Preface Human Factors Job Aid

JOB AID PURPOSE

The purpose of this Human Factors Job Aid is to serve as a desk reference for human factors integration during system acquisition. The first chapter contains an overview of the FAA human factors process in system acquisitions. The remaining eight chapters each represent a function that must be accomplished to produce a successful human factors program. The chapters offer one way that has proven successful during previous system acquisitions to accomplish the integration of human factors. The "How To" section of each chapter provides the steps to complete the function. Checklists are included to assist in the execution and implementation of a human factors program. References are provided in Appendix D.

HUMAN FACTORS IN FAA ACQUISITIONS

Appendix E contains a flowchart depicting Human Factors in the FAA Acquisition Process. This provides an overarching structure for the human factors activities in the acquisition program.

The **left axis** of the flow chart outlines four management

"vectors" of the human factors program:

- **Manage the human factors program**
- **Establish human factors requirements**
- **Conduct human factors system integration**
- **Conduct human factors test and evaluation.**

The **top axis** shows each phase of the lifecycle Acquisition Management System. The chart shows what tasks need to be accomplished, when they are conducted within the acquisition process, which chapter provides information on how to perform the tasks, and how the tasks fit into four management "vectors" to assist in managing the process.

The critical impact of human factors on systems acquisition is well documented in acquisition programs, studies, and analyses. A recent FAA Research, Engineering, and Development document states: "The FAA has recognized the role of human factors in operational errors, and the fact that human factors considerations are critical to effectively design, integrate, and evaluate equipment and procedures for use in air traffic operations." The FAA Strategic Plan emphasizes the use of technology to enhance the knowledge, skills, and abilities employed to operate and maintain new systems consistent with the available workforce. The Job Aid will help in this endeavor.

JOB AID AVAILABILITY

This Job Aid and updates to it are available on the FAA Human Factors home page at http:\\www.hf.faa.gov.

AND UPDATES Additional information on human factors support and requirements can be obtained from the Office of the Chief Scientific and Technical Advisor for Human Factors, AAR-100, (202) 267-7125.

Table of Contents

CHAPTER		PAGE
1.	FAA Human Factors Process Overview	1-1
2.	Develop Human Factors Inputs for Acquisition Documentation	2-1
3.	Develop the Human Factors Program	3-1
4.	Formulate Human Factors in System Specifications	4-1
5.	Generate Human Factors Requirements in the Statement of Work	5-1
6.	Specify Human Factors in Source Selections	6-1
7.	Integrate Human Factors in System Engineering	7-1
8.	Determine Human Factors Requirements in System Testing	8-1
9.	Coordinate with the Integrated Logistics Support Program	9-1

Appendix A - Acronyms

Appendix B - Glossary

Appendix C - Points of Contact

Appendix D - References

Appendix E - Human Factors in the FAA Acquisition Process Flowchart

Chapter 1 FAA Human Factors Process Overview

PURPOSE

This chapter defines human factors in the context of the total system concept in which the operator, maintainer, and operating environment are inte gral components of the system. When human factors is applied early in the system acquisition, it increases performance, safety, and productiv ity; decreases lifecycle staffing and training costs; and integrates program cost, schedule, and technical trade-offs.

Changes in operational, maintenance or design concepts during the later phases of an acquisition are expensive and entail high risk program adjustments. Identifying lifecycle support costs and human performance components of system operation and maintenance during investment analysis and requirements definition decreases program risks and long term support costs. These benefits are applicable to commercial-off-the-shelf (COTS) and nondevelopmental items (NDI) as well as to developmental programs.

TIMING

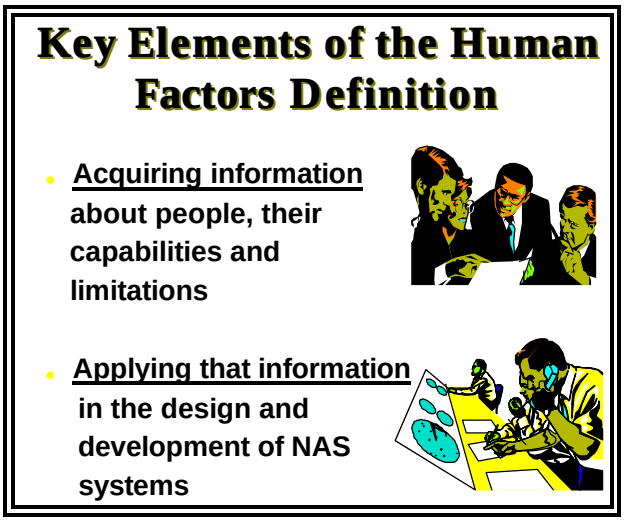
Efforts to manage the human factors program, establish requirements, conduct system integration, and test and evaluate human factors compliance must be synchronized with the system acquisition process. This synchronization is shown in the Human Factors in the FAA Acquisition Process flowchart in Appendix E.

DEFINITION OF HUMAN FACTORS

Human factors is a multidisciplinary effort to generate and compile information about human capabilities and limitations and apply that information to:

- Equipment
- Systems
- Software
- Facilities
- Procedures
- Jobs
- Environments
- Training
- Staffing
- Personnel management

to produce safe, comfortable, effective human performance.



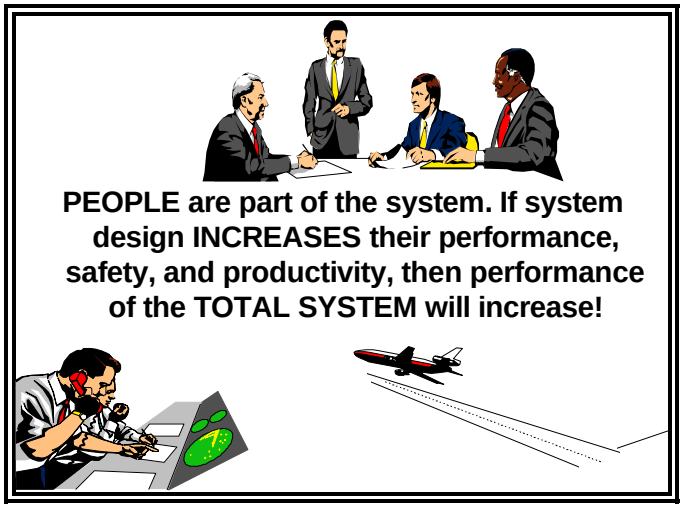
THE TOTAL SYSTEM CONCEPT

Experience has proven that when people think of acquiring a system, they tend to focus on the hardware and the software that is being purchased. Individuals often fail to visualize that the hardware/software will be operated and maintained by people. These people will have different aptitudes, abilities, and training and will operate the system under various operating conditions, organizational structures, procedures, equipment configurations, and work scenarios. The total composite of these elements and the human component will determine the performance, safety, and efficiency of the system in the National Airspace System (NAS).

To produce an effective human factors program for any system acquisition, the definition of the system should include not only the *hardware/software*, but also the *users* (*operators and maintainers)* and the *environment* in which

the system is employed.

[For the purpose of this document, the term *user* refers to the personnel that operate the equipment to perform NAS tasks and operations (operators) as well as those expected to support the system throughout its lifecycle (maintainers). The term *customer* refers to NAS customers.]



TOTAL SYSTEM PERFORMANCE

A Total System Performance equation is presented in the following figure. The probability that the total system will perform correctly, when it is available, is the probability that the hardware/ software will perform correctly, times the probability that the operating environment will not degrade the system operation, times the probability that the user will perform correctly.

By defining total system this way, human performance is calculated as a component of the hardware and software system. A system can operate perfectly from an engineering sense in a laboratory or at a demonstration site and then not perform well when it is operated by the operators and maintainers at a field location.

TOTAL SYSTEM PERFORMANCE

***f* (Total System Performance) =**

P (Hardware/Software Function Correctly)

x

P (Environment Will Not Degrade System Performance)

x

P (User Performs Task Correctly)

EXAMPLE

.999 x .99 x .9 = .89

By increasing the probability that the operator can perform the task effectively in the appropriate environment the Total System Performance will increase significantly.

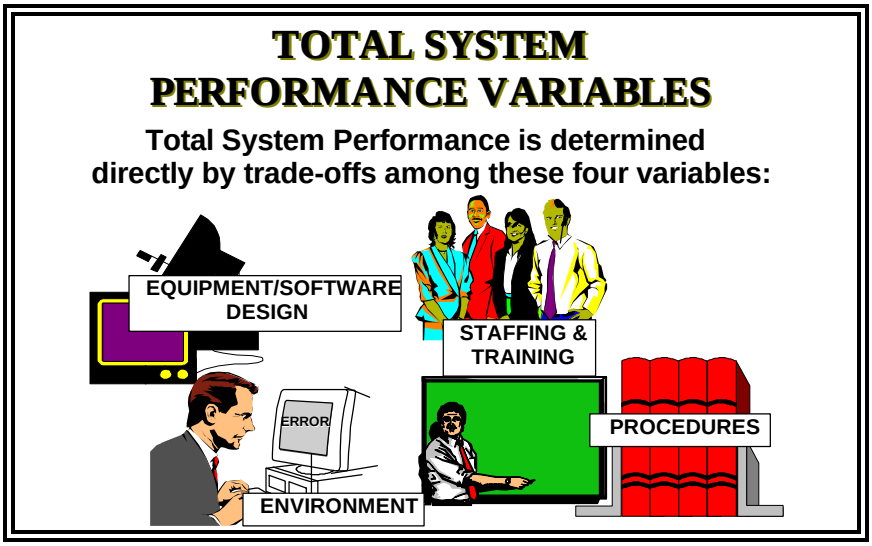
APPLICATION OF

Four variables commonly having a significant

HUMAN FACTORS INCREASES PERFORMANCE, LOWERS COST

impact on total system performance are:

- Equipment/Software design
- Environment
- Staffing and Training
- Procedures.



Since these dynamic variables interact with each other, trade-off decisions are required to optimize operational system performance.

Hardware and software design affects both the accuracy of operator task performance and the amount of time required for each task. Applying human factors principles to equipment design will increase performance accuracy and will decrease performance time. Research has shown that designing the system to improve human perform-ance is the most cost-effective

solution… especially if it is done early in the acquisition process.

EARLY APPLICATION OF HUMAN FACTORS

In the early phases of system design or development, functions are allocated to hardware, software, or people (or they can be shared). For system acquisitions (especially NDI/COTS), a market survey is conducted to reveal what and how candidate systems have already made these functional allocations in ways that do or do not enhance total system performance. Identifying human-system performance sensitivities associated with competing vendors/designs lowers technical risks and lifecycle costs (which include research and development, acquisition, and operations and support over the economic life of the system). Since operations and support costs are often much greater than the costs for research and development and acquisition, early assessment of lifecycle costs has significant benefit to the total program cost.

Early decisions made with little regard to operator capabilities and limitations are likely to result in expensive training, staffing, or re-design solutions.

Expensive Solutions

- **Equipment change packages**
- **Developing/modifying procedures**
- **Hiring more people to operate the system**
- **Staffing with people of different skills and aptitudes than the current work force**
- **Increasing the system related training requirements**

By focusing on the total system, the performance of the user is enhanced, thereby increasing the performance of the system (in its operational setting, using typical operators and maintainers). If, in the previous example, the probability that the user correctly performs the task increases from .9 to .99, total system performance will increase from .89 to .98.

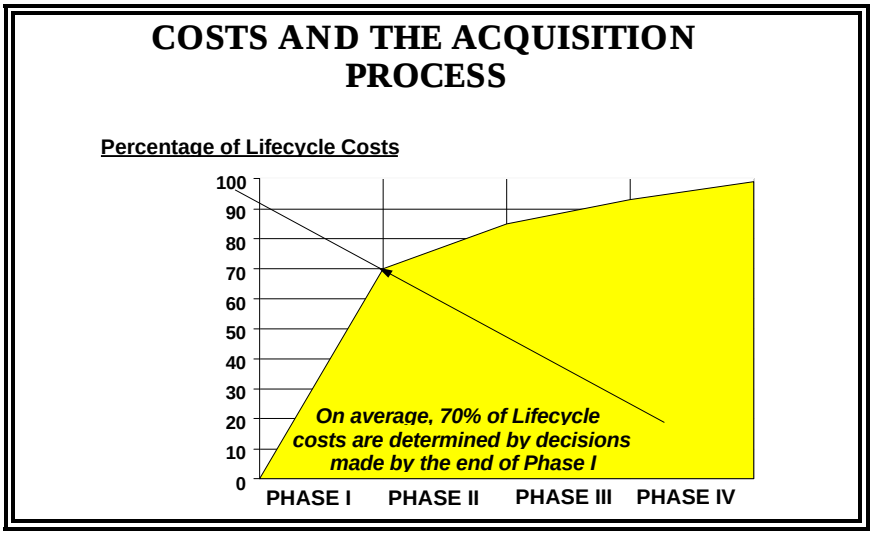
HUMAN FACTORS AREAS OF FOCUS FOR SYSTEM DESIGN

- Design for human performance
- Design workspace for user
- Design for actual environment
- Design for target population skills/aptitudes

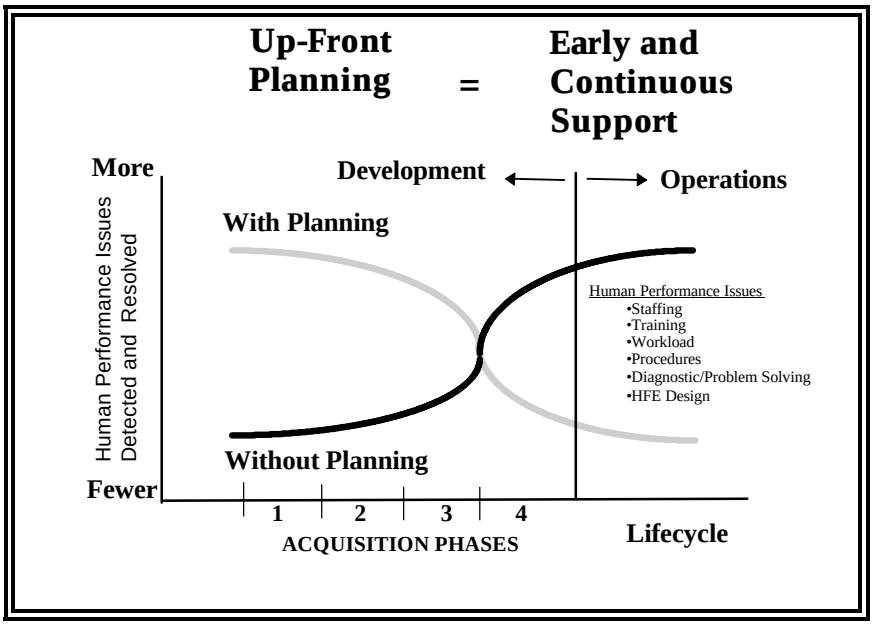
f**(Total System Performance) =**

.999 x .99 x .99 = .98

The early development and application of a human factors program is an important key to system cost and risk reduction. Most lifecycle costs are determined by decisions made during the Investment Analysis and Solution Implementation phases of the acquisition process.



