is dependent on system environments, interfaces, and other factors such as impacts on support and training.

This Air System Joint Service Specification Guide (JSSG) has been developed in concert with seven other JSSGs. These guides have been created under the assumption that, at some future point, a Weapon JSSG (used in those circumstances in which the system being developed is a weapon) will be developed and existing Air Force Guide Specifications (AFGS) for Training and Support will be converted to JSSGs. The nominal JSSG hierarchy depicted on figure 6.5-1 should not be construed as a program specification tree. While the JSSGs shown at tier 2 may represent program-unique specifications to be developed, those specification guides shown under the Air Vehicle at tier 3 may or may not have a resemblance to a program-specific specification architecture. These tier 3 JSSGs nominally communicate performance expectations for areas of air vehicle functionality. While they could exist in a program-specific form, some (or some portions) of these documents express functionality that would frequently be expressed as part of the functionality of the air vehicle. That is, in developing a program-specific air vehicle specification, portions of the tier 3 documents may be appropriately tailored and incorporated in an air vehicle specification. Additionally, the decisions regarding how best to organize requirements are frequently driven by the organization of the program, risk, and complexity, among other factors. For example,

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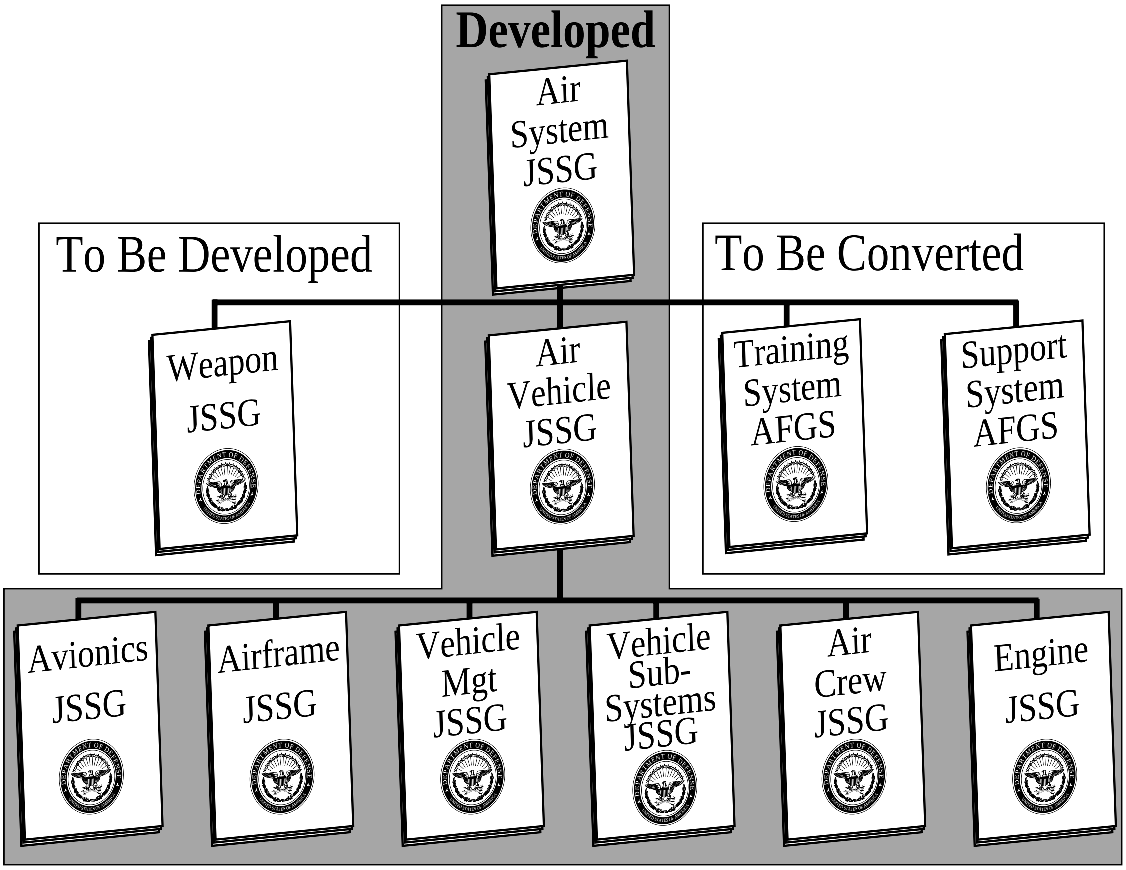

FIGURE 6.5-1. Joint Service Specification Guide specification tree.

the use of integrated product teams may make it desirable to consolidate all requirements for avionics into a single specification even though some of the performance expectations are tier 2 (i.e., air vehicle requirements) and some tier 3 (e.g., radar requirements). This would enable making a single team accountable for the development and implementation of a given area of requirements. The organization of the Joint Service Specification Guide specification tree is intended to assist the program office in constructing appropriate sets of requirements, not in hindering factors such as teamwork, team accountability, or other mechanism used to organize requirements.

6.6 Key word list.

acquisition reform
acquisition requirements
aerial refueling
aircraft
air vehicle
avionics
crew system
interface
interoperability
maintainability
operational concept

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performance specification
reliability
service life
specification template
structures
subsystem
support systems
survivability
system life cycle
systems engineering
tailorable specifiation
training system
verification
weapons

6.7 International interest.

Certain provisions of this document may be the subject of international standardization agreements. When change notice, revision, or cancellation of this document is proposed that will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

6.8 Responsible engineering office.

The DoD office responsible for development and technical maintenance of this Joint Service Specification Guide is ASC/ENS, Bldg. 560 (Area B), 2530 Loop Road West, Wright-Patterson AFB OH 45433-7101. Requests for additional information or assistance on this specification can be obtained from ASC/ENS: DSN 785-1799, commercial (937) 255-1799, FAX (937) 255-5597. Address e-mail comments to D. Sedor (sedordj@asc-en.wpafb.af.mil). Any information relating to Government contracts should be obtained through the contracting officer for the program or project under consideration.

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AIR SYSTEM

JOINT SERVICE SPECIFICATION GUIDE

APPENDIX A

AIR SYSTEM/AIR VEHICLE REQUIREMENTS LINKAGES

A.1 SCOPE

A.1.1 Scope.

This handbook is provided as an appendix to the Air System Joint Service Specification Guide. The appendix provides Air System-to-Air Vehicle requirements linkages. This appendix is not a mandatory part of the specification. The information contained herein is intended for guidance only.

A.2 APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

A.3 REQUIREMENTS LINKAGES

The following matrix shows the linkage between the requirements of the Air System and the Air Vehicle Joint Service Specification Guides:

Air System		Air Vehicle	
Para #	**Title**	**Para #**	**Title**
3.1.1	Roles and Missions	3.1.1	Point Performance
3.1.1	Roles and Missions	3.1.1.1	Flight Envelope
3.1.1	Roles and Missions	3.1.1.1.1	Aerial Refueling Envelope
3.1.1	Roles and Missions	3.1.1.2	Ground Performance
3.1.1	Roles and Missions	3.1.2	Mission Profile Performance
3.1.1	Roles and Missions	3.1.2.1	Threat Environment
3.1.1	Roles and Missions	3.1.2.1.1	Weapons Delivery
3.1.1	Roles and Missions	3.1.7	Communication
3.1.1	Roles and Missions	3.1.8.2.1	Threat Detection, Identification, Prioritization, Awareness, and Response
3.1.1	Roles and Missions	3.1.8.2.2	Defense Countermeasures
3.1.1	Roles and Missions	3.1.8.2.3	Terrain Following/Terrain Avoidance
3.1.1	Roles and Missions	3.1.8.2.6.1	Chemical and Biological Hardening
3.1.1	Roles and Missions	3.1.8.2.6.2	Chemical and Biological Personal Protection
3.1.1	Roles and Missions	3.1.8.2.6.3	Chemical and Biological Decontamination

