CH 5–1. Purpose

The Defense Acquisition Guidebook (DAG), Chapter 5, addresses Manpower Planning and Human Systems Integration (HSI) in the Defense Acquisition process. It provides guidance for including a total-systems approach; documenting manpower, personnel and training elements; and use of program manager tools that incorporate HSI considerations in the acquisition process appropriately. It also explains how HSI minimizes total ownership costs over the life cycle of a program.

CH 5–2. Background

Manpower Planning and HSI are integral parts of the Defense Acquisition Process. They focus on the role of the human in the Department of Defense (DoD) Acquisition process, and the significance manpower plays in the total ownership costs to operate, maintain, train, and support a system over the course of its life cycle. Without Manpower Planning, programs can miss pertinent key elements of HSI, suffer from millions of dollars in unnecessary costs, and result in harm to the warfighter. HSI's objective is to provide equal consideration of the human element along with the hardware and software processes for engineering a system that optimizes total system performance and minimizes total ownership costs. In addition, with the requirement for PMs to address supportability early in the early phases of the program, HSI is a key element of both engineering and supportability/logistics processes.

CH 5–2.1 Manpower Planning and Human Systems Integration

Manpower is typically the highest cost driver in the development and sustainment of acquisition programs, and can account for 67-70 percent of the program budget. When Manpower Planning is engaged along with HSI, PMs have the tools to effectively manage systems and to ensure that the human element of the system is included in the pros, cons, and risks of using a program.

CH 5–2.1.1 Manpower Planning Role in Human Systems Integration

The role of Manpower planning is to establish the right mix of personnel required for a program: military (Active, Guard, and Reserve), government civilians (U.S. and foreign nationals) and contract support manpower. Manpower analysts determine the number of people required, authorized, and available to operate, maintain, support and train for the system. Requirements are based on the range of operations during peacetime, low-intensity conflict and wartime, and should consider continuous, sustained operations, and required surge capability.

CH 5–2.2 Human Systems Integration Payoff

The payoff of utilizing HSI in all acquisition planning is enormous. Cost benefits include improved manpower utilization, reduced training costs, reduced maintenance time, and improved user acceptance decrease overall program costs. Improved operational performance can result in fewer errors, and improved design trade-off decisions can reduce life-cycle costs and decrease the need of redesigns and retrofits. Section 4.2 discusses the HSI domains, which should be considered for acquisition planning.

CH 5–3. Best Practice

DoD Instruction 5000.02 (Encl. 7) requires the PM to work with the manpower community to determine the most efficient and cost-effective mix of DoD manpower and contract support, and to identify any issues (e.g., resource shortfalls) that could impact the PM's ability to execute the program. This collaboration is conducted within the HSI framework to ensure integration with the other HSI domains.

The HSI lead for a program/project should be able to draw expertise from the manpower community to provide program assistance. For example, the decision to use Government civilians or contract labor where there is a high likelihood of hostile fire should be carefully considered. Additionally, the PM should consult with the manpower community in advance of planning for operational support services, to ensure that a sufficient workload is retained in-house to provide for career progression, sea-to-shore and overseas rotation, and combat augmentation adequately. The PM should also ensure that inherently governmental and exempted commercial functions are not contracted. These determinations should be based on current Workforce Mix Guidance DoDI 1100.22 (Encl. 7).

The PM should evaluate the manpower required and/or available to support a new system, and consider manpower constraints when establishing contract specifications to ensure that the human resource demands of the system do not exceed the projected supply. This assessment shall determine whether the new system requires a higher, lower or equal number of personnel than the predecessor system, and whether the distribution of ranks/grade will change. Critical manpower constraints should be identified in the Departments' capability documents to ensure that manpower requirements remain within DoD Component end-strength constraints. If sufficient end strength is not available, a request for an increase in authorizations should be submitted and approved as part of the trade-off process.

When assessing manpower, the system designers should examine labor-intensive, “high-driver” tasks. Moreover, these high-driver tasks might result from hardware design or hardware/software interface design problems. These tasks can sometimes be eliminated during engineering design by increasing equipment or software performance. Based on a top-down functional analysis, an assessment should be conducted to determine which functions should be automated, eliminated, consolidated or simplified to keep the manpower numbers within constraints.

Manpower requirements should be based on task analyses, which consider all factors, including fatigue; cognitive, physical and sensory overload, and environmental conditions (e.g., heat/cold); and reduced visibility. Additionally, manpower requirements should be calculated in conjunction with personnel capabilities, training and human factors engineering trade-offs.

Tasks and workload for individual systems, systems-of-systems and families-of-systems should be reviewed together to identify commonalities, merge operations and avoid duplication. The cumulative effects of systems-of-systems, families-of-systems and related systems integration should be considered when developing manpower requirements.

When reviewing support activities, the PM should work with manpower and functional representatives to identify process improvements, design options or other initiatives to reduce manpower requirements, improve the efficiency or effectiveness of support services or enhance the cross-functional integration of support activities.

The support strategy should consider the approach used to provide for the most-efficient and cost-effective mix of manpower and contract support. The support strategy should also identify any cost, schedule, performance issues; or uncompleted analyses that could impact the PM's ability to execute the program.

CH 5–3.1 Manpower Planning

The requirements of manpower planning for MDAPS are included in Operating and Support Cost-Estimating Guide (para 3.10.1 – Page 3-20) for inclusion in the Cost Assessment and Program Evaluation (CAPE) Cost Analysis Requirements Description (CARD). Additionally, manpower-planning documentation is used by Service components to estimate the number and types of people needed for specific programs and by personnel and training communities to plan and forecast their program requirements.

DoD components should require manpower planning documentation for all Acquisition Category (ACAT) I through ACAT IV programs to support development of CARD and Life Cycle Sustainment Estimates.

At program initiation, the Service component manpower authority and PM, in consultation with the MDA, should agree to reporting requirements and assumptions for manpower planning based on ACAT level and on whether the program has significant manpower implications.

Required and recommended data elements of manpower planning should meet CARD and/or Life Cycle Cost Estimate content requirements. Lower level ACAT/AAP programs with little to no manpower implications/risks may not need extensive manpower planning documentation. PMs should agree upon required manpower planning with the component manpower authority. The component manpower authority should approve the manpower planning for MDAP and designated manpower-significant programs prior to submission of the program CARD at major milestones.

Additionally, USD (P&R) promulgates separate and specific guidance concerning acquisition-related Total Force manpower planning. This guidance addresses the enduring need to provide Total Force manpower projections -- active/reserve military, Government civilians, and contracted services for the ICE/CARD.

This ensures that manpower plans are feasible and affordable and result in desired operational and support capabilities.

