

Incorporation of Human Systems Integration into a Request for Proposal (RFP)

Revision B

24 September 2017

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RECORD OF CHANGES

CHANGE NUMBER	DATE OF CHANGES	PAGES AFFECTED
A	25 June 2017	7-23
B	17 September 2017	1, 7-32

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1.0 OVERVIEW

Human Systems Integration (HSI) is the interdisciplinary technical and management processes for integrating the human into and across all system elements, an essential enabler to systems engineering (INCOSE, 2007). HSI is a Department of Defense (DoD) mandated requirement in Department of Defense Instruction (DoDI) 5000.02, Enclosure 7. When executed faithfully, it is a strategy that is initiated early in the program and works throughout the program life cycle to ensure that the product design and development meets human performance capabilities at minimum cost. These capabilities include the human cognitive, physical, and sensory skills required for manpower and personnel selection, training, usability, safety, health hazard assessment, survivability and for maintaining and supporting a system. It comprises seven domains as described in DoDI 5000.02, Enclosure 7, Human Systems Integration. The seven domains are:

1. Human Factors Engineering
2. Safety and Occupational Health
3. Manpower
4. Personnel
5. Training
6. Force Protection and Survivability
7. Habitability

For definitions, see Table 1.

2.0 TABLE 1. HSI DOMAINS.

While DoD 5000.02 Enclosure 7 includes the necessary terminology for HSI integration by the military service, HSI by the system prime contractor and subcontractors is not possible unless is the procuring agency clearly communicates its HSI requirements via the Request for Proposal (RFP). A significant misconception among agencies that prepare, review and submit RFPs is that HSI and Human Factors Engineering (HFE) are identical. Whereas HFE is one domain in HSI focused on applying the knowledge of human capabilities and limitations in design, HSI is a management and integration activity focused on applying domain knowledge across all aspects of a system and ensuring that any competing requirements and conflicts are resolved. This includes design and logistics tradeoff decisions that impact Training, Safety, Occupational Health, Habitability, Force Protection and Survivability, Manpower, and Personnel domains, and integrating all the domains.

There are several ways in which the terms HSI and HFE are confused. For instance, HSI could be called out in an RFP when the author means HFE, or HFE is called out when the author intended HSI. Such a simple error can then have implications further along in the system development lifecycle and deliverables whenever there is such a misunderstanding. A review of several documents revealed how pervasive this error is. For example, a SOW on one project called out the development of an HSI Management Plan as a Human Factors effort. Another project, presumably as the result of a poorly written SOW, placed the HSI alongside Logistics, Training, Maintainability and Safety, rather than in its appropriate role of planning and facilitating the coordination and execution of HSI. Ultimately these mistakes reflect on the quality of HSI deliverables that are delivered to the customer, as the deliverables will reflect only the HFE effort, not the integration of HSI domains per 5000.02, Enclosure 7.

For companies or organizations that receive proposals based on these erroneous RFPs, the HSI/HFE misconception creates four problems:

1. Contractors may have little ability or motivation to try and enable or develop, from the grass roots level, a fully integrated HSI approach. In addition, contractors may not have access to real end users for enabling or developing grass roots HSI efforts, especially in pre-proposal phases.
2. The RFPs tie the hands of HSI professionals with respect to planning, scheduling, and writing into the proposal a fully integrated HSI effort.
3. The acquisition authority doesn't, won't or can't hold suppliers to the intent of their need.
4. If a DOD requirement for HSI is not specified as an evaluated percentage (10 percent or more) in the RFP, then it is in the "trade space," and is often traded out. This therefore becomes a risk to the acquisition agency, the contractor, and ultimately the user if the system isn't built to their real needs.

Government entities that erroneously identify HSI may also be setting the program up for cost overrun or outright failure when they have to go back and fix issues if the end user rejects the product produced.

Fortunately, DoD has recognized this shortcoming. A government/industry partnership consisting of DoD HSI Standards Working Group and the Society for Automotive Engineers (SAE) G-45 Technical Committee is currently developing an HSI industry "best practice" standard for HSI; one of the goals is to mitigate the risk of HFE and HSI terms being used interchangeably (SAE, in review). Even when implemented, though, the standard may still not address the common misperception that HSI and HFE are one and the same. What is needed is a brief set of general guidelines RFP developers can follow to eliminate this misperception.

3.0 HSI ORGANIZATION

The RFP should require that the contractor identify and describe the organizational elements responsible for HSI functions, including any HSI Integrated Product Team (IPT) and how they interact with the system engineering team. Note that an HSI organization will not typically include any domains, as these are separate, driven by their separate SOW requirements. The contractor should, however, be prepared to identify the HSI domain(s) addressed by each element; to whom the HSI manager/lead and HSI domain leads report; and the reporting responsibility and relationships between the HSI manager/lead and the HSI domain leads. As key positions, a summary job description should be provided for the HSI manager/lead and domain leads, to ensure they meet the minimum required qualifications.

The RFP should require that the contractor plan integrate and execute an HSI program that is appropriate to system and mission needs.

The acquisition agency must also specify which of the seven HSI domains are to be integrated, require an HSI plan (which would read much like a Systems Engineering plan (SEP)), how the plan is kept aligned with the SEP), and identify any deliverables associated with HSI. The HSI plan must be able to integrate and reconcile competing requirements. The acquisition agency must then specify for each domain (1) what its requirements are, (2) how it will work with HSI, and (3) its associated deliverables. The RFP should also require that the activities in each domain must be specified in the requirements that are authored for each domain. Domain activity requirements should not be included in the HSI requirement. Finally, the contractor should state

how the HSI and systems engineering effort will be carried out on the program and how they will be given access to end users to do the appropriate HSI efforts.

3.1 HSI Organizational Relationships

The RFP should require that the contractor describe the company's organizational HSI elements and their relationship to other organizational elements affecting HSI in the program (e.g., reliability, maintainability and supportability), applicable working groups and government HSI counterparts. For more information, see the Human Systems Integration Program Plan (HSIPP) Data Item Description (DID) DI-HFAC-81743, section 4.c (Organization).

