SYSTEMS MANAGEMENT STANDARD

SAE1007™	REV. A
Issued 2021-09 Revised 2024-05 Superseding SAE1007	

Standard Practice for Habitability

RATIONALE

Revision to include AAF tailoring guidance.

FOREWORD

This SAE Systems Management Standard describes best practices for conducting Habitability activities in support of a system acquisition or sustainment contract. Habitability domain activities ensure that the environments provided for system operators, maintainers, trainers, and support personnel are safe, comfortable, and conducive to high levels of human performance, safety, and morale.

The G-45 Human Systems Integration (HSI) Committee of SAE International developed this standard practice document, in collaboration with U.S. Government agencies, including the Department of Defense, U.S. Army, U.S. Navy, U.S. Marine Corps, U.S. Air Force, U.S. Coast Guard, NASA, Department of Homeland Security (DHS), and representatives from industry.

Habitability activities are often conducted in support of Human Systems Integration (HSI). Habitability is one of the seven HSI domains recognized by the DoD and other Federal agencies. While HSI responsibility comprises tasks to plan, manage, and integrate the HSI domains, it does not include the activities of the Habitability domain itself. It is important to distinguish between HSI and domain responsibilities. The purpose of this standard is to describe the Habitability domain responsibilities.

Habitability activities and processes may be performed by a variety of personnel, depending on factors that are unique to the particular acquisition program and contractor organization. These factors include acquisition category, system complexity, operational environment, budget, and expertise availability, among others. Whereas large-scale complex systems may require a dedicated Habitability professional; smaller acquisitions may have a human factors engineer (HFE) or safety practitioner fulfill the Habitability role. Regardless of who has the responsibility for Habitability, it is important that the analyses and processes defined in this standard are applied with an appropriate level of rigor and professionalism.

This standard includes prime and sub-contractor Habitability activities; it does not include government Habitability activities. The compliance matrix in Appendix A is provided to assist Habitability specialists in ensuring that all requirements have been satisfactorily addressed. Appendix B provides a detailed listing of Habitability considerations. Appendix C provides guidance on tailoring standard requirements to fit the various DoD acquisition pathways.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/SAE1007A

BACKGROUND

For many years, Habitability requirements have been included in the DoD human engineering design criteria standard, MIL-STD-1472, and a variety of other requirements documents, such as the system specifications. However, the scope of Habitability can far exceed that of human engineering. To date, there has not been a best practice standard for contractor activities in planning and executing Habitability activities in support of system acquisition programs.

The DoD established an HSI Standards Working Group on 28 June 2012 to develop a new standard for HSI to provide comprehensive guidance to industry. The DoD selected the SAE International G-45 Human Systems Integration Committee to lead this task. SAE International executed a multi-year effort beginning in May 2016 that resulted in the development and release of a best practice standard for HSI in February 2019 (SAE6906).

To achieve a full, seven-domain HSI program, acquisition contracts must contain HSI program requirements as well as requirements in all seven domains. As of 2020, military and/or industry standards existed in five of the seven HSI domains: Human Factors Engineering (HFE), Training, Safety and Occupational Health (SOH) and Manpower and Personnel. Best practice standards are needed in the other two domains: Habitability, and Force Protection and Survivability. If the intent is for the contractor to perform activities to achieve Habitability, then the acquisition contract should contain Habitability requirements.

This standard addresses Habitability domain activities that should be conducted as part of a “stand-alone” Habitability program (4.1). Additionally, Habitability domain activities that should be conducted in support of an HSI program, when HSI is required, are addressed in 4.2.

TABLE OF CONTENTS

1. SCOPE

This SAE Systems Management Standard specifies the Habitability processes throughout planning, design, development, test, production, use and disposal of a system. Depending on contract phase and/or complexity of the program, tailoring of this standard may be applied. Appendix C provides guidance on tailoring standard requirements to fit the various DoD acquisition pathways. The primary goals of a contractor Habitability program include:

- Ensuring that the system design complies with the customer Habitability requirements and that discrepancies are reported to management and the customer.
- Identifying, coordinating, tracking, prioritizing, and resolving Habitability risks and issues and ensuring that they are:
  - Reflected in the contractor proposal, budgets, and plans.
  - Raised at design, management, and program reviews.
  - Debated in working group meetings.
  - Coordinated with Training, logistics, and the other HSI disciplines.
  - Included appropriately in documentation and deliverable data items.
- Ensuring that Habitability requirements are applied to all personnel environments, including operators, maintainers, trainers, and support personnnel.
- Identifying and pursuing opportunities to reduce Habitability costs.
- Ensuring that Habitability considerations are addressed in analyses, design decisions, trade-offs, and design changes (e.g., Engineering Change Proposals (ECP)).
- Conducting Habitability analysis activities and supporting human factors analyses (e.g., workload analysis) and other HSI domain analyses to provide evidence to support design decisions and trade-offs and to coordinate shared data.
- Ensuring that Habitability analyses, results and recommendations are timely, technically competent/complete, and included in design decisions, tradeoffs, and changes.
- Ensuring that environments experienced by subjects in experiments, simulations, tests, evaluations, and demonstrations are consistent with the customer's Habitability requirements and meet the U.S. Government and DoD policies for protecton of human subjects.
- Ensuring that Habitability issues discovered in test, evaluation, demonstration, Operational Test and Evaluation (OT&E), and operations are resolved in a technically competent/complete and timely manner.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the contract. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations or contracts unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

EIA-632	Processes for Engineering a System
EIA-649	Configuration Management Standard
EIA-649-1	Configuration Management Requirements for Defense Contracts
GEIA-STD-0007	Logistics Product Data
GEIA-STD-0010	Standard Best Practices for System Safety Program Development and Execution
SAE J1777	General Environmental Considerations for Marine Vehicles
SAE J1782	Ship Systems and Equipment - Hydraulic Systems - Noise Control
SAE1001	Integrated Project Processes for Engineering a System
SAE6906	Standard Practice for Human Systems Integration
TA-STD-0017	Product Support Analysis

2.1.2 Code of Federal Regulations (CFR) Publications

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

45 CFR 46	Protection of Human Subjects

2.1.3 U.S. Military Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

CJCSI 5123.01	Charter of the Joint Requirements Oversight Council (JROC) and Implementation of the Joint Capabilities and Development System (JCIDS)
MIL-HDBK-502	DoD Handbook: Product Support Analysis (PSA)
MIL-STD-882	DoD Standard Practice: System Safety
MIL-STD-1472	DoD Design Criteria Standard, Human Engineering
MIL-STD-46855	DoD Standard Practice: Human Engineering Requirements for Military Systems, Equipment and Facilities

Booher, H. (Ed.). (2003). Handbook of human systems integration. *John Wiley & Sons*, https://doi.org.10.1002/0471721174.

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP292 Environmental Control Systems for Rotorcraft

2.2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

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 for Ships and Marine Systems, Equipment, and Facilities

2.2.3 IEEE Publications

Available from IEEE Operations Center, 445 and 501 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE 15288.1 IEEE Standard for Application of Systems Engineering on Defense Programs

IEEE 15288.2 IEEE Standard for Technical Reviews and Audits on Defense Programs

ISO/IEC/IEEE 15288 Systems and software engineering - System Life Cycle Processes

ISO/IEC/IEEE 29148 System and Software Engineering - Life Cycle Processes - Requirements Management

2.2.4 NASA Publications

NASA Technical Services, NASA STI Program STI Support Services, Mail Stop 148, NASA Langley Research Center, Hampton, VA 23681-2199, 757-864-9658, Fax: 757-864-6500, http://ntrs.nasa.gov/.

NASA Report 4010 Space Station Group Activities Habitability Module Study

2.2.5 AIAA Publications

Available from American Institute of Aeronautics and Astronautics, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344, Tel: 703-264-7500, www.aiaa.org.

Ball, R.E. (2003). The fundamentals of aircraft combat survivability: Analysis and design (2nd edition). *American Institute of Aeronautics and Astronautics, Inc.*, https://doi.org/10.2514/4.862519.

2.2.6 U.S. Military Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

DI-HFAC-80743 Notice 1 - Human Engineering Test Plan (HETP)

DI-HFAC-80744 Notice 1 - Human Engineering Test Report (HETR)

DI-HFAC-80745 Human Engineering Systems Analysis Report (HESAR)

DI-HFAC-80746 Human Engineering Design Approach Document - Operator (HEDAD-O)

DI-HFAC-80747 Human Engineering Design Approach Document - Maintainer (HEDAD-M)

DI-HFAC-81743 Human Systems Integration Program Plan (HSIPP)

DoD Directive 5000.01 The Defense Acquisition System

DoD Instruction 5000.02 Operation of the Defense Acquisition System

Battisti, A. (2016). Shipboard habitability design criteria and practices manual (surface ships) for new ship designs and modernization (Report no. T9640-AC-DSP-010/HAB Rev 1). *Department of the Navy, Naval Sea Systems Command*. Available at https://habitability.net/WebData/T9640-AC-DSP-010_HAB.pdf.

Carr, L. and Greene, F. (2009). Human systems integration (HIS) in acquisition: Integrating human concerns into life cycle systems engineering (Report no. AFHSIO-003). *Air Force Human Systems Integration Office*. Available at https://ww3.safaq.hq.af.mil/Portals/63/documents/organizations/ADA519018%20(1).pdf.

Cullom, P.H. (2012). Shipboard habitability program (Report no. OPNAVINST 9640.1B). *Department of the Navy, Office of the Vhief of Naval Operations*. Available at https://www.med.navy.mil/Portals/62/Documents/NMFA/NMCPHC/root/Field%20Activities/Pages/NEPMU6/Operational%20Support/Environmental%20Health/OPNAVINST-9640-1B.pdf.

Department of the Navy. (2019). Habitability. *Joint fleet maintenance manual (JFMM)* (COMUSFLTFORCOMINST 4790.3, Vol. 6). Norfolk, VA: Department of the Navy. Available at https://www.coursehero.com/file/77278165/JFMM-47903-REV-Dpdf/

DoD. (2010). DoDAF architecture framework version 2.02. *Department of Defense*. Available at https://dodcio.defense.gov/Library/DoD-Architecture-Framework/.

DoD. (2017a). Best practices for using systems engineering standards (ISO/IEC/IEEE 15288, IEEE 15288.1, and IEEE 15288.2) on contracts for Department of Defense acquisition programs. *Department of Defense*. Available at https://acqnotes.com/wp-content/uploads/2014/09/OSD-Guide-to-Best-Practices-Using-Engineering-Standards-2017.pdf.