Human factors issues need to be identified and addressed early in the acquisition process. Doing so helps detect and resolve potential performance problems at the lowest cost.



"HOW TO"

Human factors is a multidisciplinary effort to generate, compile, and apply information about human capabilities and limitations.

Human factors professionals can assist in applying human factors information related to human resources management, training, safety, medical, and human engineering.

The human factors process consists of four management actions:

- Manage the human factors program
- Establish human factors requirements
- Conduct human factors system integration
- Conduct human factors test and evaluation

The human factors functions are synchronized within the acquisition process as shown in the following table. An enlarged version of this table is shown in Appendix E (Human Factors in the FAA Acquisition Process flowchart). Each function is addressed in the chapters identified in the Job Aid.

Chapter 2 Develop Human Factors Inputs for Acquisition Documentation

PURPOSE

The purpose of this function is to present the human factors inputs for integration in system acquisition documentation. Although human factors inputs are developed and iterated throughout the entire acquisition cycle, primary inputs are often through acquisition documentation. This chapter shows how the Human Factors Coordinator, working with members of the Human Factors Working Group and the Integrated Product Team (IPT), develops human factors inputs to these acquisition documents. (As used in this document, IPT refers to the IPT and/or the Product Team.)

The acquisition documents are identified, and typical inputs are discussed which help ensure that human performance supports system performance goals and objectives.

ACQUISITION

The key documents in a system acquisition

DOCUMENTS requiring an input relative to human factors are the:

- Mission Need Statement (MNS). The MNS defines a mission capability shortfall or technological opportunity the FAA should address and includes major human resource and human-system performance considerations.
- Requirements Document (RD). The RD establishes the performance baseline and operational framework for an acquisition program and includes human-system interfaces and human performance requirements.
- Investment Analysis Report (IAR). The IAR summarizes the analytical and quantitative information developed during investment analysis in the search for the best means for satisfying a mission need and identifies the human resource and performance trade-offs in terms of cost and benefit.
- Acquisition Program Baseline (APB). The APB establishes the performance, cost, schedule, and benefits baseline within which an acquisition must be implemented and includes human-system performance thresholds and concepts for conducting the supporting Human Factors Program.
- Acquisition Strategy Paper (ASP). The ASP defines the overall strategy by which an

acquisition program will be implemented and outlines the strategy and objectives for the supporting Human Factors Program.

- Integrated Program Plan (IPP). The IPP describes the detailed planning for all aspects of the program implementation and specifies the Human Factors Program tasks, activities, controls, responsibilities, and schedule.

TIMING

- The MNS is prepared in the Mission Analysis phase. JRC approval of the MNS initiates entry into the Investment Analysis phase. The MNS is revalidated at the Investment Decision. Incorporation of major human resource and performance considerations provides a basis for addressing constraints related to the human component of the required capability.
- The RD is prepared early in the Investment Analysis phase and is approved and baselined at the Investment Decision. It is at this point that detailed consideration of human-system interfaces and human performance requirements, characteristics, and criteria are initiated.
- The IAR is prepared during the Investment Analysis phase as the primary decision document at the Investment Decision. Identifying the human resource and performance trade-offs at this point provides

insight into their impact on the operational suitability and operational effectiveness in quantifiable cost and benefit terms.

- The APB is baselined at the Investment Decision. Identifying the human-system performance thresholds and concepts for conducting the supporting human factors program in the APB establishes a reference point for all future human factors trade-offs in operational suitability and operational effectiveness.
- The ASP is prepared early in the Solution Implementation phase and must be approved before release of a formal solicitation or Screening Information Request (SIR). Providing a human factors strategy in the ASP helps ensure that the solicitation addresses critical human factors contractor services.
- The IPP is prepared early in the Solution Implementation phase and must be approved before release of a formal solicitation or SIR. The human factors portion of the IPP provides an early and clear definition of the work to be conducted under the human factors program.

"HOW TO"

There is a strong link between the acquisition documentation and the planning, management, and execution of the system acquisition program. The acquisition documentation defines

the performance requirements and capabilities the system is to meet, the approach to be taken, and the specific tasks and activities that must be performed during system design, development, and implementation.

Similarly, the human factors inputs to the acquisition documentation accomplish the same result regarding the Human Factors Program. Human factors inputs define human performance requirements and criteria, identify human performance and resource trade-offs, specify human performance thresholds, establish an approach to ensure human performance supports system performance, and define the specific tasks and activities to be conducted.

Without such input, the capabilities and limitations of the designated operators and maintainers will not adequately influence the design, and may result in lower levels of operational suitability and effectiveness.

Mission Need Statement

Using the results from the mission analysis, human factors inputs to the MNS identify the human performance constraints and issues that need to be addressed or resolved. This information may come from operations and maintenance concepts, similar systems or components, and other documents which may provide insights into the effects of human factors constraints and limitations on system performance. Since most acquisitions are evolutionary,

important human factors information can be obtained from predecessor systems or their component subsystems.

Analyses and trade-off studies may be required to determine the effects of constraints and issues on system performance. The existing literature and lessons learned data bases should be reviewed.

Requirements Document

The initial RD contains generic performance and supportability requirements that do not prescribe a specific solution. The RD defines the essential performance capabilities and characteristics, including those of the human component.

Human factors inputs to the RD identify requirements for human performance factors that impact system design. Broad cognitive, physical, and sensory requirements for the operator, maintainer, and support personnel that contribute to or constrain total system performance are established.

Any safety, health hazards, or critical errors that reduce job performance or system effectiveness should be defined. The staffing and training concepts to include requirements for training devices, embedded training, and training logistics should also be described.

Investment Analysis

Human factors inputs to the IAR address, for each alternative being evaluated, the full range of

Report

human performance and interfaces (e.g., cognitive, organizational, physical, functional, and environmental) necessary to achieve an acceptable level of performance for operating, maintaining, and supporting the system.

The analysis should provide information on what is known and unknown about human performance risks in meeting minimum system performance requirements.

Human factors areas of interest relevant to the investment analysis include:

- Human performance (e.g., human capabilities and limitations, workload, function allocation, hardware and software design, decision aids, environmental constraints, team versus individual performance).
- Training (e.g., length of training, training effectiveness, retraining, training devices and facilities, embedded training).
- Staffing (e.g., staffing levels, team composition, organizational structure).
- Personnel selection (e.g., aptitudes, minimum skill levels, special skills, experience levels).
- Safety and health hazards (e.g., hazardous materials or conditions, system or equipment safety design, operational or procedural constraints, biomedical influences, protective

equipment, required warnings and alarms).

Acquisition Program Baseline

The APB is established at the Investment Decision and reflects the solution selected by the JRC for implementation. Based on the solution selected, human factors inputs to the APB are those human performance requirements necessary to achieve the required level of system performance. These inputs are derived from those indentified in the Requirements Document and reflect a refinement that provides increased definition, greater granularity, and more specificity of relevant human-system performance characteristics. Constraints, limitations, and unique or specialized training requirements, staffing levels, or personnel skill requirements should be identified.

To the degree possible, the required level of human performance should be based upon practical measures of operational effectiveness and suitability and should be stated in quantifiable terms (e.g., time to complete a given task, level of accuracy required, number of tracks to be processed per unit time).

Acquisition Strategy Paper

The ASP presents the Integrated Product Team's strategy for the technical, management, and procurement approach that will be used to execute the program. Each of the individual strategies, to include human factors, is planned in greater detail in the IPP.

Human factors input to the ASP is the strategy to be employed to ensure that the system being acquired is well-designed and appropriate for the workforce that will operate and maintain it. This strategy should be consistent with the nature, size, and complexity of the system.

The strategy should define how the level of human performance necessary to meet the required system performance will be assured. Additionally, the strategy should describe how the system design will be influenced by the capabilities and limitations of the operators, maintainers, and support personnel.

Integrated Program Plan

Building upon the content of the ASP, human factors inputs to the IPP should be a detailed listing of the specific human factors tasks and activities that must be planned and executed to support the acquisition system design and development. This listing should include those tasks and activities to be performed by the government as well as by the contractor. The human factors tasks and activities should be consistent with the nature, size, and complexity of the system being acquired.

The tasks and activities should ensure that the system design:

- Is influenced by the capabilities and limitations

of the designated operators, maintainers, and support personnel.

- Provides the required level of human performance necessary to support the overall system performance objectives and requirements.
- Addresses human resource constraints as well as unique or specialized training requirements, staffing levels, or personnel skills.

The scheduling of the human factors tasks and activities should be integrated with system engineering, test and evaluation, and key program milestones to ensure that the output products are available in a timely manner to support and influence the system design and development.

CHECKLIST QUESTIONS

- Was the human element fully addressed in the mission analysis?

- Does the Mission Need Statement input describe the human performance limitations associated with the capability shortfall or human performance enhancements associated with the new technology opportunity?
- Is the human considered part of the total system in addressing the proposed alternatives in the Mission Need Statement?

- Does the Requirements Document input ensure that the human is considered as part of the total system when addressing the required capabilities and system performance?

- Do operations and maintenance concepts in the Requirements Document adequately describe the role of the operators, maintainers, and support personnel?

- Does the Investment Analysis Report input address the human factors cost and benefits in terms of staffing, training, skills, safety, health, and human-system performance and interfaces for each alternative being considered?

- Does the Acquisition Program Baseline input identify the level of human performance and resources (e.g., personnel, training) necessary to meet the system performance requirements for the selected solution?

- Does the Acquisition Strategy Paper input describe a human factors strategy to be employed to ensure the system is well-designed and appropriate for the workforce that will operate and maintain it?

- Does the Integrated Program Plan input identify the specific human factors tasks and activities that must be planned and executed to support the system design and development?

- Are the human factors tasks and activities scheduled such that output products will be available in a timely manner?

- Are the human factors inputs consistent with the nature, size, and complexity of the system being acquired?

- Have constraints, limitations, and unique or specialized training requirements, staffing levels, or personnel skill requirements been addressed?

Chapter 3 Develop the Human Factors Program

PURPOSE

This chapter defines the overarching strategy for the conduct of a human factors effort in support of acquisition programs. The Human Factors Program establishes the approach for applying human factors engineering to the system being acquired to increase total system performance and reduce developmental and lifecycle costs (especially in the areas of staffing, personnel, operations and training). The Human Factors Program focuses on the human performance produced when the system is operated and maintained in an operational environment by members of the intended target population.

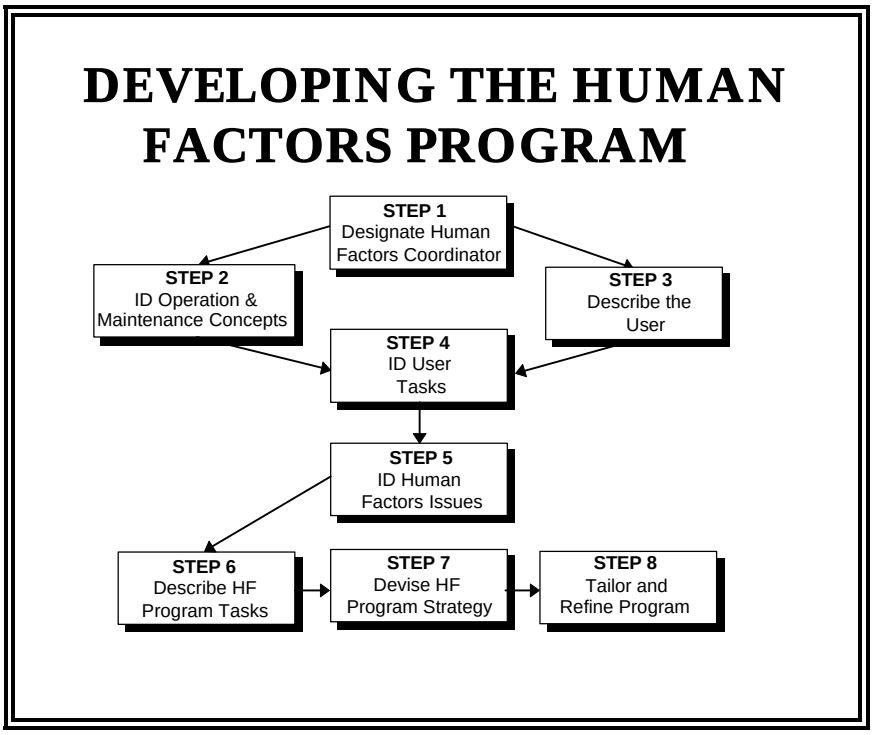
TIMING

The Human Factors Program is initiated early in the Investment Analysis phase of the system acquisition process and is refined during each subsequent acquisition phase, as required.

"HOW TO"

Establishing a Human Factors Program for a given system acquisition requires focusing on the tasks the humans (operators, maintainers, and support personnel) will perform on the system, and the

program activities that must be undertaken during the acquisition to allow early identification and resolution of human performance issues. The figure below illustrates the steps to be taken in developing the Human Factors Program.