CH 5–3.2 Total Systems Approach

The total systems approach includes equipment and software as well as people who operate, maintain and support the system; training requirements and training devices; and the operational and support infrastructure. HSI practitioners assist PMs by focusing attention on the human part of the system, and by integrating and inserting manpower, personnel, training, human factors engineering, environment, safety, occupational health hazards and personnel survivability considerations into the Defense Acquisition process. Consistent with DoDI 5000.02 (Encl.7), when addressing HSI, the PM should address each of the "domains" of HSI. A comprehensive integration within and across these domains is required, as outlined in Section 4.2 of this chapter. Chapter 1 Section 3.3.5 discusses Integrated Product and Process Development (IPPD) and Integrated Product Teams (IPTs) for acquisition planning activities.

IPPD is a management technique that integrates all acquisition activities, starting with a capabilities definition through systems engineering, production, fielding/deployment and operational support in order to optimize the design, manufacturing, business and supportability processes. At the core of the IPPD technique are IPTs. HSI should be a key consideration during the formation of IPTs. HSI representatives should be included as members of systems engineering and design teams and other IPTs that deal with human-oriented acquisition issues or topics. The various HSI domain experts should have the opportunity to work in an integrated structure to impact the system comprehensively. Domain experts working different IPT structures may make significant changes/inputs to the system without fully appreciating the effects their changes may have on other domains. Only by working closely together can the HSI practitioners bring an optimum set of human interfaces to the Systems Engineering and Systems Acquisition Processes.

HSI participants assist in IPPD as part of the IPTs by ensuring the HSI parameters/requirements in the Initial Capabilities Document (ICD), Capability Development Document, and Capability Production Document are based upon and consistent with the user representative's strategic goals and strategies. These parameters/requirements are addressed throughout the acquisition process, starting in the Capabilities-Based Assessment (CBA) and ICD and continuing throughout the engineering design, trade-off analysis, testing, fielding/deployment and operational support phases.

Performance and HSI domain issues, identified in legacy systems and by design capability risk reviews, are used to establish a preliminary list for risk management. These issues should be evaluated and managed throughout the system's life cycle at a management level consistent with the hazard.

The tools, methodologies, risk-assessment/mitigations, and set of assumptions used by the acquisition community to assess manpower and personnel and training requirements, measure human-in-the-loop system performance, and evaluate safety, occupational health hazards, survivability and habitability, need to be consistent with what the functional communities/user representatives use to evaluate performance and establish performance based metrics.

The HSI participants should ensure that the factors used by the acquisition community to develop cost estimates are consistent with:

- Manpower and personnel documentation requirements,
- Training requirements reported in the DoD Component training plans, and
- Assessments of safety and health hazards documented in the Programmatic Environment, Safety, and Occupational Health Evaluation documentation.

The HSI participants should also ensure that the Manpower Estimates and Training Strategies reported during the acquisition milestone reviews are reflected in the manning documents, training plans, personnel rosters, and budget submissions when the systems are fielded.

CH 5–3.3 Human Systems Integration References

Table 1 contains HSI-related policy and direction.

Table 1: Human Systems Integration Related Policy and Direction

Issuance Number	Title
DoD Directive 1100.4	Guidance for Manpower Programs
DoD Directive 1322.18	Military Training
DoD Instruction 1100.22	Guidance for Determining Workforce Mix
DoD Instruction 1322.26	Development, Management and Delivery of Distributed Learning" Training Transformation Implementation Plan
CJCS Instruction 3170.01	Joint Capabilities Integration and Development System
JCIDS Manual	Operation of the Joint Capabilities Integration and Development System
Joint Military Dictionary (JP 1-02)	Department of Defense Dictionary of Military and Associated Terms
AR 602-1	Human Factors Engineering Program
AR 602-2	Manpower and Personnel Integration (MANPRINT) in the Systems Acquisition Process

Table 2 contains military standards (MIL-STD), DoD handbooks (DOD-HDBK) and), military handbooks (MIL-HDBK); standard practices that may be used to support HSI analysis.

Table 2: HSI Discretionary Practices

Issuance Number	Title
MIL-STD-882E	DoD Standard Practice for System Safety
MIL-STD-1472	DoD Design Criteria Standard: Human Engineering
MIL-STD-46855A	DoD Standard Practice, Human Engineering Requirements for Military Systems, Equipment and Facilities
DOD-HDBK-743	Anthropometry of U. S. Military Personnel
MIL-PRF-29612	Performance Specification, Training Data Products A Guide for Early Embedded Training Decisions
ASTM F1166-07	Standard Practice for Human Engineering Design for Marine Systems, Equipment and Facilities
ASTM F1337-10	Standard Practice for Human Systems Integration Program Requirements for Ships and Marine Systems, Equipment and Facilities

CH 5–4. Human Systems Integration

The key to a successful HSI strategy is comprehensive integration across the HSI domains, and also across other core acquisition and engineering processes. This integration is dependent on an accurate HSI plan that includes the comprehensive integration of requirements. The optimization of total system performance and determination of the most-effective, efficient and affordable design requires upfront requirements analyses. The HSI domains (manpower, personnel, training, environment, safety and occupational health, human factors engineering, survivability and habitability) can and should be used to help determine and work the science and technology gaps to address all aspects of the system (hardware, software and human).

The PM should integrate system requirements for the HSI domains with each other, and with the total system. As work is done to satisfy these requirements, it is vital that each HSI domain anticipate and respond to changes made by other domains or which may be made within other processes or imposed by other program constraints. These integration efforts should be reflected in updates to the requirements, objectives and thresholds in the Capability Development Documents.

In today's Joint environment, the integration across systems-of-systems is necessary to achieve a fully networked Joint warfighting capability. The warfighter requires a fully networked environment and must be able to operate efficiently and effectively across the continuum of systems -- from initial recognition of the opportunity to engage, through mission completion. To accomplish this, HSI domains and human capabilities and constraints should be considered in analytic assumptions and system-of-systems analysis, modeling and testing. This provides opportunities for integration, synchronization, collaboration and coordination of capabilities to meet human-centered requirements. A fully integrated investment strategy with joint sponsorship from the Materiel Development Decision on through the series of incremental developments may be required.

CH 5–4.1 Human Systems Integration Strategy, Risk and Risk Mitigation

Acquisition Systems designs have historically been overly complex; difficult to train, learn to use and operate, and maintain. Designs should enable mission/program success by being easier to train, operate, and maintain. Systems should also be safe and efficient, cost-effective, and less likely to require redesign. Inputs from the HSI domains (manpower, personnel, training, environment, safety and occupational health, human factors engineering, personnel survivability, and habitability) should be used to determine and address performance impacts to all aspects of the system (hardware, software, and human).

HSI goals are to ensure that these systems, programs, and missions incorporate effective human-systems interfaces; achieve the required level of human performance; demand economical personnel resources, skills, and training; minimize life-cycle costs; and manage risk of loss or injury to personnel, equipment, and the environment.