DoD. (2017b). Risk, issue, and opportunity management guide for defense acquisition programs. *Department of Defense*. Available at https://www.dau.edu/tools/Lists/DAUTools/Attachments/140/RIO-Guide-January2017.pdf.

GAO. (2003). Navy actions needed to optimize ship crew size and reduce total ownership costs (Report no. GAO-03-520). *U.S. General Accounting Office*. Available at https://www.gao.gov/assets/gao-03-520.pdf.

Miles, T. (2012). NAVSEA design criteria and practices manual for submarine general arrangements design (Report no. T05U3-085). *Department of the Navy, Naval Sea Systems Command*.

U.S. Army. (2018). Soldier-materiel systems: Guide for human systems integration in the system acquistion process (Army pamphlet no. 602-2). *U.S. Army*. Available at https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN7935_DAPam602-2_FINAL.pdf.

U.S. Army. (2019). Research, development, and acquisition: Survivability of Army personnel and materiel (Army regulation no. 70-75). *U.S. Army*. Available at https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN7772_AR70-75_FINAL.pdf.

2.2.7 Other Publications

ABS. (2016a). Guide for crew habitability on offshore installations. *American Bureau of Shipping*. Available at https://ww2.eagle.org/content/dam/eagle/rules-and-guides/current/offshore/105_crewhabitabilityoffshoreinstallations/HAB_Offshore_Guide_e.pdf.

ABS. (2016b). Guide for crew habitability on ships. *American Bureau of Shipping*. Available at https://ww2.eagle.org/content/dam/eagle/rules-and-guides/current/other/102_crewhabitabilityonships/HAB_Ship_Guide_e.pdf.

ABS. (n.d.). *MLC-ACCOM notation* [PowerPoint slides]. American Bureau of Shipping. Available at https://ww2.eagle.org/content/dam/eagle/rules-and-resources/Safety-and-Human-Factors-Design/workplace-design/ergonomic-and-safety-resources/MLC-ACCOM%20Notation.pdf.

AIA. (2016). Architectural graphic standards (12th edition). *The American Institute of Architects*. Available at https://store.aia.org/products/architectural-graphic-standards-12th-edition?variant=16398864513.

INCOSE. (2015). INCOSE systems engineering handbook: A guide for system life cycle processes and activities (4th edition). *The International Council on Systems Engineering*. Available at https://www.incose.org/products-and-publications/se-handbook.

U.S. Army Aviation Systems Command. (1989). Aircraft crash survival design guide - Volume V: Aircraft postcrash survival (Report no. USAAVSCOM TR 89-D-225). *U.S. Army Aviation Systems Command*. Available at http://everyspec.com/ARMY/TM-Tech-Manual/TR_89-D-22A_VOL-5_DEC1990_44300/.

2.3 Acronyms

AoA	Analysis of Alternatives
ASAP	Aircrew Systems Advisory Panel
ASTM	American Society for Testing and Materials
CBRNE	Chemical, Biological, Radiological, Nuclear, and Explosive
CDD	Capability Development Document
CDR	Critical Design Review
CDRL	Contract Data Requirement List
CONEMP	Concept of Employment
CONOPS	Concept of Operations
COTS	Commercial Off-the-Shelf
CSWG	Crew Systems Working Group
DAG	Defense Acquisition Guidebook, or Design Advisory Group
DHS	Department of Homeland Security
DID	Data Item Description
DoD	Department of Defense

DoDAF	Department of Defense Architecture Framework
DoDI	Department of Defense Instruction
ECP	Engineering Change Proposal
EMD	Engineering, Manufacturing, and Development
FOC	Full Operational Capability
FPS	Force Protection-Survivability
FRP	Full Rate Production
GAO	Government Accountability Office
GEIA	Government Electronic Industries Association
GFE	Government Furnished Equipment
GFP	Government Furnished Property
GFI	Government Furnished Information
HDBK	Handbook
HEDAD-M	Human Engineering Design Approach Document-Maintainer
HEDAD-O	Human Engineering Design Approach Document-Operator
HESAR	Human Engineering Systems Analysis Report
HFAC	Human Factors (standardization)
HFE	Human Factors Engineering
HSI	Human Systems Integration
HSIPP	Human Systems Integration Program Plan
HSIR	Human Systems Integration Report
IAW	In Accordance With
IEEE	Institute of Electrical and Electronics Engineers
ILA	Independent Logistics Assessment
IMP	Integrated Master Plan
IMS	Integrated Master Schedule
INCOSE	International Council on Systems Engineering
IOC	Initial Operational Capability
IPS	Integrated Product Support

IPT	Integrated Product Team
ISO	International Organization for Standardization
JCIDS	Joint Capabilities Integration and Development System
KPP	Key Performance Parameter
KSA	Key System Attribute
LCMP	Life Cycle Management Plan
LCSP	Life Cycle Sustainment Plan
LRIP	Low Rate Initial Production
MAP	Maintainer Advisory Panel
NASA	National Aeronautics and Space Administration
OBS	Organizational Breakdown structure
ODASD	Office of the Deputy Assistant Secretary of Defense
PDR	Preliminary Design Review
PESHE	Programmatic Environmental Safety and Health Evaluation
PSA	Product Support Analysis
PSE	Product Support Element
RFP	Request for Proposal
SDD	System Design and Development (acquisition phase)
SDRL	Subcontract Data Requirements List
SME	Subject Matter Expert
SOW	Statement of Work
SOH	Safety/Occupational Health
STD	Standard
SE	Systems Engineering
SEMP	Systems Engineering Master Plan (Contractor)
T&E	Test and Evaluation
WBS	Work Breakdown Structure
WG	Working Group

2.4 Definitions

CAPABILITY REQUIREMENTS: A capability which is needed to meet an organization's roles, functions, and missions in current or future operations. To the greatest extent possible, capability requirements are described in relation to tasks, standards, and conditions IAW the Universal Joint Task List or equivalent DoD Component Task List (CJCSI 5123.01). Capability requirements serve as the basis for system and specification requirements.

CONTRACTOR: This term refers to the company or organization responsible for fulfilling the system acquisition contract requirements. An alternative term could be "solution provider."

CONTRACTOR HABITABILITY PRACTITIONER: Personnel responsible for planning, coordinating, and executing the Habitability program; serves as the contractor's Habitability single point-of-contact.

CONTRACTOR HABITABILITY TEAM: Refers to the contractor (typically a Prime contractor) practitioners responsible for performing Habitability activities under a systems acquisition contract. The Habitability team may also include associate contractors, subcontractors, and selected supplier personnel.

CUSTOMER HABITABILITY TEAM: Refers to the U.S. Government Habitability team in the organization(s) responsible to the procuring agency for providing Habitability support. The team may be in the procuring agency or distributed between the procuring agency and one or more other organizations.

HABITABILITY: The living and working conditions that are necessary to sustain the well being, morale, safety, occupational health, comfort, and performance of the end-user population. Habitability considerations include all aspects of the physical environment that people inhabit, for work, rest, or other purpose. It includes adequate space and environmental/temperature controls and, if appropriate, requirements for personnel services (e.g., medical, dental, and mess) and living conditions (e.g., berthing and personal hygiene) that have a direct impact on meeting or sustaining system performance/effectiveness or that have such an adverse impact on safety (e.g., GEIA-STD-0010, MIL-STD-882), health, comfort, quality of life, and morale that recruitment or retention is degraded. Many Habitability design criteria are contained in DoD Design Criteria Standard-Human Engineering (MIL-STD-1472). System design and operational performance requirements may also impact personnel Habitability.

HABITABILITY DOMAIN SYSTEM REQUIREMENTS: Physical and environmental requirements (operator/user, maintainer, trainer, and/or supporter) associated with the system, to the extent that human performance, mission effectiveness, safety, comfort, well-being, or morale may be affected. Content areas include characteristics such as space claims, noise, vibration, temperature, sanitation, and ergonomics.

HABITABILITY RISK: A physical or environmental condition with potentially adverse impact on humans. Habitability risks can be technical as well as programmatic.

HABITABILITY TASK: Any task performed by the Habitability practitioner and Habitability team that contributes to achieving goals of improving Habitability integration, improving human performance, or reducing Habitability-driven ownership costs.

HSI LEAD: Contractor person responsible for planning, coordinating and executing the HSI program; serves as the contractor's HSI single point-of-contact.

HSI PROGRAM: All the planning, analysis, risk/issue management, design support, test and evaluation (T&E), coordination, and documentation activities undertaken in response to HSI programmatic requirements contained in the system acquisition contract Statement of Work (SOW).

HSI WORKING GROUP: Typically, a chartered organization charged with carrying out all the HSI activities associated with a system acquisition program. The HSI Working Group (or may be called an Integrated Product Team [IPT], depending on the program or Service) is typically co-chaired by customer and prime contractor HSI leads. Membership usually includes HSI and HSI domain representatives from the Prime contractor and customer. The HSI Working Group may also include HSI and domain representation from major subcontractors, associate contractors, and major suppliers.

HSI PROGRAMMATIC REQUIREMENTS: Statement of Work (SOW) requirements for Human Systems Integration tasks for the contractor HSI team to execute. Focus of these requirements is on HSI program planning, coordination, execution, documentation, and reporting.

HUMAN SYSTEMS INTEGRATION (HSI): HSI is a comprehensive management and technical approach applied to systems development and integration as part of wider Systems Engineering and Integrated Product Support processes to ensure that human performance is optimized to increase total system performance and minimize total systems ownership costs. The HSI discipline focuses on addressing human considerations within system engineering and integrated product support processes to optimize total system performance. HSI efforts accomplish this by ensuring that the human is fully and continuously considered as part of the total system in the development and acquisition of all systems. Consistent with DODI 5000.02, HSI considerations comprise Human Factors Engineering (HFE), Safety and Occupational Health (SOH), Habitability, Force Protection and Survivability (FPS), Manpower, Personnel, and Training.

HUMAN PERFORMANCE: A measure of performance of human tasks in a specified environment, reflecting the ability of users (e.g., operators, trainers, supporters and maintainers) to meet system performance standards, including reliability and maintainability, under the conditions in which the system will be employed (adapted from MIL-HDBK-1908).

MANAGEMENT: Contractor senior managers and/or program manager. Since this standard applies only to contractors, the term “management” does not apply to the procuring agency program manager or other customer managers.