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Air System Para #	Air System Title	Air Vehicle Para #	Air Vehicle Title
3.1.1	Roles and Missions	3.1.8.2.6.4	Chemical and Biological Detection
3.1.1	Roles and Missions	3.1.8.2.7	Nuclear Weapons Survivability
3.1.1	Roles and Missions	3.1.9.1	Target Detection, Track, Identify, and Designation
3.1.1	Roles and Missions	3.1.9.2	Integrated Earth Space Reference Accuracey
3.1.1	Roles and Missions	3.2.1	Electromagnetic Environmental Effects
3.1.1	Roles and Missions	3.2.2	Natural Climate
3.1.1	Roles and Missions	3.2.3	Induced Environment
3.1.2	Organization	3.1.2	Mission Profile Performance
3.1.2	Organization	3.1.2.1.1	Weapons Delivery
3.1.2	Organization	3.4.3	Communication, Radio Navigation, and Identification Interfaces
3.1.3	Deployment and Mobilization	3.1.1.1.1	Aerial Refueling Envelope
3.1.3	Deployment and Mobilization	3.1.1.2	Ground Performance
3.1.3	Deployment and Mobilization	3.1.2	Mission Profile Performance
3.1.3	Deployment and Mobilization	3.4.5	Transportability
3.1.3	Deployment and Mobilization	3.4.5.1	Preparation for Transport
3.1.4	Mission Planning	3.1.3	Mission Planning
3.1.4	Mission Planning	3.1.7	Communication
3.1.4	Mission Planning	3.1.8.2.1	Threat Detection, Identification, Prioritization, Awareness, and Response
3.1.4	Mission Planning	3.1.8.2.2	Defense Countermeasures
3.1.4	Mission Planning	3.1.8.2.3	Terrain Following/Terrain Avoidance
3.1.4	Mission Planning	3.1.9.1	Target Detection, Track, Identify, and Designation
3.1.5.1.1	Training Missions	3.1.1	Point Performance
3.1.5.1.1	Training Missions	3.1.1.1.1	Aerial Refueling Envelope
3.1.5.1.1	Training Missions	3.1.1.2	Ground Performance
3.1.5.1.1	Training Missions	3.1.2	Mission Profile Performance
3.1.5.1.1	Training Missions	3.1.3	Mission Planning
3.1.5.1.1	Training Missions	3.1.4	Reliability
3.1.5.1.1	Training Missions	3.1.5	Maintainability
3.1.5.1.1	Training Missions	3.1.7	Communication
3.1.5.1.1	Training Missions	3.3.5	System Usage
3.1.5.1.1	Training Missions	3.7.1	Embedded Training
3.1.5.1.2	Operational Deployment	3.1.1	Point Performance
3.1.5.1.2	Operational Deployment	3.1.1.1.1	Aerial Refueling Envelope
3.1.5.1.2	Operational Deployment	3.1.1.2	Ground Performance
3.1.5.1.2	Operational Deployment	3.1.2	Mission Profile Performance
3.1.5.1.2	Operational Deployment	3.1.3	Mission Planning
3.1.5.1.2	Operational Deployment	3.1.4	Reliability
3.1.5.1.2	Operational Deployment	3.1.5	Maintainability
3.1.5.1.2	Operational Deployment	3.3.5	System Usage
3.1.5.1.2	Operational Deployment	3.4.5	Transportability
3.1.5.1.2	Operation Deployment	3.4.5.1	Preparation for Transport
3.1.5.1.3	Operational Missions in Peacetime	3.1.1	Point Performance

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Air System Para #	Air System Title	Air Vehicle Para #	Air Vehicle Title
3.1.5.1.3	Operational Missions in Peacetime	3.1.1.1.1	Aerial Refueling Envelope
3.1.5.1.3	Operational Missions in Peacetime	3.1.1.2	Ground Performance
3.1.5.1.3	Operational Missions in Peacetime	3.1.2	Mission Profile Performance
3.1.5.1.3	Operational Missions in Peacetime	3.1.3	Mission Planning
3.1.5.1.3	Operational Missions in Peacetime	3.1.4	Reliability
3.1.5.1.3	Operational Missions in Peacetime	3.1.5	Maintainability
3.1.5.1.3	Operational Missions in Peacetime	3.3.5	System Usage
3.1.5.1.4	Base Escape	3.1.1	Point Performance
3.1.5.1.4	Base Escape	3.1.1.1	Flight Envelope
3.1.5.1.4	Base Escape	3.1.1.2	Ground Performance
3.1.5.1.4	Base Escape	3.1.2	Mission Profile Performance
3.1.5.1.4	Base Escape	3.1.3	Mission Planning
3.1.5.1.4	Base Escape	3.1.4	Reliability
3.1.5.1.4	Base Escape	3.1.5	Maintainability
3.1.5.1.4	Base Escape	3.1.8.2.6.2	Chemical and Biological Personal Protection
3.1.5.1.4	Base Escape	3.3.5	System Usage
3.1.5.2.1	Combat Surge and Sustained	3.1.1	Point Performance
3.1.5.2.1	Combat Surge and Sustained	3.1.1.1	Flight Envelope
3.1.5.2.1	Combat Surge and Sustained	3.1.1.1.1	Aerial Refueling Envelope
3.1.5.2.1	Combat Surge and Sustained	3.1.1.2	Ground Performance
3.1.5.2.1	Combat Surge and Sustained	3.1.2	Mission Profile Performance
3.1.5.2.1	Combat Surge and Sustained	3.1.3	Mission Planning
3.1.5.2.1	Combat Surge and Sustained	3.1.4	Reliability
3.1.5.2.1	Combat Surge and Sustained	3.1.5	Maintainability
3.1.5.2.1	Combat Surge and Sustained	3.3.5	System Usage
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.1.1	Point Performance
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.1.1.1	Flight Envelope
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.1.1.1.1	Aerial Refueling Envelope
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.1.1.2	Ground Performance
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.1.2	Mission Profile Performance
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.1.3	Mission Planning
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.1.4	Reliability
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.1.5	Maintainability
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.1.7	Communication
3.1.5.2.2	Air Alert, Loiter, Surveillance	3.3.5	System Usage
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.1	Point Performance
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.1.1	Flight Envelope
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.1.2	Ground Performance

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Air System		Air Vehicle	
Para #	**Title**	**Para #**	**Title**
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.2	Mission Profile Performance
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.2.1.1	Weapons Delivery
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.4	Reliability
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.7	Communication
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.8.2.1	Threat Detection, Identification, Prioritization, Awareness, and Response
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.8.2.2	Defense Countermeasures
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.9.1	Target Detection, Track, Identify, and Designation
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.9.2	Integrated Earth Space Reference Accuracey
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.9.3	Air-to-Surface Accuracy
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.9.4	Simultaneous Release and Control of Precision Guided Munitions
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.9.5	Weapons Selection and Release Control
3.1.5.2.3	Engagement from Ground/Deck Basing	3.1.9.6	Gun Accuracy and Control
3.1.5.2.3	Engagement from Ground/Deck Basing	3.3.5	System Usage
3.1.5.2.4	Engagement from Loiter Location	3.1.1	Point Performance
3.1.5.2.4	Engagement from Loiter Location	3.1.1.1	Flight Envelope
3.1.5.2.4	Engagement from Loiter Location	3.1.2	Mission Profile Performance
3.1.5.2.4	Engagement from Loiter Location	3.1.2.1.1	Weapons Delivery
3.1.5.2.4	Engagement from Loiter Location	3.1.4	Reliability
3.1.5.2.4	Engagement from Loiter Location	3.1.7	Communication
3.1.5.2.4	Engagement from Loiter Location	3.1.8.2.1	Threat Detection, Identification, Prioritization, Awareness, and Response
3.1.5.2.4	Engagement from Loiter Location	3.1.8.2.2	Defense Countermeasures
3.1.5.2.4	Engagement from Loiter Location	3.1.9.1	Target Detection, Track, Identify, and Designation
3.1.5.2.4	Engagement from Loiter Location	3.1.9.2	Integrated Earth Space Reference Accuracey
3.1.5.2.4	Engagement from Loiter Location	3.1.9.3	Air-to-Surface Accuracy

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Air System Para #	Air System Title	Air Vehicle Para #	Air Vehicle Title
3.1.5.2.4	Engagement from Loiter Location	3.1.9.4	Simultaneous Release and Control of Precision Guided Munitions
3.1.5.2.4	Engagement from Loiter Location	3.1.9.5	Weapons Selection and Release Control
3.1.5.2.4	Engagement from Loiter Location	3.1.9.6	Gun Accuracy and Control
3.1.5.2.4	Engagement from Loiter Location	3.3.5	System Usage
3.1.5.3.1	Availability	3.1.4	Reliability
3.1.5.3.1	Availability	3.1.5	Maintainability
3.1.5.3.1	Availability	3.3.5	System Usage
3.1.5.4	Integrated Combat Turnaround Time (ICT)	3.1.1.2	Ground Performance
3.1.5.4	Integrated Combat Turnaround Time (ICT)	3.1.3	Mission Planning
3.1.5.4	Integrated Combat Turnaround Time (ICT)	3.1.6	Integrated Combat Turnaround Time
3.1.6.1	Mission Reliability	3.1.4	Reliability
3.1.6.1	Mission Reliability	3.3.5.1.1	Damage/Fault Tolerance
3.1.6.1	Mission Reliability	3.3.5.1.2	Operational Period/Inspection
3.1.6.1	Mission Reliability	3.3.7	Diagnostics and Health Management
3.1.6.1	Mission Reliability	3.3.7.1	Diagnostics Fault Detection and Fault Isolation
3.1.6.2.1	Mission and One-on-One Survivability	3.1.1	Point Performance
3.1.6.2.1	Mission and One-on-One Survivability	3.1.1.1	Flight Envelope
3.1.6.2.1	Mission and One-on-One Survivability	3.1.2	Mission Profile Performance
3.1.6.2.1	Mission and One-on-One Survivability	3.1.2.1.1	Weapons Delivery
3.1.6.2.1	Mission and One-on-One Survivability	3.1.3	Mission Planning
3.1.6.2.1	Mission and One-on-One Survivability	3.1.7	Communication
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.1.1.1	Radar Cross Section
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.1.1.2	Infrared Signature
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.1.1.3	Visual Signature
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.1.1.4	Acoustic Signature
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.1.1.5	Emission Control
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.1.1.6	Electronic Protection
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.2.1	Threat Detection, Identification, Prioritization, Awareness, and Response