3.2 HSI Working Group (HSIWG)

The RFP should require that the contractor describe their HSIWG. An HSIWG should represent all applicable HSI domains and other interfacing disciplines on the program. It should at least include members from all HSI domains, systems engineering IPT leads as required, and can include external entities, as well as customer and subcontractor representatives. The RFP should require that the contractor state how often the HSIWG meets and how HSI issues and risks are tracked. The RFP should require that the contractor provide a copy of the HSIWG Charter approved by the Program Manager. The RFP should also require that the contractor state with whom the HSIWG coordinates (e.g., domain-specific working groups, Systems Safety/ESOH Working Group, Training Working Group, Maintainer/Logistics Working Group, etc.).

4.0 SEVEN DOMAINS OF HSI

The RFP should require that the contractor plan integrate and execute an HSI program that is appropriate to system and mission needs. HSI planning and domain integration are critical to meeting these needs. When domain requirements are specified without a requirement for HSI, domain functions tend to be executed independently, with little coordination or integration.

Table 1 gives a brief definition of each domain, and Figure 1 shows the relationships between the seven HSI domains¹. The RFP writer needs to ensure that the RFP contains a separate requirement section for each HSI domain that is required on the acquisition program. If all domains are required, there should be seven separate sections, one for each domain. Then, there should be a separate section for HSI. The RFP developers should take care to tailor the RFP to reflect the requirements and scope of the HSI domains applicable to the program (for example, Force Protection/Survivability and Habitability may not apply to a software program that is to be used in an office environment). The RFP developers must ensure that, for each domain where effort is required, separate requirements are included in the RFP for each domain. If no requirements are included for a particular domain, the contractor has no obligation to conduct any activity within that domain, even if the HSI requirement mentions it.

The proposed tailoring of the RFP content should use the HSIPPDID DI-HFAC-81743 as guidance, since this document will ultimately be the structure from which the contractor's HSI effort will be built.

¹ HSI, and all of its domains are technically disciplines, and not necessarily organizational/engineering entities. If no entity exists, the RFP developers and contractor should ensure that HSI and all of its domain names are used with a modifier (e.g., Manpower requirements").

Table 1. HSI Domains.

Domain	Description
Human Factors Engineering (HFE)	HFE applies consideration of human physical and cognitive capabilities and limitations to the design of systems, products and tools.
Safety and Occupational Health	Safety and Occupational Health determines system design characteristics that can minimize the risks of acute or chronic illness, disability, or death or injury to operators and maintainers.
Manpower	Manpower addresses the numbers of people (military, civilian and contractor) required, authorized and potentially available to operate, maintain, train, and support each capability and/or system.
Personnel	Personnel define the human knowledge, skills, abilities, aptitudes, competencies, characteristics, and capabilities required to operate maintain and support each capability and/or system in peacetime or war.
Training	Training addresses the comprehensive solutions for content, scope and sequence, facilities, and planning necessary to impart the requisite knowledge, skills, and abilities to the users to effectively operate and maintain systems.
Force Protection and Survivability	Force Protection and Survivability represents those characteristics of a system that reduce the risk of fratricide and personal detection or targeting, prevent personal attack if detected or targeted, increase survival and prevent injury if personally attacked or located within an entity being attacked, minimize medical implications if wounded or otherwise injured, and minimize physical and mental fatigue.
Habitability	Habitability addresses requirements for the physical environment, personnel services (e.g., medical and mess), and living conditions (e.g., berthing and personal hygiene).

Human Systems Integration Internal Domain Interactions

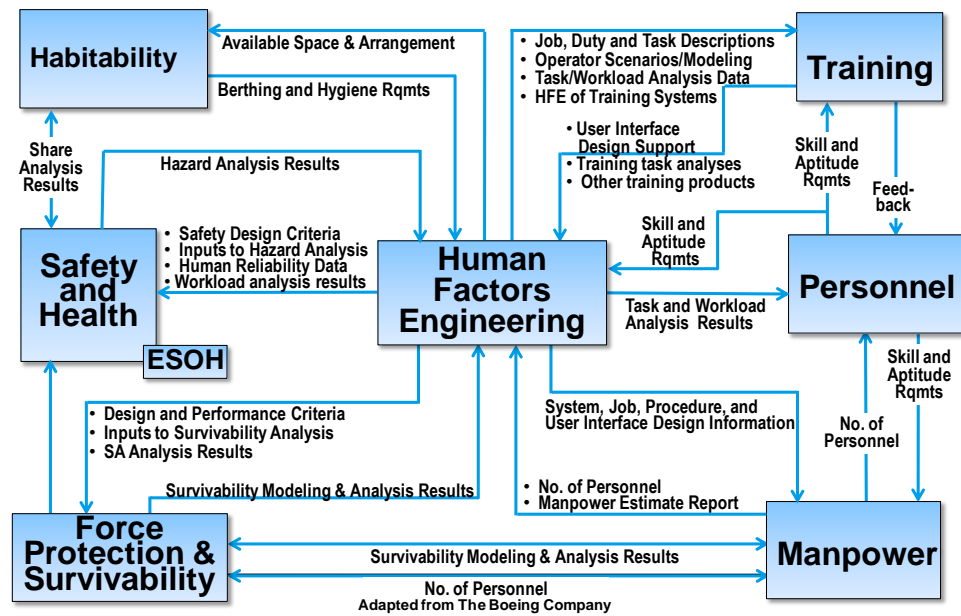


Figure 1. Interrelation of HSI Domains.

4.1 **HSI and Human Factors Engineering (HFE)**

The RFP should require that the contractor provide the methods by which the program will apply HFE principles, methods, criteria, best practices, and standards to ensure that operator, maintainer, trainer, support personnel, and manufacturer (if applicable) user interfaces are designed to improve both human and total system performance. The RFP should also require that the contractor describe the HFE activities throughout the product lifecycle including analysis, design support, evaluation, and requirement verification not already described. RFP writers should consult section 4.1.3 of the Department of Defense Handbook: Human Engineering Guidelines for Military Systems, Equipment and Facilities (MIL-STD-46855A) and the HEPP DID (DI-HFAC-81742A) for more information on HFE.

The RFP should also require that the contractor describe the role of HFE professionals in the program (e.g., define requirements, design of operator interfaces, review concepts with the end user, validate and verify that the design meets the requirements, and prepare for test) and state how they will interact with all relevant domains. Issues associated with the integration of human capabilities and limitations into the system design to optimize human-machine performance should be at the center of these interactions.