Step 1: Designate a Human Factors Coordinator

The Integrated Product Team (IPT) will designate a Human Factors Coordinator (HFC) to coordinate the Human Factors Program. The Human Factors Coordinator will develop, direct, and monitor the Human Factors Program and its activities for the system acquisition.

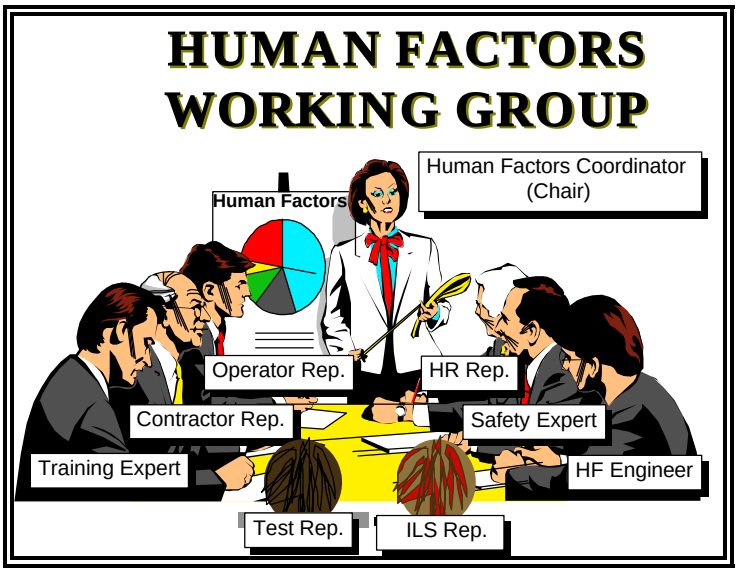
The Human Factors Coordinator role in IPT activities is to perform, direct, or assist in:

- Defining human factors impacts and constraints during mission analysis, investment analysis, and requirements determination
- Identifying human-system interfaces for market surveys, trade-off analyses, and prototypes
- Preparing and updating human factors portions of acquisition documents, procurement packages, performance measures and criteria, and data collection efforts
- Developing and analyzing operational scenarios and human-system modeling (with human-in-the-loop) for operators and maintainers
- Reviewing and assessing human factors concepts and designs
- Coordinating human factors efforts and working group activities
- Coordinating human factors with other disciplines

The HFC may establish and chair a Human Factors Working Group (HFWG). Initial HFC duties will involve submitting a recommended HFWG membership list and a HFWG charter to the IPT for approval. (*Note: A sample HFWG charter is included at the end of this chapter*). The HFC will ensure that human factors issues are identified and addressed for the system acquisition

and that the human factors strategy is formulated and applied.

The scope of work and composition of the HFWG should be tailored to the needs of the system being acquired. Possible members of the HFWG are shown in the following figure. After the contract is awarded, the IPT may elect to appoint the contractor's Human Factors Engineer as deputy chair of the HFWG.



Step 2: Identify System Operation and Maintenance Concepts

The concept(s) for how the system will be employed and maintained drives operator and maintainer tasks. Performance standards for these tasks will define the staffing and training requirements. Additional information included here should address the human performance impacts related to:

- Numbers of systems and configurations to be purchased
- Location, physical environment, and work space
- Operational conditions and limitations for the system
- Operational scenarios, training, and procedures
- Maintenance approach and procedures.

Step 3: Describe the Operators and Maintainers

Develop a profile of the people who will operate, maintain, and support the system. This is often called a ***target population description***. These are the people for whom the system should be designed. Characteristics used to describe this population include numbers of people available, skills, organizational structure, location, training history, aptitudes, and anthropometric data.

Step 4: Identify Operator and Maintainer Tasks

The human factors effort should focus on the tasks generated where the human and the system hardware and software interface. The functions that the system will perform should be identified along with the human interfaces associated with those system functions. Generally, the predecessor system is a good source for these interfaces and tasks. The predecessor system may also serve as a source of information on those

tasks that require additional staffing, skills, or training to perform. These are commonly referred to as ***high driver tasks***. The Human Factors Program should address acquiring and applying information to system design to mitigate the impact of these high driver tasks on the new system.

As the system evolves, operations and maintenance tasks should be stated in operational terms of time and accuracy of task performance. Measures of effectiveness or performance should be devised to verify the system's overall operational performance.

Step 5: Identify Human Factors Program Issues

The preceding steps have defined what people must do under what conditions. In this step, the potential risks or enhancements to system and human performance that pertain to the operational and maintenance tasks of the system being acquired should be identified. Constraints and limitations on human resources should be addressed. Some examples of issues are:

- Will the new system require additional staffing?
- Will the new system require new skills to operate and maintain the system that do not currently exist in the work force?
- Will the system require the work force to

conduct training different from that currently mandated?

- Will the target population user be able to vector xxx number of aircraft within yyy time for periods of up to zzz hours with no errors in maintaining separation?

The identification of issues should include:

- A full description of the issue
- The problem or risk associated with the issue
- The consequence(s) of not resolving the issue
- Steps to be taken to resolve the issue
- Status of the corrective action(s)

Step 6: Describe Human Factors Program Tasks, Activities, and Objectives

Given the number and nature of the issues to be resolved, the HFC identifies the major human factors objectives and what tasks and activities must be accomplished to address the issues and to execute the Human Factors Program. The Human Factors Program tasks and activities constitute the essential elements of a plan for the execution of the human factors effort. Some examples of human factors tasks and activities include:

- Studies and analyses to describe and develop the human and system performance baselines.
- Schedule for coordination and integration activities (such as meetings of the HFWG and

analyses to be conducted).

- Prototype development efforts to define and refine the statement of the system requirements.
- Activities supporting human factors in test and evaluation.
- Points during the acquisition process at which Human Factors Program progress will be assessed and refined.

Step 7: Devise a Human Factors Program Strategy

The approach taken to achieve the Human Factors Program objectives will vary with the size, cost, and complexity of the system being acquired. Different strategies are appropriate for nondevelopmental items (NDI) and commercial-off-the-shelf (COTS) acquisitions as compared to full developmental efforts. Some systems may need more or different human factors support when focused on requirements definition than on influencing the design during the system engineering process. To accommodate both the number and type of skills needed to support the program during its lifecycle, an overall strategy to acquire the necessary human factors support must be devised.

Consideration should also be given to such concerns as:

- The level of support to be rendered by the

government versus the contractor

- The equipment, data sources, and facilities needed
- The funding and other resources required
- The schedule for human factors tasks and activities
- The relationship with other program developments and requirements.

Step 8: Tailor and Iterate the Human Factors Program

Because each system acquisition program is unique in its pace, cost, size, complexity, and human interfaces, the Human Factors Program should be tailored to meet program demands. As the system progresses through the lifecycle phases of the acquisition process, changes will occur. The Human Factors Program must be structured and maintained to change iteratively with the system.

To aid in the management of the Human Factors Program, the HFWG may prepare a management approach document. A recommended format and content for such a document is shown in the following table.

HFWG MANAGEMENT DOCUMENT CONTENT AND FORMAT		
Headings		**Content**
Background	Program Summary	• Brief description of the program • Concept of operation and maintenance
	Program Schedule	• Overview of system acquisition schedule
	Target Population	(Appendix if data are lengthy) • Identify the operator and maintainer • Demographics • Biographical data • Previous training • Aptitudes • Task-related experience • Anthropometric data • Physical qualifications • Organizational relationships • Work space requirements
	Guidance	• Summarize any guidance received
	Constraints	• State if additional staffing is required by the new system • State whether an existing job series will be used or a new one created • Post limits on the amount of time that can be afforded for training • Establish standards on the working conditions that will be acceptable when the new system is fielded • Limitations imposed by maintenance policy • Requirements as a result of union agreements
Issues and Enhancements	Issue Description	• Describe the issue or problem background, importance, and consequences or task to be done to support the acquisition
	Objectives	• Identify Human Factors Program objectives • Provide performance measures and criteria in terms of time and accuracy to perform tasks to evaluate resolution of issue • When human performance thresholds are known, identify tasks for the developer to be done early enough in the acquisition to influence requirements and system

		engineering • Identify the actions to be taken to resolve each issue • Show the current status of each issue
	Actions	• Identify actions to be taken to resolve issues • Show current status of each action
Activities	Activity Description	• Identify any tasks, studies, or analyses that must be performed to resolve the issues (e.g., Human Factors Program Plan per MIL-HDBK-46855, Functional Analysis to support equipment vs. people allocation of functions, Task Analysis to produce a specific operator and maintainer task list)
	Activity Schedule	• By acquisition phase, describe the human factors tasks in terms of who, what, when, and how (resources) • Identify feeds to and dependencies on ILS, training, and test and evaluation programs
Strategy	Goals and Requirements	• Strategy should be derived from the major concerns, issues, schedule, tasks, guidance, constraints, objectives, and approach for the Human Factors Program • Answer the question, "What objectives does the government wish to achieve?" • Answer the question, "How will the government accomplish these objectives?"
	Approach	• Define who will be responsible for the Human Factors Program • Set out the extent of contractor support required • Define how human factors resources will be organized and managed to support the system acquisition
	References	• Identify relevant references needed for a full understanding of the Human Factors Program (Use appendix if appropriate.)
Review	Review	• Identify administrative handling procedures • Identify update schedule and procedure • Identify review procedures

CHECKLIST QUESTIONS

- Has a Human Factors Coordinator (HFC) been appointed by the IPT?

- Does the HFC have the appropriate human factors expertise and training?

- Does the Human Factors Working Group (HFWG) membership represent each activity having significant human factors interest in the system?

- Has the IPT approved the HFWG Charter?

- Have operation and maintenance concepts been adequately identified?

- Has the operator and maintainer target population been adequately described?

- Have the performance parameters of operator and maintainer tasks been adequately identified?

- Is there an adequate procedure for all significant unresolved human factors issues to be brought to the IPT's attention?

- Have all appropriate human factors tasks, activities, and objectives been identified and resourced?

- Has a strategy for the Human Factors Program been developed that is consistent with the size,

cost, and complexity of the system being acquired?

- Are procedures established for revising the Human Factors Program when necessary?

SAMPLE HUMAN FACTORS WORKING GROUP CHARTER

1. INTRODUCTION: This charter establishes the System X Human Factors Working Group and prescribes its responsibilities and operating procedures. The System X HFWG will contribute to the total system performance of System X by ensuring that all relevant information concerning human factors is continuously integrated into the System X development and acquisition process. The HFWG will provide the comprehensive management and technical effort necessary to achieve a fully effective Human Factors Program.

2. PURPOSE: The purpose of the System X HFWG is to assure that all human factors issues and concerns are identified and successfully addressed during the course of system development.

3. RESPONSIBILITIES: The System X HFWG will:

a. Assist in integrating the human factors effort with the system engineering effort,
b. Coordinate the development, review and execution of the System X Human Factors Program,
c. Provide a forum for direct communications between members to identify and address human factors requirements, objectives, concerns and issues,
d. Identify needed human factors tasks and activities and review the results thereof,
e. Review contract deliverables for human factors implications,
f. Provide recommendations to the Integrated Product Team and user representative(s) concerning human and system performance,
g. Ensure unresolved issues are surfaced to appropriate decision makers and propose the action to be taken to resolve those issues,

h. Maintain an audit trail of human factors activities and decisions,
i. Coordinate with appropriate human factors-related entities.

4. PROCEDURES: Meetings of the HFWG will be held at the times and frequencies deemed appropriate by the Chair. The Chair will provide for the recording and distribution of minutes of all meetings. Each member will be notified of the time, place and agenda for each meeting, normally not less that ten working days prior to the meeting. Members will be responsible for ensuring their own and supplemental representation (approved by the Chair) as may be required by the agenda. An Action Item log with suspense dates will be maintained by the Chair with responsibility for each action being assigned on the basis of functional areas and expertise. Each action item will be reviewed and the status updated at every HFWG meeting. Subcommittees, if required, will be established by the Chair.

5. MEMBERSHIP: The representatives to the HFWG will include those personnel so designated by the member agencies. The organization of the HFWG will include:

a. Chair. The IPT Human Factors Coordinator will serve as the Chair. The IPT may designate the contractor's Human Factors Representative to serve as Deputy Chair.
b. Members. Primary or alternate representatives will be present at each HFWG meeting. The designated member from each organizational element will be the spokesperson for that organization. Non-member activities that have human factors responsibilities or interests may be invited to attend meetings. HFWG membership is listed by agency or activity in the enclosure (list membership by specific agency or activity with address and phone numbers, etc.).