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Air System Para #	Air System Title	Air Vehicle Para #	Air Vehicle Title
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.2.2	Defense Countermeasures
3.1.6.2.1	Mission One on One Survivability	3.1.8.2.3	Terrain Following/Terrain Avoidance
3.1.6.2.1	Mission One on One Survivability	3.1.8.2.4	Ballistic Threat Survivability
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.2.5.1	Electromagnetic Threat Suvivability
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.2.5.2	Laser Threat Survivability
3.1.6.2.1	Mission and One-on-One Survivability	3.1.8.2.7	Nuclear Weapons Survivability
3.1.6.2.1	Mission and One-on-One Survivability	3.1.9.1	Target Detection, Track, Identify, and Designation
3.1.6.2.1	Mission and One-on-One Survivability	3.4.2.2	Weapon and Store Loadouts
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.1	Point Performance
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.1.2	Ground Performance
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.8.1.1.1	Radar Cross Section
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.8.1.1.2	Infrared Signature
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.8.1.1.3	Visual Signature
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.8.1.1.4	Acoustic Signature
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.8.1.1.5	Emission Control
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.8.1.1.6	Electronic Protection
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.8.2.4	Ballistic Threat Survivability
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.8.2.5.1	Electromagnetic Threat Suvivability
3.1.6.2.2	Parked Aircraft and Ground Support Survivability	3.1.8.2.5.2	Laser Threat Survivability
3.1.7.1.1	Air-to-Air Lethality	3.1.1	Point Performance
3.1.7.1.1	Air-to-Air Lethality	3.1.1.1	Flight Envelope
3.1.7.1.1	Air-to-Air Lethality	3.1.2	Mission Profile Performance
3.1.7.1.1	Air-to-Air Lethality	3.1.2.1.1	Weapons Delivery
3.1.7.1.1	Air-to-Air Lethality	3.1.3	Mission Planning
3.1.7.1.1	Air to Air Lethality	3.1.7	Communication
3.1.7.1.1	Air to Air Lethality	3.1.8.2.1	Threat Detection, Identification, Prioritization, Awareness, and Response
3.1.7.1.1	Air to Air Lethality	3.1.8.2.2	Defense Countermeasures
3.1.7.1.1	Air to Air Lethality	3.1.8.2.4	Ballistic Threat Survivability
3.1.7.1.1	Air to Air Lethality	3.1.8.2.5.1	Electromagnetic Threat Suvivability

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Air System Para #	Air System Title	Air Vehicle Para #	Air Vehicle Title
3.1.7.1.1	Air to Air Lethality	3.1.8.2.5.2	Laser Threat Survivability
3.1.7.1.1	Air-to-Air Lethality	3.1.8.2.7	Nuclear Weapons Survivability
3.1.7.1.1	Air-to-Air Lethality	3.1.9.1	Target Detection, Track, Identify, and Designation
3.1.7.1.1	Air-to-Air Lethality	3.1.9.2	Integrated Earth Space Reference Accuracey
3.1.7.1.1	Air-to-Air Lethality	3.1.9.4	Simultaneous Release and Control of Precision Guided Munitions
3.1.7.1.1	Air-to-Air Lethality	3.1.9.5	Weapons Selection and Release Control
3.1.7.1.1	Air-to-Air Lethality	3.1.9.6	Gun Accuracy and Control
3.1.7.1.1	Air-to-Air Lethality	3.4.2.2	Weapon and Store Loadouts
3.1.7.1.1	Air-to-Air Lethality	3.4.2.3	Gun Interface
3.1.7.1.2	Air-to-Surface Lethality	3.1.1	Point Performance
3.1.7.1.2	Air-to-Surface Lethality	3.1.1.1	Flight Envelope
3.1.7.1.2	Air-to-Surface Lethality	3.1.2	Mission Profile Performance
3.1.7.1.2	Air-to-Surface Lethality	3.1.2.1.1	Weapons Delivery
3.1.7.1.2	Air-to Surface Lethality	3.1.3	Mission Planning
3.1.7.1.2	Air to Surface Lethality	3.1.7	Communication
3.1.7.1.2	Air-to Surface Lethality	3.1.8.2.1	Threat Detection, Identification, Prioritization, Awareness, and Response
3.1.7.1.2	Air-to Surface Lethality	3.1.8.2.2	Defense Countermeasures
3.1.7.1.2	Air-to Surface Lethality	3.1.8.2.4	Ballistic Threat Survivability
3.1.7.1.2	Air to Surface Lethality	3.1.8.2.5.1	Electromagnetic Threat Suvivability
3.1.7.1.2	Air to Surface Lethality	3.1.8.2.5.2	Laser Threat Survivability
3.1.7.1.2	Air-to-Surface Lethality	3.1.8.2.7	Nuclear Weapons Survivability
3.1.7.1.2	Air-to-Surface Lethality	3.1.9.1	Target Detection, Track, Identify, and Designation
3.1.7.1.2	Air-to-Surface Lethality	3.1.9.2	Integrated Earth Space Reference Accuracey
3.1.7.1.2	Air-to-Surface Lethality	3.1.9.3	Air-to-Surface Accuracy
3.1.7.1.2	Air-to-Surface Lethality	3.1.9.4	Simultaneous Release and Control of Precision Guided Munitions
3.1.7.1.2	Air-to-Surface Lethality	3.1.9.5	Weapons Selection and Release Control
3.1.7.1.2	Air-to-Surface Lethality	3.1.9.6	Gun Accuracy and Control
3.1.7.1.2	Air-to-Surface Lethality	3.4.2.3	Gun Interface
3.1.7.2	Cargo Transport	3.1.1	Point Performance
3.1.7.2	Cargo Transport	3.1.1.1.1	Aerial Refueling Envelope
3.1.7.2	Cargo Transport	3.1.2	Mission Profile Performance
3.1.7.2	Cargo Transport	3.1.3	Mission Planning
3.1.7.2	Cargo Transport	3.1.9.2	Integrated Earth Space Reference Accuracey
3.1.7.2	Cargo Transport	3.3.6.2	Marking Of Cargo Compartments
3.1.7.2	Cargo Transport	3.4.6	Cargo and Payload
3.1.7.2	Cargo Transport	3.4.6.1	Cargo Handling
3.1.7.2	Cargo Transport	3.4.6.1.2	Cargo Winch
3.1.7.2	Cargo Transport	3.4.6.1.3	External Cargo Removal and Replacement Device
3.1.7.2	Cargo Transport	3.4.6.2	Cargo Weight and Balance
3.1.7.3	Reconnaissance/Surveillance	3.1.1	Point Performance

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Air System Para #	Air System Title	Air Vehicle Para #	Air Vehicle Title
3.1.7.3	Reconnaissance/Surveillance	3.1.2	Mission Profile Performance
3.1.7.3	Reconnaissance/Surveillance	3.1.3	Mission Planning
3.1.7.3	Reconnaissance/Surveillance	3.1.7	Communication
3.1.7.3	Reconnaissance/Surveillance	3.1.9.2	Integrated Earth Space Reference Accuracey
3.1.7.4	Aerial Refueling (Tanker)	3.1.1	Point Performance
3.1.7.4	Aerial Refueling (Tanker)	3.1.1.1.1	Aerial Refueling Envelope
3.1.7.4	Aerial Refueling (Tanker)	3.1.2	Mission Profile Performance
3.1.7.4	Aerial Refueling (Tanker)	3.1.3	Mission Planning
3.1.7.4	Aerial Refueling (Tanker)	3.1.7	Communication
3.1.7.4	Aerial Refueling (Tanker)	3.1.9.2	Integrated Earth Space Reference Accuracey
3.1.7.5	System Reach	3.1.1	Point Performance
3.1.7.5	System Reach	3.1.1.1	Flight Envelope
3.1.7.5	System Reach	3.1.1.1.1	Aerial Refueling Envelope
3.1.7.5	System Reach	3.1.2	Mission Profile Performance
3.1.8	Reserve Modes	3.1.10	Reserve Modes
3.1.8	Reserve Modes	3.3.9	Security
3.1.9	Lower Tier Mandated Requirements	3.1.11	Lower Tier Mandated Requirements
3.1.9	Lower-Tier Mandated Requirement	3.3.1.1	Propulsion, Fixed Wing
3.1.9	Lower-Tier Mandated Requirement	3.3.1.1.1	Engine Compatibility and Installation
3.1.9	Lower-Tier Mandated Requirement	3.3.1.1.1.1	Air Induction System
3.1.9	Lower-Tier Mandated Requirement	3.3.1.1.1.2	Nozzle and Exhaust Systems
3.1.9	Lower-Tier Mandated Requirement	3.3.1.1.2	Air Vehicle Propulsion Control
3.1.9	Lower Tier Mandated Requirements	3.4.13	Government Furnishings Equipment (GFE) and Directed Contractor Furnished Equipment
3.2	Environment	3.2.1	Electromagnetic Environmental Effects
3.2	Environment	3.2.2	Natural Climate
3.2	Environment	3.2.3	Induced Environment
3.2	Environment	3.2.4	Performance Limiting Environmental Conditions
3.3.1.1	System Architecture	3.3.3.2	Computer Hardware Extensibility
3.3.1.1	System Architecture	3.3.3.4	Computer Software Module Size and Complexity
3.3.1.1	System Architecture	3.3.4	Architecture
3.3.1.1.1	Growth	3.3.12	Growth Provisions
3.3.1.1.1	Growth	3.3.3.1	Computer Hardware Reserve Compacity
3.3.1.1.1	Growth	3.3.3.2	Computer Hardware Extensibility
3.3.1.1.2	Standard/Common Assets	3.3.3.3	Computer Software Programming Language
3.3.1.1.2	Standard/Common Assets	3.4.2.1.4	Ejector Unit Cartridges
3.3.1.1.3	Interchangeability	3.3.2	Interchangeability