PROCURING AGENCY: The procuring agency is the organization responsible for system acquisition and as such can be considered the “customer” (e.g., Naval Air Systems Command).

SENIOR MANAGER OR PROGRAM MANAGER: Refers to the contractor’s Senior Manager or Program Manager.

SHALL: Indicates requirements for which compliance with the specific statement is required.

SHOULD: Used for informative and guidance statements, wherever optional compliance with the recommendation is permissible.

STANDARD PRACTICE (OR BEST PRACTICE): The recommended process to be followed in implementing and executing work for a program (i.e., HSI efforts for a program) against which other practices are measured. Habitability best practices are determined by a broad-based group of DoD and contractor Subject Matter Experts (SME), who are experienced in the practice and application of Habitability on a variety of acquisition programs.

USER: Personnel, who operate, maintain, train, and support the equipment, system, or facility.

3. HABITABILITY DESCRIPTION AND OBJECTIVES

3.1 Habitability Overview

3.1.1 Introduction

Habitability factors are living and working conditions that affect the morale, safety, health, quality of life, performance, quality of work, well-being and comfort of the target population. Habitability contributes to personnel effectiveness and mission accomplishment, and often precludes recruitment and retention problems. Habitability consists of those characteristics of systems, facilities (temporary and permanent), and services necessary to satisfy personnel needs.

Habitability factors include the physical environment (e.g., adequate light, space, ventilation, sanitation, temperature and noise control), cultural environment (e.g., beliefs, practices, customs, behaviors), social environment (e.g., intentionally developed relationships, interactions, and support networks), personal services (e.g., religious, medical, and mess), working environment (e.g., freedom from physical or cognitive stressors) and living conditions (e.g., berthing and personal hygiene). The full range of Habitability considerations are most commonly applicable to systems such as ships, spacecraft, aircraft, land and amphibious vehicles, mobile systems, and permanent land facilities that support sustained, environmentally contained and/or protected operations.

The following Habitability areas are potentially applicable in the system design process:

- Environmental Control
  - Air conditioning, heating, and ventilation adequacy, contamination and quality control.
  - Temperature, humidity and other environmental ranges and controls.
  - Environmental conditions that potentially risk human safety or health.
  - Noise environment.
  - Vibration and motion environment.
  - Lighting adequacy to support human task performance.
- Habitability Facilities
  - Living and working conditions necessary to sustain the morale, safety, health, comfort, and job effectiveness of the user populations.
  - Adequate space and arrangement for work, living, personal stowage, and rest.
  - Material selection (e.g., flammability, toxicity).
  - Accommodations for users, passengers, and visitors, including those with special needs (e.g., Very Important Persons (VIP), Americans with Disabilities Act (ADA) compliance, medical needs).
  - Physical fitness and recreation facilities.
  - Stowage for Personal Effects.
  - Fresh water availability, food availability, and quality control.
  - Sanitation and waste control measures.
  - Berthing, bathing and personal hygiene capabilities.
- Job Design
  - Role, job and task characteristics to ensure adequate user performance and morale.
  - Crew routine schedules.
  - Sustaining required levels of human performance, and achieving adequate rest/maintaining circadian rhythms in extreme/extended mission environments.
- Personnel Services
  - Barber, post office, store.
  - Religious, medical, dental and food services.
  - Housekeeping (cleanliness of inhabited spaces).
  - Laundry/dry cleaning.

Habitability activities may be conducted by various personnel on an acquisition program: Habitability specialists, human factors engineers, safety specialists, environmental engineers or personnel in other disciplines. A goal of the Habitability program is to prevent duplication of effort with other domains, such as human factors engineering.

The contractor should request access to Habitability-related information and products, produced by the government, that can including the following:

a. Capability Description Document (CDD).

b. Life Cycle Management Plan (LCMP) and Life Cycle Sustainment Plan (LCSP).

c. Legacy system-specific criteria.

d. Service-specific Instructions.

e. System and subsystem specifications.

f. Government Systems Engineering (SE) and HSI Plans.

3.1.2 General Process

The general Habitability process is shown in Figure 1. This process should be followed in each acquisition phase.

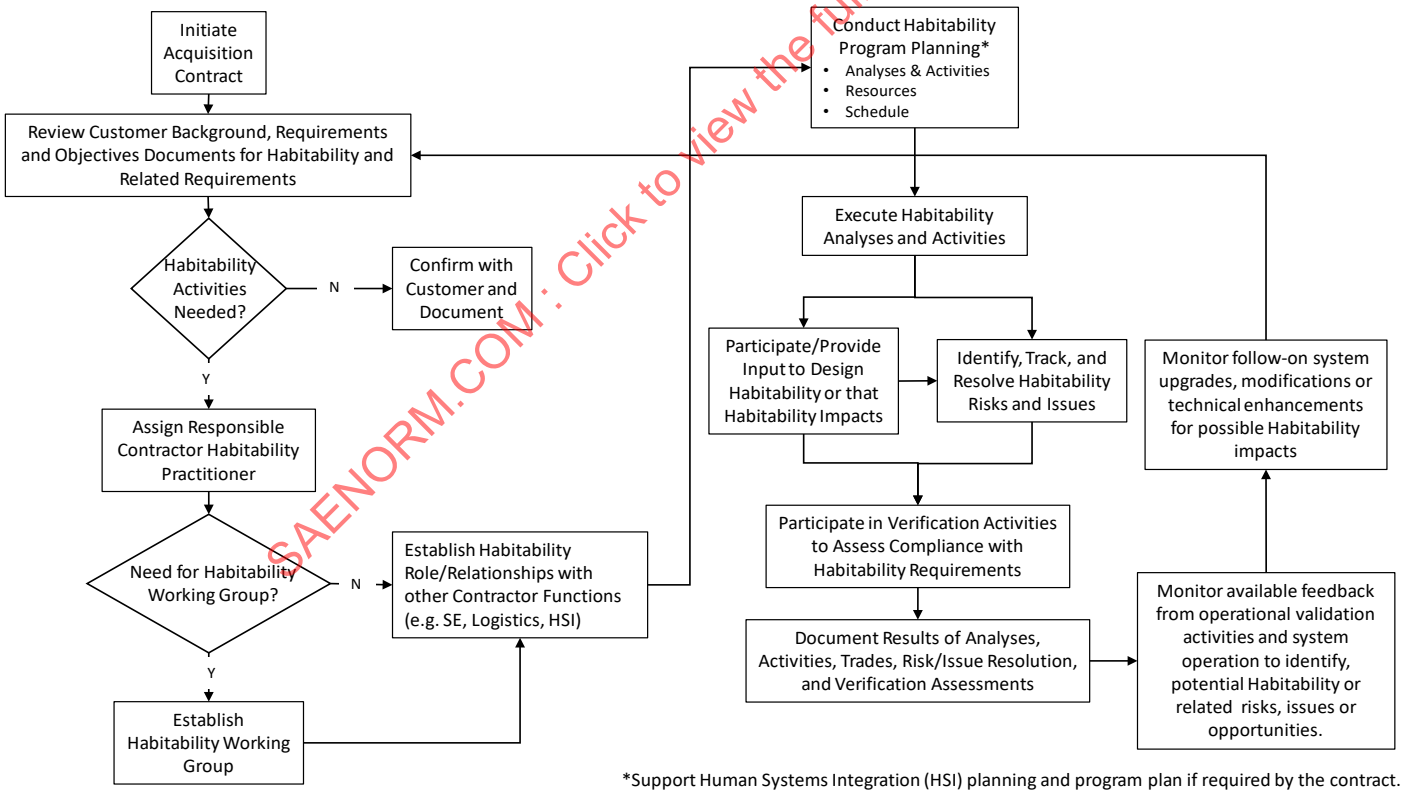

Figure 1 - General habitability process

3.1.3 Detailed Habitability Considerations

Each Habitability area listed in 3.1.1 **should** be assessed to determine how it impacts the system being developed, and/or how it is impacted by the system being developed. Habitability considerations vary considerably across types of systems—ships, aircraft, strategic and tactical command-and-control capabilities, and other types of systems. Detailed Habitability considerations in Appendix B **should** be used to guide scoping and planning of the Habitability program to be conducted under contract.

3.1.4 Habitability Coordination with Other Disciplines (General)

Habitability typically interacts with other disciplines on acquisition programs in order to fulfill their contract requirements. Figure 2 provides notional interactions with other disciplines. Sections of this standard following Figure 2 provide additional details in selected areas.

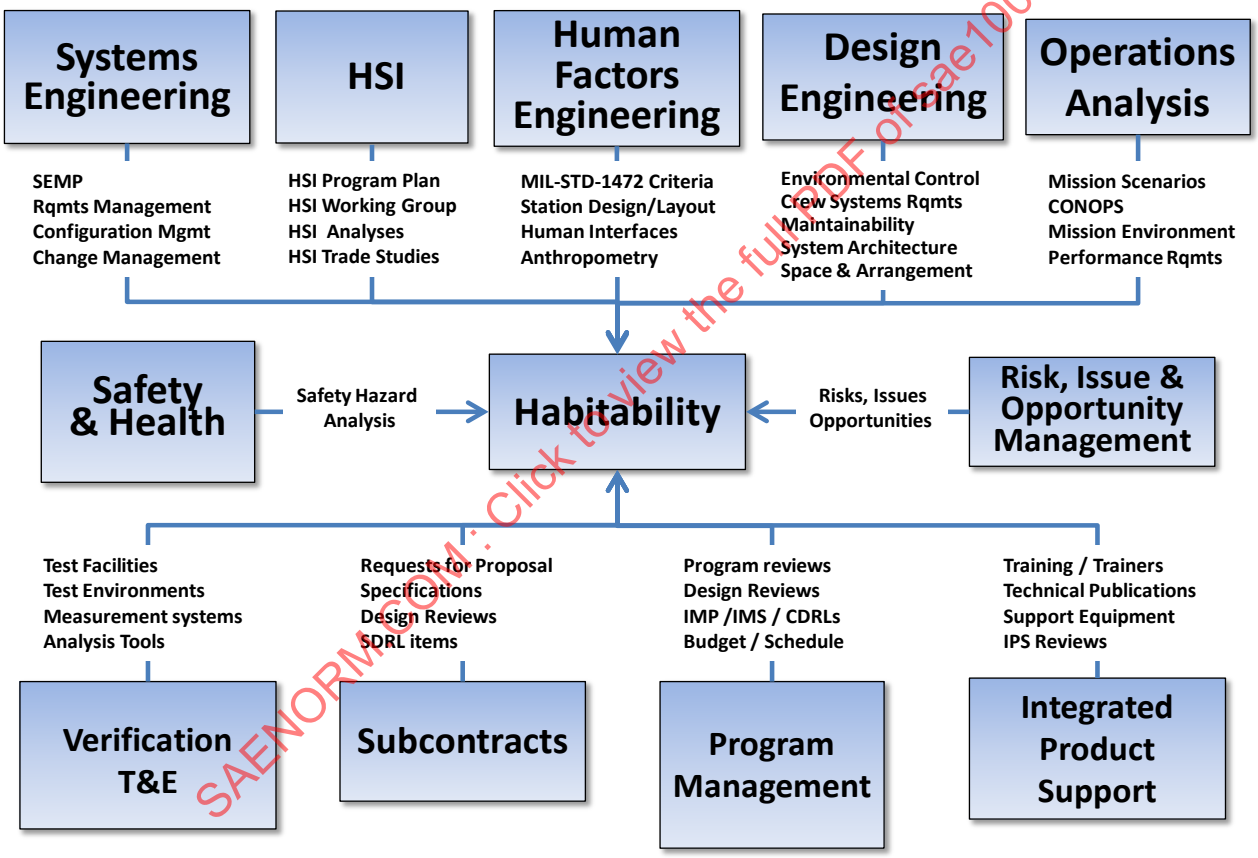

Figure 2 - Habitability interactions (notional)