The ultimate goal is to ensure that HSI is considered, planned for, and implemented early in the acquisition process, and throughout the life cycle of the program. HSI planning includes the identification of HSI-related risks and the associated cost, schedule and performance impacts, as well as the associated mitigation plans to address risk. HSI-related risks should be clearly identified and included among the other risks managed and documented by the PM.

The development of an HSI strategy should be initiated early in the acquisition process, when the need for a new capability or improvements to an existing capability is first established. To satisfy the requirements of DoDI 5000.02 (Enclosure 7), the PM should have a plan for HSI in place prior to entering Engineering and Manufacturing Development. The PM should describe the technical and management approach for meeting HSI parameters in the capabilities documents, and identify and provide ways to manage any HSI-related cost, schedule or performance issues that could adversely affect program execution.

When a defense system has complex human-systems interfaces; significant manpower or training costs; personnel concerns; or safety, health hazard, habitability, survivability, or human factors engineering issues the PM should use the HSI plan to describe the process to identify solutions. HSI risks and risk mitigation should be addressed in the PM's risk-management program.

The HSI plan should address potential readiness or performance risks and how these risks should be identified and mitigated. For example, skill degradation can impact combat capability and readiness. The HSI plan should call for studies to identify operations that pose the highest risk of skill decay. When analysis indicates that the combat capability of the system is tied to the operator's ability to perform discrete tasks that are easily degraded (such as those contained in a set of procedures), solutions such as system design, procedural changes, or embedded training should be considered to address the problem. Information overload and requirements for the warfighter to integrate data from multiple sources dynamically can result in degradation of situational awareness and overall readiness. Careful consideration of common user interfaces, information sources, and system workload management should mitigate this risk. An on-board "performance measurements capability" can also be developed to support immediate feedback to the operators/maintainers and possibly serve as a readiness measure to the unit commander. The lack of available ranges and other training facilities, when deployed, are issues that should be addressed. The increased use of mission rehearsal, as part of mission planning, and the preparation process and alternatives supporting mission rehearsal should be addressed in the HSI plan. Team skills training and joint battle space integration training should also be considered in the HSI plan and tied to readiness. Additionally, HSI issues should be addressed at system technical reviews and milestone decision reviews.

The PM's Programmatic Environment, Safety and Occupational Health Evaluation (PESHE) describes the strategy for integrating Environment, Safety, and Occupational Health (ESOH) considerations into the systems engineering process and defines how PESHE is linked to the effort to integrate HSI considerations into systems engineering. The PESHE also describes how ESOH risks are managed and how ESOH and HSI efforts are integrated. It summarizes ESOH risk information (hazard identification, risk assessment, mitigation decisions, residual risk acceptance and evaluation of mitigation effectiveness). The HSI Strategy should address the linkage between HSI and ESOH and how the program has been structured to avoid duplication of effort.

PMs should establish a logistics support concept (e.g., two level, three level), training plans, and manpower and personnel concepts that when taken together, provide for cost-effective, total, life-cycle support. MIL-HDBK-29612-1A, -2A, -3A, & -4A (Development of Interactive Multimedia Instruction) may be used as a guide for Instructional Systems Development/Systems Approach to the training and education process for the development of instructional materials. Manpower, personnel and training analyses should be tied to supportability analyses and should be addressed in the HSI plan.

Program risks related to cost, schedule, performance, supportability, and/or technology can negatively impact program affordability and supportability. The PM should prepare a "fallback" position to mitigate any such negative effects on HSI objectives. For example, if the proposed system design relies heavily on new technology or software to reduce operational or support-manning requirements, the PM should be prepared with design alternatives to mitigate the impact of technology or software that is not available when expected.

CH 5–4.2 Human Systems Integration Domains

The goal of HSI is not to duplicate efforts that are owned by the Services and program stakeholders, but rather to integrate human concerns in balance with life-cycle objectives comprehensively and robustly. The effective practice of HSI requires assessing the impact of HSI domains to arrive at viable recommendations for decision makers. Combinations of the HSI domains and the additional factors of systems engineering form the trade-space for HSI inclusion in risk assessment tests and evaluations. All HSI domains should be addressed in acquisition planning efforts. HSI domains are inter-related; changes in system design or capabilities could improve one HSI domain and adversely affect another. For example, reducing manpower or increasing skill levels for a specific maintenance job could increase training demands because more is required of the people performing the job. Program trade-off decisions should include the impact on HSI domains/issues. All of the domains are defined and described in this section.

Manpower - The number of military, civilian, and contractor personnel required and available to operate, maintain, sustain and provide training for systems.

Personnel - The cognitive and physical capabilities required to train, operate, maintain, and sustain materiel and information systems.

Training - The instruction or education and on-the-job or unit training required to provide personnel and units with their essential job skills, knowledges, values, and attitudes.

Human Factors Engineering - The integration of human characteristics into system definition, design, development and evaluation to optimize human machine performance under operational conditions.

Environment, Safety and Occupational Health (ESOH) Hazards – The minimization of human or machine errors or failures that cause injurious accidents.

Survivability - The characteristics of a system that can reduce fratricide, detectability and probability of being attacked, and can minimize system damage and soldier injury.

Habitability - The consideration of the characteristics of systems focused on satisfying personnel needs that are dependent upon physical environment, such as berthing and hygiene.

CH 5–4.2.1 Manpower

Manpower factors are those job tasks, operation/maintenance rates, associated workload, and operational conditions (e.g., risk of hostile fire) that are used to determine the number and mix of military and Government civilian manpower and contract support necessary to operate, maintain, support and provide training for the system. Manpower officials contribute to the Defense acquisition process by ensuring that the PM pursues engineering designs that optimize manpower and keep human resource costs at affordable levels (i.e., consistent with strategic manpower documentation and plans). Technology-based approaches used to reduce manpower requirements and control life-cycle costs should be identified in the capabilities documents early in the process. For example, material-handling equipment can be used to reduce labor-intensive material-handling operations, and embedded training can be used to reduce the number of instructors.

CH 5–4.2.2 Personnel

Personnel factors are those human aptitudes (i.e., cognitive, physical and sensory capabilities), knowledge, skills, abilities and experience levels that are needed to properly perform job tasks. Personnel factors are used to develop the military occupational specialties (or equivalent DoD Component personnel system classifications) and civilian job series of system operators, maintainers, trainers and support personnel. Personnel officials contribute to the Defense acquisition process by ensuring that the PM pursues engineering designs that minimize personnel requirements, and keep the human aptitudes necessary for operation and maintenance of the equipment at levels consistent with what will be available in the user population at the time the system is fielded.