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Air System		Air Vehicle	
Para #	**Title**	**Para #**	**Title**
3.3.1.2	System Service Life	3.1.8.2.6.1	Chemical and Biological Hardening
3.3.1.2	System Service Life	3.3.5	System Usage
3.3.1.2	Service Life	3.3.5.1	Service Life
3.3.1.2	System Service Life	3.3.5.1.1	Damage/Fault Tolerance
3.3.1.2	System Service Life	3.3.5.1.2	Operational Period/Inspection
3.3.1.2	System Service Life	3.3.6.2	Marking Of Cargo Compartments
3.3.1.2	Service Life	3.4.4.2.1.6.1	Accessibility
3.3.1.2	Service Life	3.4.4.2.1.6.1.1	Mounting, Installation and Alignment
3.3.1.3	Manpower and Personnel	3.1.5	Maintainability
3.3.1.3	Manpower and Personnel	3.1.6	Integrated Combat Turnaround Time
3.3.1.3	Manpower and Personnel	3.4.4	Human vehicle Interface
3.3.1.3	Manpower and Personnel	3.4.4.1.5	Controls and Displays
3.3.1.3	Manpower and Personnel	3.4.4.1.6	Warnings, Cautions and Advisories
3.3.1.3	Manpower and Personnel	3.4.4.2	Maintainer Vehicle Interface
3.3.1.3	Manpower and Personnel	3.4.4.2.1	Air Vehicle States
3.3.1.3	Manpower and Personnel	3.4.4.2.1.2	Air Vehicle Stabilization
3.3.1.3	Manpower and Personnel	3.4.4.2.1.4	Diagnostic Function Interface
3.3.1.3	Manpower and Personnel	3.4.4.2.1.4.1	Power-Off Transition
3.3.1.3	Manpower and Personnel	3.4.4.2.1.4.2	Power-On Transition
3.3.1.3	Manpower and Personnel	3.4.4.2.1.4.3	Servicing Indications
3.3.1.3	Manpower and Personnel	3.4.4.2.1.5	Servicing Interfaces
3.3.1.3	Manpower and Personnel	3.4.4.2.1.5.1	Stores Loading
3.3.1.3	Manpower and Personnel	3.4.4.2.1.5.2	Certifying the Air Vehicle for Flight
3.3.1.3	Manpower and Personnel	3.4.4.2.1.6.1.1	Mounting, Installation and Alignment
3.3.1.3	Manpower and Personnel	3.4.4.2.1.6.1.2	Adjustment Controls
3.3.1.3	Manpower and Personnel	3.4.4.2.1.6.1.3	Weight Limitations
3.3.1.4	Asset Identification	3.3.6.1	Asset Identification
3.3.2	Diagnostics	3.3.7	Diagnostics and Health Management
3.3.2	Diagnostics	3.3.7.1	Diagnostics Fault Detection and Fault Isolation
3.3.2	Diagnostics	3.3.8.2	Crash Recording
3.3.2	Diagnostics	3.4.4.2.1.4	Diagnostic Function Interface
3.3.2	Diagnostics	3.4.4.2.1.4.1	Power-Off Transition
3.3.2	Diagnostics	3.4.4.2.1.4.2	Power-On Transition
3.3.2	Diagnostics	3.4.4.2.1.4.3	Servicing Indications
3.3.2	Diagnostics	3.4.4.2.1.5.1	Stores Loading
3.3.2	Diagnostics	3.4.4.2.1.5.2	Certifying the Air Vehicle for Flight
3.3.3	Nuclear Safety	3.4.2.1.1	Nuclear Weapon Interface
3.3.4	Electromagnetic Environmental Effects (E3)	3.2.1	Electromagnetic Environmental Effects
3.3.5	Security System	3.3.9	Security
3.3.5	System Security	3.4.4.2.1.3	Maintainer/Vehicle Interface Authorization
3.3.5	System Security	3.4.4.2.1.4.1	Power-Off Transition
3.3.5	System Security	3.4.4.2.1.4.2	Power-On Transition
3.3.6	System Safety	3.1.4	Reliability
3.3.6	System Safety	3.3.10	Safety
3.3.6	System Safety	3.3.10.1.1	Armament Ejection and Launch
3.3.6	System Safety	3.3.10.2.1	Pesonal Safety and Health

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Air System		Air Vehicle	
Para #	**Title**	**Para #**	**Title**
3.3.6	System Safety	3.3.10.2.2	Crash Worthiness
3.3.6	System Safey	3.3.10.2.3	Energetics
3.3.6	System Safety	3.3.11.1	Flying Qualities, Fixed Wing
3.3.6	System Safety	3.3.11.1.1	Primary Requirements for Air Vehicle States In Common Atmospheric Conditions
3.3.6	System Safety	3.3.11.1.1.1	Allowable Levels for Air Vehicle Normal States
3.3.6	System Safety	3.3.11.1.1.2	Allowable Levels for Air Vehicle Extreme States
3.3.6	System Safety	3.3.11.1.1.3	Primary Requirements for Failure States
3.3.6	System Safety	3.3.11.1.1.3.1	Probability of Encountering Degraded Levels of Flying Qualities
3.3.6	System Safety	3.3.11.1.1.3.2	Allowable Levels for Specific Air Vehicle Failure States
3.3.6	System Safety	3.3.11.1.1.3.3	Failures Outside the ROTH
3.3.6	System Safety	3.3.11.1.2	Flying Qualities Degradation in Atmospheric Disturbances
3.3.6	System Safety	3.3.11.1.3	Control Margins
3.3.6	System Safety	3.3.5.1.1	Damage/Fault Tolerance
3.3.6	System Safety	3.3.5.1.2	Operational Period/Inspection
3.3.6	System Safety	3.3.6.2	Marking Of Cargo Compartments
3.3.6	System Safety	3.3.7	Diagnostics and Health Management
3.3.6	System Safety	3.3.7.1	Diagnostics Fault Detection and Fault Isolation
3.3.6	System Safety	3.4.2.1.5	Store Clearances
3.3.6	System Safety	3.4.2.2	Weapon and Store Loadouts
3.3.6	System Safety	3.4.2.3	Gun Interface
3.3.6	System Safety	3.4.4.2.1.3	Maintainer/Vehicle Interface Authorization
3.3.6	System Safety	3.4.4.2.1.4.1	Power-Off Transition
3.3.6	System Safety	3.4.4.2.1.4.2	Power-On Transition
3.3.6	System Safety	3.4.4.2.1.4.3	Servicing Indications
3.3.6	System Safety	3.4.4.2.1.5.1	Stores Loading
3.3.6	System Safety	3.4.4.2.1.5.2	Certifying the Air Vehicle for Flight
3.3.6	System Safety	3.4.4.2.1.6.1.1	Mounting, Installation and Alignment
3.3.6	System Safety	3.4.4.2.1.6.1.2	Adjustment Controls
3.3.6	System Safety	3.4.4.2.1.6.1.3	Weight Limitations
3.3.6	System Safey	3.4.6.1.1	Cargo Restraint
3.3.6	System Safety	3.4.6.1.2	Cargo Winch
3.3.6	System Safety	3.4.6.1.3	External Cargo Removal and Replacement Device
3.3.6	System Safey	3.4.6.2	Cargo Weight and Balance
3.3.6	System Safety	3.4.9.1	Shipboard Tipback and Turnover
3.3.6.1	Air Vehicle Non-Combat Loss Rate	3.1.4	Reliability
3.3.6.1	Air Vehicle Non Combat Loss Rate	3.3.10.1	Loss Rate
3.3.6.1	Air Vehicle Non Combat Loss	3.3.10.1.2	Fire and Explosion Protection