4.1.1 Analysis

The RFP should require that the contractor explain the role HFE requirements plays in the analysis of operator interface per the specified population of users called out for the program. The RFP should also require that the contractor state if anthropometric assessments are needed (e.g., to determine the standing and seated Design Eye Position (DEP), reach, vision, access, and clearance). The RFP should also require that the contractor explain if trade studies will be performed for optimal hardware and software user interfaces (e.g., display location and orientation in relation to the DEP, display hand/voice-control mechanisms, display size, and icons and symbols required to optimize situation awareness, task performance and workload) and how these trade studies will be conducted. Examples include:

1. Task Analysis –Identify all human operator tasks required to perform the mission level tasks. See Section 8.0 (HSI in Systems Analysis).
2. Workload and/or Situation Awareness Assessment - Identify workload assessments (e.g., preliminary and final workload analyses, part-task and full-mission workload analyses, Integrated Workload Analysis). See Section 9.4.4 (Usability & Workload/Situation Awareness Assessment).
3. Usability Analysis/Assessment – Identify usability tests to assess critical operator/maintainer equipment and interfaces. See Section 9.4.4 (Usability & Workload/Situation Awareness Assessment).

4.1.2 Design Support, Development and Procedure Development

The RFP should require that the contractor state how and when it will use HFE to guide the design of support systems , structures, avionics, hardware and software, training systems, training, facilities, support Equipment, tool design, and production Planning support The RFP should also require that the contractor explain how HFE will achieve the project's physical and graphical user interfaces and human-system automation requirements to support personnel safety, training, and task performance, and minimize confusion and error (e.g., program reviews and end user reviews):

4.1.3 Evaluation

The RFP should require that the contractor identify HFE evaluations to be conducted. This includes physical measurement, equipment weight and balance, handholds, reach and vision envelopes, usability assessments, drawing reviews, user-safety evaluations, and evaluations of display layouts. The RFP should also require that the contractor state the criteria to be used in the evaluations and how the results will be documented (e.g., per MIL standards, program specification requirements, etc.).

4.1.4 Validation and Verification (V&V)

The RFP should require that the contractor state how V&V will be performed and how HFE requirements will be evaluated as part of that process. The RFP should also require that the contractor state whether HSI as a discipline will support the HFE domain during the V&V activity, which determines that the system design meets the program requirements and their intent. The RFP should also require that the contractor state how V&V will be satisfied (e.g., data is gathered and collated from trade study results, anthropometric assessments, Human-in-the-Loop testing, WG meeting minutes, program reviews, test events). The RFP should also require that the contractor state how and where the HFE data compiled will be documented. For more information, see section 4.1.3 (Test and Evaluation) of MIL-STD-46855.

4.2 HSI and Safety and Occupational Health

The RFP should require that the contractor describe the approach by which the staff within the Safety and Occupational Health domain will analyze, design and validate the prevention and management of Safety and Occupational Health hazards. The RFP should also require that the contractor ensure that details of Safety and Occupational Health are documented such as in Programmatic Environment, Safety and Occupational Health Evaluation (PESHE) and a System Safety Program Plan (SSPP). For more information, see the Department of Defense Standard Practice System Safety (MIL-STD-882, or equivalent industry standards), and the SSPP DID (DI-SAFT-81626).

The RFP should also require that the contractor state plans for documenting and managing hazardous materials used in the system or in the system manufacturing process, along with plans for system demilitarization and disposal.

The RFP should also require that the contractor state how the Safety and Occupational Health domain will integrate or interact with all relevant domains, and specifically with the Safety community. Issues associated with the harms from death, injury, occupational illness, damage to equipment, loss of data, or damage to the environment should be at the center of these interactions.

4.3 HSI and Manpower

The RFP should require that the contractor provide a description of the approach by which the staff within the Manpower domain will analyze, design, and validate operator and maintainer tasks based on Manpower availability and affordability requirements. The RFP should require that the contractor identify all operational, maintenance and support tasks in normal and extended operations. Examples of tasks include:

1. Hardware user interfaces that accommodate the required range of operator, maintainer and Manpower size. The contractor should identify the rationale for including this task and HSI's effort in the task.

2. Work shift schedules that will use the minimum number of Manpower without exceeding maximum shift times and/or providing the most effective rest schedules during extended shift operations. The contractor should identify the rationale for including this task and HSI's effort in the task.
3. Analyses of tradeoffs among the various classifications of Manpower (e.g., active duty versus reserve, military versus civilian, contractor versus Department of Defense) and system performance.
4. Manpower affordability analysis.
5. Manpower estimation, analysis, and reporting.
6. Estimates of the contributions of manpower to the life cycle cost of operations and support.
7. Assess Manpower requirements as stated in the SOW, the Organizational Breakdown Structure (OBS), Work Breakdown Structure (WBS), Acquisition/Development Schedules, and the Proposal evaluation criteria.
8. Assess the appropriateness of total Manpower requirements, including their Military Occupational Specialty classifications (and equivalent).
9. Assess operator, maintainer and support interface, job designs and overall consistency of system design against customer provided Manpower requirements
10. Manpower Estimation Report (MER)
11. Target Audience Description (TAD)
12. Manpower Key Performance Parameters (KPP)
13. Manpower Program Objective Memorandum (POM)
14. System-specific criteria (historical and/or goals) – staffing types, numbers, specialty codes, educational/knowledge characteristics, etc.
15. Documentation of manpower at required Operational Readiness Levels and Operations Tempo (OPSTEMPO)
16. Life Cycle Management Plan (LCMP); Life Cycle Sustainment Plan (LCSP)
17. Coordinate Manpower products and Data Items with other HSI domains
18. Ensure Manpower requirements are allocated to associate contractors, subcontractors and suppliers and their efforts/products are integrated.
19. Verify that Manpower requirements are met.
20. Verify the Manpower risks and issues are suitably mitigated.

The RFP should also require that the contractor state how the manpower domain will interact with all relevant domains. The number of people needed to operate, maintain and support should be at the center of these interactions, as well as how the contractor will determine the number of people needed for operating, maintaining and supporting the system.