CH 5–4.2.2.1 Personnel Parameters/Requirements

DoDI 5000.02 (Enclosure 7) requires the PM to work with the personnel community to define the performance characteristics of the user population, or "target audience," early in the acquisition process. The PM should work with the personnel community to establish a Target Audience Description (TAD) that identifies the cognitive, physical and sensory abilities --i.e., capabilities and limitations, of the operators, maintainers and support personnel expected to be in place at the time the system is fielded. When establishing the TAD, Human Systems Integration (HSI) practitioners should verify whether there are any recruitment or retention trends that could significantly alter the characteristics of the user population over the life of the system. Additionally, HSI analysts should consult with the personnel community and verify whether there are new personnel policies that could significantly alter the scope of the user population (e.g., policy changes governing women in combat significantly changed the anthropometric requirements for occupational specialties).

Per DoDI 5000.02 (Enclosure 7), to the extent possible, systems should not be designed to require cognitive, physical or sensory skills beyond those found in the specified user population. During functional analysis and allocation, tasks should be allocated to the human component consistent with the human attributes (i.e., capabilities and limitations) of the user population to ensure compatibility, interoperability and integration of all functional and physical interfaces. Personnel requirements should be established that are consistent with the knowledge, skills and abilities (KSAs) of the user population expected to be in place at the time the system is fielded and over the life of the program. Personnel requirements are usually stated as a percentage of the population. For example, capability documents might require "physically accommodating the central 90% of the target audience." Setting specific, quantifiable personnel requirements in the Capability Documents assist the establishment of test criteria in the Test and Evaluation Master Plan.

CH 5–4.2.2.2 Personnel Planning

Personnel capabilities are normally reflected as KSAs, and other characteristics. The availability of personnel and their KSAs should be identified early in the acquisition process. The DoD Components have a limited inventory of personnel available, each with a finite set of cognitive, physical, and psychomotor abilities. This could affect specific system thresholds.

The PM should use the TAD as a baseline for personnel requirements assessment. The TAD should include information such as inventory, force structure, standards of grade authorizations, personnel classification (e.g., Military Occupational Code/Navy Enlisted Classification), description, biographical information, anthropometric data, physical qualifications, aptitude descriptions as measured by the Armed Services Vocational Aptitude Battery (ASVAB), task performance information, skill grade authorization, Military Physical Profile Serial System (PULHES), security clearance levels, and other related factors.

The PM should assess and compare the cognitive and physical demands of the projected system against the projected personnel supply. The PM should also determine the physical limitations of the target audience (e.g., color vision, acuity and hearing). The PM should identify any shortfalls highlighted by these studies.

The PM should determine if the new system contains any aptitude-sensitive critical tasks. If so, the PM should determine if it is likely that personnel in the target audience can perform the critical tasks of the job.

The PM should consider personnel factors, such as availability, recruitment, skill identifiers, promotion and assignment. The PM should consider the impact on recruiting, retention, promotions and career progression when establishing program costs, and should assess these factors during trade-off analyses.

The PM should use a truly representative sample of the target population during Test and Evaluation (T&E) to get an accurate measure of system performance. A representative sample during T&E helps identify aptitude constraints that affect system use.

Individual system and platform personnel requirements should be developed in close collaboration with related systems throughout the Department and in various phases of the acquisition process to identify commonalities, merge requirements and avoid duplication. The PM should consider the cumulative effects of system-of-systems, family-of-systems and related systems integration in the development of personnel requirements.

The PM should summarize major personnel initiatives that are necessary to achieve readiness or rotation objectives or to reduce manpower or training costs, when developing the acquisition strategy. The Life-Cycle Sustainment Plans should address modifications to the knowledge, skills and abilities of military occupational specialties for system operators, maintainers or support personnel and should highlight the modifications having cost or schedule issues that could adversely impact program execution. The PM should also address actions to combine, modify or establish new military occupational specialties or additional skill indicators, or issues relating to hard-to-fill occupations if they impact the PM's ability to execute the program.

CH 5–4.2.3 Training

Training gives users, operators, maintainers, leaders, and support personnel the opportunity to acquire, gain, or enhance knowledge and skills, and concurrently develop their cognitive, physical, sensory, team dynamics, and adaptive abilities to conduct joint operations and achieve maximized and fiscally sustainable system life cycles. The training of people as a component of material solutions delivers the intended capability to improve or fill capability gaps.

Cost-and mission-effective training facilitates DoD acquisition policy that requires optimized total system performance and minimizes the cost of ownership through a "total system approach" to acquisition management. The systems engineering concept of a purposely designed *'total system'* includes not only the mission system equipment, but, more critically, the people who operate, maintain, lead, and support these acquired systems -- including the training, training systems, and the operational and support infrastructure.

The Human Systems Integration (HSI) Training Domain assists PMs throughout the acquired system's life cycle by focusing attention on the human interface with the acquired system, and by integrating and inserting manpower, personnel, training, human factors engineering, environment, safety, occupational health, habitability and survivability as Systems Engineered elements into the Defense Acquisition process. The Systems Engineered practice of continuous application of human-centered methods and tools ensures maximum operational and training effectiveness of the newly acquired system throughout its life cycle. Systems Engineering in DoD Acquisition provides perspectives on the use of systems engineered/developed training approaches to translate user-defined capabilities into engineering specifications and outlines the role of the PM in integrated system design activities.

In all cases, the paramount goal of training for new systems is to develop and sustain a ready, well-trained individual/unit, while giving strong consideration to options that can reduce life-cycle costs, and provide positive contributions to the joint context of a system and provide a positive readiness outcome.

CH 5–4.2.3.1 Statutory and Regulatory Basis

Training of user, operator, maintainer, and leader personnel should be performed to achieve intended capabilities of new systems acquisition; enable joint integration, interoperability and testing; and ensure sustainment goals over the life cycle of weapon systems To facilitate timely, cost-effective and appropriate training, the content, development and planning of training should be performed during the earliest phases (e.g., Material Solution and Technology Development Phases) of the acquisition processes,". This is outlined within the AoA, System Training Plans (e.g. STRAPs, NTSPs, or STPs) Acquisition Strategies (AS) and Acquisition Program Baselines (APB).

To ensure appropriate training for new systems acquisition and traceability to life-cycle sustainment costs estimates, systems engineering processes should assess training impacts of materiel decision trades and appropriately documented. New Equipment Training (NET) plans (e.g., STRAPs, NTSPs and STPs) should identify service joint warfighting training requirements. Training planning and training-cost estimates should be incorporated within the Cost Analysis Requirements Description (CARD) and Life-Cycle Sustainment Plans (LCSPs).

CH 5–4.2.3.2 Training Planning

Training Planning helps the PM understand acquisition program (new or upgraded) systems training as a key performance parameter to successfully integrate DoD Decision Support Systems, e.g. the Acquisition System (DoD 5000 Series), the Joint Capabilities Integration and Development System (JCIDS) and the Planning, Programming, Budgeting & Execution (PPBE) Process, and to effectively translate joint capabilities into training system design features.

Initially, the JCIDS process should address joint training requirements for military (Active, Reserve and Guard) and civilian support personnel who will operate, maintain, lead, and support the acquired system.