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Air System Para #	Air System Title	Air Vehicle Para #	Air Vehicle Title
	Rate		
3.3.6.1	Air Vehicle Non Combat Loss Rate	3.3.5.1.1	Damage/Fault Tolerance
3.3.6.1	Air Vehicle Non Combat Loss Rate	3.3.5.1.2	Operational Period/Inspection
3.3.6.1	Air Vehicle Non Combat Loss Rate	3.3.6.2	Marking Of Cargo Compartments
3.3.6.1	Air Vehicle Non Combat Loss Rate	3.3.7	Diagnostics and Health Management
3.3.6.1	Air Vehicle Non Combat Loss Rate	3.3.7.1	Diagnostics Fault Detection and Fault Isolation
3.3.7.1	Weapons	3.1.2.1.1	Weapons Delivery
3.3.7.1	Weapons	3.1.8.1.1.1	Radar Cross Section
3.3.7.1	Weapons	3.1.8.1.1.2	Infrared Signature
3.3.7.1	Weapons	3.1.8.1.1.3	Visual Signature
3.3.7.1	Weapons	3.1.8.1.1.5	Emission Control
3.3.7.1	Weapons	3.1.8.1.1.6	Electronic Protection
3.3.7.1	Weapons	3.1.9.1	Target Detection, Track, Identify, and Designation
3.3.7.1	Weapons	3.1.9.3	Air-to-Surface Accuracy
3.3.7.1	Weapons	3.1.9.4	Simultaneous Release and Control of Precision Guided Munitions
3.3.7.1	Weapons	3.1.9.5	Weapons Selection and Release Control
3.3.7.1	Weapons	3.1.9.6	Gun Accuracy and Control
3.3.7.1	Weapons	3.3.10.2.3	Energetics
3.3.7.1	Weapons	3.4.2.1	Store Interface
3.3.7.1	Weapons	3.4.2.1.1	Nuclear Weapon Interface
3.3.7.1	Weapons	3.4.2.1.2	Electrical Interface
3.3.7.1	Weapons	3.4.2.1.3	Store Alignment
3.3.7.1	Weapons	3.4.2.1.4	Ejector Unit Cartridges
3.3.7.1	Weapons	3.4.2.1.5	Store Clearances
3.3.7.1	Weapons	3.4.2.2	Weapon and Store Loadouts
3.3.7.1	Weapons	3.4.2.3	Gun Interface
3.3.7.2	Sensor Pods	3.1.8.1.1.1	Radar Cross Section
3.3.7.2	Sensor Pods	3.1.8.1.1.2	Infrared Signature
3.3.7.2	Sensor Pods	3.1.8.1.1.3	Visual Signature
3.3.7.2	Sensor Pods	3.1.8.1.1.5	Emission Control
3.3.7.2	Sensor Pods	3.1.8.1.1.6	Electronic Protection
3.3.7.2	Sensor Pods	3.1.9.1	Target Detection, Track, Identify, and Designation
3.3.7.2	Sensor Pods	3.1.9.3	Air-to-Surface Accuracy
3.3.7.2	Sensor Pods	3.1.9.4	Simultaneous Release and Control of Precision Guided Munitions
3.3.7.2	Sensor Pods	3.1.9.5	Weapons Selection and Release Control
3.3.7.2	Sensor Pods	3.1.9.6	Gun Accuracy and Control
3.3.7.2	Sensor Pods	3.4.2.1.3	Store Alignment
3.3.7.2	Sensor Pods	3.4.2.1.4	Ejector Unit Cartridges
3.3.7.2	Sensor Pods	3.4.2.1.5	Store Clearances
3.3.7.2	Sensor Pods	3.4.2.2	Weapon and Store Loadouts

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Air System Para #	Air System Title	Air Vehicle Para #	Air Vehicle Title
3.3.7.3	Cargo	3.3.6.2	Marking Of Cargo Compartments
3.3.7.3	Cargo	3.4.6	Cargo and Payload
3.3.7.3	Cargo	3.4.6.1	Cargo Handling
3.3.7.3	Cargo	3.4.6.1.2	Cargo Winch
3.3.7.3	Cargo	3.4.6.1.3	External Cargo Removal and Replacement Device
3.3.7.3	Cargo	3.4.6.2	Cargo Weight and Balance
3.3.7.4	Other Stores	3.1.8.1.1.1	Radar Cross Section
3.3.7.4	Other Stores	3.1.8.1.1.2	Infrared Signature
3.3.7.4	Other Stores	3.1.8.1.1.3	Visual Signature
3.3.7.4	Other Stores	3.1.8.1.1.5	Emission Control
3.3.7.4	Other Stores	3.1.8.1.1.6	Electronic Protection
3.3.7.4	Other Stores	3.1.8.2.2	Defense Countermeasures
3.3.7.4	Other Stores	3.3.10.2.3	Energetics
3.3.7.4	Other Stores	3.4.2.1	Store Interface
3.3.7.4	Other Stores	3.4.2.1.2	Electrical Interface
3.3.7.4	Other Stores	3.4.2.1.3	Store Alignment
3.3.7.4	Other Stores	3.4.2.1.4	Ejector Unit Cartridges
3.3.7.4	Other Stores	3.4.2.1.5	Store Clearances
3.3.7.4	Other Stores	3.4.2.2	Weapon and Store Loadouts
3.3.8	System Usage Information Collection and	3.1.7	Communication
3.3.8	System Usage Information Collection and Retrieval	3.3.7	Diagnostics and Health Management
3.3.8	System Usage Information Collection and Retrieval	3.3.7.1	Diagnostics Fault Detection and Fault Isolation
3.3.8	System Usage Information Collection and Retrieval	3.3.8.1	Information Collection
3.3.8	System Usage Information Collection and Retrieval	3.3.8.2	Crash Recording
3.3.8	System Usage Information Collection and Retrieval	3.3.9	Security
3.3.8	System Usage Information Collection and Retrieval	3.4.4.2.1.5.2	Certifying the Air Vehicle for Flight
3.3.9	Human Systems	3.1.8.2.6.2	Chemical and Biological Personal Protection
3.3.9	Human Systems	3.1.8.2.6.3	Chemical and Biological Decontamination
3.3.9	Human Systems	3.3.10.2.1	Pesonal Safety and Health
3.3.9	Human Systems	3.3.10.2.3	Energetics
3.3.9	Human Systems	3.3.11.1	Flying Qualities, Fixed Wing
3.3.9	Human Systems	3.3.11.1.1	Primary Requirements for Air Vehicle States In Common Atmospheric Conditions
3.3.9	Human Systems	3.3.11.1.1.1	Allowable Levels for Air Vehicle Normal States
3.3.9	Human Systems	3.3.11.1.1.2	Allowable Levels for Air Vehicle Extreme States
3.3.9	Human Systems	3.3.11.1.1.3	Primary Requirements for Failure States

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Air System Para #	Air System Title	Air Vehicle Para #	Air Vehicle Title
3.3.9	Human Systems	3.3.11.1.1.3.1	Probability of Encountering Degraded Levels of Flying Qualities
3.3.9	Human Systems	3.3.11.1.1.3.2	Allowable Levels for Specific Air Vehicle Failure States
3.3.9	Human Systems	3.3.11.1.1.3.3	Failures Outside the ROTH
3.3.9	Human Systems	3.3.11.1.2	Flying Qualities Degradation in Atmospheric Disturbances
3.3.9	Human Systems	3.3.11.1.3	Control Margins
3.3.9	Human Systems	3.4.11	Furnishings
3.3.9	Human Systems	3.4.2.3	Gun Interface
3.3.9	Human Systems	3.4.4	Human vehicle Interface
3.3.9	Human Systems	3.4.4.1.1	Aircrew Anthropometrics
3.3.9	Human Systems	3.4.4.1.2	Aircrew Ingess/Egress
3.3.9	Human Systems	3.4.4.1.3	Emergency Egress
3.3.9	Human Systems	3.4.4.1.4	Aircrew Survival and Rescue
3.3.9	Human Systems	3.4.4.1.5	Controls and Displays
3.3.9	Human Systems	3.4.4.1.6	Warnings, Cautions and Advisories
3.3.9	Human Systems	3.4.4.1.7	Interior Vision
3.3.9	Human Systems	3.4.4.1.8	Exterior Vision
3.3.9	Human Systems	3.4.4.2	Maintainer Vehicle Interface
3.3.9	Human Systems	3.4.4.2.1	Air Vehicle States
3.3.9	Human Systems	3.4.4.2.1.1	Maintainer/Aircrew Communication
3.3.9	Human Systems	3.4.4.2.1.2	Air Vehicle Stabilization
3.3.9	Human Systems	3.4.4.2.1.4	Diagnostic Function Interface
3.3.9	Human Systems	3.4.4.2.1.4.1	Power-Off Transition
3.3.9	Human Systems	3.4.4.2.1.4.2	Power-On Transition
3.3.9	Human Systems	3.4.4.2.1.4.3	Servicing Indications
3.3.9	Human Systems	3.4.4.2.1.5	Servicing Interfaces
3.3.9	Human Systems	3.4.4.2.1.5.1	Stores Loading
3.3.9	Human Systems	3.4.4.2.1.5.2	Certifying the Air Vehicle for Flight
3.3.9	Human Systems	3.4.4.2.1.6.1	Accessibility
3.3.9	Human Systems	3.4.4.2.1.6.1.1	Mounting, Installation and Alignment
3.3.9	Human Systems	3.4.4.2.1.6.1.2	Adjustment Controls
3.3.9	Human Systems	3.4.4.2.1.6.1.3	Weight Limitations
3.3.9	Human Systems	3.4.6.1.3	External Cargo Removal and Replacement Device
3.4	Interfaces	3.1.3	Mission Planning
3.4	Interfaces	3.1.7	Communication
3.4	Interfaces	3.4.1	Interoperablity
3.4	Interfaces	3.4.12.1	Primary Fuel
3.4	Interfaces	3.4.12.2	Alternate Fuel
3.4	Interfaces	3.4.12.3	Restricted Fuel
3.4	Interfaces	3.4.12.4	Emergency Fuel
3.4	Interfaces	3.4.3	Communication, Radio Navigation, and Identification Interfaces
3.4	Interfaces	3.4.5	Transportability
3.4	Interfaces	3.4.7.1.1	Ground Refueling Interfaces
3.4	Interfaces	3.4.7.1.2	Defueling Interfaces
3.4	Interfaces	3.4.7.2.1	Receiver Interfaces