3.2 Habitability Relationship with Human Systems Integration

Designing for Habitability supports HSI goals by providing a comfortable and effective environment for system personnel; this facilitates physical accommodation, job satisfaction and human performance. It also supports personnel morale, health, and retention. The intent of this standard is to establish Habitability activities to be executed in support of DoD acquisition programs, including planning, analysis, design support, tradeoffs, verification, documentation and quality assurance. The overall goal of these activities is to ensure that Habitability considerations are fully included in system design decisions.

Figure 3 illustrates how the various HSI domains interact and exchange information. In this figure, the outputs of each domain (not a complete list) are shown in relation to the other domains. For example, Habitability typically provides personnel environmental requirements and data to the HFE domain to effectively support development of design requirements, products, and analyses. The following list provides guidance on the boundaries between Habitability and other HSI domains:

- Habitability and Manpower: Manpower clarifies for Habitability the numbers of people to be accommodated, and when they need to be accommodated.

- Habitability and Personnel: Personnel clarifies for Habitability the types (and numbers) of people to be accommodated, beyond the knowledge, skills and abilities of system-related personnel (e.g., operators, maintainers, trainers and support personnel. Populations are classified by status (e.g., rank, permanent/transient, social status [VIP], etc.), gender, work groups/shifts/locations, etc.

- Habitability and Human Factors Engineering: HFE domain considers the design aspects that are mission or work-task driven. Habitability considers the design aspects that are quality-of-life or life-task driven.

- Habitability and Environmental Safety and Occupational Health: ESOH sets minimum standards; Habitability sets standards for comfort and optimal performance (with optimal performance being joint considerations with HFE).

- Habitability and Force Protection and Survivability: Habitability mainly drives the numbers and locations of people that Force Protection/Survivability (or FP/S) need to protect and/or provide egress/PPE/rescue access.

When an HSI program is required by the system acquisition program contract, Habitability planning, execution documentation, reporting, coordination, and verification activities should be fully integrated and coordinated with HSI program activities. Habitability specialists should participate in HSI program activities, reviews, working group meetings, and reporting.

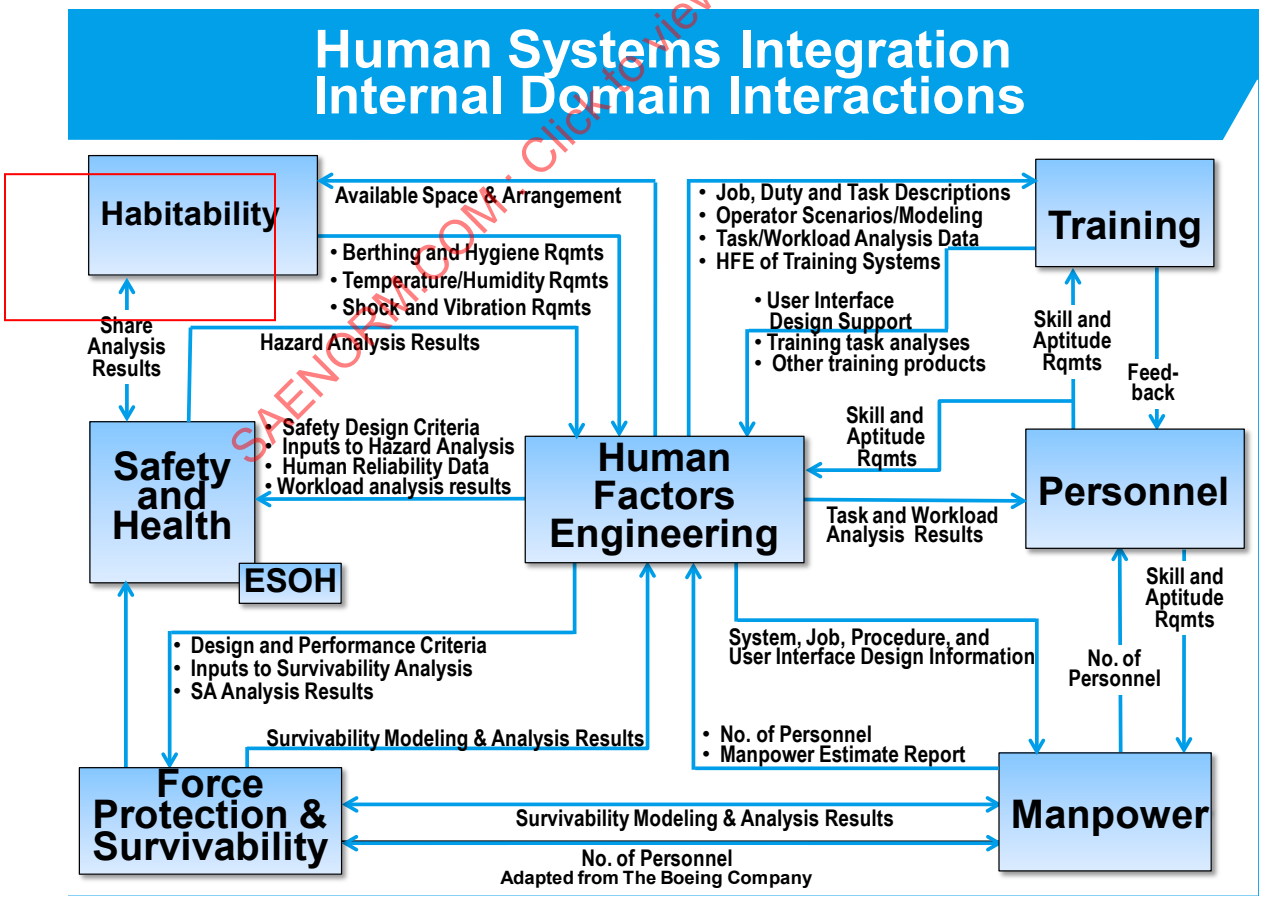

Figure 3 - Notional human systems integration internal interactions

3.3 Habitability Relationship with Systems Engineering (SE)

Habitability considerations **should** be integrated into the overall Systems Engineering (SE) approach that is applied throughout the full product lifecycle. Humans perform functions essential to mission performance during system operation, maintenance and sustainment; providing a comfortable, safe, healthy, and productive environment is an important consideration.

Habitability engineering, to be effective, **should** function as an integral part of the system acquisition project and interface with SE (especially HFE, safety, and maintainability) throughout the system life cycle. During the pre-acquisition Materiel Solution Analysis (MSA) and Technology Maturation and Risk Reduction (TMRR) phases, the role of Habitability is to inform system concept and implementation trade analyses and develop and/or refine human-in-the-system mission requirements. These are typically government-performed activities but may involve contractor support or execution as study tasks.

During contractor-performed system acquisition activities preparing for or following Acquisition Milestone B, Habitability planning and execution activities are conducted in support of system design, integration, and test. In the sustainment activities of Operations and Support (O&S), the role of Habitability is to assess and ensure the continued adequacy of the human conditions for operations, maintenance, training and support. The types and degree of activities and interfaces **should** be tailored to the characteristics of the specific project being executed. This could include consideration of the program structure, acquisition model or the benefit of model-based or agile engineering methods.

Habitability planning and analysis activities **should** be coordinated with SE technical processes, including stakeholder requirement definition, requirement analysis, architecture development, verification, validation, integration, and implementation. Habitability planning and analysis also **should** be coordinated with the SE technical management processes including technical planning, technical assessment, requirements management, risk management, configuration management, technical data management, and interface management. Habitability technical activities **should** be coordinated with SE processes including: business/finance, mission analysis, stakeholder needs and requirements definition, system architecture definition, design definition, system analysis, integration, verification, validation, operations, maintenance, and disposal.

During programmatic and technical reviews, Habitability **should** interact with SE to ensure that Habitability activities and design considerations are addressed within the context of the program's execution. This **should** include Habitability status reporting at programmatic reviews such as program management review, integrated baseline reviews, integrated system reviews and engineering change proposal reviews. Habitability technical activities and accomplishments **should** be included in the planning, entry/exit criteria development and conduct of the technical reviews. Likewise, the verification of Habitability requirements **should** be coordinated with the overall test program, especially where there is coordination with other engineering specialties or system-level requirements, to ensure comprehensive and effective verification of requirements and mission capabilities.

3.4 Habitability Relationship to Logistics

Habitability **should** contribute to the ability to provide required integrated product support (IPS) at the minimum cost. Logistics includes a variety of product support elements and requires the accomplishment of a variety of support analyses over the lifecycle of the system. Habitability **should** contribute to IPS planning, analysis, and execution due to its impact on providing cost-effective logistics support, including system maintenance and training.

3.4.1 Habitability Role in Supporting Logistics

Habitability **should** support life cycle logistics by assisting in the analysis of acquisition products, operator and maintainer environments, tasks, and processes for their impacts on life cycle supportability and life cycle cost, and assisting in the development of logistics products.

3.4.1.1 Product Support Analysis (PSA)

Product Support Analysis include the analyses needed to create the package of support functions for fielding and maintaining the readiness and operational capability of systems, subsystems, and components, including all functions related to system readiness.

