Key Human System Integration Plan Elements for Command & Control Acquisition

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Topics:
C2 Architectures and Technologies
C2 Assessment Metrics and Tools
Concepts, Theory, and Policy

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Abstract

As the Navy transitions to the guiding principles of Net-Centric Warfare, it is imperative to recognize the importance to access vital, secure and timely tactical information in any given battlespace. The Space and Naval Warfare Systems Command is the acquisition lead for several systems that will create a highly adaptive, networked and distributed defense force with the increased speed, agility and security required to support constantly evolving mission needs. The systems will provide the commander the ability to make more timely and informed decisions based upon the best information and practices. Human System Integration (HSI) is a system engineering process designed to ensure that human performance related issues are identified early in the acquisition process and mitigated during system development and testing using appropriate performance metrics and data collection methods. HSI activities are guided by an acquisition Human System Integration Plan (HSIP) that identifies and integrates design requirements for (a) Human Factors Engineering, (b) Personnel, (c) Habitability, (d) Manpower, (e) Training, (f) Safety & Occupational Health, and (g) Survivability. Key elements of HSI for Command & Control acquisition include: (1) top-down functional analysis/allocation, (2) task-centered design, (3) cognitive engineering, and (4) knowledge mapping.

Introduction

As the Navy transitions to the guiding principles of Net-Centric Warfare, it is imperative to recognize the importance to access vital, secure and timely tactical information in any given operational theater. The Navy's Space and Naval Warfare Systems Command (SPAWAR) is the lead organization responsible for transforming information technology in the military maritime domain (Gallagher, 2010). SPAWAR through their research and development centers and support activities is responsible for providing development, testing and acquisition of systems for future Navy command, control, communications, computers, intelligence, surveillance and reconnaissance products. They are the acquisition lead for several systems that will create a highly adaptive, networked and distributed naval force with the increased speed, agility and security required to support constantly evolving mission needs. These systems will provide the operational commanders the ability to make more timely and informed decisions based upon the best information and practices.

Human Systems Integration

Human Systems Integration (HSI) is a formal acquisition process that provides techniques for human performance in mission capability definition and system development. It is a system engineering practice designed to ensure that human performance related issues are identified early in the acquisition lifecycle and mitigated during system development and testing using appropriate performance metrics and data collection methods. HSI integrates human capabilities and limitations into system definition, design, development and evaluation to optimize total system performance in operational environments. DoD Instruction 5000.2 requires a comprehensive plan for HSI to be in place early in the acquisition process that will optimize total system performance, minimize total ownership costs, and ensure that the final product is built to accommodate the user population characteristics for operations, maintenance and logistics.

There are seven HSI areas that must be considered before existing technology is modernized or new technologies are acquired and deployed: Human Factors Engineering, Personnel, Habitability, Manpower, Training, Safety & Occupational Health, and Survivability (see Table 1 for examples). The HSI process incorporates the seven domains into the systems acquisition process. The goal of the development is an effective system requiring minimal training for the user, prioritization of information necessary for the decision making process, and interfaces that effectively manage and simplify operator workload, are intuitive to use, and provide for user customization where feasible. These domains are interdependent and best HSI practices optimize the mix of these elements based on discovered interdependencies and trade-offs that balance performance and cost.

Human Factors Engineering (HFE)

HFE focuses on designing human system interfaces to optimize user performance and reduce the likelihood of user errors. HFE designs should minimize or eliminate system characteristics that require excessive cognitive, physical, and sensory skills; entail extensive training or workload intensive tasks; result in mission-critical errors; or produce safety or health hazards.

Domains						
Human Factors Engineering	**Personnel**	**Habitability**	**Manpower**	**Training**	**Safety & Occupational Health**	**Survivability**
Interface Design Workload Situation Awareness Decision-Support	Knowledge, Skills & Abilities Personnel Classification Selection Recruiting Retention	Quality of Work Quality of Life Environmental Limits and Controls	Officer, Enlisted, Civilian Billets Wartime Requirements Peacetime Requirements	Initial, Follow-on, & Refresher Delivery Systems Embedded Training Distance Learning Individual Team	Accident Avoidance Health Hazards Risk Mitigation Medical	Damage Control Personnel Protection Fratricide
Human Systems Integration Design Requirements						

Table 1. Human Systems Integration Design Requirements.