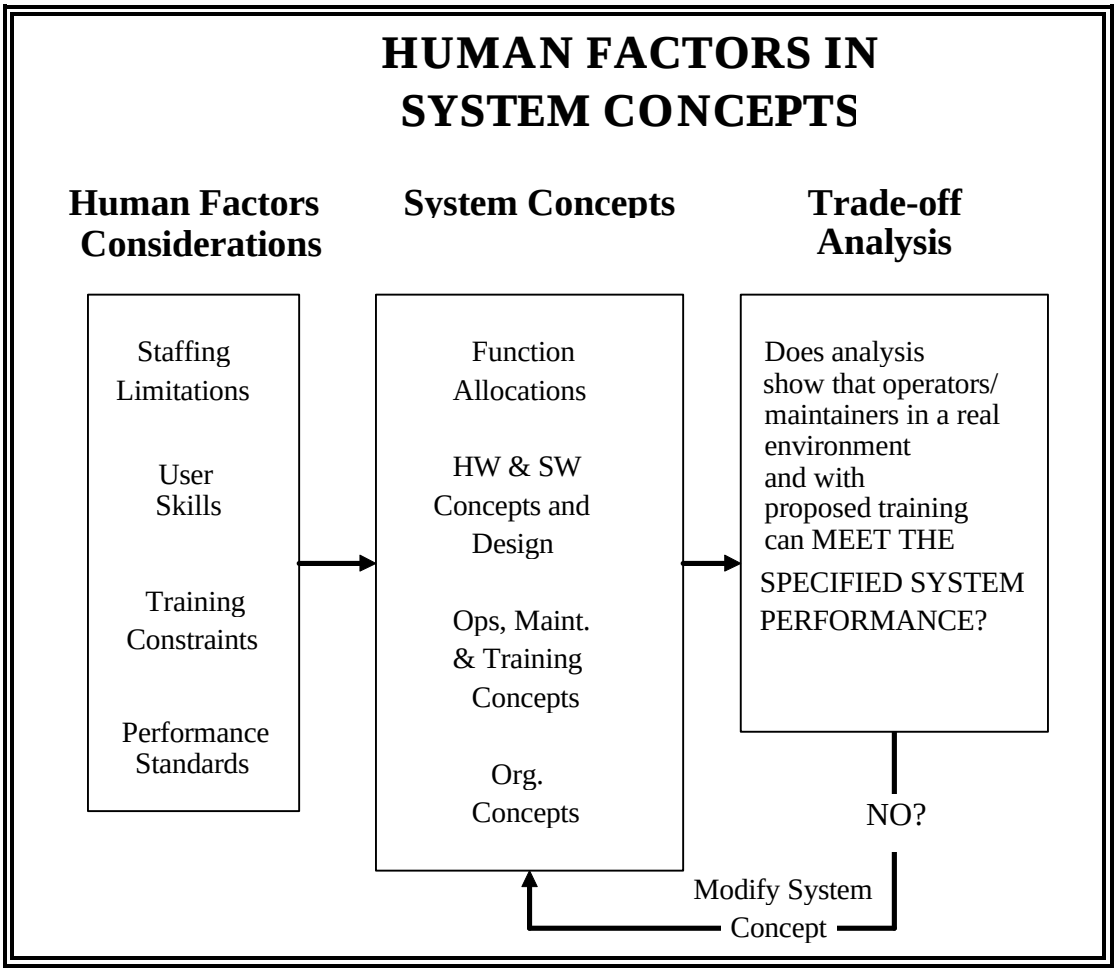
Chapter 4 Formulate Human Factors in System Specifications

PURPOSE

This chapter focuses on incorporating human performance in the system specifications. For human performance to effectively influence the system design, system specifications must accommodate the following essential ingredients for all users:

- Staffing constraints must be stated
- System operator and maintainer (user) skills
- Training time available and cost limitations for formal, informal, and on-the-job skill development
- Acceptable levels of human and system performance when operated and maintained by members of the target population

The following figure describes the process of integrating human factors in the specifications of the system to be acquired.



By identifying and defining human resource and human performance considerations, inputs are provided to the development of system concepts for functional allocation, hardware and software, operations and training, and organizational structure. Through the process of assessing these concepts and the related human resource

and human performance trade-offs of various alternatives, the system concepts (e.g., for requirements, design, and implementation) iteratively evolve. This process applies equally to developmental and to NDI or COTS acquisitions.

The purpose of this process is to place these essential ingredients into the system specifications so that human performance capabilities and limitations will be incorporated in the system acquisition in a contractually binding manner.

TIMING

Human performance considerations are embed ded into the system by incorporating human factors as requirements in the system specifications. This is initiated during the Investment Analysis phase and continues through Solution Implementation.

SYSTEM SPECIFICATIONS

From a human performance perspective, the system specification will have the most significant impact on system design. It states the technical and mission requirements for a system as an entity, allocates requirements to functional areas, documents design constraints, and defines the interfaces between or among the functional areas.

"**HOW TO"**

To achieve the design objective in a manner that results in a safe, efficient, usable system for the

lowest possible expenditure of resources, the human performance constraints and requirements need to be placed into the system specification in Sections 2, 3, and 4 of the specification.

Step 1: Provide Human Factors Inputs to Specification Section 3 - *Requirements*

Many of the human performance constraints and requirements will have already been identified. Results of investment analysis and available acquisition documentation such as the Requirements Document, Acquisition Program Baseline, and Integrated Program Plan should be reviewed to identify the functions and performance requirements that include a human component of the new system. The Integrated Product Team translates requirements into a system specification that will drive vendor selection and development in subsequent acquisition phases.

Section 3 provides the heart of the specifica tion and contains the essential requirements and descriptions that apply to the performance, design, and personnel subsystems impacts of the system. It indicates the minimum requirements that the system must meet to be acceptable.

Human factors inputs to this section should address the following issues:

- Performance characteristics - Ensure that all

operator and maintainer critical functions and tasks have been identified. Specify operator and maintainer performance standards and criteria to be used in assessing system performance.

- Physical characteristics - Specify such requirements as weight, size, portability, work space and environment, and access provisions.
- User interface - Specify criteria for display design and command language in clear and testable terms. Interface requirements should be based upon documentation and lessons learned.
- Human engineering - Specify human engineering tasks and activities for the system and include applicable documents by reference. Specify constraints on allocation of functions to people. Include those areas that address high risks, critical tasks, and priority issues. Specify hardware and software to be designed in accordance with accepted human engineering practices.
- Safety - Address health and safety issues to minimize the risk to operators and maintainers of mechanical, chemical, radiological, electrical, or environmental hazards.
- Staffing and training - Identify constraints,

limitations, and unique or specialized staffing levels, training requirements, and user skill requirements.

Step 2: Provide Human Factors Inputs to Specification Section 4 - *Quality Assurance Provisions*

This section contains the analyses, inspections, demonstrations, tests, and evaluations that the contractor is required to conduct and document to show that the requirements stated in Section 3 have been met.

Human factors inputs to this section should focus on human performance testing and data collection to ensure that the achieved level of human performance will meet system performance objectives and requirements. The goal is to be able to measure operator and maintainer performance of specified critical tasks in terms of time and accuracy and not merely rely on observations. Measures of performance may need to be specified.

A traceability matrix should be prepared to ensure that the human factors requirements stated in Section 3 are tested for compliance, and that all human performance testing that is conducted is traced back to a requirement.

The requisite skills and training levels of the user should be specified and verified. In addition to collecting system performance data on functions and tasks, the contractor may be required to

conduct interviews or administer surveys to operators and maintainers and relate their responses to their measured performance.

Step 3: Provide Human Factors Inputs to Specification Section 2 - *Applicable Documents*

Section 2 is a listing of those documents that have been referenced in other sections of the specification. Any document that is mentioned in the specification should be listed in Section 2. Similarly, any document that is listed in Section 2 should be mentioned in another part of the specification.

CHECKLIST QUESTIONS

- Has the Human Factors Working Group had the opportunity to review and comment on the system specification?
- Have potential operators, maintainers, and support personnel been identified?
- Have human performance requirements been identified?
- Have human capabilities and limitations been considered in developing total system performance requirements?
- Have human performance characteristics, physical characteristics, human engineering, safety, staffing and training requirements been specified?
- Has human performance data collection and

testing been identified to verify compliance with human factors requirements?

- Have measures of performance been identified to quantify human performance?

- Have human factors documents referenced in the specification been included in the Applicable Documents section?

Chapter 5 Generate Human Factors Requirements in the Statement of Work

PURPOSE

This chapter describes the process to generate human factors requirements in Statements of Work (SOWs), which include contract data requirements lists (CDRLs) and data item descriptions (DIDs) for FAA system acquisitions. This chapter includes human factors-related DIDs.

In simple terms, the SOW states the work the Government wants the contractor to perform, the CDRL specifies the data to be provided to the Government for a specific contract, and the DID specifies the format and content of the data to be submitted to the Government.

The objective of the human factors effort is to integrate all elements of the system involving human performance and safety, and to influence system design so as to optimize total system effectiveness. The objective of this human factors task is to translate these human performance design and integration activities to the contractor

as clear, unambiguous requirements in a contractually binding way. Human factors contractual requirements, through the SOW, CDRLs, and DIDs, are the critical elements to achieve design and development conformance.

TIMING

Human factors requirements should be included in all SOWs and contracts during the development of concepts and alternatives, the development of prototypes and first items, low-rate initial production, and full production.

"HOW TO"

HUMAN FACTORS IN STATEMENTS OF WORK

A good SOW starts with an understanding of what the government wants the contractor to do. The starting point for determining human factors requirements for inclusion in the SOW is a review of human factors requirements in the Requirements Document, Acquisition Program Baseline, and the Integrated Program Plan to identify human factors issues that must be resolved, and tasks and analyses that must be conducted by the contractor to ensure that human performance goals are met.

Essential human factors elements that must be addressed by the requirements in the SOW

include:

- Limits to the skill level and characteristics of operator, maintainer, and support personnel
- Maximum acceptable training burden
- Minimum acceptable performance of critical tasks
- Acceptable staffing limits
- System safety and health hazards

The contractor's response to these requirements will result in a comprehensive human factors program for the system which management and analysis of human engineering and ergonomics, staffing and personnel requirements, training programs, system safety considerations, and health hazards.

The contractor's human factors effort also should be coordinated with system engineering, quality assurance, integrated logistic support, and test and evaluation activities to achieve an integrated overall effort without duplication.

An adequately staffed human factors effort must be an integral part of the hardware and software analysis, design, development, and test process. The contractor's human factors effort must be planned and executed to meet the objectives, characteristics and constraints set forth in the

Statement of Work and in the System Specification. The contractor's program must demonstrate how it effectively integrates human factors with their design and development process.

The scope and level of effort to be applied to the various human factors tasks and activities must be tailored to suit the type of system being acquired and the acquisition phase. The SOW should describe the specific task or activity required and the associated data deliverable. Human factors reviews and demonstrations should be planned and conducted to coordinate and verify that requirements are being met. The contractor should convincingly indicate how human perform ance data will influence system lifecycle design and support.

Human factors inputs are generally made to the following sections of the SOW.

- Section 1 - Scope
- Section 2 - Applicable Documents
- Section 3 - Requirements
- Section 4 - Quality Assurance Provisions

Step 1: Provide Human Factors Inputs to SOW Section 1 - *Scope*

This section provides a brief statement of what the SOW does and does not cover.

Background information may be given but should be limited to what is needed to acquaint the offeror

with the basic acquisition requirement. In view of the fact that human performance is a key component of total system performance, it is also appropriate to include a short description on human-system interfaces.

Step 2: Provide Human Factors Inputs to SOW Section 3 - *Requirements*

The specific work to be performed under the contract is given in Section 3 of the SOW. The tasks must be written so that the Government and the offeror can estimate the probable cost of doing the work. The offeror will need to be able to estimate the necessary expertise, labor, and other resources from the tasks. The requirements need to be written such that there is a clear understanding of the tasks and there is no question of an obligation to perform. Only minimum performance requirements and capabilities should be cited. Desired capabilities should be clearly identified as such.

General information should be separated from directions to the contractor. This is to help ensure that background information and suggested procedures are clearly distinguishable from contractor responsibilities. Human factors objectives to consider in developing requirements are:

- Human engineering - Develop or improve the human-system interface; achieve required level of human performance during system operation

and maintenance; and make economical demands upon human resources, skills, and training.

- Staffing and personnel - Estimate and evaluate the staffing implications of alternative system concepts in terms of total numbers of personnel required, job classification, skill levels, and experience required. Additionally, conduct evaluations and trade-offs between design, operations, and training.
- Training - Identify critical and "high driver" tasks and develop the training courses, devices and aids that will enhance the human performance of mental and physical human-system interfaces within the training constraints identified. Determine optimum solutions for attaining and maintaining the required proficiency of operating and support staff.
- System safety and health hazards - Define and address the potential for harm or injury to operators, maintainers, and customers induced by hardware and software design. Provide methods for elimination of these deficiencies. Identify inherent, expected, and potential hazards based on the system concept and eliminate, preclude, or alleviate these hazards to a tolerable level.

Step 3: This section contains the analyses, inspections,

Provide Human Factors Inputs to SOW Section 4 - *Quality Assurance Provisions*

demonstrations, tests, and evaluations that the contractor is required to conduct and document to show that the requirements stated in Section 3 have been met.

Human factors inputs to this section should focus on human performance testing and data collection to ensure that the achieved level of human performance will meet system performance objectives and requirements. The goal is to be able to measure operator and maintainer performance of specified critical tasks in terms of time and accuracy and not merely rely on observations. Measures of performance may need to be specified.

A traceability matrix should be prepared to ensure that the human factors requirements stated in Section 3 are tested for compliance, and that all human performance testing that is conducted is traced back to a requirement.

The requisite skills and training levels of the user should be specified and verified. The contractor may be required to conduct interviews or administer surveys or questionnaires to operators and maintainers and relate their responses to their measured performance.

Step 4: Provide Human

Section 2 is a listing of those documents that have been referenced in other sections of the SOW. Any

Factors Inputs to SOW Section 2 - *Applicable Documents*

document that is mentioned in the SOW should be listed in Section 2. Similarly, any document that is listed in Section 2 should be mentioned in another part of the SOW.

HUMAN FACTORS IN DATA ITEM DESCRIPTIONS

A DID describes the format and content of the data that is to be provided to the Government as required by the SOW and CRDL. While not the only means of transmitting this information to the contractor, a DID is used to standardize the format and content for a given data item. This ensures consistency across contracts and between contractors.

For data to be produced and delivered, the description of the work effort necessary to produce the data must be in the SOW; the description, definitions, format and content of the data product must be provided on a DID; and the DID must be listed on the CDRL to provide delivery and other instructions.

A listing of human factors-related DIDs is provided in the following table. Each DID listed on the CDRL is a separate contract line item. The DID should be tailored to require only those items that are pertinent to the system being acquired, and what is necessary to allow the human factors engineer sufficient information to assess the quality and suitability of the contractor's human factors effort. DIDs can only be tailored

downward; items cannot be added.

The Human Factors Coordinator should prepared a list of human factors-related DIDs applicable to the system being acquired and provide them to the Integrated Product Team (IPT) for inclusion in the SOW.

HUMAN FACTORS IN CONTRACT DATA REQUIREMENTS LISTS

The purpose of the CDRL is to describe all of the items that are required to be delivered under the terms of the contract. The CDRL identifies for the offeror what reports, analyses, and other deliverable data the contractor is required to submit concerning tasks specified in the SOW. The CDRL provides information regarding the time frame for initial and subsequent submissions, the number of copies required, and the distribution. If required data are not listed on the CDRL, the contractor is not obligated to provide it to the Government.