4.4 HSI and Personnel

The RFP should require that the contractor provide a description of the approach by which the staff with the Personnel domain will analyze, design, and validate operator, maintainer and support personnel based on human performance requirements for Knowledge, Skills and Abilities (KSAs) of military and civilian personnel complexity versus life-cycle costs. The RFP should require that the contractor identify all operational, maintenance and support tasks in normal and extended operations. Examples of tasks include:

1. Hardware user interfaces that accommodate the required range of operator, maintainer and support personnel's physical size and strength. The contractor should identify the rationale for including this task and HSI's effort in the task.
2. Hardware and software user interfaces that can be used by operators with different roles. The contractor should identify the rationale for including this task and HSI's effort in the task.
3. Analyses of tradeoffs among the aptitudes of the various classifications of personnel (e.g., active duty versus reserve, military versus civilian, contractor versus Department of Defense) and system performance.
4. Experience-level analysis.
5. Analysis of tradeoffs between system design and personnel requirements (e.g., complexity versus human performance).
6. Personnel estimation, analysis, and reporting.
7. Estimates of the contributions of personnel costs to the life cycle cost of operations and support.
8. Assess Personnel requirements as stated in the SOW, the OBS, the WBS, Acquisition/Development Schedules and the Proposal evaluation criteria.
9. Assess the MER, TAD, and other relevant customer-generated Personnel characteristics and documents from Manpower for realism and provide feedback to the customer HSI organization.
10. Assess consistency of system design with customer-provided Personnel requirements. Identify potential cost reductions based on modifying Personnel requirements.
11. Assess the appropriateness of Military Occupational Specialty classifications (and equivalent) assigned by the customer to system operator, maintainer and support positions
12. Assess operator, maintainer and support interface and job designs against customer provided Personnel requirements.
13. Assess the adequacy of customer generated Personnel requirements (e.g., skills, aptitude, experience, cognitive and physical) considering user interface designs and job performance requirements.
14. Contribute Personnel inputs to HSI Planning and execution (e.g., studies, tradeoffs, risk/issue/opportunity management, etc.), including:
 15. Human aptitudes (i.e., cognitive, physical and sensory capabilities)
 16. Knowledge, skills, and abilities
 17. Development of occupational specialties
 18. Selection and assignment of personnel
19. Assess results of HFE task and workload studies, analyses, modeling activities and simulations and determine if changes are required in Personnel requirements.
20. Solicit and address comments on Personnel requirements from other HSI domain specialists.
21. Provide Personnel requirements to other HSI domain specialists and other disciplines as appropriate.
22. Collaborate with customer Personnel specialists to optimize numbers, skills, etc. of system personnel in a manner that minimizes personnel-driven ownership costs.
23. Ensure Personnel requirements are allocated to associate contractors, subcontractors and suppliers and their efforts/products are integrated.

24. Verify that Personnel requirements are met.
25. Verify the Personnel risks and issues are suitably mitigated.

The RFP should also require that the contractor state how the Personnel domain will interact with all relevant domains. For Personnel, the experiences, aptitudes, and physical characteristics, gaps in users and system capabilities, and security requirements should be at the center of these interactions.

4.5 HSI and Training

The RFP should require that the contractor provide a description of the approach by which the staff within the Training domain will analyze, design, and validate operator, maintainer and support training requirements considering such factors as user interface commonality, usability and complexity versus life-cycle costs per MIL-PRF-29612 (Performance Specification: Training Data Products) and associated DIDs for planning documents.

The RFP should require that the contractor identify all operational, maintenance and support tasks in normal and extended operations. Examples of tasks include:

1. Hardware and software user interfaces that are consistent across components to facilitate ease of training and/or maintainability. The contractor should identify the rationale for including this task and HSI's effort in the task.
2. Hardware and software user interfaces that can be used by operators with different roles and accommodate different levels of training. The contractor should identify the rationale for including this task and HSI's effort in the task.
3. Analyses of tradeoffs among the classifications of trained personnel (e.g., active duty versus reserve, military versus civilian, contractor versus Department of Defense) and system performance.
4. Analysis of tradeoffs between system design and training requirements (e.g., user interface commonality, usability, and complexity versus human performance versus training costs).
5. Estimates of the contributions of training costs to the life cycle cost of operations and support.
6. Analysis of training and media requirements, including options for individual, collective, and joint training for operators, maintainers and support personnel; and the use of training effectiveness evaluations.
7. Plan for developing training materials, including options to use simulation, embedded training, distributed learning, or other techniques to acquire and maintain skills, reduce costs, and provide training flexibility. Includes job aids and quick reference guides.
8. Plan for measuring that users not only completed the training but "learned" the training as well, specifically with regards to cognitive related tasks. This may require the application of cognitive science measurement tools that can capture this kind of information.

The RFP should also require that the contractor state how the Training domain will interact with all relevant domains. For Training, acquisition, retention and transfer of KSAs, design of curricula, training needs/requirements, training gap analysis, training effectiveness and integration of operational, maintenance and support KSAs should be at the center of these interactions.

4.6 HSI and Force Protection and Survivability

The RFP should require that the contractor describe the approach by which the staff within the Force Protection and Survivability domain will analyze, design and validate requirements to ensure that operator, maintainer and support personnel are protected against fratricide, detection, injury from natural and combat hazards and nuclear, biological and chemical effects. The RFP should also require that the contractor state how it will ensure the integrity of the crew compartment, life support equipment and provisions for rapid egress in the event the system is severely damaged or destroyed. The RFP should also require that the contractor state who will be involved in decisions (e.g., HSI professionals, representatives from the Safety team) and who will participate in and review aspects of system design that increase the probability of personnel survivability while performing the mission. Examples of tasks include:

1. Life support equipment – HSI participation in and contributions to the design, accessibility, and use of life support equipment (e.g. oxygen masks), including the ability to perform all mission tasks while using life support equipment).
2. Nuclear, Biological and Chemical (NBC) protective gear - HSI participation in, and contributions to, the design, accessibility, and use of nuclear, chemical, and biological protective gear equipment (e.g., chem-bio gloves), and the ability to perform all mission tasks while wearing protective gear.
3. Injury Protection gear and equipment design - HSI participation in, and contributions to, the design and use of injury protection gear such as laser protection goggles and hearing protection, and the design of equipment design to prevent injuries, such as eliminating sharp corner and head strike injuries.
4. Emergency egress/ditching provisions - HSI participation, and contribution to, the design and use of emergency egress and ditching provisions, including, as necessary, analysis of egress/ditching timelines; impact of adverse conditions, and demonstrations wearing personnel protection gear.
5. Assess HSI, Force Protection and Survivability requirements as stated in the SOW, the OBS, the WBS, Acquisition/Development Schedules and the Proposal evaluation criteria.
6. Assess the appropriateness of total Force Protection and Survivability requirements, as they apply to system operators, maintainers and supporters.
7. Assess operator, maintainer and support interface and job designs against customer provided Force Protection and Survivability requirements.
8. Assess customer-provided Force Protection and Survivability requirements and documents for realism and provide feedback to the customer HSI organization.
9. If the program is Force Protection and Survivability intensive, work with customer Force Protection and Survivability specialists to establish a KPP.
10. Contribute Force Protection and Survivability inputs to HSI Planning and execution (e.g., studies, tradeoffs, risk/issue/opportunity management, etc.) The inputs should include the areas such as reducing fratricide, reducing detectability, reducing the probability of an attack, minimizing the amount of damage if attacked, minimizing the number and severity of injuries, and increasing Situation Awareness (SA).
11. Assess consistency of system design with customer-provided Force Protection and Survivability requirements. Identify potential concerns and improvements.
12. Ensure that System Safety includes Force Protection and Survivability hazards in their Hazard analyses.

13. Contribute Force Protection and Survivability inputs to HSI Planning and execution in the forms of studies, tradeoffs and risk/issue/opportunity management.
14. Ensure Force Protection and Survivability requirements are allocated to associate contractors, subcontractors and suppliers and their efforts/products are integrated.
15. Verify that Force Protection and Survivability requirements are met.
16. Verify the Force Protection and Survivability risks and issues are suitably mitigated.

The RFP should also require that the contractor state how the Force Protection and Survivability domain will interact with all relevant domains. An operator's ability to function during and after exposure to hostile situations or environments should be at the center of these interactions.

4.7 HSI and Habitability

The RFP should require that the contractor summarize its approach to analyzing and meeting habitability requirements for the program. Examples include requirements for the physical environment (e.g., adequate personnel work and living space and environment control); for personnel services (e.g., medical and mess); and for living conditions (e.g., rest/housing, education, recreation, and personal hygiene) that have an impact on human performance contributions to system performance or affect the quality of life. The RFP should also require that the contractor identify known issues (e.g., lighting, ventilation, temperature control), the applicable requirements or standards, which area in the system is impacted (e.g., crew areas, galley, and maintenance facility), how the contractor plans to address the issue, and the teams and IPTs involved in finding a solution. Examples of tasks include:

1. Assess Habitability requirements in the SOW, OBS, WBS, Acquisition/Development Schedules and Proposal evaluation criteria.
2. Assess customer-provided Habitability requirements and documents for realism and provide feedback to the customer HSI organization.
3. If the program is Habitability intensive, work with customer Habitability specialists to establish KPPs.
4. Contribute Habitability inputs to HSI Planning and execution (e.g., studies, tradeoffs, risk/issue/opportunity management, etc.). Inputs should include living and working conditions, lighting, space/arrangement, ventilation, sanitation, noise, vibration, temperature, berthing, bathing, personal hygiene, bathing, and food service. Intangible needs, specifically pertaining to religious beliefs, should be considered as well.
5. Assess consistency of system design and employment concepts with customer-provided Habitability requirements. Identify and document potential habitability concerns and improvements.
6. Ensure Habitability requirements are allocated to associate contractors, subcontractors and suppliers and their efforts/products are integrated.
7. Verify that Habitability requirements are met.
8. Verify the Habitability risks and issues are suitably mitigated.

The RFP should also require that the contractor state how the habitability domain will interact with all relevant domains. Human capabilities and limitations should be at the center of these interactions.

5.0 HSI KEY PERFORMANCE PARAMETERS (KPP) AND KNOWLEDGE, SKILLS AND ABILITIES (KSA)

The RFP should require that the contractor describe the contractor's HSI KPPs and HSI KSAs for test, if any. The KPPs represent the major drivers of operational performance developed during the systems engineering requirements capture activities; the KSAs represent secondary drivers of operational performances. Also, the RFP should require that the contractor identify and quantify Measures of Effectiveness (MOE) for mission-essential tasks.

6.0 HSI IN SUPPORT OF AFFORDABILITY AND PERFORMANCE GOALS

The RFP should require that the contractor state how HSI professionals will work with the Systems Engineering Risk Management functions, Affordability personnel, Training and Maintainability, Integration and Product Support Teams to design IPTs to minimize program costs, and how the customer will reduce life-cycle costs per Section 4E (Human Systems Integration Support of Affordability and Performance Goals) of the HSIPP DID (DI-HFAC-81743A). Note that anything in excess of what is listed in the HSIPP DID should be clearly identified and stated in the RFP.

The RFP should require that the contractor state specifics like reducing the number, level, and training costs for operational and support personnel. The RFP should require that the contractor state how HSI professionals will participate in the function and task analyses that will help to determine the minimum number of operating and support personnel to perform all functions during normal and extended operations (e.g., HSI Working Group (HSIWG) meetings, design reviews). Functions include such disciplines as Training, Maintainability, Systems and Software operations to discuss levels of automation and technology insertion. The RFP should also require that the contractor discuss the ways in which they can reduce or simplify operation, training and maintenance for the design or equipment use; match the KSAs of existing customer personnel categories and/or use personnel with the lowest acquisition, training and maintenance costs.

The RFP should also require that the contractor state how HSI cost and performance factors will be formally considered during analysis, design and procedure development activities, and how they will be discussed with the customer during all Technical Reviews such as System Requirements Review (SRR), System Functional Review (SFR), Preliminary Design Review (PDR)/Interim Design Review (IDR), Critical Design Review (CDR)/Final Design Review (FDR), and in the engineering change management process. For efforts with incrementally fielded acquisition strategy (e.g., Agile Software Development), the RFP should include HSI-related costs and impacts that span across increments/builds.

If needed, the RFP should require that the contractor should provide a list of HSI affordability and performance goals (e.g., crew size, human safety provision and levels of automation) and the requirement and metric with which each goal is associated.