Training programs should employ integrated cost-effective solutions, and may consist of a blend of capabilities that use existing training program insights and introduce new performance-based training innovations. These may include requirements for school and unit training, as well as new equipment training or sustainment training. They also may include requirements for instructor and key personnel training and new equipment training teams.

Training planning should be initiated early by the PM, in coordination with the training community within the capabilities-development process beginning with the Capabilities- Based Assessment and Analysis of Alternatives. These support the development of the Initial Capabilities Document, inform the Materiel Development Decision to support the Material Solutions Analysis phase, and continue the development of the Capability Development Document.

Training should also be considered in collaboration with the other HSI domains in order to capture the full range of human integration issues to be considered within the Systems Engineering process.

Early training planning informs the Capability Development Document and should characterize the specific system training requirements, and identify the training Key Performance Parameters:

- Allow for interactions between platforms or units (e.g., through advanced simulation and virtual exercises) and provide training realism to include threats (e.g., virtual and surrogate), a realistic electronic warfare environment, communications and weapons.
- Appropriately embedded training capabilities that do not degrade system performance below-threshold values nor degrade the maintainability or component life of the system are preferred
- Initial Operational Capability (IOC) is attained and training capabilities are met by the IOC.
- An embedded performance measurement capability to support immediate feedback to the operators/maintainers and possibly to serve as a readiness measure for the unit commander.
- Training logistics necessary to support the training concept (e.g., requirements for new or upgrades to existing training facilities).
- Provide concurrent capability with actual equipment, training devices, and systems.

The training community should be specific in translating capabilities into system requirements. They should also set training resource constraints. These capabilities and constraints can be facilitated and worked through system integration efforts in several of the other HSI domains. Examples are:

- The training community should consider whether the system should be designed with a mode of operation that allows operators to train interactively on a continuous basis, even when deployed in remote/austere locations.
- The training community should consider whether the system should be capable of exhibiting fault conditions for a specified set of failures to allow rehearsal of repair procedures for isolating faults, or require that the system be capable of interconnecting with other (specific) embedded trainers in both static and employed conditions.
- The training community should consider whether embedded training capabilities allow enhancements to live maneuvers such that a realistic spectrum of threats is encountered (e.g., synthetic radar warnings generated during flight).
- The training community should consider whether the integrated training system should be fully tested, validated, verified and ready for training at the training base as criteria for declaring IOC.

From the earliest stages of development and as the system matures, the PM should emphasize training requirements that enhance the user's capabilities, improve readiness, and reduce individual and collective training costs over the life of the system. These may include requirements for expert systems, intelligent tutors, embedded diagnostics, virtual environments and embedded training capabilities. Examples of training that enhances user's capabilities include:

- Interactive electronic technical manuals to provide a training forum that can significantly reduce schoolhouse training and may require lower skill levels for maintenance personnel while actually improving their capability to maintain an operational system.
- Requirements for an embedded just-in-time mission rehearsal capability supported by the latest intelligence information and an integrated global training system/network that allows team training and participation in large-scale mission rehearsal exercises can be used to improve readiness.
- In all cases, the paramount goal of the training/instructional system should be to develop and sustain a ready, well-trained individual/unit/theater/joint, while giving strong consideration to options that can reduce life-cycle costs and provide positive contributions to the joint context of a system, where appropriate.
- Training devices and simulators are systems that, in some cases, may qualify for their own set of HSI requirements. For instance, the training community may require the following attributes of a training simulator:
    - Accommodate "the central 90 percent of the male and female population on critical body dimensions."
    - Not increase manpower requirements and considerations of reductions in manpower requirements.
    - Consider reduced skill sets to maintain because of embedded instrumentation.
    - Be High Level Architecture compliant.

- Be Sharable Content Object Reference Model (as in DoDI 1322.26 compliant).
- Be Test and Training Enabling Architecture (overview) compliant.
- Use reusable modeling and simulation devices and architectures.

The acquisition program should be specific in translating new system capabilities into the system and its inherent training requirements.

From the earliest stages of development and as the future system design matures, the PM should emphasize training requirements that enhance the user's capabilities, interoperability and improve readiness, and reduce individual and collective training costs over the life of the system. This may include requirements for expert systems, intelligent tutors, embedded diagnostics, virtual environments and embedded training capabilities.

CH 5–4.2.3.3 Development of Training Requirements

When developing the training system, the PM shall employ transformational training concepts, strategies and tools such as computer-based and interactive courseware, simulators and embedded training consistent with the program's acquisition strategy, goals, and objectives and reflect the tenants outlined in the next generation training strategy.

In addition, the program should address the requirement for a systems training key performance parameter, as described in the JCIDS Manual (Encl. D-G-1).

The USD (P&R), with the manpower, personnel and training communities, assesses the ability of the acquisition process to support the Military Departments, COCOMs and other DoD Components acquisition programs from a manpower, personnel and training readiness perspective.

The acquisition program characterizes training planning, development and execution within the (CARD). Life-Cycle Support Plans and Reports are tailored to each document type. These training summaries capture the support traceability of planned training across acquisition and capability documents, and includes logistics support planning for training, training equipment, and training device acquisitions and installations.

CH 5–4.2.3.3.1 Embedded Training

Both the sponsor and the PM provide analysis that demonstrates careful consideration to the use of embedded training as defined in DoDD 1322.18 (para 3.b.) “Military Training”: The sponsor's decisions to use embedded training should be determined very early in the capabilities-assessment process. Analysis will be conducted to compare the embedded training with more-traditional training media (e.g., simulator-based training, traditional classroom instruction and/or maneuver training) for consideration of a system's Total Operating Cost. The analysis will compare the costs and the impact of embedded training (e.g., training operators and maintenance personnel on site, compared with off-station travel to a temporary duty location for training).

CH 5–4.2.4 Human Factors Engineering

The PM employs human factors engineering to design systems that require minimal manpower; provide effective training; can be operated, maintained, and supported by users; and are suitable (habitable and safe with minimal environmental and occupational health hazards) and survivable -- for both the crew and equipment in accordance with DoDI 5000.02 (Encl. 7).

The human factors that need to be considered in the integration are discussed below. Human factors are the end-user cognitive, physical, sensory and team dynamic abilities required to perform system operational, maintenance and support job tasks. Human factors engineers contribute to the acquisition process by ensuring that the PM provides for the effective utilization of personnel by designing systems that capitalize on and do not exceed the abilities (cognitive, physical, sensory and team dynamic) of the user population. The human factors engineering community works to integrate the human characteristics of the user population into the system definition, design, development and evaluation processes to optimize human-machine performance for operation, maintenance and sustainment of the system.

