# FAA Flight Standards Human Factors Plan

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# Executive Summary

This plan addresses what each headquarters and field division should do to institutionalize the consideration of human factors in policy development, criteria preparation, process planning, regulatory initiatives, surveillance, analysis, enforcement, hiring of specialists, contracting, and training. The motivation for this is the recognition that human capabilities and limitations provide the foundation for both safety and efficiency in aviation - and therefore, in the FAA Flight Standards Service mission.

A growing global economic climate, rapid technological advances, and other forces are resulting in significant growth and complexity in the aviation system. There is recognition that the current infrastructure is reaching its limits for capacity, so modification and improvements in Communication, Navigation, and Surveillance/Air Traffic Management (CNS/ATM) concepts are being implemented to meet the needs of the changing environment. Current and future aviation operations will continue to rely extensively on human performance, especially with this movement towards future advanced CNS/ATM and the need to improve both capacity and safety performance. Therefore, more thorough consideration of human factors at this point is essential.

FAA Flight Standards Service plays a key role in overseeing and even leading some of these changes. The mission of AFS is to promote aviation safety in the interest of the American public by regulating and overseeing the civil aviation industry. Given the importance of human factors (HF) to aviation safety, AFS has a goal to ensure that human factors will be adequately included in all of its products. This will be accomplished by institutionalizing appropriate human factors considerations in internal organizational operations, external activities, and products such as regulatory and guidance material.

This plan is intended to provide a strategic basis for staffing, resource, and technical applications to institutionalize human factors in AFS. The plan assumes that HF implementation for AFS will be based on: HF/Error management philosophy and policy; a regulatory basis for human factors in the rules and advisory material; including HF in AFS products and processes; and an informed workforce.

The plan provides recommendations in the following areas:

- Error Management
- Regulatory Approach to Human Factors in the Operating Rules
- Training/ Qualification
- Systems Approach for Safety Oversight
- Operations
- Crew Procedures and Information
- Instrument Procedures
- Flight Deck - Air Traffic Services Integration
- Specific Applications/Technologies/Issues
- Field Approvals
- Maintenance
- Accident/Incident Investigation
- Organizational Processes
- Research, Engineering, and Development
- Communication and Coordination

The full plan should be referenced for description of the recommendations, the assumptions on which they are based, and associated resources.

To implement this plan, the recommended next steps are:

1) Prioritize the recommendations and identify what resources will be applied.
2) Solicit feedback from the aviation community, including industry and the international community.
3) Based on this feedback, revise and expand the plan for detailed implementation steps.
4) Incorporate the detailed planning items in appropriate business/performance planning.
5) Carry out the detailed implementation plan with appropriate oversight and monitoring.

In implementing these steps, AFS should consider the current organizational culture and potential barriers in the detailed planning, implementation, and oversight.

# 1. Introduction

The purpose of this document is to provide a plan for the FAA Flight Standards Service (AFS) to institutionalize human factors in the performance of its mission. The motivation for this is the recognition that human capabilities and limitations provide the foundation for both safety and efficiency in aviation - and therefore, in the AFS mission.

The remainder of this introduction describes the current climate for aviation, the mission of AFS and how it is affected by the current climate, the role of the humans involved in the process, and a roadmap to this document.

A number of forces are at work in aviation. A growing global economic climate, rapid technological advances, and other forces are resulting in significant growth and complexity in the aviation system. While there are many changes underway in the National Airspace System (NAS), there is recognition that changes must be considered in the context of the International Airspace System (INAS). There is recognition that the current infrastructure is reaching its limits for capacity, so modification and improvements in Communication, Navigation, and Surveillance/Air Traffic Management (CNS/ATM) concepts are being implemented to meet the needs of the changing environment. Modern aircraft continue to expand the application of automation and new technology onto the flight deck requiring changes in pilot tasks, training and qualification, and procedures. There is also a strong emphasis on improving safety in what is already a very safe system.

AFS plays a key role in overseeing and even leading some of these changes. The mission of AFS is to promote aviation safety in the interest of the American public by regulating and overseeing the civil aviation industry. To fulfill this mission, AFS directs, manages, and executes certification, inspection, and surveillance activities to ensure adequacy of flight procedures, operating methods, airman qualification and proficiency, aircraft maintenance, and the maintenance aspects of continued airworthiness programs. AFS sets certification standards for air carriers, commercial operators, air agencies, and airmen. AFS also manages the systems for registry of civil aircraft and all official airmen records, and manages an extensive program of designees.

The underlying motivation of every action and activity undertaken in AFS is that operating a safe aviation industry is the best means of encouraging civil aviation. Consequently, the general goals are:

1. Enhance the level of safety in U.S. civil aviation by instituting effective and efficient safety regulations and ensuring compliance with those regulations.

2. Promote U.S. leadership in global civil aviation by fostering the world's highest level of safety in the U.S. aviation industry and by fostering international harmonization and cooperation.

In accomplishing these goals, AFS develops a number of end products. These products can be grouped into four major product or service lines. The following list defines each major product or service line and identifies the primary end products under each:

✈ **<u>Standards/Policy</u>:** We establish national aviation policy, procedures, and criteria for the aviation community and work with foreign aviation authorities to harmonize safety standards and policy worldwide. We direct, manage, and support the FAA's rulemaking activities and the Aviation Rulemaking Advisory Committee (ARAC). This is accomplished through the following end products:

- Federal Aviation Regulations (FARs)
- Supporting Criteria (e.g., Advisory Circulars (AC), Aeronautical Information Manual (AIM), Practical Test Standards (PTS))
- FAA Directives
- Bilateral, Multilateral, and International Agreements (e.g., International Civil Aviation Organization (ICAO), Joint Aviation Authorities (JAA) Coordination)

✈ **Certification:** We apply safety standards and policies to the aviation community and establish compliance with the standards and policies. This is accomplished through the following end products:

- Airmen Certification (Licensing, Medical)
- Operator Certification
- Operations Approvals
- Airworthiness Certification (e.g., maintenance, Supplemental Type Certificate (STC))

✈ **Surveillance:** We monitor continued compliance with standards and policy and initiate corrective actions when required. This is accomplished through the following end products:

- Inspections/Evaluations/Audits
- Compliance/Enforcement Actions
- Accident Investigations

✈ **Mission Support:** We conduct aviation safety awareness training; we collect and disseminate safety-related and other aviation-related data and material, and we provide analyses of that data; we scientifically study and investigate aviation-related issues, and we promote and sponsor such research. Mission support is provided through the following end products:

- Information
- Education
- Technical/Professional Training
- Research

It should be noted that these lines are not necessary mutually exclusive. For example, the certification of a new operator is not significantly different from the ongoing surveillance of that operator once its operating certificate has been granted.

On the one hand, we recognize that current and future aviation operations will rely on human operators, especially with the movement towards future advanced CNS/ATM. Thus a safe aviation system is dependent on the capabilities and performance of the humans in that system. On the other hand, human performance is continually cited as a major factor in most accidents (Ref.1). Therefore, the limitations of human performance are a key consideration in maintaining or improving aviation safety.

Given the importance of human factors (HF), AFS has a goal to ensure that human factors will be adequately included in all its products. This will be accomplished by institutionalizing good human factors considerations in internal organizational operations, external activities, and products such as regulatory and guidance material.

The FAA Human Factors Team report on: The Interfaces Between Flightcrews and Modern Flight Deck Systems (Ref. 2) identified a number of recommendations for the implementation of human factors in the aviation community. The recommendations that are relevant to AFS are considered here, but that report addressed existing modern, large transport aircraft and their operations. This Plan is broader in the type of aircraft and operations to which it applies; it focuses on all aircraft and operations for which AFS has regulatory responsibility. This plan also incorporates safety interventions recommended in the implementation plans from the Safer Skies program.

The Flight Standards Human Factors Plan addresses areas in all AFS divisions where improved application of knowledge about human behavior and human performance may improve regulatory processes and products for improved aviation safety. To improve safety, measures must be implemented in all operational areas, including training/qualification, procedure development, airworthiness, and other areas that directly involve human performance.

**Plan Objectives**

The overall objectives of this plan are:

- Describe the error management philosophy that should used as the basis of AFS' implementation of human factors, with the intent to provide a basis for FAA's/industry's error management policy. As part of this, address the management of non-compliance with procedures.
- Evaluate the current and desired role of human factors in the regulations, with particular attention to the operating rules and make recommendations about what changes should be made to incorporate HF appropriately.
- Review (or plan for review of) current and planned division programs for HF issues - provide feedback to/on those programs from a HF perspective.
- Since AFS has the responsibility for most aircraft related CNS/ATM operating regulations and guidance material, lay the foundation for how AFS will include HF considerations in performing its mission related to the significant changes that are expected in CNS/ATM and other new technologies.
- Review the FAA HF Team Report implementation, and address those recommendations that are within the scope of this plan.
- Address HF in AFS accident/incident reviews.
- Address the AFS workforce's general HF knowledge/skills, and availability of specific HF expertise to AFS.
- Address HF research requirements for AFS related programs.
- Encourage industry to implement good practice in applying HF to design, training/qualification, procedures, etc.

To achieve these objectives, each area considered in the plan for HF application does the following:

- Address known human-performance related vulnerabilities
- Prevent/minimize human performance vulnerabilities and improve efficiency through systematic application of knowledge about human behavior and human performance in regulation, guidance, policy, and criteria related to AFS' mission in design, qualification (training, checking, and recency of experience), procedures, and provision of information
- Monitor and evaluate operations, training, and other application of the regulatory products to ensure that HF is being effectively applied.

The plan assumes that institutionalizing HF will be based on:

- Error management philosophy and policy,
- A regulatory basis for human factors in the rules and advisory material,
- Including HF in AFS products and processes, and
- An informed workforce. This includes human factors specialists, a general level of knowledge of HF in all of the appropriate workforce, and tools and methods that support them.

This plan is intended to provide a strategic basis for staffing, resource, and technical applications to institutionalize human factors in AFS. It describes what should be done, independent of organizational structure or resource constraints. It is based on functions, rather that specific organizational entities. It does not provide specific timelines and milestones, because a specific schedule is dependent on the resources applied.

The plan does include resource estimates in terms of the AFS personnel that would be required to accomplish a recommended action. Resource estimates are rough and in all cases should be revised based on more detailed planning.

The recommendations in this section were derived from a variety of sources. These include, for example:

- the analysis of operations and training performance data (Aviation Safety Action Program (ASAP), Flight Operations Quality Assurance (FOQA), Advanced Qualification Program (AQP)),
- the recommendations of National Transportation Safety Board (NTSB) and General Accounting Office (GAO) reports,
- previous agency studies (such as the FAA Human Factors Team report),

- Safer Skies recommendations,
- coordination with airline and Airline Transport Association (ATA) training and safety personnel,
- coordination with pilot unions, and
- Communication with FAA field personnel.

Human factors principles must become imbedded into the scientific, engineering, and operational methods normally used to develop all AFS products. This means ensuring from the start on all activities have proper application of HF principles in a supportive, constructive manner. This requires a workforce that has both general and specialized expertise in this area.

To be successful, the entire AFS workforce must accept these principles and be willing to include them in their routine tasks. It will require an equally strong commitment from all levels of AFS management in order to make it work. Training and reference material must be developed and made available to all AFS employees to assist with these efforts.

The remainder of this document presents the plan with recommended actions. It first discusses what human factors is, then introduces the area of error management, with associated concerns for an error management policy in AFS. Section 3 provides a description of topics where HF should be applied in AFS, with associated recommendations. Section 4 discusses AFS organizational processes, Section 5 discusses Research, Engineering, and Development; Section 6 discusses communication and coordination with other organizations within and outside the FAA; and Section 7 gives guidance for implementation of this plan.

Each of the recommended actions is classified as Strategic or Tactical. The strategic recommendations are those with long-term implications, providing a foundation for integrating human factors into AFS. These recommendations may be less detailed than some of the others, and may require more detailed planning for their implementation. The tactical recommendations tend to be more specific or defined in detail.

The staffing resources associated with each recommendations are classified into initial and ongoing (resources will need to be applied on an ongoing basis). Many of the recommendations are one-time activities and will not require ongoing application of resources, once the initial task is complete.

# 2.0 Human Factors and Error Management Philosophy

Human Factors involves the application of knowledge about human capabilities and limitations to design, training, personnel selection, procedures, and other areas. Human capabilities and limitations can be categorized in many ways, with one example being the SHEL model (Ref. 5). This conceptual model describes the components *Software, Hardware, Environment, and Liveware.* The SHEL model is described in more detail in Appendix A, but it can be briefly summarized as involving the human in particular, with all the characteristics; the interface between the human and other humans; and the interface between the human and the Hardware (equipment) and Software (procedures, checklists, etc.). This plan considers all these aspects of HF and their application to AFS activities.

## *2.1 Human Error*

An important area where human factors can be effectively applied to address safety is in the consideration of human error. In many accidents where human error is cited, the human operator is blamed for making the error; in some countries the human operator is assigned criminal responsibility, and even some US prosecutors seem willing to take similar views. While the issue of personal responsibility for the consequences of one's actions is important and relevant, it also is important to understand why the individual or crew made the error(s). In aviation, with very rare exceptions, flight crews do not intend to make errors, especially errors with safety consequences. To improve safety through understanding of human error, it is more useful to address errors as *symptoms* rather than *causes* of accidents. The next section discusses understanding of error and its management, then suggests some actions that might be constructive.

### 2.1.1 Understanding Errors

Human error is a normal byproduct of human behavior. Therefore, it is important for the aviation community to recognize that errors cannot be completely prevented. Given this fact, understanding differences in the types of errors is valuable because management of different types requires different strategies.

Human error can be divided into two basic categories (Refs. 3 and 4) (a) those which presume the intention is correct, but the action is incorrect, (including ***slips*** and ***lapses***) and (b) those in which the intention is wrong (including ***mistakes*** and ***procedural noncompliance***).

***Slips*** occur when one or more incorrect actions are performed, such as in a substitution or insertion of an inappropriate action into a sequence that was otherwise good. For example, setting the wrong altitude into the mode selector panel when the correct altitude is known and was known and intended.

***Lapses*** are the omission of one or more steps of a sequence. For example, missing one or more items in a checklist that has been interrupted by a radio call.

***Mistakes*** are errors where the human did what he or she intended, but the planned action was incorrect. Usually mistakes are the result of an incorrect diagnosis of a problem or a failure to understand the exact nature of the current situation. The plan of action thus derived may contain very inappropriate behaviors and may also totally fail to rectify a problem. For example, a mistake would be shutting down the wrong engine as a result of an incorrect diagnosis of a set of symptoms.

***Procedural noncompliance*** errors are the failure to follow established procedures or performance of actions that are generally forbidden. These errors are generally deliberate (and often well meaning), though an argument can be made that some cases can be inadvertent. An example of procedural non-compliance is pressing on with a landing even when sight minima have not been met before final approach. Some researchers call these errors "violations," but it should be mentioned that they might not necessarily be in violation of a regulation or other legal requirement.

It was mentioned earlier that management of different types of errors might require different strategies. For example, training is often proposed as a strategy for preventing errors. However, errors are a normal byproduct of human behavior. Data from thousands of flights monitored under the LOSA (Line Operational Safety Audit) program shows that the average number of operational errors for air carrier operations is slightly more than two errors per flight. While training can help reduce some types of errors, they cannot be completely trained out. For that reason, errors should also be addressed by other means, and considering other factors, such as the consequences of the error or whether the effect of the error can be reversed. As an example of using design to address known potential errors, certain switches in the flight deck have guards on them to prevent inadvertent activation.