7.0 HSI RISKS, ISSUES AND OPPORTUNITIES

7.1 HSI Risks

The RFP should require that the contractor integrate HSI risk, issue and opportunity management with the overall program. HSI professionals, in conjunction with Systems Engineering Risk Management functions, should identify HSI risks across all domains and those that rise to the level of system, segment or program level risks. The RFP should require that the contractor state how they will ensure that HSI risks are entered into the system, segment or program risk database

and create an approved mitigation plan. If applicable, training personnel should also address any potential readiness or performance risks (e.g., combat capability and readiness). The contractor's HSI plan should require studies to identify operations that pose the highest risk of skill decay. If such risks need to be addressed, the contractor's proposal should include a top-level description of the approach for addressing them (see ODASD-SE, 2017).

The RFP should require that the contractor state how often the status of HSI risks will be reported to management, and if they will be discussed in HSIWG meetings. The contractor should also provide the name of who will be responsible for ensuring that HSI risks are tracked and resolved, and ensure that the customer has up to date information on their status.

7.2 HSI Issues

The RFP should require that the contractor state how issues are documented, assigned, monitored, and tracked to resolution and what type of tracking system is used (e.g., a database or an Excel spreadsheet). The RFP should also require that the contractor state how issues are identified by HSI domain(s) and organized by categories such as criticality, origination date and organization, due date, status, Point of Contact/responsible team, and notes on proposed resolution (including required analysis).

The RFP should require that the contractor state how often the status of HSI database issues will be reported to management, and if they will be discussed in HSIWG meetings. The contractor should also provide the name of who will be responsible for ensuring that HSI issues are tracked and resolved, and ensure that the customer has up to date information on their status.

7.3 HSI Opportunities

HSI professionals, in conjunction with Systems Engineering Opportunity Management functions, should identify HSI opportunities across all domains and those that rise to the level of system, segment, or program level opportunities. The RFP should require that the contractor state how they will ensure that HSI opportunities are entered into the system, segment, or program database. If applicable, training personnel should also address any potential readiness or performance opportunities (e.g., combat capability and readiness). The contractor's HSI plan should call for studies to identify operations that pose the highest opportunity for skill improvement. If such opportunities need to be addressed, the contractor's proposal should include a top-level description of the approach for addressing them.

8.0 HSI IN SUBCONTRACTOR EFFORTS

8.1 HSI in Subcontractor Selection, Monitoring and Design Integration

The RFP should require that the contractor describe the appropriate flow of domain-related requirements to subcontractors/suppliers and the selecting, monitoring, and interacting with subcontractors, specifically with regards to government provided equipment and software that is not under the control of the prime contractor. The RFP should also require that the contractor state how the HSI team can ensure that the program's subcontractors will comply with the HSI-related or domain design and verification requirements. If HSI professionals will participate in the selection of subcontractors, the contractor should state how they will accomplish this (e.g., evaluation of HSI-related aspects of subcontractor (hardware or software) equipment, compatibility with current operator and maintainer interfaces, impact on manpower, personnel and training; personnel safety issues; maintainability issues; and environmental impacts on users).

The RFP should also require that the contractor state how subcontractor professionals will interface with the contractor (e.g., HSIWG, design reviews) to address HSI domain risks and issues (e.g., design, integration, operation, safety, maintainability, and training) relative to their systems or components being discussed.

8.2 Subcontractor HSI Deliverables and Design Data

The RFP should require that the contractor state how HSI professionals will provide data to support the development and tailoring of an HSI Supplier Deliverable Requirements List (SDRL) descriptions and Supplier Data Sheets (SDSs). The RFP should also require that the contractor state if the subcontractor deliverables include a subcontractor HSIPP or domain specific deliverables. If they do, the RFP should also require that the contractor state how its HSI professionals plan to review the subcontractor HSIPP/deliverables and coordinate and ensure their integration.

9.0 HSI IN SYSTEM ANALYSIS

The RFP should require that the contractor state how the HSI team will support analyses which contribute to the system or product design including Concept of Operations, architecture development, system/derived requirements for the program during preliminary and critical design, and how HSI will continue to work throughout the entire program/product lifecycle to mature the design of the operator interfaces, training approach, and product support. Examples of this effort can include:

1. Participation in analyzing, flowing down, aligning, and deriving requirements
2. Support mission analysis
3. Help determine system functional requirements and capabilities
4. Support system architecture needs
5. Allocating system functional requirements to humans, hardware, and/or software
6. Developing system functional flows
7. Performing system effectiveness analyses, studies, and modeling.

The RFP should also require that the contractor state any predicted product dependencies between domain analyses. The RFP should also require that the contractor note if special data, software, databases, models, or equipment are required from the procuring agency.

10.0 HSI IN SYSTEM DESIGN

The RFP should require that the contractor discuss how each of the relevant domains are integrated into the design. The RFP should also require that the contractor describe the HSI effort (for all applicable domains) in the system design to ensure fulfillment with the requirements and guidance documents for HSI on the program. The RFP should also require that the contractor provide a description of HSI participation in the selection of Commercial Off-The-Shelf (COTS) or Non-Developmental Items (NDI), participation in trade studies and analyses, task analysis to determine user requirements and user goals, mock-up evaluations and dynamic simulations, iterative usability assessments, tests (e.g., sprint demonstrations), drawing reviews and system and program technical reviews. The RFP should also require that the contractor describe the planned involvement of (and coordination to obtain) end-user personnel (e.g., operators, maintainers, trainers, and support personnel) in assessing the design, operation, maintenance, training, and support of the system, and the rationale for the methodology and human

performance criteria to be used. The RFP should also how the contractor will provide access to end-users in the development of their proposal (i.e., before contract award).

10.1 Requirements Development

The RFP should require that the contractor show how the systems and lower tier specifications will be developed with details of how the individual domains will support requirements development (e.g., participating in reviews and trade studies, performing analyses, etc.). The RFP should also require that the contractor provide description about HSI participation in requirement derivation and validation.

10.2 System Design Development

The RFP should require that the contractor describe the contractor HSI team make an assessment of the feasibility of human roles in the system (operators, maintainers, supporters, trainers) prior to CDR. .

10.2.1 Trade Studies and Analyses

The RFP should require that the contractor state what HSI and HSI domain related trade studies and analyses are to be conducted.