The Human Factors Coordinator should review the CDRL to ensure the proper timing of submission of the data and that the appropriate distribution is indicated. The Human Factors Coordinator should recommend approval or rejection of the delivered product to the IPT.

HUMAN FACTORS-RELATED DATA ITEM DESCRIPTIONS

HUMAN FACTORS ENGINEERING	
DI-HFAC-80740A	Human Engineering Program Plan
DI-HFAC-80741A	Human Engineering Progress Report
DI-HFAC-80742A	Human Engineering Dynamic Simulation Plan
DI-HFAC-80743A	Human Engineering Test Plan
DI-HFAC-80744A	Human Engineering Test Report
DI-HFAC-80745A	Human Engineering System Analysis Report
DI-HFAC-80746A	Human Engineering Design Approach Document Operator
DI-HFAC-80747A	Human Engineering Design Approach Document Maintainer
DI-HFAC-81399	Critical Task Analysis Report
MANPOWER	
DI-ILSS-80114	Logistic Support Analysis Record (LSAR) Data
DI-ILSS-81078	Mission, Collective, Individual, and Occupational Training Task Analysis Report
PERSONNEL	
DI-HFAC-80744A	Human Engineering Test Report
DI-ILSS-81078	Mission, Collective, Individual, and Occupational Training Task Analysis Report
DI-ILSS-81079	Personnel Performance Profile Tables
DI-ILSS-81153A	LSA-019, Task Analysis Summary
DI-ILSS-81173	Logistic Support Analysis Record (LSAR) Data Table Exchange/Delivery
TRAINING	
DI-ILSS-80047	Training Course Standards

DI-ILSS-80143	Training Plan
DI-ILSS-81070	Training Program Development and Management Plan
DI-ILSS-81072	Media Selection Model Report
DI-ILSS-81074	Training System Implementation Plan
DI-ILSS-81075	Training Course Control Document
DI-ILSS-81078	Mission, Collective, Individual, and Occupational Training Task Analysis Report
DI-ILSS-81088	Trainer System Functional Characteristics Report
DI-ILSS-81092	Instructional Media Package
DI-ILSS-81095	Lesson Plan
DI-ILSS-81096	Training System Utilization Handbook
DI-ILSS-81099	Training Information Package
DI-H-25724B	Student Training Materials
DI-H-25774B	Training Program Work Report

SYSTEM SAFETY/HEALTH HAZARDS

DI-H-1328A	Accident Prevention Safety Program
DI-H-1329A	Accident/Incident Report
DI-S-1838	Standard Operating Procedures for Hazardous Materials
DI-HFAC-80938A	Noise Measurement Report (NMR)
DI-SAFT-80100A	System Safety Program Plan
DI-SAFT-80101A	System Safety Hazard Analysis Report
DI-SAFT-80102A	Safety Assessment Report
DI-SAFT-80103A	Engineering Change Proposal System Safety Report
DI-SAFT-80104A	Waiver or Deviation System Safety Report
DI-SAFT-80105A	System Safety Program Progress Report
DI-SAFT-80106A	Occupational Health Hazard Assessment Report
DI-SAFT-81125	Hazard Assessment Test Report

CHECKLIST QUESTIONS

Statement Of Work (SOW)	• Are the human factors requirements consistent with the nature, complexity, and degree of human involvement of the program? • Do the human factors requirements cite the appropriate specifications or standards? • Have all human factors-related tasks and analyses to be performed by the contractor been identified in the SOW?
Contract Data Requirements List (CDRL)	• Has a human factor data requirement been prepared for each human factor deliverable cited in the SOW? • Are the human factors-related organizations included on the distribution for the delivered product? • Have the human factors data requirements been coordinated with other disciplines to eliminate redundancy of data deliverables? • Is the Human Factors Coordinator responsible for participating in the approval or rejection of the delivered product?
Data Item Description (DID)	• Has the DID been tailored (down only) to include only the information that is necessary? • Are the data item requirements consistent with the nature and complexity of the program?

Chapter 6 Specify Human Factors in Source Selections

PURPOSE

This chapter explains the functions of the human factors professional in source selection. These functions include assisting in preparation of the proposal evaluation criteria and Source Selection Evaluation Plan and participating as a member of the source selection evaluation team.

TIMING

Human factors criteria must be developed to support source selections conducted in all acquisition phases.

"HOW TO"

Since it is difficult to enforce compliance after a contract is awarded if vendor capabilities are inadequate, offerors must demonstrate the ability to incorporate human factors design criteria and guidelines into their system design and engineering before contract award. The Government first plans the approach and then includes human factors requirements in the Screening Information Request (SIR), which includes the proposal evaluation criteria. Offerors show they understand the requirements by making

human factors commitments in their proposals. The offerors must demonstrate comprehension of and the ability to comply with the total system performance concept as well as their ability to integrate human considerations into system design and development. The human factors practitioner, having provided input to the source selection evualtion plan, supports the source selection evaluation team and helps determine how well offerors have met the human factors selection criteria.

Step 1: Provide Input to the Screening Information Request

The Human Factors Coordinator assists the Integrated Product Team (IPT) in developing the documentation the offeror must submit and the proposal evaluation criteria. The criteria must define the quantity and quality of the effort required. The human factors portion of the criteria should contain two primary requirements.

1. Require offerors to define how they will organize and manage their human factors program for the system.

2. Require offerors to describe how they will execute the technical human factors program and integrate human factors throughout their design and engineering efforts.

For nondevelopmental items (NDI) or commercial-off-the-shelf (COTS) procurements,

the hardware and/or software has already been developed, so the criteria will focus on the existing product as opposed to a product to be developed. Human factors criteria must still be met.

The SIR (usually in Section L) describes the information an offeror must provide to the Government against which the proposal will be evaluated. The human factors criteria (to be included in Section L) can be stated as a separate criterion or be embedded with other criteria such as system engineering or training.

Table 6-1 (included at the end of this chapter) lists some potential human factors inputs to the proposal evaluation criteria.

Step 2: Provide Input to the Source Selection Evaluation Plan

After human factors criteria have been developed and are included in the proposal evaluation criteria portion of the SIR (Section L), the Human Factors Coordinator should help the IPT develop the Source Selection Evaluation Plan.

The weight human factors will have in rating and ranking the proposals must be determined. This will vary greatly from system to system with the greatest influence being the degree of human involvement as part of the total system. The total weight is 100% and there are legitimate compet ing interests for priority. If human factors is

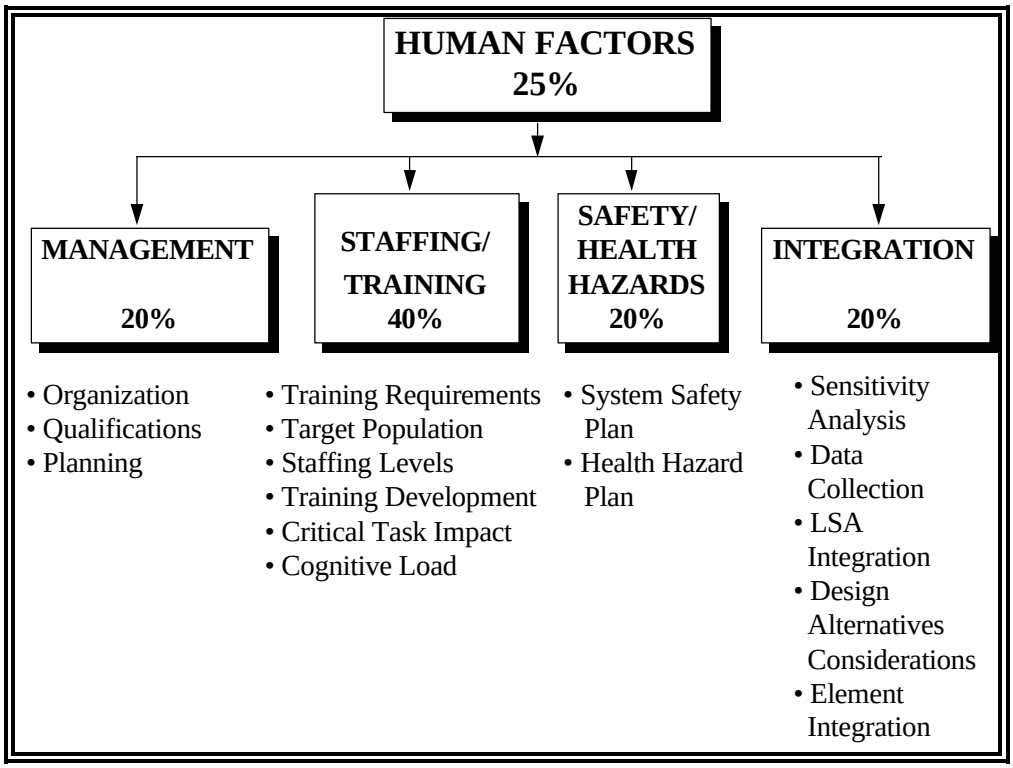
considered a separate criterion, it is assigned a weight as are other criteria such as management and cost. If human factors criteria are embedded within other criteria, it is assigned a weight as a sub-element of the main criterion (criteria).

Regardless of the approach taken, the human factors criteria must be visible and given sufficient weight, consistent with the nature of the program including the degree of human involvement, performance risks, consequence of error, and the like.

Finally, the human factors practitioner determines how each human factors criterion will be evaluated. The scoring will normally be based on quantitative and qualitative factors. The following figure demonstrates a conceptual breakout of human factors elements in a Source Selection Evaluation Plan where human factors is a separate criterion.

Step 3: Participate on the Source Selection Evaluation Team

Representation of human factors expertise on source selection evaluation team or panel(s) will provide the capability to adequately assess the human factors aspects of proposals. The human factors representative must be techni cally qualified in human factors and adequately trained in the source selection evaluation process.



Minimal qualifications and training for the team representative include knowledge of:

- The overall system and its intended purpose in the field.
- The human interface required to achieve optimum system performance.
- The human performance concerns and issues applicable to the system.
- The requirements, specifications, special instructions, deliverables, and evalua tion criteria as set forth in the SIR as well as what evidence is suficient to demonstrate

compliance with the criteria.

- The procedures for rating and ranking the proposals.

CHECKLIST QUESTIONS

Evaluation Criteria

- Have human performance criteria or standards been identified for the system and quantified in the SIR?
- Does human factors (as a separate criterion or as embedded criteria in other primary factors) adequately represent the user performance, risks, complexity, consequence, and exposure?
- Are offerors required to develop a human factors program management plan?
- Are offerors required to demonstrate technical competence in human factors?

Source Selection Evaluation Plan

- Have human factors criteria been adequately and clearly identified in the source selection evaluation plan?
- Are human factors criteria adequately weighted for this system (considering degree of human interface with hardware and/or software)?

Source Selection Evaluation Teams

- Is there a human factors member on the source selection evaluation board or supporting panel(s)?
- Is the human factors member technically qualified to evaluate human factors aspects of the proposals?
- Where human factors criteria are embedded with other criteria, is human factors represented in those other criteria evaluations?
- Is the evaulation team adequately appraised on the evidence necessary to demonstrate vendor capability and compliance?

TABLE 6-1

POTENTIAL HUMAN FACTORS INPUTS TO THE PROPOSAL EVALUATION CRITERIA

Management Planning	• Adequacy of offeror's human factors organiza tion, level of effort, lines of authority, visibility to top management, and potential impact on design decisions. • Adequacy of offeror's concept for contributing to and helping to execute the human factors program.
Execution	• Coordination of human factors activities with the total management system and work breakdown structure. • Coherence of offeror's plan for tracking and reporting human factors task performance and for assuring quality.
Technical Qualifications	• Quality of offeror's and subcontractor's previous experience in human factors-related tasks. • Capability of offeror's personnel, including key subcontractor personnel, to perform required human factors tasks.

Evaluation	• Adequacy of offeror's methodology for validat ing human factors requirements as part of the test and evaluation requirements identified in SIR. • Adequacy of test and evaluation facilities to perform human factors assessments and analyses.
Human Factors Understanding	• Offeror's understanding of human factors con cepts as a means for enhancing total system performance. • Adequacy of offeror's concept for assuring that the system design will reflect human factors goals and constraints.
Training	• Indicates how the training developer will serve as a resource for design ideas and for assisting the training impact on design. • Understanding of the impact of design on training devices and other aids. • Recognizes the impact of skill decay on sustainment training and demonstrates capability for reducing skill decay through cost-effective changes in the design. • Recognizes the influence of human aptitude on success in training and consequently, on system performance. • Recognizes the value of positive transfer of current skills on new training.

Human Engineering	• Staffing level and quality of offeror's human factors engineers, including subcontractors, available for this system. • Adequacy of plan for functional and/or task analysis and critical task identification to determine appropriate task burden on humans. • Shows approach for tracking the functions, information flow, and processing steps that the operator must monitor. • Adequacy of plan for estimating physical and cognitive workloads of operators and main tainers, by group and individually, with reference to staffing and training constraints. • Adequacy of approach for allocating functions to the human, hardware, or software for optimum system performance. • Addresses the design of the work environment, including space claims and other workstation variables, as the work environment influences system performance. • Ensures that human engineering data collection, testing, and evaluation plans use appropriate and valid equipment and tech niques such as mockups, simulations, models, and prototypes. • Adequacy of plans to conduct failure analysis and documentation of redesigns made in response to human-system performance problems and failures.

Staffing	• Adequacy of approach to reduce staffing needs while maintaining desired system performance. • Adequacy of plans for analyzing tradeoffs among design options that could produce lifecycle personnel savings and costs, informing the Government of results and making appropriate design changes. • Addresses the impact of varying staffing levels on total system performance.
Human Resource Skills	• Demonstrates an understanding of the projected operators and maintainers and the human factors goals and constraints that are imposed by that target population. • Ability to recognize the use of skill specialties that present staffing difficulties or are low in density and would be difficult to expand quickly. • Adequacy of plans for identifying the human resource-intensive aspects of the system and explaining how alternative designs will be pursued. • Adequacy of plans to identify and clarify personnel workload issues during design work. • Addresses the impact of varying skill and experience levels on total system performance. • Identifies skills that are critical to successful mission performance and explains how these skills relate to the capabilities of the operators, maintainers, and supporters.