Personnel

Knowledge, skills, and abilities are identified to operate, maintain, and sustain the system. The human performance characteristics of the user population are assessed based on the system description, projected characteristics of target occupational specialties, and recruitment and retention trends. To the extent possible, system functionality shall not require cognitive, physical, or sensory skills beyond that found in the specified user population.

Habitability

Requirements are established for the physical environment that impact system performance related quality of life and morale which may affect personnel recruitment or retention.

Manpower
This domain determines the most efficient and cost-effective mix of personnel required and authorized to operate and support the system.

Training
Based on personnel assessments, instructional support is deployed to develop knowledge, skills, and abilities necessary to operate, maintain, and sustain the system.

Safety & Occupational Health (SOH)
SOH addresses potential for new or modernized systems to fail that can lead to accidents and explores mitigation strategies to reduce potential bodily harm with regular and routine use of the system.

Survivability
This domain addresses the need to protect the user from attacks including enemy detection and fratricide. Included here are the quality of personal gear and clothing, integrity of the crew compartments, and provisions for rapid egress when systems are severely damaged or destroyed.

Human System Integration Plan

As required by DoD Instruction 5000.2, acquisition activities are guided by a plan for HSI. An effective HSI plan is critical to the successful development, testing, and deployment of maritime systems and should be initiated early in the acquisition process to optimize total system functioning. The plan should provide a roadmap to address the extent to which humans will be required to operate, maintain, and support the capability, including analysis to reduce manpower, improve human performance, and minimize personnel risk (SECNAV Instruction 5000.2C).

Best system engineering practices for Command & Control acquisition utilize a Human System Integration Plan (HSIP). An HSIP identifies and integrates design requirements for the seven domains. A detailed requirements description of each of the seven domains to be included in the HSIP is published in **Appendix A**. The HSIP is used as a planning guide and management tool to ensure that HSI issues are appropriately and adequately accommodated during system design, development and deployment. Further, the HSIP provides an HSI audit trail by documenting program guidance, sources of applicable data, and acquisition decisions. The HSIP is generally considered a “living document” and can be expanded and updated, as required. Because of the criticality of HFE, training and personnel factors to the success of command and control systems, the HSIP should be maintained and updated as operational requirements change.

Planning for Human Systems Integration encompasses capabilities assessment, program management, systems engineering, product development, program review, and testing activities by both the formal acquisition community (typically a government entity) and the developer (typically a private contractor). An important component of the planning, development and deployment process are human systems integration working group, integrated logistic support and working-level integrated product team meetings. Here design revisions or alternatives will be considered for human system integration optimization that will improve total system performance.

HSI and Command & Control

The purpose of Command & Control is to enable the effective transfer of information between and among systems and operational users to gain situational awareness, make decisions and execute of appropriate courses of action. A major thrust of HSI is to research concepts and develop tools to facilitate the effectiveness and ease of knowledge management, information foraging and exchange, collaboration, and decision-making in the networked command environments of this century. It is essential that Command & Control architectures consider how to effectively integrate operational users with information technologies and networks:

> The integrated command environment, as it pertains to warfighting, is one of the most complex control environments in existence today. The functions that must be accomplished by the "commanders" of this environment are many, varied, and often time-critical with life-or-death outcomes. Human performance, in this context, must be optimized. We can select what we believe are "optimum" humans to accomplish this functionality, and we can train them, but no amount of selection and training can compensate for poor design (Perry, Crisp, McKneely, & Wallace, 2000).