Habitability domain personnel **should** coordinate with Product Support Analysis personnel to identify support needs and resources. Habitability efforts **should** play a role in the planning and conduct of the various analyses and products in PSA as well as provide HSI data to inform the various analyses. Habitability plays a role in the following major PSA activities (e.g., MIL-HDBK-502, TA-STD-0017). The PSA program integrates domain inputs into the required PSA products.

a. **Comparative Analysis (Activity 8):** Interfacing activities include HFE, reliability, maintainability, environment, safety, occupational health, design engineers and IPS element managers.

b. **Functional Requirements (Activity 9):** Interfacing activities include design engineering, reliability, maintainability, HFE, safety and IPS element managers.

c. **Evaluation of Alternatives and Tradeoff Analysis (Activity 11):** Interfacing activities include design engineering, reliability, maintainability, affordability, safety, HFE, cost estimating, and IPS.

d. **Task Analysis (Activity 12):** Interfacing activities include reliability, maintainability, HFE, and safety.

e. **Determination of Product Support Resource Requirements (Activity 12 and 13):** Interfacing activities include design engineering, HFE, and Integrated Product Support (IPS). Design, reliability, maintainability, HFE, Habitability, environment, safety, PHS&T (Packaging, Handling, Storage and Transportation), and occupational health **should** be involved in satisfying the activity analysis requirements of Activity 12.

3.4.1.2 Product Support Elements

Integrated Product Support Elements (PSE) and support functions are necessary to sustain the readiness and operational capability of a system. Habitability **should** contribute to the definition of operating and maintenance environments. Habitability **should** assure that environmental conditions used during Logistics demonstrations are representative of expected environments and assess user job performance, safety, health, comfort and morale.

3.4.1.3 Logistics Product Data

Logistics product data, such as GEIA-STD-0007, are required for all operational and maintenance tasks associated with a system. Habitability personnel **should** provide support to logistics personnel in analyzing and gathering Habitability-related data such as task performance, task times and frequencies, task criticality, personnel skill and aptitude requirements, educational requirements, task training, and support requirements.

3.4.2 System Training Plan

The system training plan is the customer's master training plan and training tool for a new or modified system, which is required for Milestone B. Each service has such a plan, although each service calls it by a different name. It outlines the development of the total training concept, strategy, and training support system resourcing estimates for integrating the system or family of systems into the operational, institutional, and self-development domains. Habitability **should** assess the system training plan as it is developed with attention to the kinds and duration of training and training environments for operators, maintainers, trainers, trainees, and support personnel and how those aspects impact, or are impacted by, the system design.

3.4.3 Habitability Support to Independent Logistics Assessments (ILAs)

Independent Logistics Assessments (ILA) are conducted to validate a program's planning and implementation of Integrated Product Support (IPS), and the ability of the logistics program to meet established performance requirements. Results of these assessments provide a primary input to acquisition milestone and other decision reviews, including the corresponding gate reviews.

Government and contractor Habitability personnel **should** participate, and contribute data and documentation, in all program ILAs. The products and data **should** address outstanding Habitability risks and issues, any Habitability requirements being tracked or evaluated, and Habitability data impacting Logistics plans and efforts.

4. HABITABILITY PROCESS REQUIREMENTS

4.1 Habitability Requirements

4.1.1 Habitability Program Initiation

During Program Initiation, the contractor **shall** establish a Habitability program.

The Contractor **shall** identify and document program Habitability requirements, including any associated with Government Furnished Property (GFP), Equipment (GFE), Information (GFI), services, and facilities. The contractor **should** assess legacy systems (or like systems) and integrate Habitability lessons-learned to ensure that known issues are not repeated in the new system or incremental update. The contractor **should** conduct Habitability and/or environmental surveys on legacy systems if current/baseline data do not exist. The contractor **should** assess existing Habitability standards, guidelines, and handbooks for inclusion in program plans (such as the Human Systems Integration Program Plan (HSIPP) and/or Systems Engineering Master Plan (SEMP)) and for use during Habitability activities.

4.1.2 Habitability Requirements Assessment

The contractor **shall** review Requests for Proposal (RFP) and proposal evaluation criteria, drafts and final, and recommend improvements to address Habitability concerns. The contractor **shall** assess Habitability requirements in the SOW, system specification, DD1423, Organizational Breakdown Structure (OBS), Work Breakdown Structure (WBS), acquisition/development schedules, and recommend improvements to address Habitability concerns. The contractor **shall** assess customer-provided Habitability estimates for completeness and realism and provide feedback and recommendations for improvement to the customer HSI organization. The contractor **shall** develop and propose additions or modifications to customer-provided Habitability requirements, based on reviews of established Habitability criteria, standards, and reports. The contractor **should** use established Habitability criteria and acceptable ranges, such as MIL-STD-1472, to develop and/or refine system Habitability requirements.

If the program is Habitability-intensive, such as for extended space flight or sub-surface operations, the contractor **should** recommend that the customer establish a Habitability Key Performance Parameter (KPP).

4.1.3 Habitability Program Planning

The contractor **shall** plan the Habitability program, including a clear definition of the technical objectives, scope, processes, and product(s), consistent with the terms of the contract, the system requirements, and the phase of acquisition. In addition, if Systems Engineering, Human Systems Integration, and/or Lifecycle Sustainment programs are established for the overall program, the Habitability program **shall** be coordinated with the activities, schedules, and budgets included in those programs.

The contractor **shall** coordinate Habitability planning with the procuring agency. If a separate Habitability program plan is required by the contract, it **shall** be placed under configuration management for contractual execution (refer to EIA-649-1). Tailoring of the Habitability program activities **should** be consistent with the Request for Proposal (RFP)/contract. Data item description DI-HFAC-81743 describes HSI program planning elements and **should** be used as guidance Habitability program planning.

The contractor **shall** plan, schedule, budget, manage, and execute Habitability activities in accordance with this standard. Appendix B to this standard **should** be used to assist in the planning process. In planning Habitability activities, the contractor **should** avoid duplication of efforts between disciplines and groups. Developing and updating planning documentation is an iterative process, which is refined as acquisition activities progress. The contractor **shall** document resource requirements (e.g., staffing, facilities, time-phased schedule and level of effort, budgets) for the entire Habitability effort required by the contract statement of work.

The contractor **shall** ensure that Habitability activities are captured in the program's Integrated Master Plan (IMP) and Integrated Master Schedule (IMS). Data and products required by the Habitability team **shall** be documented in the IMP and IMS. Likewise, Habitability handoffs of data and products to other disciplines **shall** be documented in the IMP and IMS. The contractor **shall** ensure that Habitability needs for GFE, GFP, and/or GFI are documented in the IMP and IMS.

The contractor **shall** assess compatibility of system design and employment concepts with customer-provided Habitability requirements and document Habitability concerns and recommended improvements. The contractor **should** review the program Concept of Operations (CONOPS), Concept of Employment (CONEMP) and other contract documents, and identify and document Habitability concerns. The contractor **should** assess customer-provided operational and support scenarios that stress the capability of the Habitability systems, facilities, accommodations, and services to support sustained operations for durations required. These scenarios **should** include consideration of the impact of personnel readiness on system and mission effectiveness. Potential impacts on personnel retention, performance, and readiness **should** also be considered and quantified, if possible.

The contractor **shall** identify, document, and analyze Habitability risks, issues and opportunities to mitigate or otherwise minimize the impacts of Habitability risks and issues. Early identification of Habitability risks, issues and opportunities for improvement and cost reduction is critical to achieving success. The contractor **should** ensure that program-level trade studies and analyses include appropriate consideration of Habitability - to make accurate and informed total life cycle performance and cost decisions.

The contractor **shall** ensure that Habitability and Habitability-related system requirements are identified, refined, decomposed, allocated (flowed-down), and tracked. The contractor **shall** ensure that Habitability requirements are allocated appropriately to associate contractors, subcontractors and suppliers and their efforts/products are integrated. This often includes educating them about Habitability expectations and assumptions and verifying that the expected inputs/products included in their contracts support those expectations and assumptions. The contractor **should** coordinate Habitability requirements with other disciplines and Design IPTs.

The contractor **should** review Habitability requirements, including derived requirements, using the quality factors listed below and identify any non-conformances to program management.

a. Be valid, clear, necessary, current, and traceable to a parent requirement.

b. Be verifiable, with the method(s) of verification (i.e., analysis, inspection, demonstration, or test) documented.

c. Include any interoperability/interface constraints from a human performance/error perspective.

d. Address functional and performance requirements that impact, or may be impacted by, humans in the system.

e. Address human-related constraints, including external and internal interfaces that impact, or may be impacted by, humans in the system.

f. Be verified and validated through the contractor management/customer approval processes (refer to EIA-649-1).

g. Be based on supporting rationale such as design criteria standards, requirements analysis, functional/task analysis, and capability/architecture/design trades.

h. Be maintained such that changes to any requirement, capability, system, software, or physical component are identified and updated for each applicable item in the requirements matrices.

The contractor **shall** document the organization and stakeholders in the Habitability Working Group in a Habitability Program Plan, if required by the contract. If no Habitability Program Plan is required, the working group **shall** be documented in the SEMP or the HSI Program Plan.

4.1.4 Habitability Analysis

The contractor **shall** analyze consistency of system design and employment concepts with customer-provided Habitability requirements.

The contractor **shall** identify, analyze, and document Habitability concerns and recommended improvements.

The contractor **shall** ensure that Habitability analysis requirements allocated to associate contractors, subcontractors and suppliers and their efforts/products are managed and integrated.

The contractor **shall** analyze the Habitability considerations in 3.1.1 (repeated below) against established design criteria, such as MIL-STD-1472 and other contractually imposed criteria. Significant discrepancies **should** be coordinated with the associated design IPT and program management. Additional considerations in Appendix B **should** be included in the analysis.