System Safety and Health Hazards	• Adequacy of plans to identify potential safety hazards in all environments over system lifecycle and documentation of acceptable residual risks. • Estimates severity, frequency, and scope of exposure of risks, incidents, and accidents. • Demonstrates a plan for tracking changes in design and for continuously evaluating safety impacts. • Adequacy of plans to establish pre-defined levels of acceptable risk and estimates the influence of these risks on user and maintainer performance. • Demonstrates an understanding of health hazards, including secondary impacts on staffing decisions. • Adequacy of plans to identify psychological influences on human performance that can be controlled favorably through system design. • Evaluates hazards in the intended operating environments and determines priorities for control through initial design and retrofit. • Identifies alternative technical concepts to control, reduce, or avoid health hazard risks. • Demonstrates ability to prepare test and evaluation plans using state-of-the-art practices, criteria, standards, and lessons learned data bases.

Systems	• Assures integration of human and machine within a

Integration	system (for example, engineering decisions should be made with continual reference to human performance and system functions should be matched to human attributes during task allocation). • Adequacy of plans to coordinate and efficiently conduct the collection, analysis and interpretation of human performance data. • Assures that performance of the system is consistent with the performance and goals of larger enclosing systems. • Shows that trade-off and sensitivity analyses are used to evaluate design alternatives with appropriate emphasis on human impacts. • Presents valid human performance tests of the system in realistic and anticipated environments and combinations of environments. • Shows that system design and human factors analysis will be performed, so that problems are fed back and eliminated early in the design phase.
Operations and Support Cost Evaluation	• Adequacy of offeror's analysis of system costs and projections in relation to human factors topics. • Adequacy of offeror's cost tradeoff analysis in meeting human factors-related requirements.

Chapter 7 Integrate Human Factors in System Engineering

PURPOSE

This chapter describes the human factors engineer's role in system engineering. System engineering is the translation of operational requirements into design, development, and implementation concepts and requirements. The Human Factors Coordinator assists the IPT and contractor's system engineering effort by integrating human factors within the acquisition process. This is done by identifying the human performance boundaries, risks, trade-offs, and opportunities of the system engineering options and alternatives.

Human engineering is applied during design, development, and implementation of systems, software, and facilities to effectively integrate human resource and performance considerations. A human engineering effort is conducted to:

- Develop or improve human interfaces of the system,
- Achieve required effectiveness of human performance during system operation, maintenance, and support, and

- Make economical demands upon personnel resources, skills, training, and costs.

TIMING

Human factors in the system engineering process is initiated in the Investment Analysis phase of the acquisition process and continues through Solution Implementation.

"HOW TO"

System engineering is an interdisciplinary approach to evolve and verify an integrated and lifecycle-balanced set of system product and process solutions that satisfy customer needs.

The Human Factors Coordinator assists in the system engineering task by contributing information related to design enhancements, safety features, automation impacts, human-system performance trade-offs, ease of use, and work load. The Human Factors Coordinator also assists in identifying potential task overloading or skill creep for system operators and maintainers. Where user teams or operator juries and representatives participate in achieving an operational viewpoint to design, the IPT human factors engineer complements the effort to ensure performance data represents more than individual preferences. Optimally, the Human Factors Coordinator participates fully in system engineering design decisions.

While the actual design and development work may be completed by either the government or the contractor, the Human Factors Coordinator supporting the IPT (in conjunction with the Human Factors Working Group) provides close, continuous direction throughout the acquisition process. To accomplish this, the Human Factors Coordinator reviews all documentation for human performance impacts that will affect total system performance and exercises his or her responsibility by participating in technical meetings and system engineering design reviews.

The human engineering effort includes those tasks and activities listed in the following table. The human engineer actively participates in four major interrelated areas of system engineering:

- Planning
- Analysis
- Design and Development
- Test and Evaluation

Human Factors-Related System Engineering Tasks and Activities

- Prepare operationally-realistic mission profiles and mission scenarios.
- Prepare functional flow block diagrams for the system.
- Perform a functional analysis of each flow block and define operational and support equipment and facilities requirements.
- Prepare system and subsystem schematic block diagrams.
- Study detailed functions, environment and technical design requirements to allocate tasks to personnel, equipment, software, or some combination thereof.
- Prepare operation and maintenance timeline analyses to determine system reaction time.
- Prepare and analyze operations and maintenance workload and task data to influence equipment and procedure design, and to determine personnel requirements.
- Identify training implications.
- Conduct trade studies.
- Participate in preparation of specifications for the system.
- Participate in design reviews, demonstrations, and test and evaluation activities.

Step 1: Human Engineering in Planning

Human engineering planning is performed to ensure effective and efficient support of the system engineering effort for human performance and human resource considerations. Human

engineering program planning includes the human factors tasks to be performed, human engineering milestones, level of effort, methods to be used, design concepts to be utilized, and the test and evaluation program, in terms of an integrated effort within the total project.

The human engineering planning effort specifies the documentation requirements and assists in the coordination with other program activities. Government and contractor documentation provides traceability from initially identifying human engineering requirements during analysis and/or system engineering, through implementing such requirements during design and development, to verifying that these requirements have been met during test and evaluation. The efforts performed to fulfill the human engineering requirements must be coordinated with, but not duplicate, efforts performed by other system engineering functions.

Step 2: Human Engineering in System Analysis

To support system analysis, the functions that must be performed by the system in achieving its objective(s) within specified mission environments are analyzed for their human factors implications and alternatives. Human engineering principles and criteria are applied to specify human-system performance requirements for system operation, maintenance and support functions and to allocate system functions to automated operation and maintenance, manual operation and maintenance, or some combination thereof. Function allocation is an iterative

process to achieve the level of design detail appropriate for the level of system definition.

Functional Analysis. Human factors functional analyses are conducted to determine information flow and processing required by the users to accomplish the system objective(s) including the decisions and operations to be performed.

Human roles in the system are identified and distinguished from machine functions. Estimates of human (vs. machine) processing capability in terms of workload, accuracy, rate, and time delay are prepared for each potential operator and maintainer information processing function. Comparable estimates of equipment capability are also made. These estimates are used initially in determining allocation of functions and are refined at appropriate times for use in definition of operator and maintainer information requirements.

Functional Allocation. From projected operator and maintainer performance data and known constraints, analyses and trade-off studies are conducted to determine which system functions should be machine-implemented or software controlled and which should be reserved for the human operator and maintainer. Allocation of functions considers the error and delay risks for each design alternative so that designs prevent or minimize the impact of, or sensitivity to, situations where human decisions are made under conditions of uncertainty, time constraints, or workload stress. The potential and

opportunities to influence human or equipment capabilities through personnel selection and training as well as through equipment and procedure design are also considered.

Design Configuration. Human engineering principles and criteria are applied along with all other design requirements to identify and select the particular equipment to be operated and maintained by personnel. The selected design configuration should reflect human engineering inputs to satisfy the functional and technical design requirements and to ensure that the equipment will meet the applicable human engineering design criteria.

Task Analysis. Human engineering principles and criteria are applied to analyses of tasks and workload. These analyses are provided as basic information for developing preliminary manning levels, equipment procedures, personnel skill requirements, training needs, and communication requirements.

A task analysis is conducted as a basis for making design concept decisions. Time requirements for tasks are evaluated with respect to task duration versus time availability, task sequencing, and task simultaneity. Task requirements are evaluated with respect to accuracy; precision; completeness; and the effects of task feedback, error tolerance, and error recovery on performance. Those tasks identified during human engineering analyses

which require critical human performance are analyzed in greater detail.
Operator and maintainer workload analyses are performed and compared with performance criteria. To avoid overloading or underloading, the degree to which demands of any task or group of tasks tax the attention, capacities, and capabilities of system personnel (and thus affect performance) are also evaluated. Sensory, cognitive, and physiological limitations are considered. The workoad analyses help determine operational sequences and task times.

Human-system interface design incompatibilities and excessive skill and physical requirements, identified by task or workload analyses, are corrected by changing design or restructuring tasks to preclude degraded human performance.

Step 3: Human Engineering in Detail Design

During detail design, the human engineering requirements are converted into detail engineering design features. Design of the equipment should satisfy human-system performance requirements and meet the applicable human engineering design criteria. The human factors engineer participates in design reviews and engineering change proposals for those items having a human interface.

Tests and Studies. The government and contractor conduct experiments, tests, simulation, and studies to resolve human engineering problems specific to the system.

Experiments, tests, and studies are performed in a controlled environment with representative users in a realistic operating environment in order to validate design goals and system performance objectives.

Drawing and Representations. Human engineering principles and criteria are reflected in the engineering drawings and computer-aided design representations to ensure that the final product can be effectively, efficiently, reliably, and safely used and maintained. Design, as reflected in such drawings, should comply with applicable human engineering criteria. The human factors engineer reviews all layouts and drawings having potential impact on human performance or interface and identifies for corrective action those designs which may induce human error, excessive delay, or be unsafe.

Environmental Conditions. Human engineering principles and criteria are applied to detail design of work environments to be used by system personnel. Design of work environments which affect human performance, under normal, unusual, and emergency conditions, should consider the following:

- Acoustic noise and vibration.
- Adequate space for personnel, their movement, and their equipment.
- Adequate physical, visual, and auditory interface between personnel and their

equipment including eye positions in relation to display surfaces, controls, and other visual areas.

- Safe and efficient walkways, stairways, platforms, and inclines.
- Provisions to minimize physiological stresses.
- Provisions to minimize physical fatigue.
- Equipment handling provisions and tools.
- Safe and error-proof equipment installations.
- Protection from chemical, biological, toxicological, radiological, thermal, mechanical, electrical, and electromagnetic hazards.
- Optimum illumination commensurate with anticipated visual tasks.

Procedures. Based upon the human performance functions and tasks identified by human engineering analyses, the human engineer applies the necessary principles and criteria to the development of procedures for operating and maintaining the system. This effort ensures that the human functions and tasks are organized and sequenced for efficiency, safety, and reliability.

Software. The human engineer applies the appropriate principles to the software design in those systems where software determines part of the human interface. Software that affects controls and displays is evaluated for the impact on the human-system interface. Automated

system functions requiring human monitoring or intervention are considered as part of the human-system interface. Multifunction controls and displays that vary in function are also part of the human-system interface.

Technical Documentation. Human engineering is applied to the development of manuals, including illustrations, to ensure thoroughness, technical accuracy, suitable format of information presentation, appropriate reading level, technical sophistication required, and clarity.

Step 4: Human Engineering in Test and Evaluation

The government and contractor establish and conduct a test and evaluation program that addresses human factors to:

- Ensure fulfillment of the applicable human performance requirements;
- Demonstrate conformance of system, equipment, and facility design to human engineering design criteria;
- Confirm compliance with system performance requirements where human performance is a system performance determinant;
- Secure quantitative measures of system performance which are a function of the human interaction with equipment; and
- Determine whether undesirable design or procedural features have been introduced.

The fact that the above may occur at various stages in system development should not

preclude a final human engineering verification of the complete system.

Human engineering testing is incorporated into the system test and evaluation program and is integrated into engineering design and development tests, demonstrations, acceptance tests, fielding and other implementation assessments. Compliance with human engineering requirements should be tested as early as possible. Human engineering findings from design reviews, mockup inspections, demonstrations, and other early engineering tests should be used in planning and conducting later tests. Human engineering test planning is directed toward verifying that the system can be operated, maintained, and supported by user personnel in its intended operational environment.

Human engineering test planning should also consider data needed or to be provided by operational test and evaluation. Test planning includes methods of testing (e.g., use of checklists, data sheets, test participant descriptors, questionnaires, operating procedures, and test procedures), schedules, quantitative measures, test criteria and reporting processes.

Human engineering portions of tests include:

- Performance of task or mission;
- Critical tasks;
- Representative samples of non-critical, scheduled and unscheduled maintenance

tasks;

- Personnel who are representative of the range of the intended user populations;
- Proposed job aids, new equipment training programs; training equipment, and special support equipment;
- Collection of task performance data in actual operational environments;
- Identification of discrepancies between required and obtained task performance; and
- Criteria for acceptable performance.

Unfavorable outcomes occurring during test and evaluation are subjected to a human engineering review to differentiate between failures of the equipment alone, failures resulting from human-system incompatibilities and failures due to human error. Human-system incompatibilities and human errors occurring in the performance of critical tasks are analyzed to determine the reason for their occurrence and to propose corrective action(s).

CHECKLIST QUESTIONS

- Has the human engineering effort been planned as an integrated portion of the overall system effort?
- Has the human engineering effort been coordinated with other system engineering functions?
- Has a functional analysis been conducted to determine information flow and processing

required?

- Have the system functions been properly allocated between the hardware/software and the human?
- Does the design configuration conform to human engineering design criteria?
- Have the results of task and workload analyses been used to influence system design?
- Have required human performance tests and studies been identified?
- Does the human engineer review all drawings which have a human interface or impact human performance?
- Does the system design reflect expected environmental conditions?
- Is system software subjected to a human engineering review?
- Have human engineering testing requirements been incorporated into the system test and evaluation requirements?
- Have unfavorable outcomes during test and evaluation been subjected to a human engineering review?

Chapter 8 Determine Human Factors Requirements in System Testing

PURPOSE

This chapter discusses the determination of human factors testing requirements for the Integrated Product Team (IPT) to ensure that human factors considerations are adequately integrated into the system acquisition testing program.

Testing is performed to assess the operational effectiveness and suitability of the system to meet the mission needs. The purpose of human factors in system testing is to produce evidence of the degree to which the total system can be operated and maintained by members of the target population in an operational environment. If the total system exhibits performance deficiencies when operated or maintained by members of the target population, the testing should produce human factors causal information.

TIMING

Human factors planning for test and evaluation (T&E) activities is initiated early in the acquisition process during Investment Analysis. Specific

human factors-related T&E tasks and activities are identified in the Integrated Program Plan. The conduct of the human factors T&E is integrated with the system T&E program, which is largely performed during Solution Implementation. Post deployment assessments that include human performance parameters assist in lifecycle planning and continuous improvement.