As shown in Appendix A, effective HSI planning relies heavily on human factors engineering to specify human-system interactions for user interface design, optimizing human awareness, decision-making and actions. This is especially true for Command & Control:

> From the perspective of the user of a fielded product, the user interface is the rest of the system. If the user cannot find a particular function or a piece of information, then it may as well never have been developed. The best way to account for users in system design is to determine their needs, design the system to support completion of their tasks, and perform early and iterative evaluation with representative users (Wallace, Winters, Dugger & Lackie, 2001).

The key elements of HSI for Command & Control are from the HFE domain, because advanced mission systems require decision-aiding and an understanding of the human tasks to-be-performed:

<u>Top-down functional analysis and allocation</u>
System functions are identified and then decomposed to tasks. Tasks can be allocated to users or be automated. User roles are defined and skill sets are determined.

<u>Task-centered design (TCD)</u>
TCD is a user-interface design process which systematically identifies and takes into account relevant human performance issues and objectives. Task-centered design attempts to optimize the user interface around the capabilities of the user, rather than forcing the user to accommodate the system or function.

<u>Cognitive engineering</u>
Individual users at various levels need access to critical information related to their assigned jobs, with the ability to access more detail as required. Development of a concept of operations must be focused on the tasks that the operational users have to perform User testing at all stages during development is needed to assure appropriate functionality.

<u>Knowledge mapping</u>
Developing an adaptive system for the operational user requires a full understanding of what decision-makers needs to know to perform their jobs and designing the system to customize information access and representation.

The key HFE elements for acquisition of Command & Control systems and products should be documented in eight reports required by the HSIP. A detailed requirements description of these eight HSIP deliverables is published in **Appendix B**.

Conclusion

HSI is a vital ingredient in the acquisition of Command & Control systems. HSI integrates user capabilities with system definitions, designs, development, and deployment to operational environments and is part of the total systems engineering approach to concept refinement, design, development and testing. Key HSI elements for command & control evolve around situational awareness, distributed decision-making, and action. These elements should be documented, guided by the requirements specified in the HSIP. SPAWAR recognizes the need to optimize human performance to realize a highly adaptive, networked and distributed naval force and has taken the lead in integrating HSI requirements into existing and future Navy Command & Control systems.

References

Gallagher, S. (2010, Jan. 19). Testing the Navy's integrated future. *Defense Systems*. Retrieved from http://defensesystems.com .

Perry, A. A., Crisp. H. E., McKneely, J. A., & Wallace, D. F. (2000). The solution for future command and control: Human-centered design. In P. Hamburger (Ed.) *Proceedings of the Society of Photo-Optical Instrumentation Engineers: Vol. 4126. Integrated Command Environments* (pp. 42-53). Bellingham, WA: SPIE.

Wallace, D., Winters, J., Dugger, M., & Lackie, J. (2001). Human-centered systems engineering process guidance. Naval Surface Warfare Center Dahlgren Division (NSWCCD) TR-01/101.

Appendix A: Description HSI Specific Domain Requirements

The system shall meet the requirements of the following HSI domains:

1.0 **Human Factors Engineering** – The human subsystem shall perform an effective interface leading to satisfactory mission performance in accordance with MIL STD 1472F.

1.1 The system shall conform to the most current military standards for Human Engineering design for marine systems, equipment, and facilities.

1.2 Human performance shall be demonstrated and measured through human-in-the-loop simulation tests using representative operator and maintainer personnel and representative operational scenarios.

1.3 Equipment used in operation, maintenance, setup and support shall be designed in accordance with human factors engineering design standards that minimize human error occurrence and maximize tolerance of errors, human performance capability, and human awareness of the tactical situation.

1.4 Operators shall be capable of performing assigned mission critical tasks within accuracy, time, and energy constraints consistent with overall availability criteria for the system.

1.5 Labeling, including all printed, pictorial, or symbolic information presented visually to personnel for purposes of providing equipment, system or sub-system identification, safety and hazard alerts or procedures, operation and maintenance instructions, general information, pipe content and flow direction, space or compartment identification and informational displays, shall be designed such that the label content, format, location, coding, and structure shall be in compliance with current military standards.