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Air System		Air Vehicle	
Para #	**Title**	**Para #**	**Title**
3.4	Interfaces	3.4.7.2.2	Tanker Interfaces
3.4	Interfaces	3.4.9	Ship Compatibility
3.4	Interfaces	3.4.9.1	Shipboard Tipback and Turnover
3.4.1.2	Facility Interfaces	3.4.8	Facility Interfaces
3.4.1.3	Common Support Equipment	3.1.6	Integrated Combat Turnaround Time
3.4.1.3	Common Support Equipment	3.4.10	Support Equipment Interface
3.5	Manufacturing	3.5	Manufacturing
3.6.1	Maintenance Concept	3.1.5	Maintainability
3.6.1	Maintenance Concept	3.4.10	Support Equipment Interface
3.6.3	Protective Structures	3.4.8	Facility Interfaces
3.6.4	Packaging, Handling, Storage, and Transportation	3.4.5	Transportability
3.6.4	Packaging, Handling, Storage, and Transportation	3.4.5.1	Transportability
3.7.1	Training Capability	3.7.1	Embedded Training
3.7.2	Training Types	3.7.1	Embedded Training
3.7.3	On Equipment Training	3.7.1	Embedded Training
3.8	Disposal	3.8	Disposal
No Tier I Links Established Yet		3.4.4.3	Passenger Interfaces
TBD	Support System Specification Guide	3.4.10	Support Equipment Interface

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AIR SYSTEM

JOINT SERVICE SPECIFICATION GUIDE

APPENDIX B

REFERENCED DOCUMENTS MATRIX

B.1 SCOPE

B.1.1 Scope.

This appendix is for guidance only. This appendix identifies the documents referenced in this specification guide. It is not intended to be part of a program specification. Rather, it is provided to assist users of the specification guide in developing a program-unique specification by identifying, in a single location, all the documents referenced in this specification guide. Applicable documents required in a program-unique specification as a result of tailoring this guide are listed in section 2 of that tailored air system program specification.

B.2 APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

B.3 REFERENCED DOCUMENTS

Table B-1lists the documents referenced in the Air System Joint Service Specification Guide in column 1. Column 2 of the table identifies the location(s) in the specification template or handbook in which the documents are referenced. Documents referenced in a requirement paragraph (3.x), a verification paragraph (4.x), or suggested in the guidance sections of the Handbook (Part II), are candidate references that may be cited in sections 3 or 4 of a program-unique specification. Such references are candidates only and are subject to program-specific tailoring. Note that policy documents, including but not limited to regulations, instructions, and directives, may not be cited as mandatory references in the tailored specification.

TABLE B-1. Documents referenced in the Air System Joint Service Specification Guide.

Document Title and Date	Reference Location
Air Force Doctrine Document 1, September 1997	3.1.7.3 Requirement Rationale
AFI 63-104 Operational Flight Program	6.1.24 Definition
AFI 63-1001	3.3.1.2 Requirement Guidance
AFI 91-101 Air Force Nuclear Weapons Surety Program	3.3.3 Requirement Rationale
AFI 91-102 Air Force Weapon System Safety Studies, Operational Safety Reviews, and Safety Rules	3.3.3 Requirement Guidance
AFI 91-103 Air Force Nuclear Safety Certification Program	3.3.3 Requirement Guidance
AFI 91-107 Design, Evaluation, Troubleshooting, and Maintenance Criteria for Nuclear Weapon Systems	3.3.3 Requirement Guidance

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Document Title and Date	Reference Location
AFI 91-108 Air Force Nuclear Weapons Intrinsic Radiation Safety Program	3.3.3 Requirement Guidance
AFPD 91-1 Nuclear Weapons and Systems Surety	3.3.3 Requirement Guidance
Department of Defense Index of Specifications and Standards (DoDISS)	2.1.1, 2.2
DoD 3150.2 Safety Studies and Reviews of Nuclear Weapons Systems	3.3.3 Requirement Rationale
DoD 5000.2	3.1.1 Guidance 3.3.1.3 Requirement Rationale
Integrated Performance Based Business Environment Guide	6.3 Guidance
Joint Pub 1-02, 15 Apr 98	6.1 Definitions
Joint Technical Architecture	3.3.1.1 Requirement Guidance
MIL-STD-1822 Nuclear Certification of Weapon Systems, Subsystems, and Associated Facilities and Equipment	3.3.3 Requirement Rationale
MIL-STD-130 Identification Marking of U.S. Military Property	3.3.1.4 Requirement Guidance
MIL-STD-461Requirements for the control of Electromagnetic Interference Characteristics of Subsystems and Equipment	3.3.4 Requirement Lessons Learned
MIL-STD-464 Electromagnetic Environmental Effects Requirements for Systems	3.3.4 Requirement Guidance 3.3.4 Requirement Lessons Learned
MIL-STD-1366, Transportability Criteria	3.6.8 Requirement Guidance
MIL-STD-2073/1, DOD Standard Practice for Military Packaging	3.6.8 Requirement Guidance
National Institute of Standards and Technology (NIST) Publication 500-235	3.3.1.1 Requirement Guidance
Performance Based Product Definition Guide	3.3.1.1.1 Requirement Guidance
Pub. L. 98-525 (42 U.S.C. B (beta) 7158 Note)	2.4
“Specifications and Standards - a New Way of Doing Business” SECDEF Memorandum of 29 June 1994	Foreword, 2.4

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AIR SYSTEM

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APPENDIX C

SYSTEM INTEGRITY CONCEPT

C.1 SCOPE

C.1.1 Scope.

This appendix comprises a discussion of the system integrity concept. This appendix is for guidance only.

C.2 APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

C.3 SYSTEM INTEGRITY CONCEPT DISCUSSION

System integrity is not a performance requirement per se; however, it impacts numerous aeronautical system requirements and their verification. It is an overarching expectation that performance will be achieved and sustained for a period of time without corrective action; and that when the performance does degrade below minimums, it can be restored by corrective action. Examples include an engine that would continue to provide its minimum rated thrust throughout a given period of usage without maintenance actions, or aircraft structures that continue to provide the necessary strength to allow safe and effective flight throughout its use conditions for a specified period of time.

System integrity is tied very closely to concepts sometimes expressed as robust systems (systems that are insensitive to the environments experienced throughout the system's life cycle and easily repaired under adverse conditions); and robust design (design of a system such that its performance is insensitive to variations during its manufacturing, or in its operational environment -- including maintenance, transportation, and storage -- and the system continues to perform acceptably throughout its life-cycle despite component drift or aging).

A key viewpoint in understanding the implications of a robust approach to system integrity is that a “break” does not simply equate to a failure to operate. Rather, a more stringent perspective is necessary. That is, a “break” occurs when an item no longer provides its required performance. Is the system still usable given such a break? Maybe, but the performance required is no longer being delivered. Thus, operational conditions and tempo may make it necessary to operate at degraded levels, but the warfighter will need to understand the ramifications.

The implications are that system integrity can only be realized via a tightly integrated set of complementary performance expectations and achievements. These include

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- the environments to which the system (and its associated equipment) is exposed,
- the utilization profiles of the system (and it associated equipment),
- the relationship between the performance an item must provide and the tolerances to which it must be built,
- the margin for performance degradation that must be designed into the items to provide the durability needed for cost effective operations and support,
- the capability of the manufacturing processes to provide products that achieve the requisite performance, and
- the capability of the maintenance processes to restore the expected performance.

C.3.1 Integrity concept.

Figure C-1 conceptually addresses the problem that a comprehensive approach to system integrity is intended to address. That is, over time, the performance of items changes. Changes may come abruptly, which is frequently the case with electronic parts that tend to operate close to their initial performance and then suddenly cease to function. Changes may also occur gradually, even in electronic components, as aging, stresses and strains, wear, etc. impact the capability of the component to operate at or near its initial performance. The purpose of a comprehensive system integrity approach is to understand how the performance of an item changes with its manufacturing, operating, and support conditions and to plan for it in terms of identifying the most appropriate installed performance expectations, designs, manufacturing processes, maintenance, and sustainment procedures.

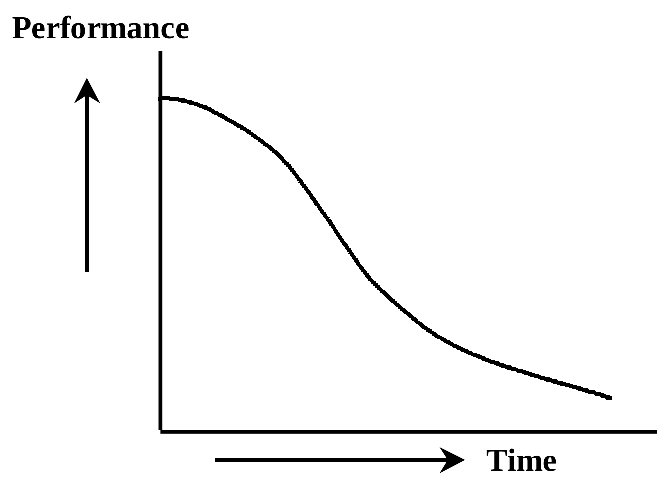

FIGURE C-1. Performance versus time.