Human factors engineering is primarily concerned with designing human-system interfaces consistent with the physical, cognitive and sensory abilities of the user population. Human-system interfaces include:

- **Functional interfaces -** Functions and tasks, and allocation of functions to human performance or automation.
- **Informational interfaces -** Information and characteristics of information that provide the human with the knowledge, understanding and awareness of what is happening in the tactical environment and in the system.
- **Environmental interfaces -** The natural and artificial environments, environmental controls, and facility design.
- **Cooperational interfaces -** Provisions for team performance, cooperation, collaboration and communication among team members and with other personnel.
- **Organizational interfaces -** Job design, management structure, command authority, policies and regulations that impact behavior.
- **Operational interfaces -** Aspects of a system that support successful operation of the system such as procedures, documentation, workloads and job aids.
- **Cognitive interfaces -** Decision rules, decision support systems, provision for maintaining situational awareness, mental models of the tactical environment, provisions for knowledge generation, cognitive skills and attitudes and memory aids.
- **Physical interfaces -** Hardware and software elements designed to enable and facilitate effective and safe human performance such as controls, displays, workstations, worksites, accesses, labels and markings, structures, steps and ladders, handholds, maintenance provisions, etc..

CH 5–4.2.4.1 Parameters/Requirements

Human factors requirements, objectives and thresholds should be derived from each of the HSI domains and should provide for the effective utilization of personnel through the accommodation of the cognitive, physical and sensory characteristics that directly enhance or constrain system performance. In many cases, the interface design limitation may require trade-offs in several of the other domains and vice versa.

Cognitive requirements address the human capability to evaluate and process information. Requirements are typically stated in terms of response times and are typically established to avoid excessive cognitive workload. Operations that entail a high number of complex tasks in a short time period can result in cognitive overload and safety hazards. The capability documents should specify whether there are human-in-the-loop requirements. These could include requirements for "human in control," "manual override" or "completely autonomous operations." Knowledge, skills, and abilities for operators, maintainers, and other support personnel continuously change with the increasing complexity of emerging systems. These requirements should be cross-correlated with each of the HSI domains.

Physical requirements are typically stated as anthropometric (measurements of the human body), strength and weight factors. Physical requirements are often tied to human performance, safety and occupational health concerns. To ensure that the users can operate, maintain and support the system, requirements should be stated in terms of the user population. For instance, when the user requires a weapon that is "one-man portable," weight thresholds and objectives should be based on the strength limitations of the user population and other related factors (e.g., the weight of other gear and equipment and the operational environment). For example, it may be appropriate to require that "the system be capable of being physically maintained by 90% of both the male and female population, inclusive of battle dress or arctic and Mission Oriented Protective Postures-Level 4 protective garments inside the cab," or that "the crew station physically accommodate 90% of the female/male population, defined by current anthropometric data, for accomplishment of the full range of mission functions."

Sensory requirements are typically stated as visual, olfactory (smell) or hearing factors. The Capability Development Document should identify operational considerations that affect sensory processes. For example, systems may need to operate in noisy environments where weapons are being fired or on an overcast moonless night with no auxiliary illumination. Visual acuity or other sensory requirements may limit the target audience for certain specialties.

CH 5–4.2.4.2 Application of Human Factors Engineering

Human Factors Engineering (HFE) plays an important role in each phase of the acquisition cycle, to include requirements of development, system definition, design, development, evaluation and system support for reliability and maintainability in the field. To realize the potential of HFE contributions, HFE must be incorporated into the design process at the earliest stages of the acquisition process (i.e., during the Materiel Solution Analysis and Technology Development phases). It should be supported by inputs from the other HSI domains as well as the other Systems Engineering processes. The right decisions about the human-machine interfaces early in the design process optimize the human performance, and hence, the total systems performance. HFE participation continues to each succeeding acquisition phase, continuing to work trade-offs based on inputs from the other HSI domains and the hardware and software designs/adaptations. The HFE practitioners provide expertise that includes design criteria, analysis and modeling tools and measurement methods that help to ensure that program office design systems are operationally suitable, safe, survivable, effective, usable and cost-effective. In any system acquisition process, it is important to recognize the differences between the competencies (skills and knowledge) required for the various warfighters. Application of HFE processes leads to an understanding of the competencies needed for the job, and help identify if requirements for knowledge, skills and abilities (KSAs) exceed what the user can provide and whether the deficiency leads to a training or operational problem. HFE tools and techniques can be used to identify the KSAs of the target audience and account for different classes and levels of users and the need for various types of information products, training, training systems, and other aids. While it is critical to understand the information processing and net-centric requirements of the system, it is equally important to understand the factors affecting format and display of the data presented to the user to avoid cognitive overload. This applies equally to the system being designed as well as to the systems that interface with the system. The system should not place undue workload or other stress on systems with which it must interface.

CH 5–4.2.4.2.1 General Guidelines

HFE principles, guideline and criteria should be applied during development and acquisition of military systems, equipment and facilities to integrate personnel effectively into the design of the system. An HFE effort should be provided to develop or improve all human interfaces of the system; achieve required effectiveness of human performance during system operation, maintenance, support, control and transport; and, make economical demands upon personnel resources, skills, training and costs. The HFE effort should be well integrated with the other HSI domain participation, and should include, but not necessarily be limited to, active participation in the following three major interrelated areas of system development.

CH 5–4.2.4.2.2 Analysis

Identify the functions to be performed by the system in achieving its mission objectives and analyze them to determine the best allocation of personnel, equipment, software or combinations thereof. Allocated functions should be further dissected to define the specific tasks to be performed to accomplish the functions. Each task should be analyzed to determine the human performance parameters; the system, equipment and software capabilities; and the operational/environmental conditions under which the tasks are conducted. Task parameters should be quantified where possible, and should be expressed in a form that permits effective studies of the human-system interfaces in relation to the total system operation. HFE high-risk areas should be identified as part of the analysis. Task analysis should include maintenance and sustainment functions performed by crew and support facilities. Analyses should be updated as required to remain current with the design effort.

CH 5–4.2.4.2.3 Design and Development

HFE should be applied to the design and development of the system equipment, software, procedures, work environments and facilities associated with all functions requiring personnel interaction. This HFE effort should convert the mission, system and task analysis data into a detailed design and development plan to create human-system interface that will operate within human performance capabilities, facilitate/optimize human performance in meeting system functional requirements and accomplish the mission objectives.

CH 5–4.2.4.2.4 Test and Evaluation

Human Factors Engineering (HFE) and the evaluation of all human interfaces should be integrated into engineering design and development tests, contractor demonstrations, flight tests, acceptance tests, other development tests, and operational testing. Compliance with human interface requirements should be tested as early as possible. Test and Evaluation (T&E) should include evaluation of maintenance and sustainment activities and evaluation of the dimensions and configuration of the environment relative to criteria for HFE and each of the other HSI domains. Findings, analyses, evaluations, design reviews, modeling, simulations, demonstrations and other early engineering tests should be used in planning and conducting later tests. Test planning should be directed toward verifying that the system can be operated, maintained, supported and controlled by user personnel in its intended operational environment with the intended training. Test planning should also consider data needed or provided by operational test and evaluation. (See Chapter 8 – Test and Evaluation).