1.6 The system shall provide support for an intelligence system comprising all machine and human interfaces, sensing devices, signal distribution mechanisms, processors, displays, software, decision aids, storage devices, and necessary interfaces with other onboard and off-board systems required to provide intelligence support to the operational mission.

1.7 The system design shall consider automation in areas where a reduction in personnel can be achieved without loss of combat effectiveness or human performance and safety.

1.8 The design shall emphasize simplicity and reliability of automated equipment to achieve the maximum practicable reduction in total personnel.

1.9 Human-machine interfaces shall be designed to be intuitive and interoperable to produce a common look and feel with consistent protocols for system operation.

1.10 The design of Open Systems Architecture and the integration of its major elements shall follow sound HSI principles to maximize human performance as an element of total system performance, and the resulting integrated design will not overload the cognitive sensory and physical capabilities of the operators, maintainers and support personnel.

1.11 Displays shall be designed, labeled, arranged and located in compliance with current military standards.

1.12 Human-computer interfaces shall be designed to ensure rapid and accurate information manipulation and assimilation.

1.13 Displays shall only present to the user the information required at a point in time, in a format designed to make the information immediately accessible, readable and usable.

1.14 The design, format, coding, and structure of labels used throughout the system shall follow a common approach.

1.15 Human error will not degrade the reliability of systems. A human-machine interface design strategy shall be implemented that emphasizes HSI design of interfaces, software, and systems to be standardized (following current military standards), and to be error resistant and error tolerant.

1.16 The communications system shall include management functions for monitoring, controlling, and configuring communications assets.

1.17 Systems shall be designed to promote commonality of communications message content, format, procedures, hand shake, and syntax.

1.18 Communications systems design and implementation shall address communications effectiveness, speech intelligibility, message understandability, error modes in transmitting and receiving messages, and use of constrained language, controlled syntax, and restricted vocabulary.

1.19 Speech intelligibility of voice communication systems shall be assessed as part of test and evaluation exercises and in compliance with current military standards.

1.20 Workload shall be reduced for legacy and developmental systems by consolidating control and by simplifying system operation and control through extensive use of job performance aids, decision aids, procedures guides and augmented human-machine interfaces.

1.21 Decision aids shall be used for managing system complexity; assisting users in coping with information overload; focusing the user's attention; assisting the user in accomplishing time-consuming activities more quickly; assisting when limited data results in uncertainty; overcoming human limitations that are associated with uncertainty, the emotional components of decision-making, finite-memory capacity, and systematic and cognitive biases; and assisting the user in retrieving, retaining, representing or manipulating large amounts of information, combining multiple cues or criteria, allocating resources, managing detailed information, performing computations, and selecting and deciding among alternatives.

1.22 Decision aids shall reduce the number of response options, which focuses the user's attention on the most viable options.

1.23 The elements of a situation display, such as symbology, shall be designed and organized to support a rapid assessment and understanding of the tactical situation.

1.24 Computer systems shall be usable by intended users. In this context usability of a system interface refers to the extent to which: (a) human-computer interfaces have been designed in accordance with user cognitive, perceptual and memory capabilities; (b) software command modes are transparent to the user; (c) displays are standardized and are easily read and interpreted; (d) the user is always aware of where he or she is in a program or problem (situational awareness); (e) procedures are logically consistent; (f) user documentation is clear, easily accessed and readable; (g) on-line help is available and responsive; (h) the user is only provided with that information needed when it is needed; and (i) the user understands how to navigate through a program and retrieve needed information.

1.25 Usability requires that user expectancies are met, that operations are intuitive, that displays are readable, that presented information and communications are immediately meaningful, that the incidence and impact of user errors are minimized, and that human interfaces are designed in conformity with current human engineering design standards.

1.26 In designing for maintainability in an optimized manning system, the effort shall identify the issues attendant to maintenance effectiveness and safety with reduced manning; identify the roles of the on-board human maintainer vs. automation and shore-side personnel in system/watercraft/platform maintenance; and identify maintainability reduced manpower HSI design concepts and criteria.