- Environmental Control
  - Air conditioning, heating, and ventilation adequacy, contamination and quality control.
  - Temperature, humidity and other environmental ranges and controls.
  - Environmental conditions that potentially risk human safety or health.
  - Noise environment.
  - Vibration and motion environment.
  - Lighting adequacy to support human task performance.
- Habitability Facilities
  - Living and working conditions necessary to sustain the morale, safety, health, comfort, and job effectiveness of the user populations.
  - Adequate space and arrangement for work, living, personal stowage, and rest.
  - Material selection (e.g., flammability, toxicity).
  - Accommodations for users, passengers, and visitors, including those with special needs (e.g., Very Important Person (VIP), Americans with Disabilities Act (ADA) compliance, medical needs).
  - Physical fitness and recreation facilities.
  - Stowage for personal effects.
  - Fresh water availability, food availability, and quality control.
  - Sanitation and waste control measures.
  - Berthing, bathing and personal hygiene capabilities.
- Job Design
  - Role, job and task characteristics to ensure adequate user performance and morale.
  - Crew routine schedules.
  - Sustaining required levels of human performance, and achieving adequate rest/maintaining circadian rhythms in extreme/extended mission environments.

- Personnel Services
    - Barber, post office, store.
    - Religious, medical, dental and food services.
    - Housekeeping (cleanliness of inhabited spaces).
    - Laundry/dry cleaning.

4.1.5 Habitability Support to Pre-Milestone B Activities

Prior to Milestone B, the government may conduct exploratory research, assessment of Commercial Off-The-Shelf (COTS) products, existing systems or facilities, and development of system or subsystem prototypes as part of their risk reduction and requirements development efforts. The contractor may be tasked to support these efforts by providing COTS products, providing access to existing systems or facilities, conducting risk reduction activities, or developing and testing prototypes. When tasked, the contractor **shall** provide Habitability assumptions, design considerations, and constraints related to the systems, facilities, equipment, or capabilities being investigated by the government, consistent with the contract.

If included in the Pre-Milestone B contract, the contractor **shall** assess and document if system capability requirements are realistic and consistent with Habitability requirements. If included in the Pre-Milestone B contract, the contractor **shall** analyze and research emergent technologies for their potential in mitigating identified Habitability risks and issues or realizing identified Habitability opportunities.

4.1.6 Habitability Support to System Development

The contractor **shall** ensure that the system complies with contract Habitability requirements.

The contractor **shall** ensure that Habitability requirements are fulfilled by the design, development, or selection of logistics support equipment, and computer-based systems and other training systems.

The contractor **shall** ensure that Habitability requirements are fulfilled by the design and/or development of system facilities, such as warehouses, support equipment, training facilities, mission planning/debriefing centers, and data analysis facilities.

The contractor **shall** ensure that Habitability requirements are fulfilled by the design of manufacturing equipment, tools, processes, and personnel workspaces, especially regarding personnel ergonomics, safety, comfort, and efficiency.

The contractor **shall** ensure that Habitability-related risks and issues are updated, documented, and mitigated or otherwise controlled. The contractor **should** periodically inform program management, design IPT leads, and other technical discipline personnel of Habitability compliance status, risks, issues, and concerns.

The contractor **shall** ensure that Habitability is addressed in early design assessments (e.g., test bench assessments of preliminary user interface concepts) and that significant results are presented in coordination with HSI at system design reviews, such as PDR and CDR.

The contractor **shall** ensure that significant Habitability risks and issues are presented and documented at major program and technical reviews; e.g., Preliminary Design Review (PDR), Critical Design Review (CDR).

The contractor **shall** ensure that Habitability entrance, accomplishment, and exit criteria for major program and technical reviews are satisfied.

The contractor **shall** ensure that Habitability risks and issues resulting action items from CDR are closed prior to the next major program review and Milestone C review.

The contractor **shall** ensure that Habitability requirements allocated to associate contractors, subcontractors and suppliers are integrated, monitored and reported. For programmatic and system design requirements allocated to subcontractors and suppliers, the contractor **shall** ensure that evidence of compliance is provided to program management.

The contractor **shall** conduct periodic Habitability working group meetings unless Habitability support has been allocated to a higher-level working group (e.g., systems engineering or HSI).

The contractor **shall** communicate to management opportunities to implement Habitability design alternatives that may improve system availability, personnel accommocation, personnel effectiveness; reduce operations or sustainment costs; or improve personnel retention.

The contractor **shall** ensure that Habitability supports change management. Habitability **should** (1) identify potential design change impacts on personnel Habitability affecting physical environment, cultural environment, social environment, personal services, medical, and mess, and living conditions; (2) identify possible mitigation strategies; and (3) ensure that Himpacts are reflected in the cost of engineering changes.

The contractor **should** monitor the effectiveness and quality of Habitability activities and periodically inform program managers and customer Habitability personnel of concerns.

The contractor **should** coordinate Habitability activities with other engineeering and logistics disciplines.

The contractor **should** coordinate Habitability products and deliverable data tems with other related disciplines.

Habitability is impacted by requirements, analyses, and changes in other HSI domains, and by Systems Engineering, and Integrated Logistics. A few examples of Habitability high-drivers and Domain interrelationships are provided in Table 1 for information.

Table 1 - Drivers/cross-domain interelationships impacting habitability

Domain/ Other	High Drivers Impacting Habitability
Manpower/SE Requirements	Maximum crew and passenger size
HFE	Anthropometric accommodations Work station design
Force Protection/Survivability (FP/S)	Emergency Egress Crash worthiness Protective clothing and equipment
SOH	Fire safety Flammability of materials/off-gassing Long duration missions in uncomfortable, cramped, confined spaces
Regulations, Laws, and Standards	Air worthiness impacts/Habitability impacts on air worthiness Takeoff and Landing certification Emergency equipment Doors
Systems Engineering (SE)	Mission/Function/Task analysis results Mission duration/extended missions Mission-related requirements (e.g., VIPs, ADA compliance, patient transport) Extreme environments Personal clothing and equipment
Program Level	Cost limitations Acquisition strategy

4.1.7 Habitability Support to System Verification

The contractor **shall** integrate Habitability requirements into overall program verification planning. System verification events must assess Habitability under both nominal and worst-case conditions specified by the requirements.

The contractor **shall** ensure that Habitability and Habitability-related requirements are formally verified in accordance with the program verification plan.

The contractor **should** ensure that Habitability personnel are integrated in verification planning and verification activities involving user personnel to ensure that environmental conditions are appropriate to the job and identify Habitability-related risks or issues. Habitability planning includes identifying the needs for resources, facilities (e.g., simulation systems, test benches, prototype equipment, and actual equipment) and personnel. The contractor's Habitability verification activities **should** maximize efficiencies such as using existing equipment, facilities, and demonstrations (e.g., logistics demonstrations) to the greatest extent feasible in order to minimize costs.

Habitability verification **shall** include consideration and assessment of the scenarios and environments that may stress system availability or effectiveness due to limitations in personnel readiness, including those from the Concept of Operations. Verification of requirements **should** be through the approved methods of conducting appropriate assessments such as test, inspection, analysis, and demonstration. For tests/assessments impacting on Habitability, the following **should** be considered:

- Nominal versus worst-case test conditions.
- Sensor/transducer placement (e.g., noise, temperature) and calibration.
- Minimum requirements versus objectives.

The contractor **shall** document and provide evidence of compliance with Habitability requirements in the system specification. If deviations are identified, the contractor **should** investigate causes and develop proposed mitigations. The contractor **shall** document compliance with requirements contained in this standard in accordance with Appendix A. This evidence of compliance may take the form of:

a. Closure of the task in the IMS,

b. Presentation of the task results in major program design reviews or program management reviews, or

c. Completion and approval of program data items or reports associated with the task

The contractor Habitability Lead or designee **shall** ensure proper protection of human subjects prior to the start of any data collection event in accordance with 45 CFR 46 or equivalent.

If required by the contract, the contractor **shall** support operational testing and validation of the system.

4.1.8 Habitability Support to System Sustainment

When included as part of system sustainment tasking and requirements, the contractor **shall** ensure that the actual environmental, work and living conditions supporting Habitability, personnel/system readiness, and personnel retention are consistent with those that were projected and tested. When deviations are identified and/or proposed, the contractor **should** investigate causes, develop and propose effective mitigations.

During production, operations, and sustainment, Habitability **shall** support program change management and configuration management activities.

Once system design, development, development test and operational test are complete, the program typically moves through one or more Low Rate Initial Production (LRIP) phases, and then into Full Rate Production (FRP). After Initial Operational Capability (IOC) has been reached, production continues until complete. Beginning with early production, the contractor **should** monitor testing, operations and trainee exercises and identify any Habitability issues. From IOC, through Full Operational Capability (FOC) when all operational units are operational, the system operates and is sustained by the program. Changes occur for a variety of reasons, including updates to incorporate new technologies, correct problems identified in T&E and operations, address obsolescence issues, or to add operational capabilities in response to changing mission needs.

4.1.9 Habitability Working Group

The contractor **shall** establish a Habitability working group (WG) that provides a forum for contractor and customer Habitability SMEs to review Habitability team approaches and issues, and provide recommendations for improvement unless Habitability is allocated to a higher-level working group (e.g., SE or HIS).

The HWG (or higher-level WG) **shall:**

- Review the implementation and execution of Habitability requirements across the program.
- Review the status of Habitability risks, issues and opportunities.
- Make recommendations to the HSI core team to facilitate meeting contractual Habitability requirements.
- Obtain broad DoD customer/Prime contractor/sub-contractor review of Habitability requirements, plans, SOH-related SDRL submissions, draft CDRL products, accomplishments, risks, and issues.

Unresolved Habitability risks and issues **should** be presented to a higher-level for discussion and resolution.

4.2 Habitability Requirements in Support of Human Systems Integration

The purpose of this section is to provide additional Habitability requirements in support of a contractually required HSI program. The contractor **shall** integrate Habitability support with HSI in the following areas: HSI program initiation, planning/budgeting/scheduling, requirement flow-down/management, analysis, tradeoffs, design support, verification/validation, documentation, quality control/reporting, risk/issue management, and documentation. The contractor **shall** coordinate and de-conflict related HSI and domain area activities to avoid duplication of effort.

4.2.1 Habitability Support to HSI Analysis

HSI analyses identify and characterize human considerations and impacts across the system lifecycle. These activities can be conducted by both the customer HSI team and the contractor HSI team. The contractor **shall** ensure that Habitability inputs are made to HSI analyses in the following areas, as applicable:

- HSI Architecture Support Analysis.
- HSI Domain Tradeoff Analysis.
- Risk, Issue, and Opportunity Analysis.
- Technology Analysis.
- Habitability Contribution to Affordability Analysis.

The contractor **should** provide Habitability support to HSI analyses as needed. Typical HSI and Domain analyses are shown in Table 2. The contractor **should** ensure that Habitability analysis results are documented, analyzed, and coordinated with other HSI domains.