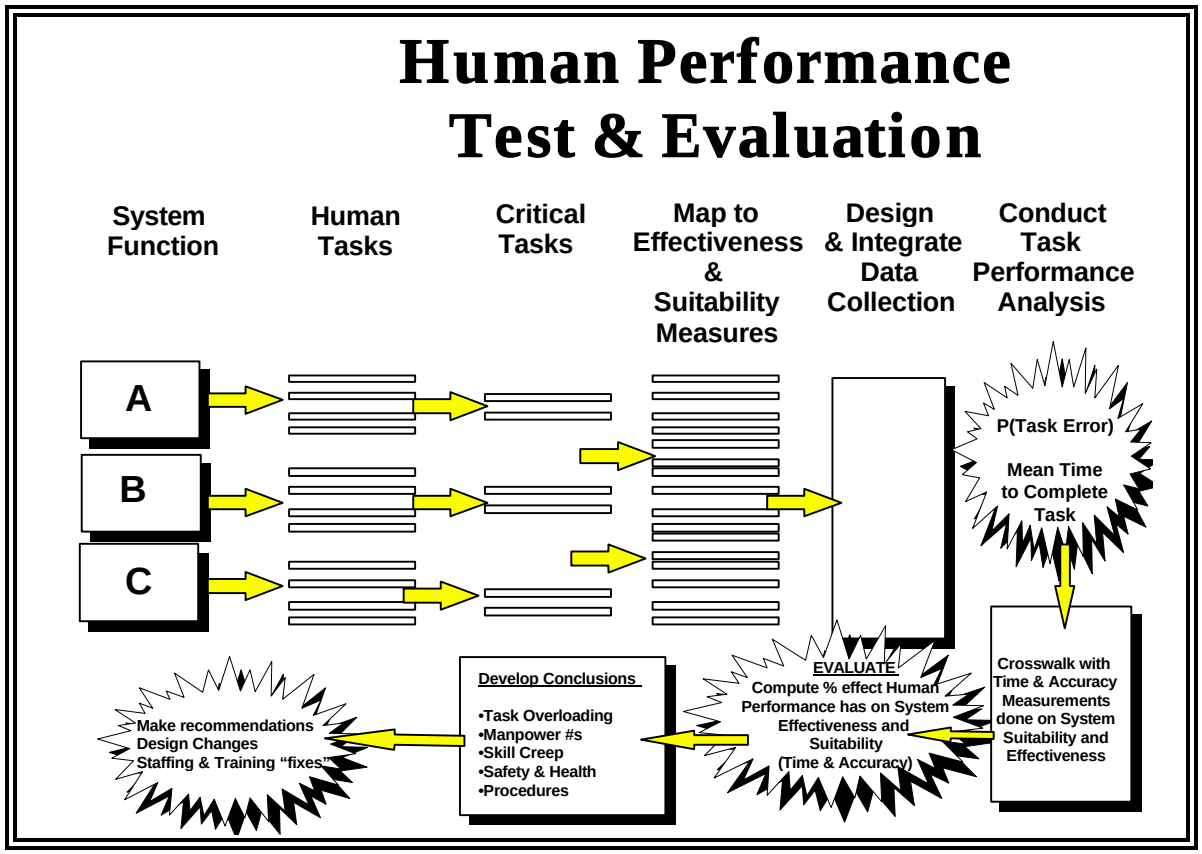
"HOW TO"

Key principles for addressing human factors requirements in system testing are:

- Coordinate human factors test planning early in the acquisition program.
- Measure human performance of critical tasks during testing in terms of time, accuracy, and operational performance.
- Leverage human factors data collection by integrating efforts with system performance data collection.
- Make recommendations for human factors design and implementation changes and human performance improvements.

Providing human factors in system testing entails an early start and a continuous process. The figure below illustrates the flow of this process. During the conduct of a front-end analysis, and in conjunction with developing the Human Factors

Program, plans and analyses help identify the system functions. The human factors experts review the system functions and identify the human tasks that may be critical to the performance of those functions.



Simulations, studies, analyses, prototype evaluations, research, and trade-off studies may be required by the human factors experts to determine the effect of human performance on system performance.

Using the system's mission objectives, critical

operating issues and related criteria, the human factors experts derive measures of effectiveness, measures of suitability, and the criteria and performance thresholds associated with these measures. Data requirements and data collection plans are formulated along with resources required (e.g., funding, analytical personnel, data collection equipment). Human performance is then tested, analyzed, and evaluated for its impact on system performance.

Since the purpose of incorporating human factors in system acquisition is to produce safer, more effective systems, a continuous feedback loop is established to the IPT and the operator representative to recommend design and implementation changes and possible staffing and training solutions.

Step 1: Conduct Front-End Analysis

This step consists primarily of applying the results from the front-end analysis conducted during mission analysis and investment analysis to feed the Human Factors Program. Predecessor system(s), similar system components, lessons learned, and other documentation are used to identify critical operational issues, resource limitations and constraints, critical tasks, and operator and maintainer performance levels, as well as system performance thresholds that should be incorporated into the testing program.

Step 2: Develop Human Factors Testing Requirements

Using the system critical operational issues, human performance operational issues are derived. Based on the results of the front-end analysis, human performance measures of effectiveness (MOE) and measures of performance (MOP) are developed in terms that relate human performance to system performance and operational suitability.

Human factors requirements should identify the data to be collected that is necessary to satisfy the MOEs and MOPs. The data to be collected must be integrated into the system test and evaluation planning and should identify needed support (e.g., personnel and other resources, facilities, software tools, equipment).

Products of this step may include:

- Human factors test planning for inclusion in the system test and evaluation planning
- Issues for resolution by the Human Factors Program
- New or changed procedures for operational test and evaluation
- Operator and maintainer task lists to include identification of critical tasks
- Human performance measures of effective ness

and measures of performance

- Identification of data requirements
- A listing of data collection tools, surveys, questionnaires, analyses, and evalua tion schemes
- Resource requirements including equipment, software, data analysis skills, data collection personnel, computer time, personnel training requirements, and the like.

Step 3: Conduct Human Performance Testing

Human factors involvement in early system test and evaluation is critical to producing safe, suitable, and effective systems. Developmental testing, conducted early to reduce risk, often provides useful operational and human factors information. Developmental testing assesses progress toward meeting critical operational issues as well as readiness to proceed to operational testing. Operational test and evaluation, conducted to estimate or verify operational effectiveness and suitability, provides information about human performance as an integral part of system performance.

Data are collected during the developmental and operational tests and the effect of human performance on system performance and operational suitability is calculated or estimated. Inconsistencies between the measures used in the investment analysis and the results obtained from

actual test data need to be resolved. Testing and evaluation should assess the validity of the assumptions and conclusions made during the analysis of various alternatives.

Human performance testing of nondevelopmental or commercial-off-the-shelf items should take advantage of warrantees, previous commercial testing, and product experience. Modeling and simulation are some of the powerful tools used to verify human performance associated with various design approaches.

Step 4: Apply Results of Human Performance Testing

The information developed by the human factors test and evaluation effort provides the IPT and the user representative feedback to produce the safest and most effective system possible within program baselines. Recommendations may be made for design or implementation changes or human performance improvements, or training solu tions.

CHECKLIST QUESTIONS

- Has a front-end analysis adequately identified the human performance issues for test planning?
- Have human performance critical operational issues and criteria been identified?
- Have human performance Measures of Effectiveness (MOEs) and Measures of

Performance (MOPs) been identified?

- Are data requirements identified that will satisfy the MOEs and MOPs?
- Have the resources necessary to support the collection of human performance data been identified and made available?
- Has the human factors data collection effort been integrated with the system data collection effort(s)?
- Have options been identified for human performance data collection if the primary data collections plans are not feasible or practical?
- Are human performance data collected in terms of task performance time and accuracy?
- Are data collectors trained to identify and report potential human performance issues?
- Are other sources sources of data (such as user comments) being reviewed for human performance issues?
- Have human performance data been analyzed with respect to training effectiveness, task overloading, skill creep, safety, health hazard or procedural inadequacy issues?
- Has feedback been provided to the IPT?

Chapter 9 Coordinate with the Integrated Logistics Support Program

PURPOSE

This chapter explains the rationale and steps taken to coordinate the analyses and information content and flow between the Human Factors (HF) and Integrated Logistics Support (ILS) programs.

ILS is a disciplined approach to integrate support considerations into design, to acquire the necessary initial support for the system, and to identify lifecycle support requirements. The Human Factors Program provides the human resource and performance dimension for logistics support requirements and functions. Close coordination between the human factors and ILS programs will reduce data redundancies and result in more effective use of information for both programs.

TIMING

- The human factors effort begins during the Investment Analysis phase as does the primary ILS effort. Initial human factors documentation is developed in this phase as is initial ILS documentation. Later, this documentation will be incorporated into the Integrated Program Plan.

- Coordination between the Human Factors Working Group (HFWG) and the ILS Management Team (ILSMT) begins during the Investment Analysis phase and continues throughout the remainder of the acquisition process, as shown in the following table. Each element in the table represents an opportunity for cooperation between the Human Factors and the ILS programs.

"HOW TO"

Coordinating the Human Factors and ILS programs takes active and continuous communication. There are many opportunities to plan requirements, collect data, and share information, especially in the areas of maintenance staffing, training, training support, and personnel skills. Coordination will result in program cost savings or cost avoidance by eliminating redundancy and will strengthen the planning, analysis, design, and testing for both programs during all phases of the acquisition process.

COORDINATION OF ILS & HUMAN FACTORS ACTIVITIES		
PHASE	**ILS**	**HUMAN FACTORS**
INVESTMENT ANALYSIS	• Form ILSMT • Initiate the ILS program • Conduct early ILS analyses • Develop initial ILS documentation	• Form HFWG • Initiate the HF program • Conduct early human factors analyses • Develop initial HF documentation
SOLUTION IMPLEMENTATION	• Conduct ILSMT meetings • Identify contractual requirements • Review data from ILS analyses • Update ILS documentation	• Conduct HFWG meetings • Identify contractual requirements • Review data from HF analyses • Update HF documentation
IN-SERVICE MANAGEMENT	• Conduct ILSMT meetings • Identify issues from post-fielding assessments • Collect lessons learned	• Conduct HFWG meetings • Identify issues from post-fielding assessments • Collect lessons learned
	COORDINATE	

Step 1: Coordinate Joint Participation in Meetings

The Human Factors Coordinator participates in ILSMTs and the ILS representatives participate in HFWGs. If the participants in the meetings appear to be similar, it may be economical to coordinate meeting times and locations. There are many opportunities for the two groups to share workload as they develop their HF and ILS documentation. Joint participation in meetings allows the participants to address common issues and areas of concern.

Step 2: Coordinate Conduct of Analyses

The ILS and human factors communities offer a rich environment for tools to assist in the analyses to be conducted in support of the acquisition program during its lifecycle. Many are readily available within the FAA acquisition working environment. For guidelines, standards, and tools not already available from support services such as the FAA Acquisition System Tool (FAST), the process of identification should exploit other centers of information and expertise, including the FAA Human Factors Office, Crew Station Ergonomics Information Analysis Center (CSERIAC), National Technical Information Service (NTIS), and Defense Technical Information Center (DTIC). Some approaches and techniques may be performed in-house with available expertise and facilities while others require non-routine training, specialized equipment, and unique capabilities and facilities.

Subsequent to the identification of analyses and data requirements, comparing the planned tasks and activities for the two programs yields an assessment of the synergy to be achieved between the ILS and human factors efforts. Many analyses and analytical techniques may simultaneously provide results that meet both human factors needs and logistic support analysis (LSA) requirements. Analyses and data requirements that may intersect both programs include such areas as:

- Use Studies: Assessment of the intended use of new equipment identifies the impact of the operational and support environment on the constraints and limitations of the operators and maintainers.
- Comparative Analyses: Baseline comparisons with other systems are established to represent the characteristics of the new system for design and supportability features and to identify high cost human resource and high risk human performance areas.
- Trade-off Analyses: Staffing, training, and human performance implications are evaluated for alternative approaches to design and support.
- Task Analyses: Operations and support tasks are identified and analyzed for human resource and performance considerations.

- Early Fielding Analyses: The impact of the introduction of new equipment is assessed in terms of supportability and suitability.

The results of the human factors and ILS analyses conducted during the acquisition should be shared, and it may be beneficial to create a common data base as well as to collaborate on lessons learned.

Step 3: Coordinate Inputs to Procurement Documents

Joint development of inputs to the Screening Information Request (SIR) (statement of work, specifications, and data to be delivered) benefits the human factors and ILS programs. Coordinated inputs to the SIR will help prevent redundancy and by delineating unique requirements for one program not covered by the other. The complementary effort provides full coverage of the needs of system operators, maintainers, and supporters during system acquisition. In many cases, the same data will meet human factors and LSA requirements. An example is LSA Task 203, Comparative Analysis. This task can aid in developing human factors constraints and identifying human factors issues to be resolved in the new system, especially costly tasks that degrade total system performance.

CHECKLIST QUESTIONS

- Does the Human Factors Coordinator participate in ILSMT meetings?
- Do ILSMT members participate in HFWG meetings?
- Has the Human Factors Coordinator reviewed and provided comments on the ILS documentation?
- Have ILSMT members reviewed and provided comments on the human factors documentation?
- Has the Human Factors Coordinator participated in ongoing relevant logistical support analyses?
- Have ILSMT members participated in ongoing relevant human factors analyses?
- Have HFWG and ILSMT members cooperated in developing inputs to the Screening Information Request?
- Have HFWG and ILSMT members reviewed contractor proposals to ensure that the Government is only procuring the minimum essential data for each program?
- Have HFWG and ILSMT members reviewed the results of human factors and LSA analyses and used them to improve system design, training, staffing, and operational and maintenance concepts?