1.27 The system shall be designed to minimize maintenance, and maintenance personnel shall be provided the necessary tools, information, technical documentation and skills to perform maintenance.

1.28 Each item in which a failure may occur shall be capable of isolation from the rest of the operating equipment and system for maintenance and repair.

1.29 On-board maintainer workloads and skill requirements shall be reduced through reach-back to provide technical assistance and "just-in-time-training," and extensive use of job performance aids, decision aids, procedure guides and augmented human-machine interfaces.

1.30 Maintenance functions and tasks shall be simplified and maintainer workloads reduced through extensive intelligent decision aiding and incorporation of a maintainer's associate to assist in diagnostics decision making.

1.31 Maintenance of human-machine interfaces shall be designed in terms of HSI standards, and will incorporate decision support, intelligent tutoring, on-line help, job performance aiding, data fusion, embedded training, and multi-modal/multi-media/hyper-media capabilities to achieve function, task simplification and consolidation.

1.32 The design of the human-machine interface to facilitate maintenance shall be in compliance with current military standards.

1.33 Technical manuals shall be designed to be readily accessible, readable, and usable by intended users.

1.34 Design of a technical manual shall be appropriate to the knowledge and skills of its users, to the tasks they will perform using the document, and to the environment in which the users will perform these tasks.

1.35 Systems, equipment and components shall be installed to facilitate accessibility for operating efficiency and for inspection, adjustment, maintenance and repair, replacement and removal.

1.36 The system shall provide space to enable the disassembly, repair, test, and checkout of systems and equipment to be repaired in place without dismantling other machinery, piping or structure.

1.37 The system shall be operable and maintainable by personnel whose physical characteristics range from the 5th percentile female to the 95th percentile male.

1.38 The system shall ensure crew rest levels are in accordance with current military standards.

1.39 Structures and components: Design, orientation, labeling and access to valves shall be in compliance with current engineering design standards.

1.40 The system shall use current military standards for the determination of whether there are one or two accesses and whether they are by inclined ladder, vertical ladder, or both, and whether the escapes are trunked.

1.41 Design of doors, hatches, and all provisions for access shall comply with current military standards.

1.42 Passageways shall be designed to allow for emergency egress of all personnel to safe areas.

1.43 Design of walkways and passageways shall comply with current military standards.

1.44 Weight lifting and carrying limits for human transport of material shall be in compliance with current military standards.

1.45 Equipment shall be arranged to facilitate access for maintenance and operation by a person within the 5th percentile female through the 95th percentile male range of applicable anthropometric data as defined by current military standards.

1.46 Interoperability and usability system testing and certification shall be accomplished starting in design and continuing during construction by, where feasible, leveraging joint test networks.

1.47 Lighting requirements in the system shall be in compliance with current military standards.

2.0 **Personnel** – The system shall be capable of being operated and maintained by crew with the lowest level of knowledge, skills, and abilities commensurate with satisfactory mission performance.

3.0 **Habitability** – The system shall provide an adequate environment, i.e., noise, light, heat, vibration, etc., for crew operation and maintenance.

4.0 **Manpower** – The number and mix of personnel shall support effective mission performance and drive the design activities. The systems shall provide sufficient manning levels to enable the crew to perform simultaneous, safe evolutions throughout the mission.

4.1 The system shall automate damage control actions to the most practical extent to support manning level requirements.

4.2 The system shall provide sufficient manning levels to enable the crew to perform simultaneous evolutions throughout the mission.

4.3 Crew size will be minimized through function allocation, human-centered design and function / task consolidation, elimination or automation features that will reduce watch station, maintenance and training requirements, and enhance human performance.

4.4 Implementation of the system shall leverage existing shore infrastructure (manpower and training assets) where feasible, and unique shore infrastructure requirements must be defined and resourced.