Table 2 - Typical HSI and domain analyses

HSI Analyses and HSI-Related Analyses P = Primary Contributor(s) S = Secondary Contributor(s) X = External Collaborations	HFE	Manpower, Personnel	Training	Safety & Occ. Health	Force Prot. & Survivability	Habitability	HSI Lead	Product IPTs	Prgm. Mgmt.	Rel. & Maint.	Systems Engrg.	Logistics Supt.	Manuf. Plnng
HSI Analyses													
HSI Architecture Support Analysis	S	S	S	S	S	S	P	X	X	X	X	X	X
HSI Domain Tradeoff Analysis	S	S	S	S	S	S	P	X	X	X	X	X	X
Risk, Issue and Opportunity Assessment	S	S	S	S	S	S	P	X	X	X	X	X	X
HSI contribution to Technology Analysis	S	S	S	S	S	S	P	X	X	X	X	X	X
HSI contribution to Affordability Analysis	S	S	S	S	S	S	P	X	X	X	X	X	X
Human Factors Engineering Analysis													
Mission analysis	P	S	S					X	X		X		
Function and Function Allocation analysis	P	S	S					X	X		X		
Job and Role definition analysis	P	P	S					X		X	X	X	X
Task analysis	P	P	S					X		X	X	X	X
User Workflow analysis	P	S	S					X			X	X	
Accessibility/maintainability analysis	P			S				X		X	X	X	
Task performance, fatigue and workload analysis, modeling and simulation	P		S		S			X	X	X	X	X	
Operator interface design analysis (includes usability)	P	S	P	S				X			X		
Maintainer interface design analysis (includes usability)	P	S	P	S				X		X	X	X	X
Human-Environment analysis	P			P		S		X		X	X	X	
Human-Machine Interface design compliance analysis	P			P				X		X	X	X	X
Situation Awareness analysis	P		S		P			X			X		
Digital Model and Mockup assessments	P		S	S	S	S		X		X	X	X	X
Human reliability analysis	P			S				X			X		
Human error analysis	P		P	S				X		X	X	X	
Space claim analysis for humans, tools, etc.	P			S	S	S		X	X		X		X
Training system design analysis	P		P	S				X		X	X	X	
Support equipment design analysis	P			S				X		X	X	X	
Facility design analysis	P	S	S	S	S	P		X	X	X	X	X	X
Manpower and Personnel Analysis													
Number and mix of personnel (military, civilian and contractor)	S	P								X		X	
Manpower Estimate analysis (supporting /assessing the CARD)	S	P	S					X	X			X	
Skill, knowledge, experience and aptitude analysis for all jobs, roles, tasks	S	P	S					X		X	X	X	
Job Task Analysis	S	P	S					X			X	X	
Training Analysis													
Analysis of new or unique combinations of training	S		P								X	X	
Training methods/media selection and tradeoff analysis /modeling	S		P									X	
Training task difficulty analysis	S		P					X		X	X		
Training effectiveness analysis	S	S	P					X	X		X		
Safety and Occupational Health Analysis													
Hazard analysis (e.g., Preliminary, System, Operating & Support)	S			P	S	S		X	X	X	X	X	X
Safety Requirements/Criteria Analysis	S			P	S			X	X		X	X	
Software safety analysis	S			P	S			X			X	X	
Health Hazard analysis	S			P	S			X	X	X	X	X	
Safety design compliance analysis	S			P	S	S		X			X	X	X
Accident/mishap analysis	S			P	S			X	X	X	X	X	
Fault tree analysis	S			P				X		X	X		
Noise, blast, chemical/biological/radiation exposure analysis	S			P	P	S		X	X	X	X	X	
Physical force, explosives, temperature extremes analysis	S			P	P	S		X		X	X	X	
Force Protection and Personnel Survivability Analysis													
Fratricide reduction analysis	S				P				X		X		
Survivability analysis	S				P			X			X		
Physical and mental fatigue analysis	S				P	P					X	X	
Survivability Severity vs. probability analysis	S				P			X			X		
Force Protection design compliance analysis	S				P	S		X	X		X	X	
Habitability Analysis													
Berthing and Hygiene requirements analysis	S			S		P		X			X		
Personnel services analysis (e.g., medical, food, water, sleep, exercise)	S			S		P		X	X		X	X	
System environmental impacts on personnel	S			S		P		X	X	X	X	X	
Habitability design compliance analysis	S			S		P		X	X	X	X	X	

4.2.2 Habitability Support to HSI Pre-Milestone B Activities

The procuring agency may contract with one or more prime contractors prior to Milestone B to advance system development planning, reduce risk, draft procurement documents and/or assist with conducting analyses and tradeoffs. The contractor **should** coordinate Habitability requirements, risks, issues and opportunities with the HSI Team. The contractor **should** coordinate plans, activities, products, and documentation, prototyping and test results with the HSI Team. The contractor **should** provide results of these investigations to assist with technology selection decisions and management of identified HSI risks and issues.

If included in the Pre-Milestone B contract, the contractor **shall** ensure that results of Habitability analyses are provided to HSI in support of the Analysis of Alternatives (AoA).

The contractor **shall** report Habitability findings, conclusions, implications and recommendations for system development to the HSI Team, consistent with Pre-Milestone B contract requirements. Habitability **should** provide feedback to the customer's HSI organization, to include recommended changes to proposed SDD contract requirements, with accompanying rationale. The contractor also **should** recommend Habitability requirements to the HSI Team for the engineering and manufacturing development (EMD) program (such as OBS, WBS, IMP, IMS, SOW, system specification, Contract Data Requirement List [CDRL], SEMP, and HSIPP).

4.2.3 Habitability Support to HSI in System Development

This section specifies the Habitability process requirements to be accomplished in support of HSI during EMD phase.

- The contractor **shall** ensure that Habitability considerations are appropriately coordinated with other HSI domains.
- The contractor **shall** include unresolved Habitability risks and issues as part of HSI entrance, exit and accomplishment criteria.
- The contractor **should** ensure that unresolved Habitability risks and issues are resolved in HSI action items from CDR prior to the next major program review and Milestone C review.
- The contractor **shall** ensure that HSI customer reviews address Habitability concerns, risks, issues and opportunities at customer SME reviews such as Crew Systems Working Groups (CSWGs), Design Advisory Groups (DAGs), Aircrew Systems Advisory Panels (ASAPs), Maintainer Advisory Panels (MAP), or other review meetings in accordance with the program IMP and IMS.
- The contractor **shall** ensure that Habitability impacts are included by the HSI Team in change management and configuration management activities including: analysis and selection of candidate solutions, selection of the preferred solution, implementation of the selected solution, and verification of the effectiveness and suitability of the selected solution (refer to EIA-649-1).
- The contractor **shall** share Habitability concerns and/or issues during development and operational testing, document with the HSI team and HSI customer.
- The contractor **shall** ensure that Habitability is included in the planning and conduct of HSI program reviews.

4.2.4 Habitability Support to the HSI Working Group

The contractor **shall** provide Habitability support to HSI working group meetings throughout the contract period of performance. The contractor **should** ensure that Habitability plans, activities, risk, issues, opportunities, analysis and verification results, products, deliverable data and formal data handoffs to other disciplines are discussed and any discrepancies are satisfactorily resolved. Habitability **should** participate as appropriate in HSI Working Group meeting planning, scheduling, execution, action item investigation, and documentation and reporting.

4.2.5 Habitability Evidence of Compliance with HSI Programmatic Requirements

The contractor **shall** collaborate with the HSI Lead to facilitate efficiencies across domains and related disciplines when conducting verification activities.

The contractor **should** ensure that the results of verification of Habitability requirements are coordinated with other HSI domains, any other appropriate disciplines, and/or teams.

Habitability **shall** ensure proper protection of human subjects prior to the start of any HSI data collection event in accordance with 45 CFR 46 or equivalent.

The contractor **should** provide feedback to HSI and program management regarding the results of verification activities, such as the comfort, safety and well-being of the humans in the system (i.e., operators, maintainers, trainers, sustainers).

Verification, is the process of determining that the system meets the design specification. Validation is the process of determining whether or not the system functions the way it was intended to function in the environment for which it was designed. Validation of the system occurs during the OT&E portion of the program. OT&E is often conducted without the participation of the contractor.

4.2.6 Habitability Support to HSI in Production, Operations, and Sustainment

Whenever changes are made in the system design, the contractor **shall** ensure that Habitability impacts and effective corrective actions are coordinated with HSI.

4.2.7 Habitability Support to HSI Program Progress Reporting, and Quality Control

Over the past several decades, it has been shown that ten parameters of Human Systems Integration must be demonstrated for HSI programs to be successful (Booher, 2003). If requested by HSI, Habitability personnel **shall** support HSI progress reporting and quality control activities, including the planning, development of approach and assessment criteria, data gathering and reporting.

5. NOTES

5.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

APPENDIX A - COMPLIANCE MATRIX

Paragraph Number	Process Requirement	Evidence of Compliance	Artifact/Report
4.1.1	During Program Initiation, the contractor **shall** establish a Habitability program.		
4.1.1	The Contractor **shall** identify and document the program Habitability requirements, including any associated with Government Furnished Property (GFP), Equipment (GFE), Information (GFI), services, and facilities.		
4.1.2	The contractor **shall** review the draft Requests for Proposal (RFP) and proposal evaluation criteria and recommend improvements to address Habitability concerns.		
4.1.2	The contractor **shall** assess Habitability requirements in the SOW, system specification, DD1423, Organizational Breakdown Structure (OBS), Work Breakdown Structure (WBS), Acquisition/Development Schedules, and recommend improvements to address Habitability concerns.		
4.1.2	The contractor **shall** assess customer-provided Habitability estimates for completeness and realism and provide feedback and recommendations for improvement to the customer HSI organization.		
4.1.2	The contractor **shall** develop and propose additions or modifications to customer-provided Habitability requirements, based on reviews of established Habitability criteria, standards, and reports.		
4.1.3	The contractor **shall** plan the Habitability program, including a clear definition of the technical objectives, scope, processes, and product(s), consistent with the terms of the contract, the system requirements, and the phase of acquisition.		
4.1.3	In addition, if Systems Engineering, Human Systems Integration, and/or Lifecycle Sustainment programs are established for the overall program, the Habitability program **shall** be coordinated with the activities, schedules, and budgets included in those programs.		
4.1.3	The contractor **shall** coordinate Habitability planning with the procuring agency.		
4.1.3	If a separate Habitability program plan is required by the contract, it **shall** be placed under configuration management for contractual execution (refer to EIA-649-1).		
4.1.3	The contractor **shall** plan, schedule, budget, manage, and execute Habitability activities in accordance with this standard.		
4.1.3	The contractor **shall** document resource requirements (e.g., staffing, facilities, time-phased schedule and level of effort, budgets) for the entire Habitability effort required by the contract statement of work.		
4.1.3	The contractor **shall** ensure that Habitability activities are captured in the acquisition program Integrated Master Plan (IMP) and Integrated Master Schedule (IMS).		
4.1.3	Data and products required by the Habitability team **shall** be documented in the IMP and IMS.		
4.1.3	Likewise, Habitability handoffs of data and products to other disciplines **shall** be documented in the IMP/IMS.		
4.1.3	The contractor **shall** ensure that Habitability needs for GFE, GFP, and/or GFI are documented in the IMP and IMS.		
4.1.3	The contractor **shall** assess compatibility of system design and employment concepts with customer-provided Habitability requirements and document Habitability concerns and recommended improvements.		