Appendix A Acronyms

APB	Acquisition Program Baseline
ASP	Acquisition Strategy Paper
CDRL	Contract Data Requirements List
COTS	Commercial-off-the-Shelf
CSERIAC	Crew Station Ergonomics Information Analysis Center
DID	Data Item Description
DTIC	Defense Technical Information Center
FAA	Federal Aviation Administration
FAST	FAA Acquisition System Tool
HF	Human Factors
HFC	Human Factors Coordinator
HFP	Human Factors Program
HFWG	Human Factors Working Group
IAR	Investment Analysis Report
ILS	Integrated Logistics Support
ILSMT	Integrated Logistics Support Management Team
IPP	Integrated Program Plan
IPT	Integrated Product Team
JRC	Joint Resources Council
LSA	Logistics Support Analysis
LSAR	Logistics Support Analysis Record
MAR	Major Acquisition Review
MIL-HDBK	Military Handbook

MIL-STD	Military Standard
MNS	Mission Need Statement
MOE	Measure of Effectiveness
MOP	Measure of Performance
NAS	National Airspace System
NDI	Nondevelopmental Item
NTIS	National Technical Information Service
RD	Requirements Document
SIR	Screening Information Request
SOW	Statement of Work
T&E	Test and Evaluation

Appendix B Glossary

Acquisition Program Baseline
An acquisition document that establishes the performance, cost, schedule, and benefits framework within which an acquisition must be implemented.

Acquisition Strategy Paper
An acquisition document that defines the overall strategy by which an acquisition program will be implemented.

Anthropometry
Of, or relating to, the study of human body measurements, especially on a comparative basis.

Availability
The probability that an item will be operationally ready to perform its function when called upon at any point in time.

Cognition
The act, power, or faculty of apprehending, knowing, or perceiving.

Commercial-off-the-Shelf
A product or service that has been developed for sale, lease, or license to the general public. The product is currently available at a fair market value.

Contract Data Requirements List

A list of data requirements that are authorized for a specific acquisition and made part of the contract.

Critical Operational Issue
A key operational effectiveness or suitability issue that must be examined in operational test and evaluation to determine a system's capability to perform its mission.

Critical Task
A task requiring human performance which, if not accomplished in accordance with system requirements, will most likely have adverse effects on cost, system reliability, efficiency, effectiveness, or safety. A task is also considered critical whenever equipment design characteristics demand human performance which approaches the limits of human capabilities.

Data Item Description
A description of the content and format of the data that is to be provided to the government for a specific acquisition.

Developmental Test and Evaluation
That portion of test and evaluation conducted to assist the engineering design and development process by determining incrementally the degree to which functional engineering specifications are attained.

Evaluation Criteria
Standards used to judge the achievement of operational effectiveness and suitability as they relate to a level of performance against which system characteristics and capabilities are compared (e.g., two false detections per hour).
Exit Criteria

Program-specific accomplishments or performance parameters that must be achieved before an acquisition can progress further. Exit criteria may also identify minimum activity and accomplishments that must be achieved during the next acquisition phase.

High Driver Task
A performance task required by the design of the system and which is a significant contributor to the "cost of ownership" of the system by its requirement for high-aptitude users, or substantial training to maintain satisfactory total system performance.

Human Factors
A multidisciplinary effort to generate and compile information about human capabilities and limitations; and apply that information to equipment, systems, facilities, procedures, jobs, environments, training, staffing, and personnel management for safe, comfortable, effective human performance.

Human Factors Engineer
An individual with specialized expertise in human performance as well as in systems engineering and the acquisition process.

Human Factors Engineering
The application of human factors considerations concurrent with other engineering disciplines during the design, development, and fielding of a system in which human performance is essential in meeting safety and performance objectives.

In-service Management
That part of the lifecycle acquisition management process after

commissioning of a product when it is functioning to satisfy mission need.

Integrated Logistics Support
A disciplined, unified, and iterative approach to achieving the integration of support considerations into system and equipment design; the development of support requirements that are related directly to readiness objectives; the acquisition of required support; and the provision of required support during the operational phase at minimum cost.

Integrated Product Team
A multidisciplinary team (with tiered structure) that plans and executes the acquisition of FAA systems to meet mission and customer needs. Included tasks are: identification of resource requirements; development of plans, measures, and program milestones; communication with other IPTs; timely execution of plans and activities for lifecycle management; and ensuring the needs and interests of the functional discipline are represented.

Integrated Program Plan
An acquisition document that details the planning for all aspects of program implementation. It integrates the planning requirements of several previous planning documents including the program master plan, the integrated logistics support plan, the test and evaluation master plan, the program implementation plan, the human factors plan, and the procurement plan.

Investment Analysis
That part of the lifecycle acquisition management process that determines the most advantageous solution to an approved mission need. It involves development of operational requirements, a market search to determine industry capabilities, analysis of various alternative approaches for

satisfying requirements, and affordability assessment to determine what the FAA can afford.

Investment Analysis Report
An acquisition document that summarizes the analytical and quantitative information developed during investment analysis in the search for the best means for satisfying mission need.

Maintainability
The ability of an item to be retained in or restored to a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources.

Measures of Effectiveness
Expressions of the system's task accomplishment as they relate to the critical and other operational issues, i.e., how well an item of equipment or system performs in terms of mission completion (e.g., reliability in radar detection).

Measures of Performance
Quantitative or qualitative metrics of the system's capabilities or characteristics as they relate to the measures of effectiveness (e.g., mean false detection rate).

Mission Analysis
That part of the lifecycle acquisition management process during which the most critical capability shortfalls and technological opportunities are identified and prioritized. It is a continuous, rigorous, forward-looking analytical activity based on input from the operational workforce, integrated product teams, the aviation community, the NAS architecture, and projections of future demand for services.

Mission Need Statement
An acquisition document that defines a mission shortfall or technological opportunity the FAA should address.

Nondevelopmental Item
An item that is available in the commercial marketplace including commercial-off-the-shelf equipment; any previously developed item that is in use by a department or agency of the United States, a state or local government, or a foreign government with which the United States has a mutual defense cooperation agreement; or any item that requires only minor modification to meet the requirements of the agency.

Operational Assessment
An evaluation of operational effectiveness and suitability made by an operational test activity, with user support as required, on other than production systems.

Operational Effectiveness
The degree to which a product accomplishes its mission when used by representative personnel in the expected operational environment.

Operational Suitability
The degree to which a product intended for field use satisfies its availability, compatibility, transportability, interoperability, reliability, maintainability, safety, human factors, logistics supportability, documentation, personnel, and training requirements.

Operational Test and Evaluation
That portion of test and evaluation conducted in an environment as operationally realistic as possible to evaluate the operational effectiveness and suitability of a product including compatibility, interoperability,

survivability, maintainability, and supportability.

Performance
Those operational and support characteristics of a product that allow it to perform its mission over time. Support characteristics include support elements necessary for operation.

Personnel
The people needed to develop, operate, maintain, and support a system. Human resource considerations associated with personnel include information relating to their numbers, aptitudes, grades, organizational structure, job category, biographical and training information, anthropomorphic data, and physical qualifications.

Reliability
The ability of a system and its parts to perform its mission without failure, degradation, or demand on the support system.

Requirements Document
An acquisition document that establishes the performance baseline and operational framework for an acquisition program.

Risk
A subjective assessment made regarding the likelihood of achieving an objective within a specified time and with the resources provided.

Risk Management
All actions taken to identify, assess, and eliminate or reduce risk to an acceptable level in selected areas (e.g., cost, schedule, operations, technical, producibility).

Screening Information Request
Any request made by the FAA for documentation, information, or offer for the purpose of screening, and for determining which offeror provides the best value solution for a particular procurement.

Solution Implementation
That part of the lifecycle acquisition management process during which the alternative selected at the investment decision to satisfy mission need is developed to the point where it is ready to go into operational service.

Staffing
The personnel strength as expressed in the numbers, series, and grades of personnel required and/or available. It is expressed in relationship to the applicable organizational level.

Supportability
The degree to which planned support (including test, measurement, and diagnostic equipment; spares and repair parts; technical data; support facilities; transportation requirements; training; manpower; and software support) meets system reliability, availability, and maintainability requirements.

System Safety
The application of engineering and management principles, criteria, and techniques to optimize safety within the constraints of operational effectiveness, time, and cost throughout all phases of the lifecycle.

Target Population Description
The identification of the salient characteristics of the people who are expected to operate, maintain, and support the system. It is prepared to assist hardware and software designers in considering human aptitudes,

performance, capabilities, and limitations.

Task Analysis
The processes by which the human performance required by a hardware and software configuration is recorded and analyzed. It may include, but not be limited to, task time, task accuracy, knowledge required, skill required, and ability required.

Technical Manual
A publication that contains instructions for installation, operation, maintenance, training, and support for a product, component, or support equipment. A technical manual normally includes operational and maintenance instructions, parts lists or parts breakdown, and related technical information or procedures.

Test and Evaluation
Process that verifies how well an acquisition product meets technical and operational requirements; provides data to assess acquisition, developmental, technical, and operational risk for decision making; verifies subsystem performance; and ensures that all critical issues to be evaluated have been adequately considered and resolved.

Appendix C Points of Contact

AIR CARRIER TRAINING

Dr. Eleana Edens	AAR-100	202/267-7867

AIRCRAFT MAINTENANCE HUMAN FACTORS RESEARCH

Dr. William Shepherd	AAM-240	202/267-8338

AIR TRAFFIC CONTROL RESEARCH

Mr. Lawrence Cole	AAR-100	202/267-9853

AVIATION MEDICINE

Dr. Jerry Hordinsky	AAM-600	405/954-6820

CNS SYSTEMS HUMAN FACTORS

Dr. Charles Overbey	AND-4	202/267-7938

FAA/NASA AMES LIAISON

Dr. Phyllis Kayten	AAR-100	415/604-1396

HUGHES TECHNICAL CENTER HUMAN FACTORS

Dr. Mike McAnulty	ACT-530	609/485-4751

HUMAN FACTORS APPLICATIONS

Mr. Glen Hewitt	AAR-100	202/267-7163
Mr. Alan Poston	AAR-100	202/267-7777

HUMAN FACTORS IN SYSTEM ARCHITECTURE

Dr. Mark Rodgers	ASD-110	202/358-5372

HUMAN FACTORS RESEARCH

Dr. Thomas McCloy	AAR-100	202/267-7167

HUMAN PERFORMANCE/FATIGUE RESEARCH

Mr. Ronald Simmons	AAR-100	202/267-7058

HUMAN PERFORMANCE RESEARCH

Dr. David Schroeder	AAM-500	405/954-4846

MITRE HUMAN FACTORS ENGINEERING SPECIALTY GROUP

Dr. Karol Kerns	MITRE	703/883-5587

NAS INFRASTRUCTURE HUMAN FACTORS

Dr. Mitchell Grossberg	AND-100	202/358-4931

SECURITY HUMAN FACTORS

Dr. James Fobes	ART-100	609/485-4944

VOLPE HUMAN FACTORS

Dr. Donald Sussman	VOLPE-NTSC	617/494-2413

Appendix D References

- FAA Acquisition Management System (April 1996)
- FAA Acquisition Guide for Program Managers (April 1994)
- FAA Order 1800.58A, NAS Integrated Logistics Support Policy (August 1993)
- FAA Order 3900.19A, Occupational Safety and Health (October 1982)
- FAA Order 9550.8, Human Factors Policy (October 1993)
- FAA-STD-005, Specifications (August 1993)
- FAA Human Factors Design Guide (January 1996)
- MIL-STD-881B, Work Breakdown Structures for Defense Material Items (March 1993)
- MIL-STD-882C(1), System Safety Program Requirements (January 1996)
- MIL-STD-1388-1A(4), Logistic Support Analysis (January 1993)

- MIL-STD-1388-2B(1), DOD Requirements for a Logistic Support Analysis Record (January 1993)

- MIL-STD-1472D(3), Human Engineering Design Criteria for Military Systems, Equipment and Facilities (February 1994)

- MIL-HDBK-245D, Preparation of Statement of Work (SOW) (April 1996)

- MIL-HDBK-759C, Human Engineering Design Guidelines (July 1995)

- MIL-HDBK-761A, Human Engineering Guidelines for Management Information Systems (September 1989)

- MIL-HDBK-46855, Human Engineering Requirements for Military Systems, Equipment, and Facilities (January 1996)

- NASA-STD-3000, Revision B, Man-Systems Integration Standard (July 1995)

SELECTED READINGS

Billings, C. E. (1991). Human-Centered Aircraft Automation: A Concept and Guidelines (NASA Technical Memorandum 103885). Washington, DC: NASA.

Boff, K., & Lincoln J. (Eds.). (1988). Engineering Data Compendium: Human Perception and Performance (Vols. 1- 3). Wright-Patterson Air Force Base, OH: Harry G. Armstrong Aerospace Medical Research Laboratory.

Booher, H. R. (Ed.). (1990). MANPRINT: An Approach to Systems Integration. New York: Van Nostrand Reinhold.

Cardosi, K. M., & Huntley, M. S. (Eds.). (1993). Human Factors for Flightdeck Certification Personnel (DOT/FAA/RD-93/5; DOT-VNTSC-FAA-93-4). Washington, DC: USDOT/FAA.

Cardosi, K. M., & Murphy, E. D. (Eds.). (1996). Human Factors in the Design and Evaluation of ATC Systems: A Handbook for FAA User Teams. Washington, DC: USDOT/FAA.

Federal Aviation Administration. (1995). The National Plan for Civil Aviation Human Factors. Washington, DC: Federal Aviation Administration.

Meister, D. (1985). Behavioral Analysis and Measurement Methods. New York: John Wiley.

Salvendy, G. (Ed.). (1987). Handbook of Human Factors. New York: Wiley-Interscience.

Sanders, M. S., & McCormick, E. J. (1993). Human Factors in Engineering and Design (7th ed.). New York: McGraw-Hill.

Wickens, C. D. (1992). Engineering Psychology and Human Performance (2nd ed.). New York: Harper Collins.

Wiener, E. L., & Nagel, D. C. (Eds.) (1988). Human Factors in Aviation. New York: Academic Press.