### 2.1.2 Error Management

Error management can be viewed as involving the tasks of error avoidance, error detection, and error recovery (Refs. 6 and 7). Error avoidance is important, because it is certainly desirable to prevent as many errors as possible. Error detection and recovery are important, and in fact it is the safety consequences of errors that are most critical.

Some of the lessons learned about errors and their management that experienced human operators have developed skills for performing error management tasks. For example, expert pilots tend to disregard errors that have no consequences for the tasks underway. In fact, detection and recovery from errors is considered to be a true manifestation of expertise. Therefore, it is possible that design, training, and procedures can directly support these tasks, if we get a better understanding of those skills and tasks. However, understanding of those skills and tasks is far from complete.

There is international recognition of the importance of this area. Many airlines in the US and Europe are providing training to their flight crew in error management. ICAO has also recognized the importance of this area and has fostered it in its recommendations for training. AFS can build on those pioneering efforts and that experience.

### 2.1.3 What Should Be Done about Human Error?

This section includes some recommendations for dealing with error as part of the execution of the AFS mission.

**Stop the blame** that inhibits in-depth addressing of human error, while appropriately acknowledging the need for individual and organizational responsibility for safety consequences. Blaming the pilot (or maintainer, or dispatcher...) for errors has many consequences, and provides a disincentive to report errors. Yet such reports are extremely important to help understand where safety improvements should be made. However, the enforcement responsibilities of the FAA must be balanced against the detrimental effect that placing blame entails. The Administrator has issued policy statements encouraging the airlines to adopt FAA-sponsored programs that revolve around the voluntary reporting of errors (ASAP, FOQA, etc).

**Evaluate errors in accident and incident analyses.** In many accident analyses, the reason why an error is made is not addressed. This happens because the data are not available, as well as for other reasons. However, to the extent possible with the data available, the types of errors and reasons for them should be addressed as part of the accident investigations. As an example of a way this could be done, Ref. 7 proposes a taxonomy for categorizing errors that contributes to this understanding, when applied in accident investigation. The purpose should be to treat errors as symptoms, rather than causes of accidents. Consideration also should be given to the possible biases introduced by hindsight (Ref. 9).

### *2.2 Error Management Policy*

**Recommendation Error-mgt-1: Develop an error management policy to be the foundation of AFS' application of HF into its processes and products. Develop guidance for the workforce on how this policy will apply, because it will require AFS personnel to acknowledge that not all errors can be prevented and to balance error tolerance with enforcement responsibilities.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | 0.25 HF, 0.25 other | 0.125 |

Error management/mitigation should be a fundamental part of everything the FAA and industry does. AFS should ensure that error management is consistently applied in all of FAA policy, criteria, guidance, and actions.

An important example of the benefits of such a policy/approach can be taken from the introduction of the ASRS (Aviation Safety Reporting System). The ASRS program initiated the concept of encouraging pilots to voluntarily report safety violations that might be otherwise undiscovered, with the understanding that such self-reporting would provide some degree of protection from enforcement action on the part of the FAA. The decision was made that only "egregious" violations would lead to enforcement action (actions that were intentional, criminal, involved drugs or alcohol, etc.). This program was so successful that the exchange of limited protection from enforcement action for otherwise-unavailable safety data has been expanded to include additional programs, most notably ASAP and FOQA.

The success of this type of program is illustrated by the over 20,000 ASAP reports analyzed and processed by the FAA and airline personnel American Airlines over the last six years. According to data published by the airline, 99% of these ASAP reports contain safety concerns for which the self-report was the sole source of data for the safety issue. That is, the "standard" oversight systems maintained by the FAA and the airline management detected only 1% of these potential compromises to safety. This is a convincing argument for the FAA endorsement of similar safety programs.

There is data from the insurance industry that organizations that have such policies and approaches are safer. It takes time for such programs to have an effect on safety, so the sooner they are started and disseminated, the better. There are already significant activities in other parts of the world

In AFS, this policy should be applied by every organization. It should be implemented through guidance in the inspector's handbook, possibly including a checklist for inspectors. Changes to handbooks should be coordinated with industry. Any appropriate changes to orders, such as Order 2150.3, should be implemented. Training and education on the guidelines developed will be needed for management and the inspector workforce. Indoctrination and recurrent training for the workforce should include this material. For this to be successfully implemented, inspectors must feel comfortable that management will back them up. This may require a culture change in many offices and for many individuals.

# 3. Topics for Human Factors Application Within AFS

To determine where HF should be applied in the AFS mission, known and anticipated activities and programs within AFS were considered. Several of the topics, technology areas, and programs were reviewed as time permitted. The recommendations for applying HF to the programs that were reviewed are described below. These recommendations address three broad categories:

- Known vulnerabilities: recognized and well-documented problems (e.g., pilots' difficulties learning and using automation).
- Prevention: avoiding or minimizing future problems (e.g., tailoring training programs to the declining experience level of the pilot population).
- Monitoring and evaluation: to determine the success of ongoing training and flying operations, to include measuring the effects of safety interventions and activities, or new technologies (e.g., FOQA data).

In looking at each of these broad categories for a particular topic, the planning team addressed the following questions:

- Regulation/Advisory Material: What guidance must Flight Standards develop for industry, and how should HF be applied?
- Handbooks/Training/Information for the Workforce: What guidance must Flight Standards develop for its own personnel?
- Research: What Research, Engineering & Development (RE&D) activity must the FAA sponsor or conduct to develop the information needed to provide the required FAA and industry material?
- Industry Standards: What industry organization, process or document should the FAA work with to address this topic?
- Coordination with other Organizations: What FAA organization, process or document must the FAA work with to address this topic?

Specific actions are recommended below to address HF in the reviewed programs and activities. Recommendations also are made below for those AFS programs for which a review was not yet conducted.

In addition to the specific actions just mentioned, recommendations are made to address the need for ongoing monitoring, review, and participation in AFS activities. Examples include (but are not limited to) participation in regulatory projects and ICAO committees, membership on appropriate Integrated Planning Teams (IPT), industry standard development, oversight of R, E & D activities, and consultation on various topics.

## *3.1 Regulatory Approach to HF*

**Recommendation Reg-1: Review relevant existing material (operating rules, advisory material, policy, and related references) and make recommendations about what regulatory standards and/or advisory material should be updated to consistently address human performance vulnerabilities, and prevention and management (detection, tolerance, and recovery) of human error. This should apply to criteria for flight crew, maintainers, dispatchers, and flight attendants.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | 6 people 3 months each (2 HF, 4 other) | |

*This may be an underestimate of resources - evaluate when detailed implementation planning is done.*

An ad hoc review team should be formed with appropriate technical expertise to review and address the role of HF in the operating rules (relative to the airworthiness rules), and the balance of HF in CFR Parts 61, 91, 121, 135, etc. Recommendations for changes should reflect the error management philosophy and policy described in earlier recommendations.

One reason this review is important is because HF is addressed differently in different parts of the regulations. Clearly training/qualification and operational approvals are part of the operating rules, and the task recommended above should consider changes based on the recommendations in later sections.

Approval of equipment design raises more questions. The airworthiness regulations do not (and are not intended to) address all aspects of equipment design, except as it is related to airworthiness of the aircraft. But there are likely to be HF issues associated with the crew interfaces. For example, the FAA is receiving application for approval of Electronic Flight Bags (EFB). If the EFB is not connected to the airplane, then the provisions of Part 25 do not apply. However, the HF aspects may be important to the operational approval. Thus it will be important to identify what aspects of HF should be addressed as part of the operating rules and what should be in the airworthiness rules.

Include participants from industry, Aircraft Certification, ATS, etc.

### *3.2 Pilot Training/ Qualification - General Aviation & Air Carrier*

#### 3.2.1 General Aviation (GA)

**Recommendation GA-Training1: Identify GA training requirements involving human factors.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | ✓ | ✓ | 0.25 | |

An ad hoc review team should be formed with appropriate technical expertise to review relevant Practical Test Standards (PTS) references, ACs, and the GA inspector's handbook, to develop a plan, identify resources needed and schedules to address HF considerations in these references.

Examples of GA HF related issues to address:

- Error management skills for GA pilots – This should emphasize topics involving a group of accidents/incidents that have remained on the GA "hit parade" since aviation began. Examples:
  - Fuel exhaustion
  - Stall/spins
  - Scud running
  - Emergency landings
- Providing guidance on getting good weather info and making good decisions with that information. This should address practical aspects of use of the current sources pilots now have reference getting weather information.[1]
- Safer Skies GA Weather JSAT Recommendation 2 emphasizes the need to provide for better training materials and programs with updated practical guidance on weather hazard risk assessment, avoidance, and recovery.
- Addressing Airborne Emergencies (e.g., Lost, Deteriorating Weather, or Engine Failure - finding safe or safest landing areas. It is now possible to better address the human factors of in-flight emergencies.[2]

[1] For example, sources include TV's weather channels, the internet, local weather radar TV imagery, ATIS, Pilot Reports (PIREPS) from pilots just having flown in the weather, weather data contractors, international sources, uplink of weather information to an aircraft, etc. AFS should appropriately address the modern weather related role of Flight Service Stations (FSS). Do not overstate or understate it. Note: Simply reiterating the historical view that only FSS based weather or DUATS (Direct User Access Terminal System) provide valid weather for use for aviation operations is unrealistic, because other good sources of data are available. Many users do not depend on the FSSs to the same extent as previously for pre-flight weather.

- Human error data collection – establishing a central collection point of new human error information as well as studies and research already conducted. Analysis of studies past can aid in determining training requirements.
- GA training syllabi are not based upon task analyses that specify training needs – an application of human factors principles
- Training on the use of new technology is not required under Part 91 and, currently the format and reading level of the accompanying manuals are written more toward the understanding of the technician rather than the pilot.
- Safer Skies GA CFIT requires the actions of a GA Safety Council to coordinate training and educational programs on terrain avoidance. Deliverables include effectiveness measuring and providing pilot incentives. These require human factors considerations.
- Personal minimums in general risk, mission completion, and mountain flying are planned products of Safer Skies GA CFIT interventions. These deliverables are dependent on sound human factors guidance.
- Safer Skies GA Weather interventions include the development of a Model Flight Operations Manual. This will be researched and prepared primarily by specialists in GA human factors.

An HF review should consider what could practically be done in this area, and how to best provide FAA criteria or industry incentives to help improve capability in this direction.

**Recommendation GA-Training-2: For aircraft requiring type ratings, analyze the current state of Flight Training Devices (FTDs) to determine the range of their capabilities and to determine their effectiveness in training. From this information, establish an increasing range of credit for which various FTDs or simulators may be used in lieu of actual flight. This information would be used to update regulations and guidance material, which currently may not apply appropriate credit allowances or incentives for various FTDs or simulators.**

**For small aircraft, analyze current personal computer (PC) simulation devises to determine the range of their capabilities and effectiveness in training. From this information, establish if credit can be given toward pilot currency and/or certification requirements.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | | ✓ | 0.25 | |

Credit information would be used to update regulations and guidance material, which currently applies the same credit allowance to all FTDs, regardless of their differences.

**Recommendation GA-Training-3: Develop and implement scenario-based weather training and testing to develop pilot weather judgment and decision making skills.** *(Safer Skies GA Weather JSIT, Program 11)*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | | ✓ | 0.25 | |

Some of the discussions leading up to this intervention focused on the need for simulation devices that provide pilots with a realistic simulation of flight into adverse environments.

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[2] Given current technology and capability (i.e., FMS, GPS, Electronic Flight Instrumentation System (EFIS) Map, and RNP), it should be possible to provide better pilot situation awareness to better respond to in-flight emergencies such as engine failure in Single Engine aircraft. This is still a major source of fatalities, and is increasing in importance as more single-engine aircraft fly at night and in serious IFR.

- Developing scenario based weather training and testing – guidelines for determining appropriate content, realism and effect require human factors research and expertise
- Delivering - techniques are not known to most trainers in industry and guidance must be provided

**Recommendation GA-Training-4: Investigate the use of innovative training tools and methods to expand pertinent safety related knowledge of pilots on a continuing basis. The FAA and the aviation community should explore incentives to encourage continued training and education beyond the minimum required by the current regulations.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | ✓ | | 0.25 | |

Except for those operating large or turbine aircraft, Part 91 operators are not required to seek training other than in furtherance of a certificate. Training, therefore, occurs primarily on a voluntary basis. The challenge of continuing education for GA is dependent upon a constant source of new and appropriate information. Little is know among the general pilot population about human factors, and we need guidance on how, when, and where to present that information.

GA pilots are often just coming of age as they begin to face the human factors involved with increasing technology. Situation awareness, decision-making, and error management can all become easier with technology; however, many are still in that transition period when technology is more a hindrance than help. Just as there remains a mix of skills in the use of new/old technology, there is increased traffic flow. We have no choice but to meet or obligation for creating venues for continuing education.

**Recommendation GA-Training-5: Investigate the further revision of Practical Test Standards and Testing Materials to ensure appropriate treatment of human performance related subjects and safety knowledge of pilots, instructors, inspectors and designees.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | ✓ | | 0.25 | |

### 3.2.2 Air Carrier

The most significant safety challenge to air carrier training over the next decade is the need to train an increasingly inexperienced workforce to fly in an increasingly complex aviation environment. Human Factors considerations have and will continue to play a vital role in addressing this challenge.

**Recommendation Air-Carrier-Training-1: Update Regulatory/Guidance Material. Ensure the rewrites and updates of all training rules and guidance for both industry and the FAA will include appropriate HF considerations.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200 | ✓ | ✓ | 2 HF, 3 other | |

Guidance for industry in located primarily in CFR 14, Parts 61, 63, 65, 108, 121, 135 & 142, in Advisory Circulars 120-28, 29, 31, 33, 35, 40, 41, 42, 45, 50, 51, 53, 54 55, 57, 58, 62, 67 & 71, and in the Practical Test Standards (FAA-S-8081-5C). Guidance for FAA is located primarily in FAA Order 8400.10 (Aviation Safety Inspector's Handbook) and FAA inspector training programs. Ensure rewrites and updates include adequate industry coordination and input.

**Recommendation Air-Carrier-Training-2: Automation and Cognitive Skills. Improve training and safety of operations in the areas of automation management and cognitive skill development.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200 | ✓ | ✓ | 0.25 HF, 0.25 other AFS | |

- Provide suitable training and evaluation of cognitive skills (e.g., PTS, AQP criteria).
- Investigate and develop more effective methodologies for training/evaluation of automation skills and knowledge.
- Improve methods for identifying skills and knowledge required for effective automation management.
- Develop improved human performance models for understanding effective automation management.
- Develop improved guidance and task analysis methodologies for automating training/evaluation.
- Review requirements for basic airmanship skills, and the maintenance of those skills when flying automated aircraft.
- Investigate effects that modern automated aircraft and operations may be having on the hands-on skills of pilots, and on situation awareness, during normal and non-normal operations.