Paragraph Number	Process Requirement	Evidence of Compliance	Artifact/Report
4.1.3	The contractor **shall** identify, document, and analyze Habitability risks, issues, and opportunities to mitigate or otherwise minimize the impacts of Habitability risks and issues.		
4.1.3	The contractor **shall** ensure that Habitability and Habitability-related system requirements are identified, refined, decomposed, allocated (flowed-down), and tracked.		
4.1.3	The contractor **shall** ensure that Habitability requirements are allocated appropriately to associate contractors, subcontractors and suppliers and their efforts/products are integrated.		
4.1.3	The contractor **shall** document the organization and stakeholders in the Habitability Working Group in a Habitability Program Plan, if required by the contract.		
4.1.3	If no Habitability Program Plan is required, the working group **shall** be documented in the SEMP or the HSI Program Plan.		
4.1.4	The contractor **shall** analyze consistency of system design and employment concepts with customer-provided Habitability requirements.		
4.1.4	The contractor **shall** analyze, identify, and document Habitability concerns and recommended improvements.		
4.1.4	The contractor **shall** ensure that Habitability analysis requirements allocated to associate contractors, subcontractors and suppliers and their efforts/products are managed and integrated.		
4.1.4	The contractor **shall** analyze the Habitability considerations in 3.1.1 (repeated below) against established design criteria, such as MIL-STD-1472 and other contractually imposed criteria.		
4.1.5	When tasked, the contractor **shall** provide Habitability assumptions, design considerations, and constraints related to the systems, facilities, equipment, or capabilities being investigated by the government, consistent with the contract.		
4.1.5	If included in the Pre-Milestone B contract, the contractor **shall** assess and document if system capability requirements are realistic and consistent with Habitability requirements		
4.1.5	If included in the Pre-Milestone B contract, the contractor **shall** analyze and research emergent technologies for their potential in mitigating identified Habitability risks and issues or realizing identified Habitability opportunities.		
4.1.6	The contractor **shall** ensure that the system is designed consistent with contract Habitability requirements.		
4.1.6	The contractor **shall** ensure that Habitability requirements are fulfilled by the design, development, or selection of logistics support equipment, and computer-based systems and other training systems.		
4.1.6	The contractor **shall** ensure that Habitability requirements are fulfilled by the design and/or development of system facilities, such as warehouses, support equipment, training facilities, mission planning/debriefing centers, and data analysis facilities.		
4.1.6	The contractor **shall** ensure that Habitability requirements are fulfilled by the design of manufacturing equipment, tools, processes, and personnel workspaces, especially regarding personnel ergonomics, safety, comfort, and efficiency.		
4.1.6	The contractor **shall** ensure that Habitability-related risks and issues are updated, documented, and mitigated or otherwise controlled.		

Paragraph Number	Process Requirement	Evidence of Compliance	Artifact/Report
4.1.6	The contractor **shall** ensure that Habitability is addressed in early design assessments (e.g., test bench assessments of preliminary user interface concepts) and that significant results are presented in coordination with HSI at system design reviews, such as PDR and CDR.		
4.1.6	The contractor **shall** ensure that significant Habitability risks and issues are presented and documented at major program and technical reviews (e.g., Preliminary Design Review [PDR], Critical Design Review [CDR]).		
4.1.6	The Contractor **shall** ensure that Habitability entrance, accomplishment, and exit criteria for PDR are satisfied.		
4.1.6	The Contractor **shall** ensure that Habitability entrance, accomplishment, and exit criteria for CDR are satisfied.		
4.1.6	The contractor **shall** ensure that Habitability is addressed in resulting action items from CDR prior to the next major program review and Milestone C review.		
4.1.6	The contractor **shall** ensure that Habitability requirements allocated to associate contractors, subcontractors and suppliers are integrated, monitored, and reported.		
4.1.6	For programmatic and system design requirements allocated to subcontractors and suppliers, the contractor **shall** ensure that evidence of compliance is provided to program management.		
4.1.6	The contractor **shall** conduct periodic Habitability Working Group meetings unless Habitability support has been allocated to a higher-level working group (e.g., systems engineering or HSI).		
4.1.6	The contractor **shall** communicate to management opportunities to implement Habitability design alternatives that may improve system availability, personnel accommocation, personnel effectiveness; reduce operations or sustainment costs; or improve personnel retention.		
4.1.6	The contractor **shall** ensure that Habitability supports change management.		
4.1.7	The contractor **shall** integrate Habitability requirements into overall program verification planning.		
4.1.7	The contractor **shall** ensure that Habitability and Habitability-related requirements are formally verified in accordance with the program verification plan.		
4.1.7	Habitability verification **shall** include consideration and assessment of the scenarios and environments that may stress system availability or effectiveness due to limitations in personnel readiness, including those from the Concept of Operations.		
4.1.7	The contractor **shall** document and provide evidence of compliance with Habitability requirements in the system specification.		
4.1.7	The contractor **shall** document compliance with requirements contained in this standard in accordance with Appendix A.		
4.1.7	The contractor Habitability Lead or designee **shall** ensure proper protection of human subjects prior to the start of any data collection event in accordance with 45 CFR 46 or equivalent.		
4.1.7	If required by the contract, the contractor **shall** support operational testing and validation of the system.		

Paragraph Number	Process Requirement	Evidence of Compliance	Artifact/Report
4.1.8	When included as part of system sustainment tasking and requirements, the contractor **shall** ensure that the actual environmental, work and living conditions supporting Habitability, personnel/system readiness, and personnel retention are consistent with those that were projected and tested.		
4.1.8	During production, operations, and sustainment, Habitability **shall** support program change management and configuration management activities.		
4.1.9	The contractor **shall** establish a Habitability Working Group (HWG) that provides a forum for contractor and customer Habitability SMEs to review Habitability team approaches and issues and provide recommendations for improvement (unless Habitability is allocated to a higher-level working group [e.g., HIS]).		
4.1.9	The HWG (or higher-level WG) **shall:** ▪ Review the implementation and execution of Habitability requirements across the program. ▪ Review the status of Habitability risks, issues and opportunities. ▪ Make recommendations to the HSI core team to facilitate meeting contractual Habitability requirements. ▪ Obtain broad DoD customer/Prime contractor/sub-contractor review of Habitability requirements, plans, SOH-related SDRL submissions, draft CDRL products, accomplishments, risks and issues.		
4.2	The contractor **shall** integrate Habitability support with HSI in the following areas: HSI program initiation, planning/budgeting/scheduling, requirement flow-down/management, analysis, tradeoffs, design support, verification/validation, documentation, quality control/reporting, risk/issue management, and documentation.		
4.2	The contractor **shall** coordinate and de-conflict related HSI and domain area activities to avoid duplication of effort.		
4.2.1	The contractor **shall** ensure that Habitability inputs are made to HSI Analyses in the following areas, as applicable: ▪ HSI Architecture Support Analysis. ▪ HSI Domain Tradeoff Analysis. ▪ Risk, Issue, and Opportunity Analysis. ▪ Technology Analysis. ▪ Habitability contribution to Affordability Analysis.		
4.2.2	If included in the Pre-Milestone B contract, the contractor **shall** ensure that results of Habitability analyses are provided to HSI in support of the Analysis of Alternatives (AoA).		
4.2.2	The contractor **shall** report Habitability findings, conclusions, implications, and recommendations for system development to the HSI Team, consistent with Pre-Milestone B contract requirements.		
4.2.3	The contractor **shall** ensure that Habitability considerations are appropriately coordinated with other HSI domains.		
4.2.3	The contractor **shall** include unresolved Habitability risks and issues as part of HSI entrance, exit, and accomplishment criteria.		
4.2.3	The contractor **should** ensure that unresolved Habitability risks and issues are resolved in HSI action items from CDR prior to the next major program review and Milestone C review.		

Paragraph Number	Process Requirement	Evidence of Compliance	Artifact/Report
4.2.3	The contractor **shall** ensure that HSI customer reviews address Habitability concerns, risks, issues, and opportunities at customer SME reviews such as Crew Systems Working Groups (CSWGs), Design Advisory Groups (DAGs), Aircrew Systems Advisory Panels (ASAPs), Maintainer Advisory Panels (MAP) or other review meetings in accordance with the program IMP and IMS.		
4.2.3	The contractor **shall** ensure that Habitability impacts are included by the HSI Team in change management and configuration management activities including: analysis and selection of candidate solutions, selection of the preferred solution, implementation of the selected solution, and verification of the effectiveness and suitability of the selected solution.		
4.2.3	The contractor **shall** share Habitability concerns and/or issues during development and operational testing, document with the HSI team and HSI customer.		
4.2.3	The contractor **shall** ensure that Habitability is included in the planning and conduct of HSI program reviews.		
4.2.4	The contractor shall provide Habitability support to HSI working group meetings throughout the contract period of performance.		
4.2.5	The contractor **shall** collaborate with the HSI Lead to facilitate efficiencies across domains and related disciplines when conducting verification activities.		
4.2.5	Habitability **shall** ensure proper protection of human subjects prior to the start of any HSI data collection event in accordance with 45 CFR 46 or equivalent.		
4.2.6	Whenever changes are made in the system design, the contractor **shall** ensure that Habitability impacts and effective corrective actions are coordinated with HSI.		
4.2.7	If requested by HSI, Habitability personnel **shall** support HSI progress reporting and quality control activities, including the planning, development of approach and assessment criteria, data gathering and reporting.		