10.2.2 Design Prototypes, Mockups & Simulations

The RFP should require that the contractor describe HSI domain related prototypes (e.g., dynamic software design prototypes, electronic human models in mature hardware design, or higher fidelity physical mockups) in addition to, or in place of, static and lower fidelity mockups (e.g., PowerPoint slides, foam core). For more information, see sections 5.2.2 and 5.2.3 of MIL-STD-46855A.

10.2.3 Usability & Workload/Situation Awareness Assessments

The RFP should require that the contractor describe HFE operator/maintainer/user workload/situation awareness assessments (per MIL-STD-46855, section 5.1.2.3) and usability assessments that enable mission accomplishment at tolerable workload and situation awareness levels. The level should be determined by agreement between the customer and the contractor. Two important factors should be determined:

1. What types of tasks are involved? Are they cognitive-based, physical/manual, or a combination thereof?
2. How will workload be measured? Neurological (e.g., electroencephalograms (EEGs), eye trackers), Physiological, Subjective (e.g. Bedford Scale), Performance (primary and secondary tasks), or a combination of the three categories.

Once this is established, the levels or criteria can then be agreed upon between the contractor and customer.

The RFP should require that the contractor give rationale for conducting usability assessments, situation awareness assessments and workload analysis. The RFP should also require that the contractor state when the assessments/analyses will be performed, and what they are intended to accomplish, and how workload information will be shared with all domains requiring such information. The RFP should also require that the contractor state who will evaluate the assessments/analyses.

10.3 Technical and Program Reviews

The RFP should require that the contractor identify HSI domain related technical reviews, such as Technical Interchange Meetings (TIMs), the HSIWG and various related working groups such as a Crew Station Working Group (WG), a Systems Safety WG, a Training WG, familiarization sessions with the user, the Maintainer TIM, etc. The RFP should also require that the contractor identify the major Program Reviews (e.g., SRR, PDR, and V&V/Test in which HSI domain issues will be addressed and how HSI related issues will be included in the design review entrance/exit/acceptance criteria.

10.4 Tools

If there is a requirement that the contractor conduct analyses and assessments, the RFP should require the contractor to identify the tools it intends to use to conduct these analyses and assessments (e.g., Usability Assessment tool, Software Usability Measurement Inventory, part-task and full-task simulators, mockups and simulations, peer reviews). The RFP should also require that the contractor develop a plan for all required HSI-specific tools and provide brief descriptions of the tools used for performing various analyses or conducting design development activities per Section 4H (Human Systems Integration in System Analysis) of the HSIPP (DI-HFAC-81743A).

11.0 HSI IN PROCEDURE DEVELOPMENT

The RFP should require that the contractor state how HSI supports the HFE and Training domains in creating, reviewing and validating procedures for users (e.g., developing operator manuals, interactive electronic technical manuals, and training media).

12.0 HSI IN VERIFICATION

The RFP should require that the contractor state how the contractor's HSI's team will participate in T&E and other verification activities as part of its integrated test and evaluation program. The RFP should also require that the contractor describe how (e.g., methods, metrics and tools) and when HSI requirements will be verified for compliance. The test facilities and the number and role(s) of HSI personnel who will support T&E should also be discussed. A schedule of HSI tests, evaluations, and other verification activities (inspections, analyses, and demonstrations) in support of program milestones should also be provided by the contractor. The RFP should also require that

The RFP should require contractors to state how HSI professionals will support T&E activities to verify HSI requirements as conducted by their IPTs. Specifically, the contractor's HSI effort should include verification through analysis that all requirements are met or properly accounted for and traded off. The RFP should also require that the contractor establish Pass/Fail criteria prior to the test.

12.1 Test Facilities

The RFP should require that the contractor state how verification of the aspects of the design will be conducted (e.g., require direct observation or parametric measurement during tests). The RFP should also require that the contractor state what personnel will support the T&E IPT to provide inputs into Test Work Descriptions (TWDs) or test reports. The RFP should also require that the contractor provide a list and description of all test facilities.

12.2 Test Subjects

The RFP should require that the contractor state what type of test subjects will be used (age range and experience levels) for the tests. The RFP should also require that the contractor state if customer support is required for obtaining test subjects. Finally, the RFP should require that subjects conform to the Cost Analysis Requirements Document (CARD) manpower tables and the Target Audience Description (TAD), and the subjects should represent the Military Occupation Specialties (MOS) identified for each job.

12.3 Test Conduct

The RFP should require that the contractor state how test participants will be briefed on the design, function and operation of the equipment under evaluation and the specific tasks to be performed during the test. The RFP should also require that the contractor state the guidelines to be used for human subject testing (e.g., American Psychological Association (APA)), and how tests are internally reviewed (e.g., through a human subject testing review board). The RFP should also require that the contractor state if pretest sessions will be conducted to allow subjects to gain experience with the control and display or maintenance equipment prior to the actual test. The contractor also should state when performance parameters subjective data will be collected.

12.4 Test Documentation

The RFP should require that the contractor state how the results of the tests (e.g., laboratory tests, mockup evaluations, simulation studies) will be documented (e.g., individual test reports). Test reports should also include a detailed description of the test methods, scenarios, subject characteristics, test apparatus, and data-reduction techniques.

The RFP should also require that the contractor state who will be responsible for writing the test reports and evaluations (i.e., HSI, a domain of HSI, or T&E).

12.5 Test Equipment

The RFP should require that the contractor identify non-system equipment involved in the tests, including equipment that may be worn or carried by the test subjects, such as communications gear, helmets, survival equipment, etc. The RFP should require that the contractor provide a list of non-system equipment and the performance requirement or standards that dictate or support the use of the gear needed to ensure system compatibility and operability by test subjects.

12.6 HSI Test Schedule

The RFP should require that the contractor provide a schedule of HSI tests, evaluations, and other verification activities (e.g., inspections, analyses, and demonstrations) in support of the program's milestones.

13.0 DATA SOURCES

13.1 Standards

The RFP should require that the contractor provide a list of contractor, university, industry, technical society and government standards and documents that will be applied to the HSI effort, and activities and any proposed tailoring.