**Recommendation Air-Carrier-Training-3: Flight crew and Dispatcher training. Improve HF aspects of crewmember and dispatcher training and qualification programs. Encourage CRM, HF and Error Management training programs for both industry and FAA personnel.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200 | ✓ | ✓ | 0.5 HF, .5 other AFS | |

- Facilitate industry development of error management training for flight crews, dispatchers, management and other operations personnel.
- Identify error management considerations for FAA personnel (e.g. inspectors) related to their oversight responsibilities for operators.
- Ensure the effectiveness of the HF aspects of Line Oriented Simulation (LOS) training and checking activities
- Incorporate HF considerations into addressing the declining experience levels of certain elements of the pilot population.
- Ensure the incorporation of HF considerations into instructor/evaluator calibration training and evaluation.
- Develop improved guidelines for matching pilot entry capabilities and experience to training requirements and content. Consider the significantly different operating environments that may exist within an airline, or between different kinds of operations.
- Validate HF crewmember training effectiveness through the line oriented safety audit (LOSA) program.
- Facilitate the integration of CRM, cognitive skills and technical skill performance in crewmember and dispatcher training programs.
- Encourage the development of task-analysis based training programs for crewmembers and dispatchers, to include the integration of technical, CRM and cognitive tasks.
- Provide HF related incentives to spur use of innovative training tools and methods.
- Provide incentives and alternative methods for flight crews to gain or maintain experience in critical or difficult takeoffs and landings, as well as critical arrival and departure procedures that are infrequently used.
- Reassess the HF aspects of recency of experience requirements for flight crews.
- Determine the extent to which training in HF and CRM transfer to alter flight deck performance.

**Recommendation Air-Carrier-Training-4: Simulation. Improve the effectiveness of simulated flight, both simulators and simulations, in crewmember training, qualification and evaluation.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200 | ✓ | ✓ | 0.25 HF, 0.25 other | |

- Update simulator and flight training device (FTD) fidelity requirements for pilot training, qualification and evaluation.
- Develop guidance for optimizing simulator and FTD fidelity requirements for training and checking.
- Improve simulator and FTD evaluation criteria by investigating the relationship between key simulator and FTD features and capabilities, and the quality of subsequent learning transfer to pilot performance in actual aircraft flight.
- Develop standard methods and criteria to more effectively and efficiently generate LOS scenario event sets.

**Recommendation Air-Carrier-Training-5: Data Tools and Integrity. Improve the sensitivity, validity, reliability and usability of crewmember and dispatcher performance data. Facilitate industry/FAA data sharing,**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | ✓ | 0.25 HF, 0.25 other | |

- Develop procedures and software tools to improve measurement and monitoring of performance data quality for crewmembers and dispatchers, as well as their instructors and evaluators.
- Integrate performance data from various air carriers and FAA performance databases (AQP, FOQA, etc.) for a more complete characterization of training and operational performance.
- Integrate FAA training and performance databases (e.g. AQP) into ATOS.
- Develop data quality assessment tools.
- Develop uniform data-driven quality control tools.
- Develop data-driven curriculum maintenance methodologies.
- Integrate quantitative and qualitative performance assessment methods and data.
- Develop databases to support the development and maintenance of task-based training systems.
- Collect data on the effectiveness of current flight crew training programs

Coordinate with AFS-800, ATA Training Committee, RAA, ATA HF Committee, ATA Automation Subcommittee, ATA AQP Working Group, ATA AQP ISD Focus Group, ATA AQP Data Management Focus Group, ATA AQP LOS Focus Group, ATA AQP Instructor/Evaluator Focus Group, and ATA AQP CRM Focus Group

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Material to be considered for retention:

**Recommendation Air-Carrier-Training-1: Ensure the rewrite of CFR Part 121 Subpart N&O includes appropriate HF considerations and has adequate industry input (i.e., as part of the ARAC process).**

**Recommendation Air-Carrier-Training-3: Reassess HF aspects of recency of experience requirements for flight crews involved in flight operations. Consider providing incentives and**

**alternative methods for flight crews to gain or maintain experience in critical or difficult takeoffs and landings, and critical arrival and departure procedures that are infrequently used.**

Resources: 0.25 HF

**Recommendation Air-Carrier-Training-5: Ensure that flight safety and training managers are appropriately educated about human factors considerations, particularly with regard to automation.**

Resources: 0.125 HF

**Recommendation Air-Carrier-Training-6: Support investigation of the use of innovative training tools and methods to expand pertinent HF related safety related knowledge of flight crews on a continuing basis. The FAA and the aviation industry should explore incentives to encourage continued training and education beyond the minimum required by the current regulations.**

Resources: 0.125 HF

This should be done through Research, Engineering and Development efforts and other mechanisms as appropriate.

**Recommendation Air-Carrier-Training-7: Consider the potential need for other HF related RE&D activities in areas to improve current training.**

Resources: 0.5 HF for requirement definition and oversight.

Support research to determine the extent to which traditional FAR 121 (including "Single Visit") and various AQP programs are effective, or may be further improved. Support research to find ways to potentially simplify AQP administration provisions. Support research to recommend ways to revise criteria or enhance FAR 121 subpart N and O programs to still get "AQP like" benefits, but with less administration burden and complexity (e.g., to allow more timely and widespread implementation).
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### *3.3 System Approach for Safety Oversight*

Background: The FAA is in the process of transitioning to a Systems Approach to Safety Oversight (SASO) model, wherein the collection and analysis of performance data by both airline and FAA personnel becomes an increasingly critical foundation for certification and surveillance activities.

The aviation industry today is characterized by emerging and rapidly changing technologies, increased operating complexity, rapid growth in commercial and general aviation air traffic volumes, and changes in the composition of the air transport fleet.[3] In conjunction with these changes, the National Airspace System (NAS) is undergoing sweeping changes of its own as it moves to implement the concepts and capabilities of the Free Flight paradigm

The accelerating pace of innovation in the aviation industry is placing unprecedented strain on Flight Standards' ability to achieve the Safety Mission as well as its ability to promote the safe growth of aviation within the National Airspace System. To reduce aviation accident rates in today's modern, technology-driven aviation environment, a compliance-only approach to oversight is no longer sufficient. AFS must

[3] Recent trends in the air carrier industry include outsourcing of aircraft maintenance and pilot training, use of unproven safety practices by emerging carriers, and rapid innovation in aircraft types, engine types, and avionics equipment. These and other changes are increasing the demands placed on safety inspectors.

institute a compliance-plus program for oversight that makes efficient use of increasingly limited resources to identify and mitigate risks.

The FAA began to implement a series of oversight strategies, based on the collection and analysis of various forms of compliance data by FAA personnel. These programs include the Certification Standardization Evaluation Team (CSET), ATOS and the Safety Performance Analysis System (SPAS). These programs are being integrated with the Systems Approach for General Aviation (SAGA), as an AFS solution towards system safety oversight of aviation.

The System Approach for Safety Oversight (SASO) operational concept will not change Flight Standard's underlying mission of certification, surveillance, investigation, and enforcement. The systems-based concept for oversight is a multidisciplinary approach emphasizing cooperative problem solving and proactive identification and mitigation of risk. It will achieve this using a well-trained workforce equipped with reengineered business processes, comprehensive safety data, and sophisticated analytical tools and models working in an automated environment. A principal component of this approach is the integration of AFS' oversight and analysis processes.

AFS has a needed capability to develop a system safety model to identify and manage risks, and to eliminate accident causal factors in the aviation industry. This requires that AFS develop and acquire new certification and surveillance data, linked data repositories with comparable data records and formats, new analysis and risk assessment tools to identify risks and target inspector resources, and training programs. Within this framework, AFS must also integrate human factors considerations, promote information sharing with the aviation community, and allow for continuous improvements that keep pace with and utilize advances in technology.

**Recommendation In-service-data-1: Publish Flight Operations Quality Assurance (FOQA) final rule (14 CFR part 13). Update Flight Operations Quality Assurance (FOQA) Advisory Circular to match final rule. Publish Protection of Voluntarily Submitted Information final rule (14 CFR part 193)**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200/900 | | ✓ | 0.25 | |

**Recommendation In-service-data-2: Provide 8400.10 Handbook guidance to match final FOQA rule and Advisory Circular. Provide 8400.10 Handbook guidance to match final Protection of Voluntarily Submitted Information rule.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200/900 | | ✓ | 0.25 | |

Resources: 0.25 HF

**Recommendation In-service-data-3: If an advisory circular is developed providing industry with guidance on data management techniques, address any relevant HF aspects of that circular.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200/900 | | ✓ | 0.5 | |

**Recommendation In-service-data-4: If an advisory circular is developed providing industry with guidance on data management techniques, provide suitable HF related 8400.10 Handbook guidance.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200/900 | | ✓ | 0.25 | |

**Recommendation In-service-data-5: Conduct an HF related assessment of AQP/ASAP/FOQA data and performance monitoring tools within the Flight Standards Services Air Transportation Oversight System (ATOS) and the current Aviation Performance Measurement System (APMS) Program, and make recommendations for any necessary changes.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200/900 | | ✓ | 0.25 | |

The FAA intends to (1) continue ongoing efforts to integrate various related Flight Standards Services databases, and (2) begin to integrate those other databases into the ATOS process.

Coordinate activities among AFS-200, AFS-300, AFS-800 and AFS-900. Continue to coordinate data issues with the ATA Training Committee, Advanced Qualification Program Working Group, and Data Management Focus Group

### *3.4 Operations*

**Recommendation Ops-1: With assistance from groups (such as ATA, NATA, and RAA, NBAA and other industry representative groups as appropriate), review key lists of active issues/programs to be sure that any FAA related HF aspects of each are being appropriately supported or addressed by FAA.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | 0.25 | |

Examples may include application of new technology in ways that differ from, and may conflict with, the air carriers.

**Recommendation Ops-2: With key FAR121 aircraft and avionics manufacturers' assistance (e.g., Boeing, Airbus, Bombardier and Embraer) review the respective manufacturers' lists of key active issues/programs relative to new transport aircraft types, and ensure that any FAA related AFS HF aspects of those programs are being appropriately addressed.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200 | ✓ | | 0.25 | |

Examples of issues may include Airbus' second generation FMS, FANS (Future Air Navigation System) A and B, datalink incorporation in the American Airlines B767, and planned tests; and Automatic Dependent Surveillance - Broadcast (ADS-B) implementation.

**Recommendation Ops-3: With key FAR135 aircraft and avionics manufacturers' assistance (e.g., Cessna, Raytheon, Gulfstream) review the respective manufacturers' lists of key active issues/programs relative to new commuter or regional jet aircraft types, and ensure that any FAA related AFS HF aspects of those programs are being appropriately addressed.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | 0.25 | |

For example, issues may include: large numbers of regional jet operations are being integrated into the INAS, implementation of datalink communication, RNP, modernized icing provisions, and increasing single-engine single-pilot commuter IFR (Instrument Flight Rules) operations.

**Recommendation Ops-4: Conduct a review of HF aspects of pertinent AFS division efforts (-200, -300, -400, -600, -900) for any air-carrier-related efforts/activities. Include at least the following programs as a start:**

- **Runway incursion reduction**
- **Flight and duty time criteria update**
- **LAHSO and "near airport" system errors response**
- **HF aspects of programs related to use of Landing Systems (xLS, GPS Landing System (GLS)) or area navigation (RNAV), VNAV or Required Navigation Performance (RNP) procedures, training, and avionics.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | ✓ | 1 | |

**Runway Incursions or Near-Airport Operations**

For runway incursions or near-airport operations, ensure HF consideration of at least the following issues or considerations:

- Difficulty with communications
- Communication Clutter (e.g., frequency congestion)
- Inappropriate clearances (speeds, altitudes, runway exits)
- Communication Complexity (e.g., excessive information to remember)
- Airport configuration design
- Aircraft design (MAP displays, internal lighting, visual polars)
- Airport lighting and marking (e.g., lack of standardization)
- Position awareness
- Conspicuousness of aircraft (external lighting)

**Flight & Duty Time**

Support FAA's re-consideration of an approach to Flight & duty time criteria that is increasingly based on scientific HF concepts and principles, rather than principally on negotiated fixed limit values. Coordinate with other authorities and industry (e.g., Operators, aircraft manufacturers, pilot groups).

For Flight & duty time, ensure HF consideration of at least the following issues or considerations:

- Review historical, NASA/literature, and FAA current efforts as an initial basis.
- Determine what is being done internationally (e.g., innovation elsewhere)
- Consider including in any proposals an alternative of goal oriented criteria rather than simple time limits. (e.g. an approach considering progressive fatigue, duty periods, back of clock operations, trip sequences, flight departure times, effective rest, and crossing multiple time zones. Address potential effects of bid lines, crew pairings, cross month effects, reserve duty, in-flight rest, personal fatigue judgement or assessments, and other related factors.

- Develop flight and duty provisions to permit either classic fixed generic time limit values (albeit updated), or flexible Operator developed and Op-Spec approved methods.
- Ensure consistency with new planned long range aircraft.
- Ensure consideration of "Micro Sleep" and other mitigation techniques
- Consideration of environment (e.g., criticality of instrument flight procedures)
- Consideration of crew procedures
- Consideration of Flight deck design/interface
- Consideration of Operational requirements (e.g., response to Extended Twin Operations diversion)
- Consideration of ATS procedures/requirements (density or intensity)
- Consider environment/facility availability or provision requirements

**Other HF Related Specific Topics**

Consider FAA's potential need to address HF related subjects such as:

- The increasing incidence of in-flight diversions and the HF factors expected to affect an air carrier's diversion decisions (e.g., medical emergencies in large aircraft).
- Growth in numbers of regional aircraft and the human factors of the resulting INAS operations.
- Increasing globalization of the industry and the consequences of the increasing multicultural nature of operations within a flight deck, within an airline, or within the INAS (e.g., language).

### *3.5 Crew Procedures and Information*

**Recommendation Procedures-1: Conduct an industry-coordinated study to determine reasons why pilots may not follow procedures, for both GA and air carrier.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200/800 | | ✓ | 0.5 | |

This should build on previous efforts.[4] Once a study is done, implement an appropriate response to its findings, as warranted. Address any necessary handbook changes to cover this issue.

Coordinate with the ATA Training and Flight Systems Integration committees, and FOQA/ASAP efforts, to attempt to start to gather information to address this procedures issue.

**Recommendation Procedures-2: Determine a method to better address GA related human error management/decision making**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | ✓ | | 0.25 | |

**Recommendation FltCrewInfo-1: Ensure that operators have an appropriate process, with demonstrated effectiveness, for informing flight crews about relevant accidents, incidents, in-service problems, and problems encountered in training that could affect flight safety. This relevant information could/should come from other operators, manufacturers, etc.**
*(Recommendation Comm/ Coord-4, FAA HF Team Report)*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |

[4] Hudson, P.T.W. Bending the Rules II: Why do people break rules or fail to follow procedures? and, What can you do about it?

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200 | | ✓ | 0.25 | |

At present, "in-service" safety event experience having potential future safety consequence that may be known to pilots, operators, ATS system, airport authorities, manufacturers or authorities on an individual basis, may not necessarily be collected, exchanged, or shared with other relevant aviation organizations or entities to help preclude future events. This recommendation will lead to AFS reviewing current field guidance, policies, and Orders (e.g., 8400.10) to assure that CMOs/CMUs are appropriately assuring that their respective operators have an effective mechanism in place to address such information internally. This includes a means to collect, assess, and provide it back to a manufacturer, to FAA (CMO or AEG, ), to an airport or a foreign authority, when appropriate, or to receive and re-distribute such information when received (e.g., from a manufacturer, from FAA, from safety related organizations such as ATA, ASRS, or from accepted industry sources such as FSF).