4.5 All systems shall be designed for maintainability, and reductions in manpower requirements for system maintenance (both planned and unscheduled) shall be achieved through an in-depth analysis of maintenance related tasks, early identification of maintenance concepts, and definition of maintenance requirements and constraints early in the design process. Burdens imposed on manpower, personnel and training related to system maintenance shall be identified as early as possible and refined throughout the development process.

5.0 **Training** – Training time and effort shall be consistent with system complexity.

5.1 Total System Training Architecture (TSTA) shall be implemented to minimize the use of unique equipment; to provide seamless proficiency training; and to include new learning techniques, simulation technology, embedded training and instrumentation systems that provide anytime, anyplace training to provide for a mission-ready crew.

5.2 The system shall provide a TSTA that supports on demand individual training to the crew, on demand team (unit) training to the crew, on demand force level training to the crew, and mission rehearsal capability while in port.

5.3 The system shall provide a TSTA that supports on demand individual training to the crew, on demand team (unit) training to the crew, on demand force level training to the crew, and mission rehearsal capability while underway.

5.4 The acquisition program shall promote manpower and training cost savings to the greatest extent possible consistent with thorough identification and analysis of all associated knowledge, skills and abilities for all tasks allocated to humans required for the efficient operation and employment of the system.

5.5 HSI strategies will be implemented to realize system efficiency and establish point of departure for effective and efficient training. The program will promote training efficiencies consistent with thorough analysis of all associated skill sets required for the efficient operation and employment of the system. All required training, fleet and individual skills will be documented in the Navy Training System Plan.

5.6 Intelligence training shall employ an intelligence training architecture that provides a seamless continuum of training supported by existing and specific training systems, and methodologies including onboard and distance support capabilities, which shall be in compliance with and shall augment the TSTA. The organic onboard training capability shall provide operational and proficiency training for members of the intelligence team.

6.0 **Safety and Occupational Health** (SOH) – The system shall provide a safe working environment and conditions for all personnel by incorporating design features that eliminate, reduce, and/or mitigate the potential for injury, illness, disability, or death.

6.1 The system shall meet safety requirements established in DOD standards.

6.2 If there are any known safety problems in the baseline system, they shall be described and goals shall be stated to eliminate the problems.

6.3 A System Safety Program Plan shall be established and integrated into the System Engineering Management Plan. It shall describe strategy and the approach for implementing system safety requirements into the systems engineering process to achieve acceptable mishap risk through hazard identification, analysis, risk assessment and risk management.

6.4 The SOH program shall be integrated into the design, development, manufacture, use, maintenance and disposal of the system.

6.5 The system shall provide safe working and living environments and conditions for all embarked personnel by incorporating design features that eliminate, reduce and/or mitigate the potential for injury, illness, disability or death of all assigned and embarked personnel, and minimize hazardous material usage, including reduction in quantity and variety.

7.0 **Survivability –** System design shall strive to ensure the integrity of the crew compartment and permit rapid egress when the system is damaged or destroyed. The system design shall clearly reduce the risks of fratricide, detectability, and probability of attack. Personnel shall be protected in the event of accident or damage to the weapon platform.

7.1 The system shall provide no less than two separate means (paths) of egress from each fire zone to either an adjacent personnel fire protection area or an area of safe refuge (adjacent zone/weather).

7.2 The system shall have capability to control the spread of damage, minimize crew casualties and restore the craft to safe operation or safely evacuate the crew.

7.3 The system shall have the capability to detect, classify and locate fire, smoke, toxic gases, flooding, structural damage and hull breach throughout the craft.

7.4 Damage control actions shall be automated to the most practical extent to support optimum manning level requirements to include automatic detection, location, classification and management of fire, heat, toxic gases and flooding; structural damage and hull breaching throughout the watercraft using the craft’s damage control management system; and identification of hazardous material within spaces.

Appendix B: HSIP Requirements for Human Factors Engineering

The objective of requiring these reports is to provide the lead program system engineer with the information required to verify that appropriate Human Factors Engineering processes are being utilized by the subsystem managers and the actual developer. The format and requirements for these deliverables, referred to as Data Item Descriptions, can be found at the Defense Technical Information Center (http://www.dtic.mil), under Human Systems Standards and Guidance Documents.