CH 5–4.2.5 Environment, Safety and Occupational Health Hazards

Environment, safety and occupational health hazards include design features and operating characteristics of a system that create significant risks of bodily injury or death, loud noise, chemical and biological substances, extreme temperatures and radiation energy. Each of the various military departments/services treat the three HSI domains of Environment, Safety and Occupational Health (ESOH) differently, based on oversight and reporting responsibility within each of the services. DoD ESOH Guidance for systems acquisition programs can be found in Chapter 3, Systems Engineering. What is important to the HSI practitioner and the systems engineer is that these three domains are of vital importance to the HSI effort, and are integrated within it. While the ESOH communities have unique reporting requirements that trace to National-level mandates, the importance of integrating these domains in the HSI construct cannot be overemphasized. The human aspect brings a host of issues to a system that should be accommodated in each of these three areas; each must be considered in consonance with the other HSI domains. How they are considered in an integrated manner is left to the PM and Systems Engineering.

Environment includes the natural and manmade conditions in and around the system and the operational context within which the system will be operated and supported. This "environment" affects the human ability to function as a part of the system.

Safety factors consist of those system design characteristics that serve to minimize the potential for mishaps -- causing death or injury to operators, maintainers, and supporters or threatening the survival and/or operation of the system. Prevalent issues encompass factors that threaten the safe operation and/or survival of the platform: walking and working surfaces, including work at heights; pressure extremes; and control of hazardous energy releases such as mechanical, electrical, fluids under pressure, ionizing or non-ionizing radiation (often referred to as "lock-out/tag-out"), fire and explosions.

Occupational health factors are those system design features that serve to minimize the risk of injury, acute or chronic illness or disability and/or reduce job performance of personnel who operate, maintain or support the system. Prevalent issues include noise, chemical safety, atmospheric hazards (including those associated with confined space entry and oxygen deficiency), vibration, ionizing and non-ionizing radiation and human factors issues that can create chronic disease and discomfort such as repetitive motion diseases. Many occupational health problems, particularly noise and chemical management, overlap with environmental impacts. Human factor stresses that create the risk of chronic disease and discomfort overlap with occupational health considerations.

CH 5–4.2.5.1 ESOH Hazard Parameters and Requirements

Environment, safety, and health hazard parameters should address all activities inherent to the life cycle of the system, including test activity, operations, support, maintenance and final demilitarization and disposal. Environment, safety, and health hazard requirements should be stated in measurable terms, whenever possible. For example, it may be appropriate to establish thresholds for the maximum level of acoustic noise, vibration, acceleration shock, blast, temperature or humidity or impact forces etc., or “safeguards against uncontrolled variability beyond specified safe limits,” where the Capability Documents specify the "safe limits." Safety and health hazard requirements often stem from human factor issues and are typically based on lessons learned from comparable or predecessor systems. For example, both physical dimensions and weight are critical safety requirements for the accommodation of pilots in ejection-seat designs. Environment, safety, and health hazard thresholds are often justified in terms of human performance requirements, because, for example, extreme temperature and humidity can degrade job performance and lead to frequent or critical errors. Another methodology for specifying safety and health requirements is to specify the allowable level of residual risk as defined in MIL-STD-882D (DoD Standard Practice for System Safety), for example, “There shall be no high or serious residual risks present in the system.”

CH 5–4.2.5.2 Programmatic ESOH Evaluation

The HSI Plan should recognize the appropriate timing for the Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) and define how the program intends to ensure the effective and efficient flow of information to and from the ESOH domain experts to work the integration of environment, safety, and health considerations into the systems engineering process and all its required products.

CH 5–4.2.5.2.1 Health Hazard Analysis

Health Hazards Analysis (HHA) should be conducted during each phase of the acquisition process, beginning with a review of issues related to predecessor systems. During early stages of the acquisition process, sufficient information may not always be available to develop a complete HHA. As additional information becomes available, the initial analyses are refined and updated to identify health hazards, assess the risks determine how to mitigate the risks, formally accept the residual risks and monitor the effectiveness of the mitigation measures. The health hazard risk information is documented in the PESHE. Health hazard assessments should include cost avoidance figures to support trade-off analysis. There are nine health hazard issues typically addressed in an HHA, defined below.

Acoustical Energy - The potential energy that transmits through the air and interacts with the body to cause hearing loss or damage to internal organs.

Biological Substances - An infectious substance generally capable of causing permanent disability or life-threatening or fatal disease in otherwise healthy humans.

Chemical Substances - The hazards from excessive airborne concentrations of toxic materials contracted through inhalation, ingestion and skin or eye contract.

Oxygen Deficiency - The displacement of atmospheric oxygen from enclosed spaces or at high altitudes.

Radiation Energy - Ionizing: The radiation causing ionization when interfacing with living or inanimate mater. Non-ionizing: The emissions from the electromagnetic spectrum with insufficient energy to produce ionizing of molecules.

Shock - The mechanical impulse or impact on an individual from the acceleration or deceleration of a medium.

Temperature Extremes and Humidity - The human health effects associated with high or low temperatures, sometimes exacerbated by the use of a materiel system.

Trauma - Physical: The impact to the eyes or body surface by a sharp or blunt object. Musculoskeletal: The effects to the system while lifting heavy objects.

Vibration - The contact of a mechanically oscillating surface with the human body.

CH 5–4.2.6 Survivability

Survivability factors consist of those system design features that reduce the risk of fratricide, detection and the probability of being attacked and that enable the crew to withstand natural and manmade hostile environments without aborting the mission or suffering acute chronic illness, disability or death. Survivability attributes, as described in the Joint Military Dictionary (JP 1-02), are those that contribute to the survivability of manned systems. In the HSI construct, the human is considered integral to the system, and personnel survivability should be considered in the encompassing "system" context.

CH 5–4.2.6.1 Survivability Parameters/Requirements

A Survivability/Force Protection Key Performance Parameter should be considered for any "manned system or system designed to enhance personnel survivability" when the system may be employed in an asymmetric threat environment. The Capability Documents should include applicable survivability parameters, which may include requirements to eliminate significant risks of fratricide or detectability or to be survivable in adverse weather conditions and the nuclear, biological and chemical (NBC) battlefield. NBC survivability, by definition, encompasses the instantaneous, cumulative and residual effects of NBC weapons upon the system, including its personnel. It may be appropriate to require that the system "permit performance of mission-essential operations, communications, maintenance, re-supply, and decontamination tasks by suitably clothed, trained and acclimatized personnel for the survival periods and NBC environments required by the system."