This issue needs to be considered in how to apply this safety information flow assessment both to air carriers and GA, and operations as well as maintenance areas of responsibility.

AFS maintenance related organizations should assure that a mechanism exists to exchange this kind of safety information from the level of an operator's management to the level of a maintenance technician.

AFS operations related organizations should assure that a mechanism exists to exchange this kind of safety information from the level of an operator's management to the level of an individual pilot.

**Recommendation FltCrewInfo-2: Redesign and modernize the information provided to the flight crew in notices to airmen (NOTAMs), meteorological data, etc. The information should be prioritized and highlighted in terms of urgency and importance, and presented in a clear, well-organized, easy-to-understand format suitable for use with current and future airplanes.** *(based on Recommendation Comm/ Coord-5)*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | ✓ | 1 | |

Because of the growth in volume, complexity, and criticality of certain aviation operations (e.g., increasing dependence on use of "data base" related information), effectiveness of current and future aeronautical information systems increasingly depends on suitable organization, description, prioritization, and use of that information. The current system has as its historical root organization and descriptions that are complex, coded, not prioritized, and not filtered by significance. It is now necessary to reconsider the form and organization of this information, and improve it's suitability for current and future operations (e.g., inappropriate or unnecessary meteorological abbreviations [Fume/"FU" abbreviation for smoke]; sorted NOTAMS for significance (e.g. downplay 250' Crane located far from flight path versus emphasize a critical Runway maintenance closure time, or field report of a significant snow condition NOTAM).

Coordinate this activity with the Standing Committee on In-Flight Icing effort on terminology.

**Recommendation FltCrewInfo-3: Conduct a human factors review of the AIM and update according to the findings. Return conceptual oversight responsibility for information included in the AIM to AFS.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-400 | | ✓ | 0.3 | |

Numerous provisions of the AIM are outdated and need to be reconsidered, revised or modernized (holding pattern holding waypoint entry method reference initial "fly by" passage of the holding WP, for certain FMS equipped aircraft) or update of "lost COM" procedures regarding use of backup ACARS or data link methods. Some changes may require associated regulatory action (e.g., on an air carrier "lost COM situation" into KORD, stay on the planned LNAV/VNAV path to the expected runway, rather than stay at FL390 and spiral down in a holding pattern over an IAF at the elapsed flight plan time. This human factors oriented review should be practical, AFS related and operationally oriented.

Recommend initiation of, and coordinate with, a parallel ATS effort.

**Recommendation FltCrewInfo-4: Support development of better methods for Part 91 operators to assess weather risks. The methods should consider potential use of decision models, best practices, and other available materials and weather sources to help pilots better determine "weather-risks" associated with flight planning or operational decisions.** *[Adapted from GA Safer Skies recommendation - Wx JSIT]*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | ✓ | | 0.125 | |

Many new weather products are becoming available for description or reporting of severe weather, icing, AWOS/ASOS, "nowcasting", use of satellite imagery, use of the internet, use of "electronic flight bag" products through data link, and eliciting, integration and re-reporting of pilot reports. This recommendation addresses both preparation of AFS sponsored R&D efforts to take better advantage of these new technology thrusts, and updating of FAA related operational materials or references for training or checking (testing) criteria, to reflect these new capabilities.

As a minimum, coordinate with the SAE G10 Human Behavioral Technology Committee, and consider recommending that SAE G10 support completion of this task.

**Recommendation FltCrewInfo-5: Provide HF support to development of an Advisory Circular (AC) with respect to pilot awareness of Controlled Flight Into Terrain (CFIT) hazards. Assist in disseminating the AC widely, including at airshows, to major flight schools, to DPEs, and to the flight instructor community. Regional Safety Programs should support including the AC in safety seminars, and the AC should be addressed in DPE recurrent qualification**. *[Adapted from - GA JSIT recommendation.]*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | ✓ | ✓ | 0.25 | |

GA exposure to CFIT exists, as well as air carrier exposure. This effort attempts to apply lessons learned from air carrier CFIT related efforts to GA, as well as address largely GA unique CFIF aspects (e.g., night "scud running" or mountain VFR operations exposure)

**Recommendation FltCrewInfo-6: Review FAA's program for weather services to be sure it is relevant and sensitive to HF issues.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | ✓ | 0.25 | |

Resources: 0.25 HF

Terminology and abbreviations are examples of issues that need attention. AFS should exert HF international leadership, such as to re-assess the METAR/TAF abbreviation-coding schema. This is important internationally to ease training, use of and interpretation of critical weather information. For example, there are difficult to read and easily mistaken "time periods" specified in forecasts. Another example is weather abbreviation codes like "BR" for Mist, "FU" for Smoke, or "GR" for Hail, each of which have their original basis in a foreign language, rather than in the international aviation language of English. Therefore, they are sometimes misleading or confusing, particularly when combined. Reducing HF vulnerability in areas such as this requires a significant re-assessment in light of modern technology and global operations.

**Recommendation FltCrewInfo-7: The FAA should encourage simplified flight deck and cabin messages, training, manuals, and procedures with clearer meaning to non-native English speakers. The FAA should encourage the use of internationally understood visual symbols and pictures where appropriate, rather than verbal descriptions or directions.**
*(Recommendation Culture-2, FAA HF Team Report)*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | 0.25 | |

With increasing multi-cultural global operations for both passengers and flight crews, it is increasingly important that emergency procedures and instructions be clear and unambiguous in languages represented by people on the aircraft and people externally working with the aircraft (airport personnel, maintenance personnel, rescue crews). This recommendation addresses preparation of AFS sponsored FAA related advisory material outlining hazards and benefits of improvement in this area.

One source of data for this task might be to take the lessons from maintenance structural repair manuals for general use.

**Recommendation FltCrewInfo-8: The FAA should provide leadership to update ICAO phraseology standards and to encourage their use.**
*(Recommendation Culture-3, FAA HF Team Report)*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-400 | ✓ | ✓ | 0.125 | |

Continued ASRS data, airline reports, and other operational events note continued vulnerability in this area. Variation in phraseology such as "line up and wait" versus "position and hold" need for the long term to be resolved. This will particularly be important as data link use is initiated and increases, in a mixed COM environment. This recommendation addresses an AFS led effort to initiate ICAO reconsideration of this subject, in conjunction with U.S. ATS representatives. This effort should be operationally managed and led by the flight operations community (due to the significance of worldwide operations), and not be delegated primarily to leadership by U.S. ATS.

Coordinate with SAE G10 and support the relevant subcommittee activity.

### *3.6 Instrument Procedures*

**Recommendation Instrument-procedures-1: Address the human factors aspects of new or revised instrument procedure types, including, at least:**

- **Procedure development criteria to support Flight Management System (FMS) equipped aircraft to use LNAV and VNAV.**
- **Standards for electronic display of instrument charts.**
- **Support research necessary to determine improved human factors guidelines for the design and presentation of instrument procedures.**
- **Development of RNAV 3-D and RNP Instrument Approach Procedures criteria.**
- **Optimum consolidation and presentation of approach charts and procedures to various runway ends, airports, for various minima, and levels of capability (e.g., RNP, xLS).**
- **Development and implementation of "special" procedures and facilitating transition to public use procedures, where appropriate.**
- **Development of departure criteria, approach criteria including curved path and segmented path, and turning missed approach criteria utilizing FMS.**
- **Any necessary vertical flight procedures (e.g., approaches to helicopter landing sites, point-in-space procedures).**
- **Ensure appropriate operational HF input from pilots, air traffic services and industry in the design of instrument procedures.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-400 | ✓ | ✓ | 0.25 | 0.5 |

This effort should systematically address HF aspects of instrument procedure evolution. Consider at least the following factors or capabilities in the vision of the future for instrument procedures:

RNAV
RNP (linear criteria)
VNAV
Multi-sensor operation
Sensitivity to both normal and non-normal operations
Sensor-independent operations
Satellite-based navigation as part of the above
Movement toward "Time-based" procedures (e.g., 4D, Required Time of Arrival (RTA))
Description of a coherent evolving family of instrument procedures (xLS family, RNAV family, & other classic procedures)

AFS is largely responsible for addressing operational criteria for equipment and procedures associated with the implementation of new and evolving technologies in the INAS. Associated HF related regulatory, advisory and handbook material needs to be developed to support the implementation of new or revised instrument procedures consistent with the above factors. HF related research, training, and coordination within the FAA and industry will also be required in this area.
Flight Standards Service's Flight Technologies and Procedures Division (AFS-400) should work in partnership with Air Traffic Service and Aircraft Certification Service.

### *3.7 Flight Deck/Air Traffic Services Integration*

**Recommendation FltDeck-ATS-1: AFS should ensure new procedures and policies are clearly communicated to and coordinated with Air Traffic Services.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200/400 | ✓ | ✓ | 0.125 | |

New operations based on RNP, Cat I, II and III, ADS-B, Data Link (potentially affecting lost comm procedures), use of new Weather Products (icing forecasts), and other such advances now require increased AFS/ATS coordination. This recommendation is to initiate a plan to establish that activity.

Coordinate with ATS.

The FAA should promote timely and clear communications between flight crews and Air Traffic Services through, at least the following recommendations.

**Recommendation FltDeck-ATS-2: Accelerate the efforts for transmission of information via datalink, as appropriate (e.g., Automated Terminal Information System (ATIS), weather, pre-departure clearances). Ensure clear and intelligible transmission of ATIS and clearance information, where data link is unavailable or unsuitable; (ATIS: do a review of existing automatic ATIS for correct phraseology, length, pauses, syntax, language/culture issues, brevity, speed of presentation, clarity, etc. Clearance: review for phraseology)**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | ✓ | 1.875 | |

Resources: HF should be directly involved in the first 3 items (0.5 HF each) and as consultant to the last 3 (0.125 HF)
Total: 1.875 HF

This effort establishes an AFS initiated effort to coordinate with a ATA to assess problem hub airport sites around the U.S. to make recommendations as to where additional short term data link (ACAS or FANS 1) applications may be initiated (as currently at KDTW for ACARS), and where "problem" ATIS information could be improved.

Coordinate with ATS.

**Recommendation FltDeck-ATS-3: Develop standard procedures and taxi routes, especially for busy airports.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-400 | ✓ | ✓ | 0.125 | |

This effort establishes an AFS initiated effort to coordinate with ATA to assess problem hub airport sites around the U.S. They would make recommendations as to where additional abbreviated/coded "taxi clearance procedures" may be initiated (as currently done at KDTW), and where "problem" taxi clearances as far as complexity, repetition, clarification or confusion could be improved.

ATS should identify when a taxi clearance differs from standard. Flight crews should be trained for these.

**Recommendation FltDeck-ATS-4: Identify existing air traffic procedures that are incompatible with highly automated airplanes. These incompatible procedures should be discontinued or modified as soon as feasible. Task an existing advisory group or, if necessary, establish a new forum, to develop recommended policy and procedures that will ensure coordination between the design of air traffic procedures and the design and operation of highly automated airplanes. Continue to support the on-going work of ATPAC.** *(Based on Recommendations Comm/Coord-1 and -2, FAA Human Factors Team Report)*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-400 | ✓ | ✓ | 0.125 | |

This effort establishes an AFS initiated effort to coordinate with a ATA RNAV/FMS Task Force to assess problematic procedures around the U.S. This effort would produce recommendations to initiate procedure improvement to address complexity, confusion, adverse flight deck effects or safety vulnerability (e.g., problem with FMS CIVET altitude constraints with VNAV).

### *3.8 Specific Applications/Technologies/Issues*

**Recommendation Technology-1: Address human factors issues of new technologies, applications, and issues, considering (at least) pilot training/qualification, procedures (crew and instrument), information and documentation, displays/controls, design, and error management**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-400 | ✓ | ✓ | 9.5 HF (0.5 HF per application, for 19 applications) | |

Resources: Total 9.5 HF (0.5 HF per application, for the 19 applications listed below)

The introduction of new technologies and procedures affects all users of the NAS, including commercial and general aviation, and will require the evaluation of human factors issues associated with each application. New technologies and their application to the NAS will include one or more of the following:

- Pilot training/qualification
- Pilot procedures/instrument procedure criteria
- Information & documentation (e.g., manuals, other documentation for the pilot)
- Displays/presentation of information to the flight crew/Controls (includes alerting)
- Design (e.g., equipment, instrument procedures, etc.)

Error management - the prevention, detection and recovery from errors - should be explicitly addressed as a component of all of the above. The regulatory guidance should reflect these areas, and other issues/areas that are specific to the topic. Human factors should be evaluated in the context of integration across the entire flight deck, and effects on existing processes and procedures.

| Error Management (prevention, detection, recovery) | | | | |
|---|---|---|---|---|
| | Pilot training/ qualification | Pilot procedures | Pilot info & doc | Displays/Controls design |
| Display of traffic information | Regulation/Advisory material<br>Develop pilot training standards for use of ADS-B<br>Rewrite AC120-55A to include<br><br>Handbook<br>Develop handbook material to go into 8400.10 for operational approval of ADS-B<br><br>Research<br>Yes - future applications.<br><br>Training of workforce<br>Include as part of recurrent<br><br>Industry standards<br>None required.<br><br>Coordination with other organizations<br>Coordinate with ATS, AIR on guidance material development | Regulation/Advisory material<br>Develop pilot procedures for use of ADS-B<br><br>Handbook<br>Develop handbook material for operational approval of ADS-B<br><br>Research<br>Yes - future applications. Pilot-in-the-loop test & eval required<br><br>Training of workforce<br>Include as part of recurrent<br><br>Industry standards<br>Not applicable.<br><br>Coordination with other organizations<br>ATS, AIR on guidance material development | Regulation/Advisory material<br>Develop pilot documentation for use of ADS-B<br><br>Handbook<br>Develop handbook material for operational approval of ADS-B<br><br>Research<br>Yes - future applications. Pilot-in-the-loop test & eval required<br><br>Training of workforce<br>Include as part of recurrent<br><br>Industry standards<br>Not applicable.<br><br>Coordination with other organizations<br>ATS, AIR on guidance material development | Regulation/Advisory material<br>AC120-55A should be modified to describe features that ADS-B must have to support particular pilot tasks for particular operational applications.<br><br>Handbook<br>Develop handbook material to go into 8400.10 for operational approval of ADS-B<br><br>Research<br>Yes - future applications. Pilot-in-the-loop test & eval required<br><br>Training of workforce<br>Include as part of recurrent<br><br>Industry standards<br>RTCA, SAE G10 standards in progress.<br><br>Coordination with other organizations<br>ATS, AIR on guidance material development |

This table provides an example of the recommendations for one of the application/ technologies. A similar set of recommendations applies to each of the application areas listed below.