13.2 Requirements Documents

The RFP should require that the contractor identify, assess and show responsiveness to the customer requirements, documents and contract documents that impact the program's HSI effort

and activities (e.g., SOW, program specifications, DoD Systems Engineering Technical Review Checklist, Certification Plans, Integrated Logistics Plans, Product Support Plans, Airworthiness Reports) and a brief description of each. The RFP should also require that all contractor-developed requirements documents be identified and available for government approval.

14.0 HSI DELIVERABLE DATA PRODUCTS

The RFP should require that the contractor provide a list and brief description of the HSI accessible or deliverable data products specified in the RFP or proposed by the company and specify the data product development/update schedule. The RFP should also require that everything documented by HSI should be accessible to the customer under the contract.

Below is a sample (but not exhaustive) list of deliverables (NAVSEA, 2003). If the format of the deliverable is directed by a Data Item Description (DID), the DID number is shown in parentheses.

HSI

1. Human Systems Integration Program Plan (DI-HFAC-81743A)
2. Human Systems Integration Report (DI-HFAC-81833)

Human Factors Engineering

1. Critical Task Analysis Report (DI-HFAC-81399B)
2. Human Engineering Design Approach Document – Operator (DI-HFAC-80746C)
3. Human Engineering Design Approach Document – Maintainer (DI-HFAC-80747B)
4. Human Engineering Program Plan (DI-HFAC-81742A)
5. Human Engineering Systems Analysis Report (DI-HFAC-80745C)
6. Human Engineering Test Plan (DI-HFAC-80743B)
7. Human Engineering Test Report (DI-HFAC-80744B)
8. User Workflow Diagram

Safety and Occupational Health

1. Programmatic Environmental Safety and Health Evaluation (PESHE) Plan (DI-ENVR-81840)
2. System Safety Program Plan (SSPP) (DI-SAFT-81626)
3. System Safety Hazard Analysis Report (SSHAR) (DI-SAFT-80101C)
4. Operating, Support, Health, and Safety (OSH&S) Hazard Analysis Report (OSH&S) (DI-SAFT-81841)

Manpower

1. Consolidated Manpower, Personnel; and Training Report (DI-ILSS-80290B)
2. Cost Assessment Requirements Document

Personnel

1. Consolidated Manpower, Personnel; and Training Report (DI-ILSS-80290B)
2. Personnel Management Requirements and Concept

Training

1. Capability to Conduct Team Training and Multi-ship Training within Capabilities of the Battle Force Tactical Training (BFTT)
2. Consolidated Manpower, Personnel; and Training Report (DI-ILSS-80290B)
3. Curriculum and Media to Support Familiarization Training
4. Curriculum and Media to Support Operation/Maintenance Training for Specified Systems
5. Dedicated Training Environment (Electronic Classroom and Learning Resource Center)
6. Instructional Media Design Package (DI-SESS-81520B)
7. Instructional Media Package (DI-SESS-81526C)
8. Instructional Media Requirements Document (DI-SESS-81519C)
9. Instructional Performance Requirements Document (DI-SESS-81518C)
10. Test Package (DI-SESS-81525C)
11. Training Development Facility
12. Training Program Structure Document (DI-SESS-81521B)
13. Training Situation Document (DI-SESS-81517C)

Force Protection and Survivability

1. Survivability Cost Effectiveness Tradeoff Studies Report (DI-RELI-81500)
2. Personnel Survivability Concept
3. Survivability Analysis Report (DI-MISC-80564B)

Habitability

1. Color Coordination Manual (S) for Habitability Spaces (DI-MISC-81123)

15.0 TIME-PHASE SCHEDULE AND LEVEL OF EFFORT

The RFP should require that the contractor supply a program schedule that integrates HSI and individual domain activities. This HSI schedule should include a milestone chart with level of effort information, key HSI decision points, and program decision points. See section 4S (Time-Phase Schedule and Level of Effort) of the HSIPP DID (DI-HFAC-81743) for more information.

16.0 HSI PROGRAM QUALITY CONTROL

16.1 HSI Program Quality Control by Domain

The RFP should require that the contractor describe the approach for periodically assessing the quality of HSI program efforts over the course of the system development contract. The RFP should also require that the contractor describe the method and criteria for evaluating the quality (relative success, progress) in each HSI domain, and when such assessments will take place (e.g., at each major program review). See section 4T (HSI Program Quality Control) of the HSIPP DID (DI-HFAC-81743A) for more information.

16.2 Assessment of HSI Program Success

The RFP should require that the contractor identify, quantify and assess measures (e.g., top-level leadership, focus on human-centered design, source selection policy) and a list of methods/criteria) to determine HSI success by the contractor and sub-contractors on the program.

17.0 ACRONYMS

APA	American Psychological Association
CARD	Cost Analysis Requirements Document
CDR	Critical Design Review
COTS	Commercial Off-The-Shelf
DEP	Design Eye Position
DID	Data Item Description
DoD	Department of Defense
EEG	Electroencephalogram
GDTA	Goal Directed Task Analysis
HFE	Human Factors Engineering
HSI	Human Systems Integration
HSIPP	Human Systems Integration Program Plan
HSIWG	Human Systems Integration Working Group
IDR	Interim Design Review
IPT	Integrated Product Team
KPP	Key Performance Parameters
KSA	Knowledge, Skills and Abilities
LCMP	Life Cycle Management Plan
LCSP	Life Cycle Sustainment Plan
MOE	Measures of Effectiveness
MOS	Military Occupation Specialties
NBC	Nuclear, Biological and Chemical

NDI	Non-Developmental Items
OBS	Organizational Breakdown Structure
OPSTEMPO	Operational Readiness Levels and Operations Tempo
OSH&S	Operating, Support, Health, and Safety
PDR	Preliminary Design Review
PESHE	Programmatic Environment, Safety and Occupational Health Evaluation
POM	Program Objective Memorandum
RFP	Request for Proposals
SDRL	Supplier Deliverable Requirements List
SA	Situation Awareness
SDS	Supplier Data Sheets
SFR	System Functional Review
SOW	Statement of Work
SRR	System Requirements Review
SSHAR	System Safety Hazard Analysis Report
SSPP	System Safety Program Plan
TAD	Target Audience Description
T&E	Test and Evaluation
TIM	Technical Interchange Meeting
TWD	Test Work Description
WBS	Work Breakdown Structure
WG	Working Group
V&V	Validation and Verification

18.0 REFERENCES

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