The implications of this performance degradation are illustrated in Figure C-2. The performance required is the minimum performance expected (Pr) over some period of time (Tu). After that time, the performance may degrade to unacceptable levels. As a result, a performance margin (Pm) must be established and designed to (Dp) if the item is expected to maintain the minimum performance over a given time period. Thus, the performance values selected for use in a specification represent the minimum performance that is acceptable (Pr) with verifications

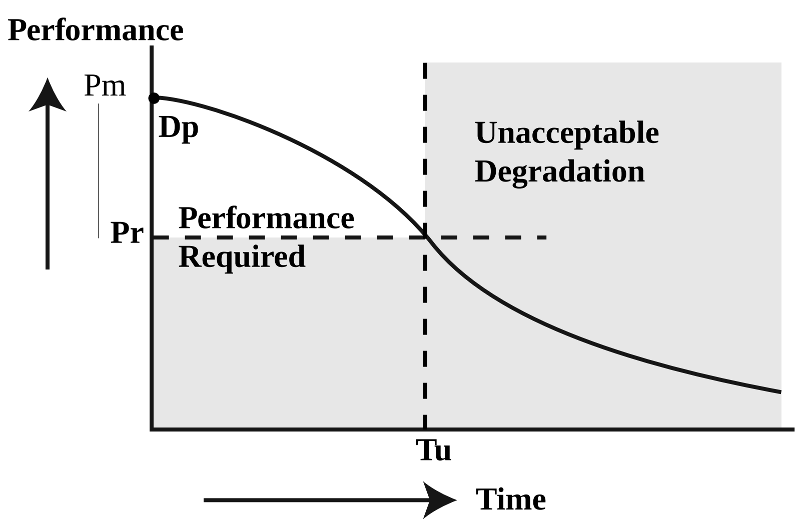

FIGURE C-2. Required Performance and Unacceptable Degradation.

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that confirm that adequate performance margins (Pm) have been established to maintain that minimum performance (Pr) throughout the given time period Tu).

If the expected period of use needs to be longer (for example as a result of design trades, performance reallocations, cost impacts etc), the performance margin (and the resulting design point) must also increase to ensure the performance the item delivers meets or exceeds the minimum performance required over that extended time, as illustrated in Figure C-3. In establishing a design point, it becomes essential to understand how the performance of an item changes with time and the time interval over which that minimum performance must be realized without corrective action. Care must be taken, frequently in concert with the warfighter, not to change the time interval arbitrarily. Once the design margins are set (even well advanced in definition) changing the duration of a period of "no corrective actions" can result in significant redesign and even reallocation of performance requirements. The warfighter may, at his discretion, choose to operate the item beyond its design limits. Agreement must be reached early enough in development so that cost-effective design points can be established with the understanding that the item may not provide the minimum performance required if it is operated beyond the durations established.

Some items may only experience degradation when they are used. Other items may exhibit the majority of their degradation not from time in a given state, but rather from the number of times they are turned on and off (for example electrical equipment) or the number of times they are cycled from a lower to higher power state (such as engines). Other items may exhibit degradation simply from storage (for example batteries, some propellants etc). Thus an understanding must be gained of both the use and non-usage conditions and their impact on the item's performance.

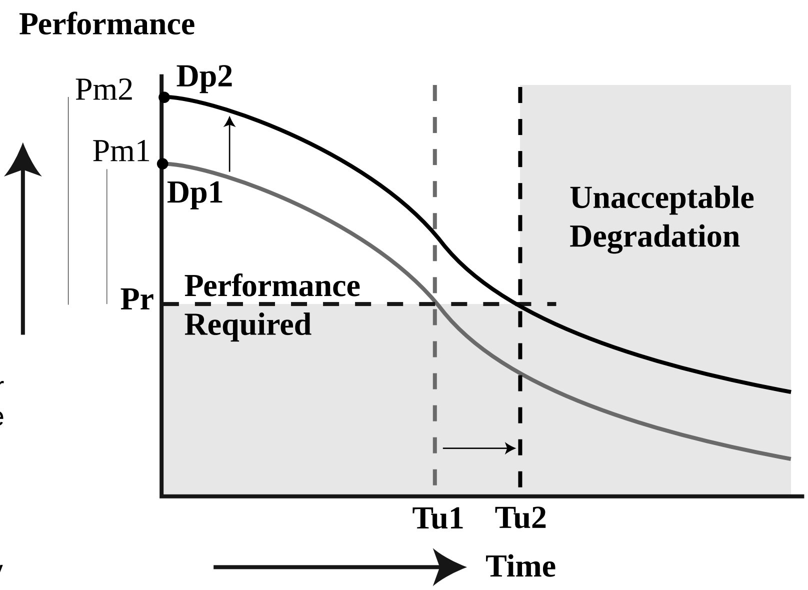

FIGURE C-3. Extending the time period.

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Unfortunately, performance degradation is not the only factor that must be addressed to establish a design point. For example, manufacturing process variation (Figure C-4) adds margins that must be considered. Larger design margins need to be allocated for manufacturing processes that exhibit a wide range of variability than for those that exhibit a narrower range, illustrated as the difference between two manufacturing processes. As a result, contractors with more capable processes may be able to design and build the product at less expense than those with less capable processes. In either case, however, the contractor must understand the capability of his processes. This is one reason to establish the performance expected and the duration for which it is expected rather than to specify an arbitrarily higher expected performance.

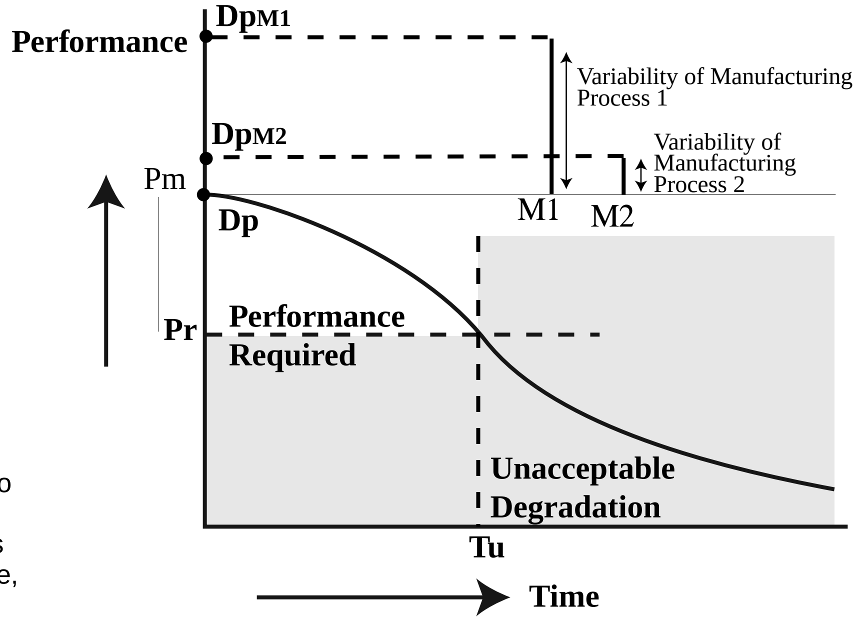

FIGURE C-4. Manufacturing impacts.

Another factor is the impact of materials (nominally illustrated in Figure C-5). Some materials can be more wear tolerant than others and exhibit less performance degradation over a given period of time, thus resulting in an ability to lower the performance margin and a change in the design point from Dp1 to Dp2. Alternatively, this figure could also be representative of a different design that is more tolerant of the environments experienced by the item.

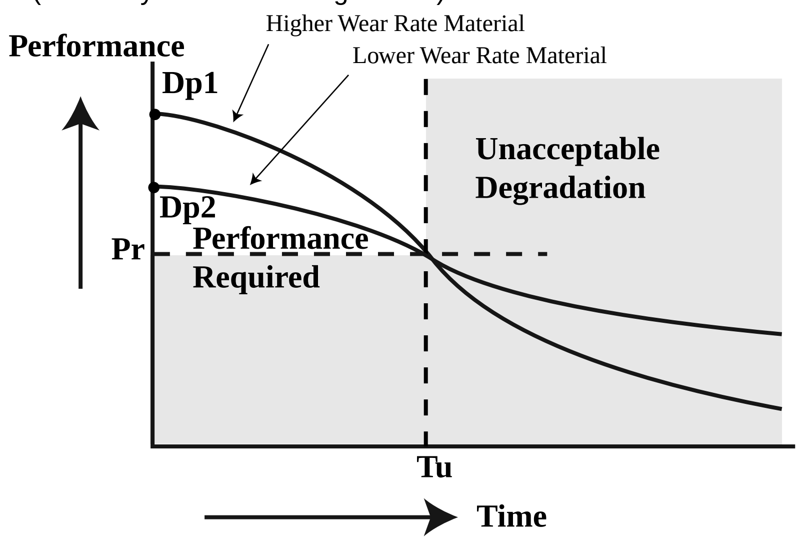

FIGURE C-5. Material impacts.

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The support environment and impacts on the support system must also be incorporated. What happens when performance eventually degrades below the performance required? It will be necessary to ensure that performance maintenance procedures are devised to recover the performance such as that illustrated in Figure C-6. Thus, planned maintenance actions need to be part of the system design to keep the required performance at acceptable levels (e.g., changing a battery at a scheduled time).