In addition to the application "display of traffic information," the following applications should have the same categories addressed:

1. RNP based RNAV Instrument Procedures
2. VNAV
3. GPS Landing System (GLS)
4. Head Up Displays (HUD)
5. Enhanced vision
6. Synthetic vision
7. Electronic Flight Bags
8. Controller-Pilot Data Link Communication (CPDLC)
9. Improved weather presentation in the flight deck
10. Vertical Situation Displays
11. Highway-in-the-sky PFD displays
12. Traffic information displays
13. Terrain displays
14. Navigation Map displays
15. Electronic checklists
16. Integration of information on displays (e.g., Multi-Function Displays (MFD))
17. Unoccupied Air Vehicles (UAV) operating in the INAS
18. Night Vision Goggles (NVG)

**Recommendation Technology-2:** Address HF aspects of research done to investigate the potential safety benefit of improving warning systems in general aviation aircraft (e.g., adding a warning system in general aviation flight decks to alert a pilot to failure of a single onboard attitude indicator). Assess the potential benefit of allowing or encouraging installation of better or more modern instrumentation in GA aircraft (e.g., replacing the "turn-coordinator" instrument requirement with an alternate requirement encouraging or permitting use of a second attitude indicator using an alternate source of power).
*(Adapted from the Safer Skies recommendation).*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | | ✓ | 0.125 | |

A note about operational evaluation for new technology: AFS is the organization responsible for granting operational approval of new equipment and procedures. Accomplishing this approval may require the demonstration and/or analysis of specific skills and events in a realistic flight deck environment, in a valid operational context, so that issues in the interaction between specific equipment or maneuvers within the INAS environment. While a small portion of this work is done in actual aircraft, the vast majority of this work is now done in advanced simulators for time, cost, efficiency, and safety reasons. To be relevant, operational evaluation work done in simulators should be representative of the aircraft in service with airlines and the other major users of the INAS.

An operational evaluation program that realistically evaluates human factors issues is often based on the use of advanced, real-time, pilot-in-the-loop operational simulation techniques available through use of FAA-approved Level C or Level D simulation devices possessing a high level of simulation fidelity. These simulators require a complete aircraft and systems performance database based on actual aircraft manufacturers' flight test data and systems design. Other methods of simulation such as numerical analysis, graphic plotting, mathematical or system modeling, and part-task simulation are valid techniques for use in certain situations and these should certainly be used when appropriate.

All testing for operational approval requires credible, appropriately rigorous, valid testing that includes proper test design from an HF perspective, in addition to being operationally valid. Test subjects should be qualified and typed on the aircraft and systems being evaluated to get the most relevant results. Such pilots may be able to contribute substantially to solving operational and procedural problems encountered. Including all stakeholders in the process as early as possible is beneficial, as well.

### *3.9 Maintenance*

FAA pursues research and development in human-centered aircraft maintenance and inspection issues and develops and applies products that provide practical solutions to requirements from the aviation industry, labor, and government agencies. The goals of the program are

(1) To mitigate errors in aircraft maintenance and ground operations.
(2) Direct and coordinate industry and regulatory efforts nationally and internationally.
(3) Improve the effectiveness and efficiency of the aviation maintenance and FAA aviation safety inspector workforce.

The program tasks are subdivided into four primary activities;
(1) Error management: Projects include: proactive safety assessment, measurement of error investigation effectiveness, error intervention in heavy maintenance, error risk analysis in line maintenance, FOD (Foreign Object Damage) reduction programs, root cause analysis of AMT rule violations,
(2) Maintenance organizations: Projects include: AMT fatigue studies, validation of MRM, impact of cultures on maintenance working environment, analysis of risk management in maintenance organizations, develop and update the human factors guide in aviation maintenance.
(3) Skill and training : Projects include :development of AMT training /rating model, develop distance learning standards for AMT training ,develops standards for AMT structured ex programs, study of methods to optimize AMT certification, evaluation of air carrier maintenance training, and an alternate means of compliance implementation, integration of military certification to FAA requirements.
(4) Proficiency: Projects include; application of interventions to improve inspection performance, best practices in engine inspection performance, human factors in inspection reliability, HF practices for confined space entry, development of prototype HF training, study of use of technology to support inspection training in GA, regional, corporate aviation.

The FAA flight standards maintenance human factors program sponsors an International Human Factors in Maintenance Symposium jointly with the UK CAA and Transport Canada .The symposium has been held annually for the last 12 years and is rotated through the respective countries. This is the only international forum designed to specifically address aviation maintenance HF issues, and currently has participants from more than 20 countries.

Specific information about the maintenance human factors program may be found on the website: http://hfskyway.faa.gov

**Recommendation Maintenance-1: Initiate rulemaking effort to require error mitigation programs as part of the certification of all new 121/135/145 organizations. This should be harmonized with JAA and Transport Canada.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-300 | | ✓ | 0.25 | |

**Recommendation Maintenance-2: Provide guidelines for improved maintenance training (e.g., Part 147 schools) to facilitate training of mechanics in human factors related topics, including error mitigation, and Maintenance Resource Management (MRM), etc.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-300 | | ✓ | 0.25 | |

| **Recommendation Maintenance-3: Develop guidelines to facilitate training programs to better match maintenance technician entry level knowledge and skills to training program content.** | | | | |
|---|---|---|---|---|
| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
| | Strategic | Tactical | Initial | Ongoing |
| AFS-300 | | ✓ | 0.125 | |

| **Recommendation Maintenance-4: Explore ways to better introduce HF considerations in the design of maintenance characteristics of aircraft, and identify what actions should be taken to best address this issue for various classes of GA and air carrier aircraft.** | | | | |
|---|---|---|---|---|
| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
| | Strategic | Tactical | Initial | Ongoing |
| AFS-300 | ✓ | | | 1 |

One person is needed in AFS-300 to oversee/manage the HF in maintenance efforts.

Coordinate with Central Region and Small Airplane Directorate.

### *3.10 Field Approvals*

The RTCA Certification Task Force identified and recommended the following:

> The authorities should work with industry to review the use of the TSO, STC (Amended Type Certificate (TC) in case of TC holders), or field approval processes when seeking airworthiness approval for an aircraft modification. Special focus should be placed on (1) providing the kind of self certification of the manufacturing process for STC holders that is obtained by TSO holders, and (2) ensuring that human factors issues are appropriately addressed regardless of which of these processes is followed. (Recommendation 12, Section 3.5)

Field approvals are being done for increasingly complex avionics. However, there is insufficient guidance for complex multi-function systems requiring thorough human factors evaluation of the human-computer interface, user manual documentation to explain the complex operation, or human-machine evaluations of the eventual integration into a variety of flight deck systems with differing airframe design philosophies.

In addition, Field Approving Officials lack the education and training concerning human factors principles and practices relative to flight deck design to assess the human-machine performance implications for task performance, workload, and safety when performing field approvals for installations of equipment into aircraft.

**Recommendation Field-Approval-1: Develop guidance for the field approval process to address human factors considerations. Provide this guidance and basic human factors training to Field Approving Officials**.

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-300 | | ✓ | 0.25 | |

Coordinate with Aircraft Certification.

Note: this may be preempted by the new policy/NPRM on field approvals.

### *3.11 Accident/Incident Investigation*

**Recommendation Investigate-1: Systematically incorporate HF considerations into accident /incident investigation. For example, in n accident/incident investigations where human error is considered a potential factor, investigate the factors that contributed to the error, including design, training, operational procedures, the airspace system, or other factors.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | 0.75 | 0.25 |

AFS should adapt evaluation tool/methods for assessing human error in accident and incident investigation. Incorporate this material and guidance into Accident Investigation course, and provide recurrent training to those who have already taken the course

The FAA should encourage other organizations (both domestic and foreign) conducting accident/incident investigations to do the same. This recommendation should apply to all accident/incident investigations involving human error, regardless of whether the error is associated with a pilot, mechanic, air traffic controller, dispatcher, or other participant in the aviation system. This should apply to general aviation as well as commercial transport. *(Recommendation Measures-2)*

Coordinate this activity with the Office of Accident Investigation.

### *3.12 Review of other AFS Programs*

**Recommendation Review-1: Conduct an HF oriented review of current active air carrier related programs within AFS-200, -300, -400, and -900 (e.g., ATOS, CSET) and make recommendations for suitably addressing HF aspects of each.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-200/900 | ✓ | | 0.5 | |

The development of this plan did not include a detailed review of all division programs. However, a full assessment of HF needs in the Flight Standards Service should include such a review.

**Recommendation Review-2: Conduct an HF oriented review of current active general aviation related programs within AFS-800, -300, -400, and -900 and make recommendations for suitably addressing HF aspects of each.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | ✓ | | 0.5 | |

Resources: 0.5 HF

The HF reviews mentioned above should include at least the following:

- ATOS
- CSET
- SPAS
- Flight attendant programs
- Dispatcher programs
- GA programs

**Recommendation Review-3: Conduct an HF oriented review of regional division tasks and functions to identify the specific HF applications to support field office efforts, and determine the HF skills and knowledge needed for those efforts.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | 0.5 | |

****text to go here***not yet completed*

### *3.13 Ongoing Activities Requiring Human Factors Application*

In addition to the specific actions just mentioned, recommendations are made to address the need for ongoing monitoring, review, and participation in AFS activities. Examples include (but are not limited to) Safer Skies implementation plans, participation in regulatory projects, ICAO committees, appropriate Integrated Planning Teams (IPT), industry standard development, oversight of R, E & D activities, and consultation on various topics, etc.

As an example, the following activities illustrate the type of ongoing activities that should be accomplished for ICAO-related activities:

- HF related ICAO efforts should address improving HF coordination with ICAO staff, assuring HF suitability of US proposed inputs to ICAO activities such as panels or study groups, and assuring suitability of ICAO issued products such as Standards, Recommended Practices, Manuals, or Circulars.
- FAA HF efforts should be coordinated with similar ICAO Secretariat efforts. Periodic coordination meetings (at least 1 per year) should be held between key FAA and ICAO staff representatives to address programs and plans updates.
- AFS should initiate an HF based review of each proposed US Panel Position, Working Paper, Information Paper, and other such documents taken by U.S. members or advisors to ICAO activities. This should include HF aspects of any Interagency Group for International Aviation (IGIA) coordination documents.
- Each time an ICAO product (e.g., revised or new ICAO Standard, Recommended Practice, or Manual is referred to FAA requesting a U.S. response (e.g., via State Letter), a Human Factors oriented review should be conducted of both the proposed ICAO reference, and the associated U.S. response. This review should be made an inherent part of the U.S. review process for ICAO new or change proposals.

As a result of the need for these ongoing activities, previous experience has shown that HF specialist resources are needed in each of the policy-making organizations, and in each of the regional organizations.

Resources: see section 4, Recommendation Org-1.

## 4. AFS Organizational Recommendations

In AFS, there are many areas in organizational processes that are relevant to institutionalizing human factors. These areas include, for example:

Workforce knowledge, skills, abilities in human factors:

- Education of workforce in HF
- HF specialists - where, how many, what qualifications

Defining roles and responsibilities

These two topics are the highest urgency in starting to institutionalize HF into AFS.

The items listed below are also important and should be pursued as resources can be applied. They should be done with the organizational goals and workforce responsibilities in mind (see Appendix C for more detail).

- Workforce methods, processes, tools, including:
  - Usability of tools used by the workforce
  - Methodology used by the workforce (e.g., scientific method)
  - Importance of setting requirements based on operational needs
    - Top down definition of requirements
    - Systems engineering approach that incorporates HF
  - Corporate memory
  - Appropriate mix of disciplines, skills, and expertise for getting tasks done

- Workplace issues (e.g., noise and ergonomics)
- Management buy in and commitment
- Standardization/uniformity among organizations finding compliance

**Recommendation Org-1: The FAA should appropriately staff the standards/policy organizations with human factors expertise and integrate personnel with organizational processes.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | | 14 |

Based on the current organization, one HF specialist in each division/region with technical responsibility would be appropriate, (AFS-200, AFS-300, AFS-400, AFS-800, AFS-900, each of the nine regions).

AFS has recommended the development of functional areas of responsibility to address global transportation, advanced technologies, general aviation and international. The proposed organization would have similar resource requirements as described above but the specialists would be placed differently in the organization, due to the restructuring of responsibilities.

The human factor specialists will have unique qualifications that address both the technical and operational requirements for their particular area of expertise, as well as human factors experience. This cadre of HF experts will be available to ensure that human factors issues are addressed in all AFS regional activities. It seems desirable for one of the specialists to function as a human factors coordinator with all others in Flight Standards. This Coordinator would be responsible for coordinating the application of HF across AFS, and ensuring that regional HF personnel and staff are kept abreast of changes in FAA policy and the operational environment that could affect HF issues. This HF coordinator should work with the Chief Scientific and Technical Advisor for Flight Deck Human Factors, who is responsible for HF strategy, direction, and coordination across Regulation and Certification (AVR). In addition, the AFS HF coordinator should work with the human factors specialists in Aircraft Certification and in AAR-100.

See Appendix B for recommended qualifications for human factors specialists and hiring considerations. Implementation of this recommendation should be followed by development of a more detailed staffing plan based on the organizational structure in place at that time.

**Recommendation Org-2: AFS should develop a systematic training program for appropriate Flight Standards Services personnel (including management and inspectors) to provide initial and recurrent training in the area of human factors as it relates to operational approvals and evaluating flight crew performance.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-500 | ✓ | | 0.5 | |

Resources: 0.5 HF, plus funding for contractual support of training development.

Both management and the inspector workforce should be provided with appropriate training. The FAA inspector workforce should be trained in the application of HF considerations to all aspects of their work. AFS will provide guidance specifically targeted at the various areas of technical expertise that will ensure that HF is an integral part of routine daily activities. On-going guidance materials and training will be provided on the application of HF principles to the performance of routine duties, and handbook, advisory material and procedures development. The fact that the guidance material and training are ongoing indicates that the process will incorporate methods of evaluating HF activities and providing feedback for their continued improvement and evolution. Guidance materials and HF training provided to the inspector workforce should be tailored to their specific areas of expertise and the environment within which they operate.

This recommendation should be implemented as soon as possible.

**Recommendation Org-3: AFS should provide appropriate regulatory personnel with a guide or roadmap to current Federal Aviation Regulations, advisory material, policy memoranda, and other guidance material dealing with human performance. AFS should ensure that this material is used in airline qualification program assessments, airman qualification, and other activities as appropriate.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | ✓ | 0.33 | |

Guidance to the workforce is necessary to aid them in applying human factors knowledge to AFS activities. As guidance is developed, it should be disseminated as part of updates to the guide or roadmap.

## 5. Research, Engineering, and Development (R, E, & D)

Reference 11 describes the current process within AVR for identifying and communicating requirements for human factors research. The process is theoretically simple, although the details are somewhat more complicated. This process, and the monitoring and application of the research efforts and their findings, provide an important basis for including human factors knowledge and data into AFS processes and products.

**Recommendation R&D-1: AFS should improve the knowledge of personnel in Flight Standards Service about processes for identifying and communicating requirements for HF research (either specific studies required or identification of areas of concern).**
*(Recommendation Knowledge-12)*

| Type of recommendation | | Lead organization | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| Strategic | Tactical | | Inital | Ongoing |
| ✓ | ✓ | AFS-1 | 0.125 | |

Develop a document describing the process for identifying requirements within AFS and as part of the AVR process. Distribute to personnel in AFS.