1.0 Human Factors Engineering (HFE). The developer shall establish and conduct an HFE effort that conforms to American Society for Testing and Materials (ASTM) F 1337-91, MIL STD 1472F, MIL-HDBK-46855A, ISO 13407, and ISO TR 16982. The Developer shall develop and apply HFE to all areas of human machine integration, information flows, operator tasks, maintenance tasks, and installation tasks. The developer shall perform the HFE effort concurrently with the design of all elements of the system, both hardware and software, having an interface with the maintainer/system administrator.

1.1 Human Engineering Program Plan (HEPP). The developer shall develop an HEPP which describes the developer's entire human engineering program, identifies its elements, and explains how the elements will be managed.

1.2 Task Analysis/Task Allocation Report. The developer shall develop a report describing the results of analyses of tasks performed by the developer to provide a basis for evaluation of the design of the system, equipment, or facility. The evaluation will verify that human engineering technical risks have been minimized and solutions are in hand.

1.3 Human Engineering Design Approach Document (HEDAD). The developer shall develop an HEDAD for the operator/maintainer. This document describes design interface requirements of equipment that must be operated and maintained. This document provides a source of data to evaluate the extent to which equipment having an interface with operators and maintainers meets human performance requirements and human engineering criteria.

1.4 Human Systems Engineering Analysis Report (HESAR). The developer shall complete a HESAR that describes the HFE efforts conducted as part of the system analysis. The data are used by the procuring activity to evaluate the appropriateness and feasibility of system functions and roles allocated to operators and maintainers.

1.5 Human Engineering Test Plan (HETP). The developer shall develop a Human Engineering Test Plan (HETP) identifying test requirements to ensure that human performance requirements for maintainers and system administrators are met and demonstrate that the personnel, equipment/software combination can accomplish the intended operational system, administration and maintenance functions. The HETP should identify the types of tests to be conducted, the test subjects to be used and how they compare to the user population, and the data collection and reporting methods to be used. To avoid duplication with other system test planning, the developer can reference where testing will be completed in other system test plans. The HETP should identify the types of tests to be conducted, the test subjects to be used and how they compare to the user population, and the data collection and reporting methods to be used.

1.6 Human Engineering Simulation Description. The developer shall provide a description of simulation use related to human engineering which details the developer's intended use of mockups and simulators in support of human engineering analysis, requirements definition/implementation, design support, and test and evaluation.

1.7 Human Engineering Test Report (HETR). The developer shall complete a Human Engineering Test Report that documents the compatibility of the human performance requirements, personnel selection criteria, training program, and design of the personnel equipment/software interfaces. The HETR confirms that human performance requirements have been met or defines the degree to which problems may exist. Again to avoid duplication with other test reports, the developer can reference where test reporting is completed in other system test reports.

1.8 Task Centered Design Considerations. Additional content will be required to document the task centered design (TCD) process. TCD requires a thorough task analysis to support the development of design features that improve system performance. Task analysis is at the center of a system engineering task centered design process. Human task centered design focuses on the human in the loop, making the human the independent variable in the systems engineering process. The task analysis includes two levels of integration for HSI to be effective: element versus element, and element versus design. Element versus element integration can be viewed as optimizing the mix of manpower, personnel, training, human engineering, safety, health hazards, habitability, and survivability. Element versus design integration optimizes the allocation of functions to hardware, software or the user when accomplishing system trade-offs in design. The ultimate goal of HSI is to optimize total system performance and reduce life cycle cost. Often these elements are approached independently within the same defense organizations and projects. HSI brings these elements together so that interdependencies can be highlighted and tradeoffs can be considered from a common frame of reference. The task analysis report will describe a defined set of tasks, subtasks and supporting procedures to enable (1) the development of human task-centered structures and (2) the identification of skill requirements for a given job or group of jobs.