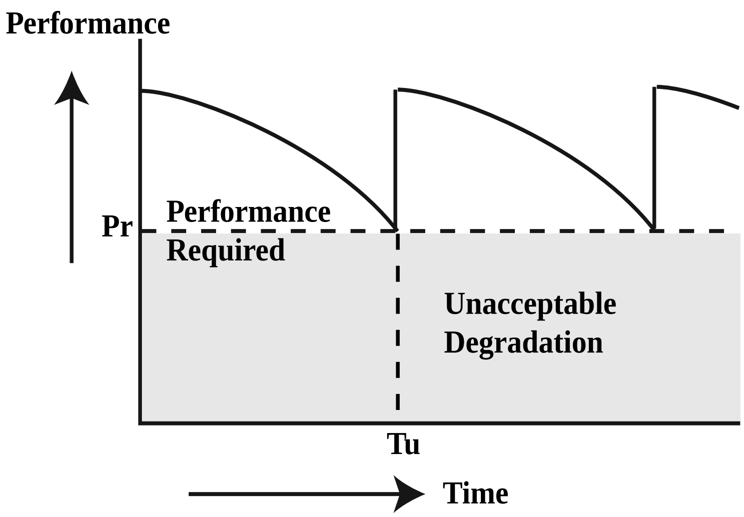

FIGURE C-6. Performance maintenance.

There are other parameters that should (must?) be considered as well. These may include additional performance margins to handle variations in or margins needed to compensate for

- crew capabilities,
- operating conditions,
- item criticality to mission success or safety,
- the degree of certainty in performance variation versus time
- time windows to schedule/perform performance maintenance (e.g., how good was the estimate of when performance maintenance needed to be conducted)

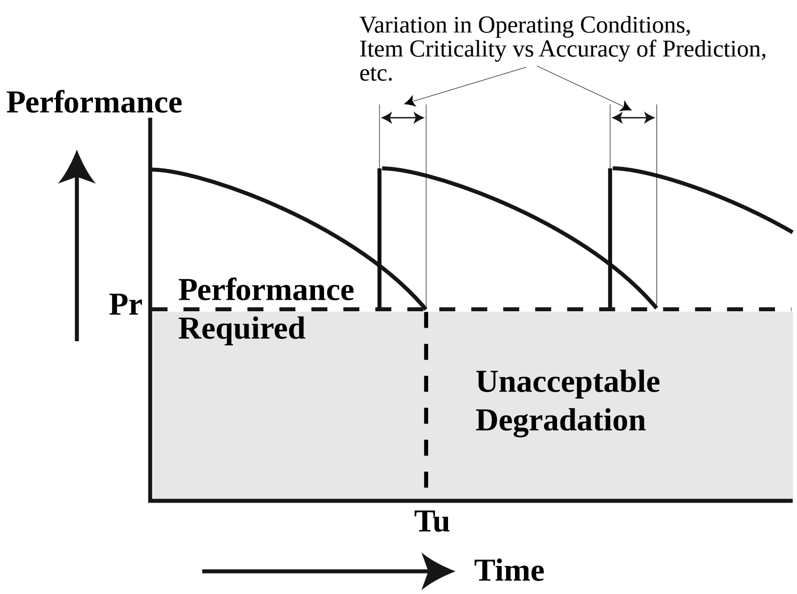

FIGURE C-7. Performance maintenance margins.

While methods of handling uncertainty in the estimation of when to conduct performance maintenance include providing an additional performance margin or to shorten the interval between periodically recurring performance maintenance actions, these may not prove to be the most cost-effective methods. They may work well when the uncertainty in Tu is small and/or the cost of additional performance margin is minimal. However, they may not be suitable when variations in operational conditions, material wear rates and characteristics, and other factors result in significant variation in performance versus time. In these circumstances, inspections, planned as part of maintenance activities and included in the system design, may prove to be of benefit.

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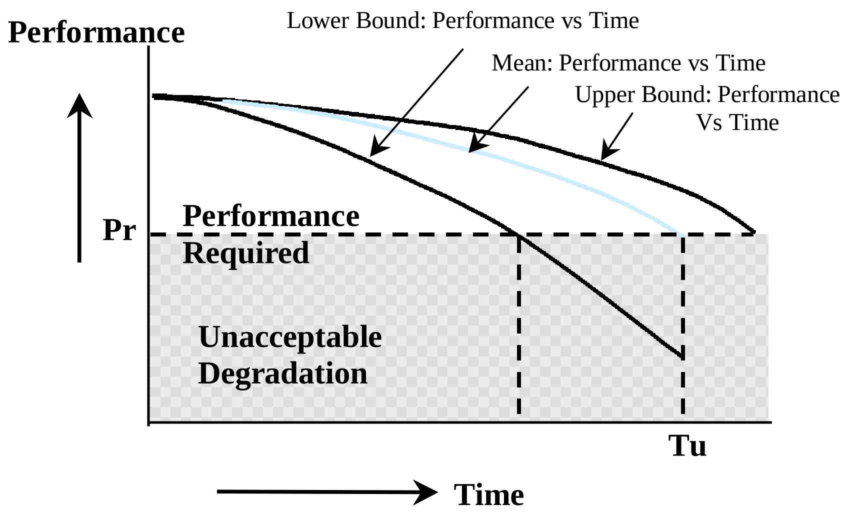

FIGURE C-8. Performance vs time uncertainty.

If a suitable performance versus time relationship can be determined such that an item will be known to exceed its minimum required performance with a high degree of certainty for some known period, inspections can be scheduled to examine the item prior to the point at which performance variation results in a significant likelihood of failure to achieve required performance. Such a relationship is depicted in Figure C-8. Note that, while the mean value of the performance vs time relationship shows a "long" Tu, the lower boundary (confidence limits need to be established) of the performance versus time relationship indicates that there is a significant probability (significance would be based on the confidence limits used) that the item would fail to provide the required performance at some time Ti. Inspections could be scheduled prior to Ti. If such inspections revealed that the item was operating near the upper boundary, an option would be to take no further action. If the item were operating below the mean, it may be time for performance maintenance actions. The decisions on what action to take would depend on the performance as inspected, its relationship to the performance variation curves, and the time interval between the inspection point and an estimate of when the performance provided will no longer exceed the minimum required.

From a design solution perspective, there are numerous alternatives to implementing a system integrity approach. These include

- Establishing an interval (Tu) at which time performance maintenance will be performed
- Establishing performance margins to control when Tu occurs and ensuring such margins incorporate impacts of material wear, aging, operational variation, manufacturing process variation, uncertainty in estimating Tu, etc.
- Inspecting item performance at an interval Ti, at which point it is known with a high degree of certainty that item performance meets or exceeds the performance required
- Tracking item performance over time (i.e., flight history information) and using that information as the trigger point for performance maintenance and to provide "measured" data to refine the performance vs time curves
- Incorporating diagnostics that signal when performance has degraded below an established threshold (the performance required, Pr, or some margin above it).
- etc.

The determining factor on what combination of approaches is appropriate can be driven by:

- requirements such as system life cycle and safety
- cost-benefit of inspection versus planned remove, replace and refurbish or throw away
- cost-benefit of implementing diagnostics or tracking flight history information
- etc.

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Regardless of the way performance degradation is addressed in the design, our job is to state what is expected (performance required over a given duration) and then verify that all pertinent factors were addressed in the design. These factors include the planned (expected) utilization of items, the characteristics of parts/materials and their relationship to an item's performance, maintenance concepts, component/material wear characteristics versus utilization, the environments in which items are used, the support structure etc. Further, these factors must be sufficiently understood, documented, and accounted for in order to enable the needed planning for cost-effective performance maintenance.

Under the Performance-Based Business Environment concept, there are additional factors to consider. For example, procurement of replacement parts/items using approaches such as F3I (Form, Fit, Function, and Interface) or a MBTP (Modified Build to Print - where the contractor is given the latitude of using his own production processes rather than those used in the original design and manufacturing). In principle, both reprocurement approaches are backed by sufficient data. The reality may be somewhat different.

With the MBTP approach, the risk lies in adequate characterization of the original manufacturing processes and incorporating that information accurately in the design package as a requirement to meet. These risks may be small. On the other hand, the F3I relies on having a complete and accurate characterization of all the product characteristics that significantly impact the item's performance. The ability to ensure such characterization is where the risk lies. This risk can be mitigated by ensuring that a comprehensive, as installed, full cycle (i.e., complete verification using all the criteria employed in the original incremental verifications used to confirm that required performance would be achieved throughout EMD). This can get very expensive -- so expensive that it can preclude employment of the approach.

A strategy to mitigate the risks is necessary. One method to decrease the overall costs could involve being more thorough with parts/items that are mission- or safety-critical and less thorough with other parts/items. Still, the dilemma remains as to "how thorough" verifications need to be to establish that sufficient verification has been accomplished. While there are no easy answers, handling this situation as a risk with emphasis on consequences of failure can redress some of the problems. For example, is the consequence of failure loss of life or is it simple injury? Is the consequence inability to detect a target or is it mission survival? Considering these factors may provide some relief on the thoroughness of the verifications needed. Some level of risks to be accepted may need to be addressed in reprocurement actions. These types of issues tend to provide a strong argument for tracking supplier capability (capability as evidenced by the consistent quality of his products) and using this information in selecting appropriate reprocurement sources.

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