**Recommendation R&D-2: AFS should improve communication about HF research programs, research results, and advances in technology to appropriate AFS personnel.**
*(Recommendation Comm/ Coord-8, FAA HF Team Report))*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | | ✓ | 0.125 | |

Clearly it is important for AFS personnel to be able to communicate HF R&D requirements. This is not sufficient, however. One area of concern has been the monitoring of the research efforts and taking the research results

## 6. Communication and Coordination

Successful implementation of this plan will depend on communication among the participants and users to accomplish the desired outcomes. The communication and coordination must take place within AFS, within AVR, within the FAA in general, and with outside organizations.

**Recommendation Comm-1: The FAA should improve and increase interaction between the Flight Standards and Aircraft Certification Services.**
*(Recommendation Comm/ Coord-6, FAA HF Team Report)*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | 0.125 | |

Explore ideas such as personnel exchanges, and courses to explain the relationship between the airworthiness regulations and the operating regulations. Increase the implementation of joint advisory circulars between AFS and AIR to foster communication on particular issues/technologies.

**Recommendation Comm-2: The FAA should increase Aircraft Certification and Flight Standards Services personnel's knowledge about each other's roles and responsibilities. In particular, increase certification pilots' and engineers' knowledge of line operations considerations, and Aircraft Evaluation Group personnel's knowledge about airworthiness certification considerations.**
*(Recommendation Knowledge-11, FAA HF Team Report)*

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | 0.125 | |

**Recommendation Comm-3: Promote participation and commitment by other organizations as appropriate in investigations, policy development (e.g., readback-hearback) and other AFS activities, as needed.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-1 | ✓ | | | |

Resources: should be embedded in the resources for other recommendations.

This item should not require additional resources, because it should be a fundamental part of the relevant recommendations. It is important enough to mention it explicitly.

**Recommendation Comm-4: Continue the work under the Aviation Safety Program (ASP) and incorporate HF areas (such as, error management) for pilot and maintenance technician knowledge.**

| Lead organization | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|
| | Strategic | Tactical | Initial | Ongoing |
| AFS-800 | ✓ | | 0.125 | |

Resources: 0.125 HF

Another area where communication is important is AFS' Aviation Safety Program (ASP). The ASP goal is to "sell" safety and to encourage compliance to the FARs. The ASP has been a "quiet" success for over 30 years; it is considered to be a "quiet" program because preventing an accident rarely gets publicity.

The ASP safety goal is accomplished by using such educational tools as videos, presentations, publications, and safety articles of interest to pilots and mechanics. Safety presentations are given in a variety of meetings, ranging from a few mechanics in the back of the hangar to large audiences at air shows.

This program has two organizational elements: airworthiness and operations. The airworthiness element fosters training of mechanics in Air Carrier, General Aviation, FAA Part 145 Repair Stations, and Part 147 Maintenance Technician Schools. The Operational element focuses on the large GA pilot community.

**Recommendation Comm-5: For each technical area, ensure that there is a appropriate forum for issues to be identified and resolved, that includes each of the major stakeholders, users, regulators, and any others that should be involved in solving issues.**

Resources: 0.125 AFS

As an established part of the development process, AFS should establish and maintain active working relationships with professional industry and international organizations. These include ATA, RTCA, General Aviation Manufacturers' Association (GAMA), Airline Pilots Association, Allied Pilots Association, SAE, AIAA, IEEE, ICAO, and the Flight Safety Foundation, among others. These organizations develop recommended practices, standards and guidance that can be used to develop AFS ACs and guidance materials. They also are an excellent source of subject matter experts and consultants. Early inclusion of participants from these organizations can facilitate development of products and harmonization/Bi-lateral agreements.

# 7. Implementation of this plan

## *7.1 Keys to success and next steps*

Some key areas for successful implementation include management commitment and buy-in, communication of the plan to relevant stakeholders, getting feedback on the plan and updating it accordingly in detailed implementation plans, understanding and working within the AFS organizational culture, and being aware of potential barriers.

### 7.1.1 Management buy in and commitment

For human factors considerations to become a part of all AFS activities, full support and buy in from management will be needed. Management will provide the overall guidance, resources and staffing required to implement the human factors program described in this document.

To accomplish this buy in and commitment, management should be briefed and educated, and it should be communicated to them how the application of human factors expertise and knowledge has benefit for the organization. Feedback from management and their organizations should be incorporated into the more detailed planning that will be required to implement these recommended actions.

### 7.1.2 Communication and Feedback

The initial activity should be to brief AFS management, starting with AFS-1 and AFS-2, then division managers, and then the members of the divisions. Depending on the specific guidance from AFS-1/2 on priorities, resources, and directions, the divisions should be asked to provide feedback on the plan and develop more detailed implementation plans in specific areas for specific recommendations. In addition, it would be valuable to ask industry and other outside organizations for their feedback on the plan.

The feedback from internal and external sources should be used to revise the plan according to the priorities and resource guidance provided by AFS leadership, and to begin implementation

### 7.1.3 Working within the AFS Organizational Culture

Successful implementation will depend on understanding and working within the existing organizational culture. While some culture changes may be desired to carry out all features of this plan for the long term, the reality is that any implementation must begin within the existing organizational processes and culture. We encourage the detailed planning and implementation of the recommendations to explicitly address this by directly identifying the needs and concerns of the workforce within the current organizational culture.

### 7.1.4 Potential Barriers

Implementing the recommendations will be challenging, for a variety of reasons. Many of the recommendations call for changes that will generate resistance. In this section, the following potential barriers to implementation of the recommendations are identified, so that the barriers can be addressed.

The following barriers may exist to varying degrees for all the recommendations:

**Resources**. Considering that resources (i.e., people, money, and time) are always in short supply, there must be a very compelling reason to invest resources in a particular activity.

**Resistance to change**. There is a natural tendency to resist many types of changes, especially if individuals, groups, or organizations feel threatened. For each of these recommendations, it will be important to communicate the intent and potential safety benefits.

**Turf protection**. This is another common response to change, especially change that has the potential to be major.

**Defensiveness**. Another common response is defensiveness against perceived criticism.

**Misunderstandings about Human Factors**. There are many misunderstandings about human factors, what it means, and what it involves. A few that are often encountered are:

- There is a single, agreed-upon definition of human factors. It is difficult to find a commonly agreed-upon definition. For example, we found that some people use "human factors" and "crew resource management (CRM)" to mean the same thing. Human factors is much broader than CRM, although CRM is certainly an important part of human factors.

- There are no special skills or training required to do human factors work (corollary: We're all human, so we can all do human factors). There is a common misperception that anyone can "do human factors" (whatever is meant by that -- see previous bullet) because they are human. Therefore, for example, they can design or evaluate a display or interface based on personal preferences. This perception of human factors overlooks the vast amount of objective, systematic methods and data developed from theoretical and empirical human factors efforts done for a variety of applications. Knowledge of these methods and data is important for appropriately applying human factors. A related and important point that is often overlooked is that subjective opinion or judgment may differ significantly from objective performance results. Judgments and opinions can be very valuable for gaining insight, but are not satisfactory substitutes for objective performance data.

- Experienced pilots (or maintenance technicians, etc.) are the same as human factors experts. As mentioned in the last point, human factors work requires special knowledge and skills. Piloting skills are equally valuable but are different from human factors skills.

- There is a simple, single-point solution to every human factors problem**.** As mentioned earlier, the issues we identified are highly interrelated. It is unrealistic to assume that simple, single-point solutions will usually solve human factors problems.

- HF evaluation is a democratic process**.** Just because more than half of a number of evaluators (or test subjects) have a certain opinion or judgment does not necessarily make that judgment the "right" answer from a human performance perspective. As mentioned earlier, subjective opinion or judgment may differ significantly from objective performance results.

#### 7.1.4 Summary of Next Steps

In summary, to implement this plan, the recommended next steps are:
1. Prioritize the recommendations and identify what resources will be applied.
2. Solicit feedback from the aviation community, including industry and the international community.
3. Based on this feedback, revise and expand the plan for detailed implementation steps.
4. Incorporate the detailed planning items in appropriate business/performance planning.
5. Carry out the detailed implementation plan with appropriate oversight and monitoring.

In implementing these steps, AFS should consider the current organizational culture and potential barriers in the detailed planning, implementation, and oversight.

### *7.2 Human Factors Staffing*

As mentioned earlier, successful implementation will require knowledge and expertise within the AFS workforce, including general knowledge of human factors among the entire workforce as well as specialists with detailed expertise in this area. Currently there are no human factors specialists in the divisions themselves. Therefore, human factors specialists should be brought into the organization (hired, transferred,

or developed) to provide detailed human factors expertise in implementing the recommendations provided above. The specialists should be able to work across organizational lines as necessary to achieve successful implementation within the AFS organization.

### *7.3 Oversight and Monitoring of the Implementation*

Oversight and monitoring of the implementation should include the creation of a standing HF committee within the AFS organization to monitor and review HF related activities, and to make recommendations and proposals to AFS management. The HF committee will consist of the Chief Scientific and Technical Advisor for Flight Deck Human Factors, the HF specialists, representatives from the AFS field offices, divisions, and other organizations as appropriate (e.g., Aircraft Certification). The AFS HF Coordinator should lead it. At periodic meeting the AFS HF Committee should review the progress made, lessons learned and any new or ongoing problems with which the committee could provide assistance.

There should be (at least) an annual briefing to AFS-1/2 on the progress of the implementation.

## Appendix A - What is Human Factors

Human Factors involves the application of knowledge about human capabilities and limitations to design, training, personnel selection, procedures, and other areas. Human capabilities and limitations can be categorized in many ways, with one example being the SHEL model (Ref. 3). This conceptual model describes the components *Software, Hardware, Environment, and Liveware.* The SHEL model is illustrated in Figure 1 and is described in more detail in Appendix A, but it can be briefly summarized as involving the human, or Liveware; the equipment, or Hardware; the procedures, papers, manuals, etc., or Software; the surrounding Environment; and other humans (Liveware).

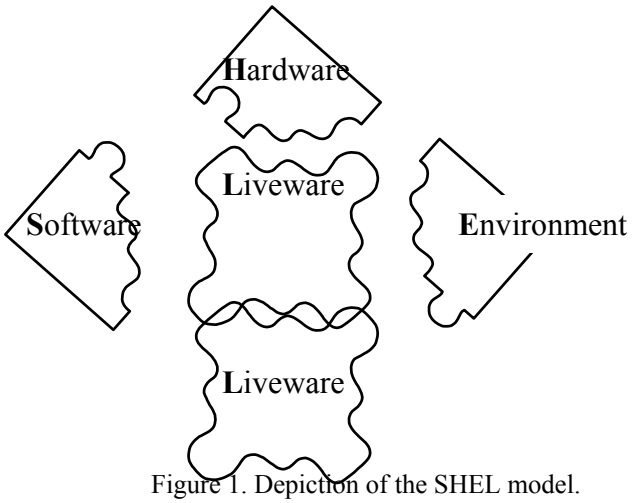


Figure 1. Depiction of the SHEL model.

The center of the model is the human, or *Liveware*. This is the hub of Human Factors. It is simultaneously the most valuable and the most flexible component of the system. However, the human is subject to many limitations, which are now predictable in general terms. The "edges" of this component are not simple or straight, and it may be said that the other components must be carefully matched to them to avoid stress in the system and sub-optimal performance.

To achieve this matching, it is important to understand the characteristics of this component.
**Physical size and shape**. In the design of most equipment, body measurements and movement are important to consider at an early stage. There are significant differences among individuals, and the population to be considered must be defined. Data to make design decisions in this area can be found in anthropometry and biomechanics.
**Fuel requirements**. The human needs fuel (e.g., food, water, and oxygen) to function properly. Deficiencies can affect performance and well being. This type of data is available from physiology and biology.
**Input characteristics**. The human has a variety of means for gathering input about the world around him or her. Light, sound, smell, taste, heat, movement, and touch are different forms of information perceived by the human operator; for effective communication between a system and the human operator, these forms much be understood. This knowledge is available from biology and physiology.
**Information processing.** Understanding how the human operator processes the information received is another key aspect of successful design, training, and procedures. Poor human-machine interface or system design that does not adequately consider the capabilities and limitations of the human information processing system can strongly affect the effectiveness of the system. Short- and long-term memory limitations are factors, as are the cognitive processing and decision-making processes used. Many human errors can be traced to this area. Psychology, especially cognitive psychology, is a major source of data for this area.
**Output characteristics.** Once information is sensed and processed, messages are sent to the muscles and a feedback system helps to control their actions. Information about the kinds of forces that can be applied and

the acceptable direction of controls are important in design decisions. As another example, speech characteristics are important in the design of voice communication systems. Biomechanics and physiology provide this type of information.
**Environmental tolerances.** People, like equipment, are designed to function effectively only within a narrow range of environmental conditions, such as temperature, pressure, noise, humidity, time of day, light, and darkness. Variations in these conditions can all be reflected in performance. A boring or stressful working environment can also affect performance. Physiology, biology, and psychology all provide relevant information on these environmental effects.

Humans can vary significantly in the above characteristics. Once the effects of these differences are identified, some of them can be managed through appropriate selection, training, and standardized procedures. Others may be beyond practical influence, and the overall system must be designed to accommodate them safely and effectively.

This *Liveware* is the hub of the conceptual model. For successful and effective design, the remaining components must be adapted and matched to this central component.

The first of the components that requires matching to the characteristics of the human is *Hardware.* This interface is the one most generally thought of when considering human-machine systems. An example is designing seats to fit the sitting characteristics of the human. The design of displays to match the human's information processing characteristics is even more complex. Controls, too, must be designed to match the human's characteristics, or problems can arise from, for example, inappropriate movement or poor location. The user is often unaware of mismatches in this liveware-hardware interface. The natural human characteristic of adapting to such mismatches masks but does not remove their existence. Thus this mismatch represents a potential hazard to which designers should be alerted.

The second interface with which Human Factors is concerned is that between Liveware and Software. This definition does not limit itself to computer software. Instead, it encompasses all of the non-physical aspects of the systems such as procedures, manual and checklist layout, symbology, and computer programs. The problems are often less tangible than in the Liveware-Hardware interface and more difficult to resolve.

One of the earliest interfaces recognized in flying was between the human and the environment. Pilots were fitted with helmets against the noise, goggles against the airstream, and oxygen masks against the altitude. As aviation matured, the environment became more adapted to the human (e.g., through pressurized aircraft). Other aspects that have become more of an issue are disturbed biological rhythms and related sleep disturbances, because of the increased economic need to keep aircraft, and the humans who operate them, flying 24 hours a day. The growth in air traffic and the resulting complexities in operations are other aspects of the environment that are becoming increasingly significant now and in the future.

The last major interface described by the SHEL model is the human-human interface. Historically, questions of performance in flight have focused on individual performance. Increasingly, attention is being paid (appropriately) to the performance of the team or group. Pilots fly as a crew; flight attendants work as a team; maintainers, dispatchers and others operate as groups; therefore, group dynamics and influences are important to consider in design, training, and procedures. Another area that is being increasingly recognized as important is the topic of organizational policies and practices.

One point that should be apparent from the discussion above is that Human Factors Engineering is inherently multidisciplinary, and should be integrated with other disciplines.

## Appendix B - Human Factors Specialist Qualifications and Hiring Process

Human factors specialists have a relatively new and unique role within Regulation and Certification (AVR). It is critical to place qualified personnel in the positions of HF specialists. It is also important to standardize the hiring procedures to ensure that appropriate candidates are selected.