The consideration of survivability should also include system requirements to ensure the integrity of the crew compartment and rapid egress when the system is damaged or destroyed. It may be appropriate to require that the system provide for adequate emergency systems for contingency management, escape, survival and rescue.

CH 5–4.2.6.2 Survivability Planning

The Joint Capabilities Integration and Development System capability documents define the program's combat performance and survivability needs. Consistent with those needs, the Program Manager (PM) should establish a survivability program. This program, overseen by the PM, should seek to minimize: the probability of encountering combat threats; the severity of potential wounds and injury incurred by personnel operating or maintaining the system; and, the risk of potential fratricidal incidents. To maximize effectiveness, the PM should assess survivability in close coordination with systems engineering and test and evaluation activities.

Survivability assessments assume the warfighter is integral to the system during combat. Damage to the equipment by enemy action, fratricide or an improperly functioning component of the system can endanger the warfighter. The survivability program should assess these events and their consequences. Once these initial determinations are made, the design of the equipment should be evaluated to determine if there are potential secondary effects on the personnel. Each management decision to accept a potential risk should be formally documented by the appropriate management level as defined in DoDI 5000.02 (Encl. 7).

During the early stages of the acquisition process, sufficient information may not always be available to develop a complete list of survivability issues. An initial report is prepared; listing those identified issues and any findings and conclusions. Classified data and findings are to be appropriately handled according to each DoD Component's guidelines. Survivability issues typically are divided into the following components:

- **Reduce Fratricide -** Fratricide is the unforeseen and unintentional death or injury of "friendly" personnel resulting from friendly forces employment of weapons and munitions. To avoid these types of survivability issues, personnel systems and weapon systems should include anti-fratricide systems, such as Identification of Friend or Foe and Situational Awareness systems.
- **Reduce Detectability -** Reduce detectability considers a number of issues to minimize signatures and reduce the ranges of detection of friendly personnel and equipment by confounding visual, acoustic, electromagnetic, infrared/thermal and radar signatures and methods that may be utilized by enemy equipment and personnel. Methods of reducing detectability could include camouflage, low-observable technology, smoke, countermeasures, signature distortion, training and/or doctrine.
- **Reduce Probability of Attack -** Analysts should seek to reduce the probability of attack by avoiding the appearance as a high-value target and by actively preventing or deterring attack by warning sensors and the use of active countermeasures.
- **Minimize Damage if Attacked -** Analysts should seek to minimize damage, if attacked, by:
    - Designing the system to protect the operators and crew members from enemy attacks.

  - Improving tactics in the field so survivability is increased.
  - Designing the system to protect the crew from on-board hazards in the event of an attack (e.g., fuel, munitions, etc.).
  - Designing the system to minimize the risk to supporting personnel if the system is attacked. Subject matter experts in areas such as nuclear, biological and chemical warfare, ballistics, electronic warfare, directed energy, laser hardening, medical treatment, physiology, human factors and Information Operations can add additional issues.
- **Minimize Injury -** Analysts should seek to minimize:
  - Combat, enemy weapon-caused injuries.
  - The combat-damaged system's potential sources and types of injury to both its crew and supported troops as it is used and maintained in the field.
  - The system's ability to prevent further injury to the fighter after being attacked.
  - The system's ability to support treatment and evacuation of injured personnel. Combat-caused injuries or other possible injuries are addressed in this portion of personnel survivability, along with the different perspectives on potential mechanisms for reducing damage. Evacuation capability and personal equipment needs (e.g., uniform straps to pull a crew member through a small evacuation port) are addressed here.
- **Minimize Physical and Mental Fatigue -** Analysts should seek to minimize injuries that can be directly traced to physical or mental fatigue. These types of injuries can be traced to complex or repetitive tasks, physically taxing operations, sleep deprivation or high-stress environments.
- **Survive Extreme Environments -** This component addresses issues that may arise once the warfighter evacuates or is forced from a combat-affected system such as an aircraft or watercraft and should immediately survive extreme conditions encountered in the sea or air until rescued or an improved situation on land is reached. Dependent upon requirements, this may also include some extreme environmental conditions found on land, but generally this component is for sea and air, where the need is immediate for special consideration to maintain an individual's life. Survival issues for downed pilots behind enemy lines should be considered here.

The PM should summarize plans for survivability in the Life-Cycle Sustainment Plan, Section 3.1.5 under Other Sustainment Considerations. If the system or program has been designated by Director, Operational Test & Evaluation for live-fire test and evaluation (LFT&E) oversight, the PM should integrate T&E to address crew survivability issues into the LFT&E program to support Congressional requirements. The PM should address the special equipment or gear needed to sustain crew operations in an operational environment.

CH 5–4.2.7 Habitability

Habitability factors are those living and working conditions necessary to sustain the morale, safety, health and comfort of the user population. They directly contribute to personnel effectiveness and mission accomplishment, and often preclude recruitment and retention problems. Examples include: lighting, space, ventilation and sanitation; noise and temperature control (i.e., heating and air conditioning); religious, medical and food services availability; and berthing, bathing and personal hygiene.

Habitability consists of those characteristics of systems, facilities (temporary and permanent) and services necessary to satisfy personnel needs. Habitability factors are those living and working conditions that result in levels of personnel morale, safety, health and comfort adequate to sustain maximum personnel effectiveness, support mission performance and prevent personnel retention problems.

CH 5–4.2.7.1 Habitability Parameters/Requirements

Habitability is one of several important factors included in the overall consideration of unit mission readiness. Per DoDI 5000.02 (Encl.7), the PM shall work with habitability representatives to establish requirements for the physical environment (e.g., adequate light, space, ventilation and sanitation, and temperature and noise control). If appropriate, requirements for personal services (e.g., religious, medical and mess) and living conditions (e.g., berthing and personal hygiene) if the habitability factors have a direct impact on meeting or sustaining performance requirements, sustaining mission effectiveness or having such an adverse impact on quality of life or morale that recruitment or retention rates could be degraded. Examples include requirements for heating and air-conditioning, noise filters, lavatories, showers, dry-cleaning, and laundry.

While a system, facility and/or service should not be designed solely around optimum habitability factors, these factors cannot be systematically traded-off in support of other readiness elements without eventually degrading mission performance.

CH 5–4.2.7.2 Habitability Planning

The PM should address habitability planning in the Life-Cycle Sustainment Plan Section 3.1.5 Other Sustainment Considerations and identify habitability issues that could impact personnel morale, safety, health or comfort or degrade personnel performance or unit readiness or result in recruitment or retention problems.

CH 5–Version and Revision History

The table below tracks chapter changes. It indicates the current version number and date published, and provides a brief description of the content.

Version #	Revision Date	Reason
0	2/1/2016	Chapter 5 initial upload
1	7/11/2017	Update Broken Links
2	10/25/2017	Update Broken Links
3	7/09/2018	Update Broken Links