To hire appropriate personnel, the following tasks are critical: determining the qualification, roles and responsibilities for the position(s); drafting position descriptions; preparing appropriate job announcements; recruiting; and the screening and selection process. It is also important to capitalize on the lessons learned from hiring the existing set of human factors specialists, including those hired in Aircraft Certification. One important lesson learned is that it is better to defer hiring, rather than to hire an individual who is not adequately qualified in human factors or does not have the other appropriate knowledge, skills and abilities (e.g., interpersonal skills).

While the ultimate hiring authority rests with the hiring office, the AVR Chief Scientific and Technical Advisor for Flight Deck Human Factors[5] should be involved in all phases of the hiring process for each new human factors specialist hired into AFS. Suggested guidelines for each task are described in the subsequent paragraphs.

### Roles and Responsibilities

It is envisioned that the roles and responsibilities for each human factors specialist will be appropriate to the office to which they are to assigned. Currently in AFS these include, for example:

- Policy Offices: Primary emphasis on regulatory and policy development (FARs, Advisory Circulars, AIM, and Handbook Bulletins, etc.- as appropriate for that office). Coordination among offices is critical.
- Field Offices (e.g., Flight Standards District Offices): Primarily support human factors aspects of office responsibilities.
- AFS Human Factors Coordinator: Responsible for coordinating the application of HF across AFS, and ensuring that regional HF personnel and staff are kept abreast of changes in FAA policy and the operational environment that could affect HF issues. This HF coordinator should work with the Chief Scientific and Technical Advisor for Flight Deck Human Factors, who is responsible for HF strategy, direction, and coordination across AVR. In addition, the AFS HF coordinator should work with the human factors specialists in Aircraft Certification and in AAR-100.

### Position Descriptions and Job Announcements That Reflect the Appropriate Knowledge, Skills, and Abilities

An individual in this position must have qualifications in the following area:

- Human factors applications. This could be someone with formal training in Human Factors with a Human Factors degree or selected areas of psychology (such as cognitive psychology or experimental psychology), Human/Computer Interaction (so the degree may be in Computer Science), or selected areas of Engineering (such as Industrial Systems or Cognitive Engineering). This knowledge may be acquired from formal training or from experience (note that the experience must provide a comparable level of knowledge to the formal training).

Additionally the applicant should have qualifications in the following areas:

- Understanding of aviation operations, maintenance and training/qualification from a human performance perspective.
- Knowledge of aviation.

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[5] This position was formerly known as (and is sometimes still referred to as) the AVR National Resource Specialist.

- Knowledge of regulations and regulatory processes, etc.(desired)

The position could be classified in several ways (e.g., HF specialists in AIR are classified as either an Engineering Psychologist Series 180 or as an Engineer Series 861). However, an Engineering degree should not be listed as a minimum requirement for this position, as any of the degrees listed above are considered minimally acceptable, provided the person has human factors education, training, and experience.

It is important for the success of the position that the person hired truly has the knowledge of human factors necessary to be a specialist. For example, an aeronautical engineer who has a basic understanding of human factors is valuable (as an aeronautical engineer), but not as a human factors specialist; significantly more knowledge is required. An analogy might be that it would not be appropriate to hire a person with only a private pilot's license and knowledge of basic aerodynamics as a flight test pilot, because they don't have the specialized knowledge and skills to do that job.

It will be a challenge to get someone with the combination of qualifications listed above. The FAA has a great deal of expertise in rules and rulemaking, so priority should be placed on the aviation human factors qualifications. It will be extremely important for the individual to have a practical perspective, with a focus on applying human factors knowledge and principles in a systematic, objective, rigorous manner. Thus, applicants with only human factors research experience with no applied experience should especially be evaluated for their ability to apply their knowledge and work in an operational environment. Additionally, the person's perspective, philosophy about human factors, and especially their interpersonal skills will be extremely important.

A good starting point for examples of position justifications and descriptions would be to examine the descriptions for the human factors specialists within Aircraft Certification. The position description and job announcement should be tailored towards the needs of the hiring office while ensuring the applicant has the required fundamental knowledge of human factors.

**Recruiting**

One the human factors position has been defined, documented, and approved, the AFS hiring office should work with their human resources office, the AVR Chief Scientific and Technical Advisor for Flight Deck Human Factors, as well as with existing human factors specialists to begin recruiting. Efforts should be made to recruit from companies and individuals with known ties to human factors specialists working in industry and other governmental agencies.

It is recommended that concurrent with the posting of the new position on the FAA's job vacancies web page, that the position be advertised in the Human Factors and Ergonomics Society (HFES) newsletter (Bulletin) and/or the HFES Placement Service (jobs database). This may be done by contacting HFES at:

Human Factors and Ergonomics Society
P.O. Box 1369, Santa Monica, CA 90406-1369
Tel: (310) 394-1811 FAX: (310) 394-2410
Email: hfesps@aol.com
WEB: Http://hfes.org

Once the job is announced and the announcement is posted on the FAA's job vacancies web page, notification of the job announcement should be sent to all the AVR and AAR-100 human factors specialists currently employed by the FAA to help with finding qualified candidates. This will facilitate the recruiting process since the notification will alert current employees to the vacancy and they can pass on the information to other human factors candidates potentially interested in applying.

**Screening and Selection Processes**

The following is a list of recommendations for the screening and selection process:

1. All potential new human factors specialists should go through a consistent interview/review process.

2. In addition to the AFS management, a core HF team should be involved in the interview process and make hiring recommendations for all new hires. This team should at a minimum consist of:
    - the Chief Scientific and Technical Advisor for Flight Deck Human Factors
    - a representative from AAR-100 (ARA HF group)
    - at least one other currently employed HF specialist in AIR
    - the local hiring management team representatives and human resources personnel as required.

    The ultimate hiring decision is up to the local office management, but should be based on input from all team members.
3. A core question bank should be used during all interviews to ensure knowledge and expertise in Human Factors, not just in "humans." This core set should be developed by the team identified above in #2, which may be based on the question set developed during the hiring of human factors specialists in AVR.

## Appendix C - Goals and Current Organization Composition

### AVR/AFS Performance Goals

These are the performance goals that AFS must meet in order to ensure the success for the AVR organization. From these four performance areas they developed four broad-based performance goals for AVR. The targeted performance areas are as follows.

1. Contribute to aviation safety by developing policies and/or standards, programs, and systems to reduce the number of aviation accidents and incidents related to human factors.

2. Contribute to aviation safety by developing policies and/or standards, program, and systems to reduce the number of aviation accidents and incidents related to production systems, certification, and maintenance errors.

3. Establish performance targets aimed at enhancement of the AVR Surveillance Process to forecast, identify, and target areas where surveillance best addresses critical safety issues.

4. Improve industry compliance with aviation standards through the adoption of voluntary internal audit/self-disclosure programs.

In addition to the overall goals established by AVR, AFS has developed the following organizational specific goals that will enable us to achieve success in these areas. They are:

1. Implement a system of accountability for all of Flight Standards.
2. Develop a systems capability for the acquisition and analysis of aggregate operational flight data.
3. Improve the business processes used to manage the AFS training program.
4. Develop and implement an advanced qualification data analysis and reporting system.
5. Convert the airmen certification and rating application to an internet-based system entitled I-ACRA.
6. Improve tactics for managing change.
7. Develop strategy for institutionalizing Human Factors.
8. Explore the feasibility of a systems approach for general aviation.
9. Improve the requirements process.
10. Continuing air transportation oversight system development.
11. Initiate rulemaking to address anomalies present in the FAA's management and oversight of air carrier manuals.

### AFS Organization and Workforce Composition

In addition to the Service support staff, there are eight distinct organizational elements and an extensive system field offices reporting to the Director, Flight Standards Service. Total Service employment is 4,754 personnel. In addition to its federal civilian workforce, AVR utilizes over 6,800 "designees" (sometimes called examiners). Designees are private persons, or groups of individuals, designated to act as representatives of the FAA Administrator. Designees are a significant extension of our capacity to enhance aviation safety, and also represent an extensive "leveraging" of the resources we have.

### Customer Base

Table 1 gives a summary of the AFS Primary Customer Base. Ultimately the traveling public is our "customer" with these individuals and organizations providing the conduit through which we deliver our products. The AVR Business Plan contains a more detailed list with supporting information.

**Table 1**

**Primary Customer Base** (as of October, 1998)

| | |
|---|---|
| ➔**Air Operator Certificates — 7,700**<br>FAR PART 121 – 149 (e.g. United Airlines)<br>FAR PART 135 – 2,856 (Commuter, On-Demand)<br>FAR PART 125 – 156 (Baltimore Orioles)<br>FAR PART 129 – 552 (Foreign carriers)<br>FAR PART 133 – 405 (External Load)<br>FAR PART 137 – 2,996 (Agricultural)<br>FAR PART 91 – 586 (Public Use)<br><br>➔**Air Agency Certificates — 5,780**<br>FAR PART 141 – 494 Pilot Training Schools<br>FAR PART 145 – 5,009 Repair Stations<br>FAR PART 147 – 181 Maintenance Schools<br>FAR PART 142 – 96 Training Center<br><br>➔**Aircraft — 206,924**<br>Part 121 – 7,440<br>Part 135 Commuter – 908<br>Part 135 On-Demand – 11,276<br>General Aviation – 187,300 | ➔**Active Pilots — 616,340** (as of 12/97)<br><br>➔**Non-Pilot Personnel** (as of 12/97)<br>Mechanics – 383,897<br>Ground Instructors – 69,366<br>Other – 87,629<br><br>➔**Flight Instructors — 78,102**<br><br>➔**NTSB (AVR) Recommendations — 150 avg./yr.**<br><br>➔**Designees**<br>Flight Standards – 6,820<br><br>➔**Aviation Industry Trade Organizations** |

******Please note - this has not been fully updated*****

**Appendix D - Recommendations**

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|---|---|---|
| | | | | Strategic | Tactical | Initial | Ongoing |
| Error-mgt-1 | Develop an error management policy to be the foundation of AFS' application of HF into its processes and products. Develop guidance for the workforce on how this policy will apply, because it will require AFS to acknowledge that not all errors can be prevented and to balance error tolerance with enforcement responsibilities. | AFS-1 | 2.2 | ✓ | | *0.25 HF, 0.25 other* | 0.125 |
| Reg-1 | Review relevant existing material (operating rules, advisory material, policy, and related references) and make recommendations about what regulatory standards and/or advisory material should be updated to consistently address human performance vulnerabilities, and prevention and management (detection, tolerance, and recovery) of human error. This should apply to flight crew, maintainers, dispatchers, and flight attendants. | AFS-1 | 3.1 | ✓ | | 6 people 3 mths each (2 HF, 4 other) total | |
| GA-Training-1 | Identify general GA training requirements involving human factors. | AFS-800 | 3.2 | ✓ | | 0.25 | |
| GA-Training-2 | For aircraft requiring type ratings, analyze the current state of Flight Training Devices (FTDs) to determine the range of their capabilities and to determine their effectiveness in training. From this information, establish a range of credit for which various FTDs may be used in lieu of actual flight.<br><br>For small aircraft, analyze current personal computer (PC) simulation devises to determine the range of their capabilities and effectiveness in training. From this information, establish if credit can be given toward pilot currency and/or certification requirements. | AFS-800 | 3.2.1 | | ✓ | 0.25 | |

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|---|---|---|
| | | | | Strategic | Tactical | Initial | Ongoing |
| GA-Training-3 | Develop and implement scenario-based weather training and testing to develop pilot weather judgment and decision making skills. *(Safer Skies GA Weather JSIT, Program 11)* | AFS-800 | 3.2.1 | | ✓ | 0.25 HF | |
| GA-Training-4 | Investigate the use of innovative training tools and methods to expand pertinent safety related knowledge of pilots on a continuing basis. The FAA and the aviation community should explore incentives to encourage continued training and education beyond the minimum required by the current regulations. | AFS-800 | 3.2.1 | ✓ | | 0.25 HF | |
| GA-Training-5 | Investigate the further revision of Practical Test Standards and Testing Materials to ensure appropriate treatment of human performance related subjects and safety knowledge of pilots, instructors, inspectors and designees. | AFS-800 | | | ✓ | 0.25 HF | |
| Air-Carrier-Training-1 | Ensure the rewrite of CFR Part 121 Subpart N&O includes appropriate HF considerations and has adequate industry input (i.e., as part of the ARAC process). | | 3.2.2 | | | 2 HF, 3 other AFS | |
| Air-Carrier-Training-2 | Ensure the necessary HF related updates occur to training and qualification related advisory circulars, such as:<br>• AC 120-35 (Line Oriented Simulation)<br>• AC 120-40 (Simulator Qualification)<br>• AC 120-45 (Flight Training Device Qualification)<br>• AC 120-51 (Crew Resource Management)<br>• AC 120-53 (Crew Qualification and Type Rating for Transport Aircraft)<br>• AC 120-54 (Advanced Qualification Program).<br><br>Ensure that the updates include adequate industry coordination and input. | | 3.2.2 | | | 1 HF | |
| Air-Carrier-Training-3 | Reassess recency of experience requirements for flightcrews involved in flight operations. Consider providing incentives and alternative methods for flight | | 3.2.2 | | | 0.25 HF | |

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|---|---|---|
| | | | | Strategic | Tactical | Initial | Ongoing |
| | crews to practice takeoffs and landings, and perhaps arrival and departure procedures that are infrequently used. | | | | | | |
| Air-Carrier-Training-4 | Incorporate suitable human factors considerations into the 8400.10 Air Carrier Inspector's Handbook guidance. Similarly, incorporate suitable human factors considerations into new inspector and recurrent inspector training, including consideration of each of the applicable factors or items listed above. | | 3.2.2 | | | 0.5 HF | |
| Air-Carrier-Training-5 | Ensure that flight safety and training managers are appropriately educated about human factors considerations, particularly with regard to automation. | | 3.2.2 | | | 0.125 HF | |
| Air-Carrier-Training-6 | Support investigation of the use of innovative training tools and methods to expand pertinent HF related safety related knowledge of flight crews on a continuing basis. The FAA and the aviation industry should explore incentives to encourage continued training and education beyond the minimum required by the current regulations. | | 3.2.2 | | | 0.125 HF | |
| Air-Carrier-Training-7 | Consider the potential need for other HF related RE&D activities in areas to improve current training. | | 3.2.2 | | | 0.5 HF | |

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|---|---|---|
| | | | | Strategic | Tactical | Initial | Ongoing |
| Ops-1 | With assistance from groups (such as ATA, NATA, and RAA, NBAA and other industry representative groups as appropriate), review key lists of active issues/programs to be sure that any FAA related HF aspects of each are being appropriately supported or addressed by FAA. | | 3.3 | ✓ | | 0.25 HF | |
| Ops-2 | With key FAR 121 aircraft and avionics manufacturers' assistance (e.g., Boeing, Airbus, Bombardier, Embraer) review the respective manufacturers' lists of key active issues/programs relative to new commuter or regional jet aircraft types, and ensure that any FAA related AFS HF aspects of those programs are being appropriately addressed. | | 3.3 | ✓ | | 0.25 HF | |
| Ops-3 | With key FAR135 aircraft and avionics manufacturers' assistance (e.g., Cessna, Raytheon, Gulfstream) review the respective manufacturers' lists of key active issues/programs relative to new commuter or regional jet aircraft types, and ensure that any FAA related AFS HF aspects of those programs are being appropriately addressed | | 3.3 | ✓ | | 0.25 HF | |
| Ops-4 | Conduct a review of HF aspects of pertinent AFS division efforts (-200, -300, -400, -600, -900) for any air-carrier-related efforts/activities. Include at least the following programs as a start:<br>▪ Runway incursion reduction<br>▪ Flight and duty time criteria update<br>▪ LAHSO and "near airport" system errors response<br>▪ HF aspects of programs related to use of Landing Systems (xLS, GLS) or RNAV, VNAV or RNP procedures, training, and avionics. | | 3.3 | ✓ | | 1 HF | |
| Procedures-1 | Conduct an industry-coordinated study to determine reasons why pilots may not follow procedures, for both GA and air carrier. | | 3.4 | | ✓ | 0.5 | |

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|---|---|---|
| | | | | Strategic | Tactical | Initial | Ongoing |
| Procedures-2 | Determine a method to better address GA related human error management/decision making | | 3.4 | | ✓ | 0.25 | |
| Instrument-proc-1 | Address the human factors aspects of new or revised instrument procedure types, including, at least:<br>• Procedure development criteria to support FMS equipped aircraft to use LNAV and VNAV.<br>• Standards for electronic display of instrument charts.<br>• Support research necessary to determine improved human factors guidelines for the design and presentation of instrument procedures.<br>• Development of RNAV 3-D and RNP Instrument Approach Procedures criteria.<br>• Optimum consolidation and presentation of approach charts and procedures to various runway ends, airports, for various minima, and levels of capability (e.g., RNP, xLS).<br>• Development and implementation of "special" procedures and facilitating transition to public use procedures, where appropriate.<br>• Development of departure criteria, approach criteria including curved path and segmented path, and turning missed approach criteria utilizing FMS.<br>• Any necessary vertical flight procedures (e.g., approaches to helicopter landing sites, point-in-space procedures).<br>• Ensure appropriate operational HF input from pilots, air traffic services and industry in the design of instrument procedures. | | 3.5 | ✓ | ✓ | 0.5 HF per year | |
| FltCrew-Info-1 | Ensure that operators have an appropriate process, with demonstrated effectiveness, for informing flight crews about relevant accidents, incidents, in-service problems, and problems encountered in training that could affect flight safety. This relevant information could/should | | 3.6 | | ✓ | 0.25 HF | |

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|---|---|---|
| | | | | Strategic | Tactical | Initial | Ongoing |
| | come from other operators, manufacturers, etc. *(Recommendation Comm/ Coord-4)* | | | | | | |
| FltCrew-Info-2 | Redesign and modernize the information provided to the flight crew in notices to airmen (NOTAMs), meteorological data, etc. The information should be prioritized and highlighted in terms of urgency and importance, and presented in a clear, well-organized, easy-to-understand format suitable for use with current and future airplanes. *(based on Recommendation Comm/ Coord-5)* | | 3.6 | ✓ | ✓ | 1 HF | |
| FltCrew-Info-3 | Conduct a human factors review of the AIM and update according to the findings. Return conceptual oversight responsibility for information included in the AIM to AFS. | | 3.6 | | ✓ | 0.3 HF | |
| FltCrew-Info-4 | Support development of better methods for Part 91 operators to assess weather risks. The methods should consider potential use of decision models, best practices, and other available materials and weather sources to help pilots better determine "weather-risks" associated with flight planning or operational decisions. (*Adapted from GA Safer Skies recommendation - Wx JSIT)* | | 3.6 | | ✓ | 0.125 HF | |
| FltCrew-Info-5 | Provide HF support to development of an Advisory Circular (AC) with respect to pilot awareness of Controlled Flight Into Terrain (CFIT) hazards. Assist in disseminating the AC widely, including at airshows, to major flight schools, to DPEs, and to the flight instructor community. Regional Safety Programs should support including the AC in safety seminars, and the AC should be addressed in DPE recurrent qualification. *[Adapted from - GA JSIT recommendation.]* | | 3.6 | | ✓ | 0.25 HF | |
| FltCrew-Info-6 | Review FAA's program for weather services to be sure it is relevant and sensitive to HF issues. | | 3.6 | ✓ | ✓ | 0.25 HF | |
| FltCrew-Info-7 | The FAA should encourage simplified flight deck and | | 3.6 | | | 0.25 | |

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
|---|---|---|---|---|---|---|---|
| | | | | Strategic | Tactical | Initial | Ongoing |
| | cabin messages, training, manuals, and procedures with clearer meaning to non-native English speakers. The FAA should encourage the use of internationally understood visual symbols and pictures where appropriate, rather than verbal descriptions or directions. *(Recommendation Culture-2, FAA HF Team Report)* | | | ✓ | | HF | |
| FltCrew-Info-8 | The FAA should provide leadership to update ICAO phraseology standards and to encourage their use. *(Recommendation Culture-3, FAA HF Team Report)* | | 3.6 | | ✓ | 0.125 HF | |
| FltDeck-ATS-1 | FltDeck-ATS-1: AFS should ensure new procedures and policies are clearly communicated to and coordinated with Air Traffic Services. | | 3.7 | ✓ | | 0.125 HF | |
| FltDeck-ATS-2 | Accelerate the efforts for transmission of information via datalink, as appropriate (e.g., Automated Terminal Information System (ATIS), weather, pre-departure clearances). Ensure clear and intelligible transmission of ATIS and clearance information, where data link is unavailable or unsuitable; (ATIS: do a review of existing automatic ATIS for correct phraseology, length, pauses, syntax, language/culture issues, brevity, speed of presentation, clarity, etc. Clearance: review for phraseology) | | 3.7 | ✓ | | 1.875 HF | |
| FltDeck-ATS-3 | Develop standard procedures and taxi routes, especially for busy airports. | | 3.7 | | ✓ | 0.125 HF | |
| FltDeck-ATS-4 | Identify existing air traffic procedures that are incompatible with highly automated airplanes. These incompatible procedures should be discontinued or modified as soon as feasible. Task an existing advisory group or, if necessary, establish a new forum, to develop recommended policy and procedures that will ensure coordination between the design of air traffic procedures and the design and operation of highly automated airplanes. Continue to support the on-going work of | | 3.7 | ✓ | | 0.125 HF | |

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
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| | | | | Strategic | Tactical | Initial | Ongoing |
| | ATPAC. *(Based on Recommendations Comm/Coord-1 and -2, FAA Human Factors Team Report)* | | | | | | |
| In-service-data-1 | Publish the FOQA final rule (14 CFR Part 13). Update the FOQA Advisory Circular to match final rule. Publish Protection of Voluntarily Submitted Information final rule (14 CFR part 193) | | 3.8 | | | 0.25 HF | |
| In-service-data-2 | Provide 8400.10 Handbook guidance to match final FOQA rule and Advisory Circular. Provide 8400.10 Handbook guidance to match final Protection of Voluntarily Submitted Information rule. | | 3.8 | | | 0.25 HF | |
| In-service-data-3 | Develop an advisory circular providing industry with guidance on data management techniques. | | 3.8 | | | 0.5 HF | |
| In-service-data-4 | Provide 8400.10 Handbook guidance on data management techniques. | | 3.8 | | | 0.25 HF | |

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| | | | | Strategic | Tactical | Initial | Ongoing |
| In-service-data-5 | Integrate AQP/ASAP/FOQA data and performance monitoring tools within the Flight Standards Services Air Transportation Oversight System (ATOS) and the current Aviation Performance Measurement System (APMS) Program. | | 3.8 | | | 0.25 HF | |
| Technology-1 | Address human factors issues of new technologies, applications, and issues, considering (at least) pilot training/qualification, procedures (crew and instrument), information and documentation, displays/controls, design, and error management. | | 3.9 | | | 9.5 HF | |
| Technology-2 | Address HF aspects of research done to investigate the potential safety benefit of adding a warning system in general aviation flight decks to alert a pilot to failure of a single onboard attitude indicator; Assess the potential benefit of replacing the "turn-coordinator" instrument requirement with an alternate requirement for use of a second attitude indicator. (*Adapted from the Safer Skies GA recommendation).* | | 3.9 | | | 0.125 HF | |
| Maintenance-1 | Require error mitigation programs as part of the certification of all new 121/135/145 organizations. | | 3.10 | | | 0.25 HF | |
| Maintenance-2 | Require Part 147 schools to train mechanics in maintenance human factors including error mitigation, Maintenance Resource Management (MRM), etc. | | 3.10 | | | 0.25 HF | |
| Maintenance-3 | Develop guidelines for matching maintenance technician entry level to training content. | | 3.10 | | | 0.25 HF | |
| Maintenance-4 | Explore the issue of design for maintenance to identify what actions should be taken to address this for GA and air carrier. | | 3.10 | | | 0.25 HF | |

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| | | | | Strategic | Tactical | Initial | Ongoing |
| Investigate-1 | In accident/incident investigations where human error is considered a potential factor, investigate the factors that contributed to the error, including design, training, operational procedures, the airspace system, or other factors. | | 3.11 | | | 0.75 HF initially, 0.25/year ongoing | |
| Field-Approval-1 | Develop guidance for the field approval process to address human factors considerations. Provide this guidance and basic human factors training to Field Approving Officials. | | 3.12 | | | 0.25 HF | |

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
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| | | | | Strategic | Tactical | Initial | Ongoing |
| Review-1 | Conduct an HF oriented review of current active air carrier related programs within AFS (e.g., ATOS, CSET) and make recommendations for suitably addressing HF aspects of each. | | 3.13 | | | 0.5 HF | |
| Review-2 | Conduct an HF oriented review of current active general aviation related programs within AFS and make recommendations for suitably addressing HF aspects of each. | | 3.13 | | | 0.5 HF | |
| Org-1 | The FAA should appropriately staff the standards organizations with human factors expertise and integrate personnel with organizational processes | | 4 | | | 14 HF/year | |
| Org-2 | AFS should develop a systematic training program for appropriate Flight Standards Services personnel (including management and inspectors) to provide initial and recurrent training in the area of human factors as it relates to operational approvals and evaluating flight crew performance. | | 4 | | | 0.5 HF | |
| Org-3 | AFS should provide appropriate regulatory personnel with a guide or roadmap to current Federal Aviation Regulations, advisory material, policy memoranda, and other guidance material dealing with human performance. AFS should ensure that this material is used in airline qualification program assessments, and airman qualification, and other activities as appropriate. | | 4 | | | 0.33 HF | |
| R&D-1: | AFS should improve the knowledge of personnel in Flight Standards Service about processes for identifying and communicating requirements for HF research (either specific studies required or identification of areas of concern). (*Recommendation Knowledge-12, FAA HF Team Report*) | | 5 | ✓ | | 0.125 HF | |
| R&D-2 | AFS should improve communication about HF research programs, research results, and advances in technology to appropriate AFS personnel. *(Recommendation Comm/* | | 5 | ✓ | | 0.125 HF | |

| ID | Recommendation | Lead org | Section ref | Type of recommendation | | AFS HF Staffing Resources (FTEs) | |
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| | | | | Strategic | Tactical | Initial | Ongoing |
| | *Coord-8, FAA HF Team Report*) | | | | | | |
| Comm-1 | The FAA should improve and increase interaction between the Flight Standards and Aircraft Certification Services. *(Recommendation Comm/ Coord-6, FAA HF Team Report*) | | 6 | ✓ | | 0.125 AFS | |
| Comm-2 | The FAA should increase Aircraft Certification and Flight Standards Services personnel's knowledge about each other's roles and responsibilities. In particular, increase certification pilots' and engineers' knowledge of line operations considerations, and Aircraft Evaluation Group personnel's knowledge about airworthiness certification considerations. *(Recommendation Knowledge-11, FAA HF Team Report*) | | 6 | ✓ | | 0.125 AFS | |
| Comm-3 | Promote participation and commitment by other organizations as appropriate in investigations, policy development (e.g., readback-hearback) and other AFS activities, as needed. | | 6 | ✓ | | should be embed ded in the resourc es for other recom menda -tions | |
| Comm-4 | Continue the excellent work under the Aviation Safety Program (ASP) and incorporate HF areas (such as, error management) as identified in earlier recommendations for pilot and maintenance technician knowledge. | | 6 | | | 0.125 HF | |
| Comm-5 | For each technical area, ensure that there is a appropriate forum for issues to be identified and resolved, that includes each of the major stakeholders, users, regulators, and any others that should be involved in solving issues. | | 6 | ✓ | | 0.125 AFS | |

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**Acronym List**

| | |
|---|---|
| AC | Advisory Circular |
| ADS-B | Automatic Dependent Surveillance - Broadcast |
| AFS | Flight Standards Service |
| AIM | Aeronautical Information Manual |
| AQP | Advanced Qualification Program |
| ARAC | Aviation Rulemaking Advisory Committee |
| ASAP | Aviation Safety Action Program |
| ASRS | Aviation Safety Reporting System |
| ATA | Air Transport Association |
| ATIS | Automated Terminal Information System |
| ATOS | Aviation Safety Oversight System |
| ATS | Air Traffic Service |
| AVR | FAA Regulation and Certification |
| CFR | Code of Federal Regulations |
| CFIT | Controlled Flight Into Terrain |
| CMO | Certificate Management Office |
| CNS/ATM | Communication, Navigation, and Surveillance/Air Traffic Management |
| CPDLC | Controller-Pilot Data Link Communications |
| CRM | Crew Resource Management |
| CSET | Certification Standardization Evaluation Team |
| DPE | Designated Pilot Examiner |
| FANS | Future Air Navigation System |
| FAR | Federal Aviation Regulations |
| FBO | Fixed Base Operator |
| FOD | Foreign Object Damage |
| FOQA | Flight Operations Quality Assurance |
| FMS | Flight Management System |
| FSDO | Flight Standards District Office |
| FSS | Flight Service Station |
| FTD | Flight Training Device |
| GA | General Aviation |
| GAMA | General Aviation Manufacturer's Association |
| GAO | General Accounting Office |
| GLS | GPS Landing System |
| GPS | Global Positioning System |
| HF | Human Factors |
| HUD | Head-up Displays |
| ICAO | International Civil Aviation Organization |
| IFR | Instrument Flight Rules |
| IGIA | Interagency Group for International Aviation |
| INAS | International Airspace System |
| JAA | Joint Aviation Authorities |
| LAHSO | Land and Hold Short Operations |
| LOS | Line oriented scenario |
| MFD | Multi-Function Displays |
| MRM | Maintenance Resource Management |
| NAS | National Airspace System |
| NATA | National Air Transportation Association |
| NBAA | National Business Aircraft Association |
| NOTAM | Notice to Airmen |
| NTSB | National Transportation Safety Board |

| | |
|---|---|
| NVG | Night Vision Goggles |
| PIREP | Pilot Report |
| PTS | Practical Test Standards |
| RAA | Regional Airline Association |
| R,E& D | Research, Engineering & Development |
| RNAV | Area navigation |
| RNP | Required Navigation Performance |
| SASO | Systems Approach to Safety Oversight |
| SAGA | Systems Approach for General Aviation |
| SPAS | Safety Performance Analysis System |
| STC | Supplemental Type Certificate |
| TC | Type Certificate |
| UAV | Unoccupied Air Vehicles |
| VNAV | Vertical Navigation |
| xLS | x-type (Instrument, GPS, etc.) Landing System |