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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

[Policy Statement Number ANM–01–03]

Factors To Consider When Reviewing an Applicant's Proposed Human Factors Methods of Compliance for Flight Deck Certification

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of policy statement; request for comments.

SUMMARY: This notice announces a proposed FAA general statement of policy that is applicable to the type certification process of transport category airplanes. This policy statement provides guidance to FAA Certification Teams that will enable them to conduct an effective review of an applicant's proposed methods of compliance identified in a Human Factors Certification Plan, or the human factors components of a general Certification Plan, if one is submitted as part of a type certification certificate (TC), supplemental type certification certificate (STC), or amended type certificate (ATC) application. This policy also is applicable in cases where an applicant chooses to identify methods of compliance in other types of documents, such as a letter containing the description of changes to production configurations. This guidance describes a process to promote early discussion and agreement between the FAA and the applicant regarding the methods by which the applicant may demonstrate compliance with human factors-related regulations during certification projects. This notice is to advise the public of FAA policy and give all interested persons an opportunity to review and comment on the policy statement.

DATES: Send your comments by June 15, 2001.

ADDRESSES: Address your comments to the individual identified under **FOR FURTHER INFORMATION CONTACT**.

FOR FURTHER INFORMATION CONTACT: Steve Boyd, Federal Aviation Administration, Transport Airplane Directorate, Transport Standards Staff, Airplane & Flightcrew Interface Branch, ANM–111, 1601 Lind Avenue SW., Renton, WA 98055–4056; telephone (425) 227–1138; fax (425) 227–1320; e-mail: *9-ANM-111-humanfactors@faa.gov*.

SUPPLEMENTARY INFORMATION:

Comments Invited

The FAA invites your comments on this proposed general statement of policy. We will accept your comments, data, views, or arguments by letter, fax, or e-mail. Send your comments to the person indicated in **FOR FURTHER INFORMATION CONTACT.** Mark your comments, ''Comments to Policy Statement ANM–01–03.''

Use the following format when preparing your comments:

- Organize your comments issue-by-issue.
- For each issue, state what specific change you are requesting to the proposed general statement of policy.
- Include justification, reasons, or data for each change you are requesting.

We also welcome comments in support of the proposed policy.

We will consider all communications received on or before the closing date for comments. We may change the proposals contained in this notice because of the comments received.

Effect of General Statement of Policy

The FAA is presenting this information as a set of guidelines suitable for use by certain applicants for a type certificate (TC), supplemental type certificate (STC), or amended type certificate (ATC). However, the general policy stated in this document is not intended to establish a binding norm; it does not constitute a new regulation, and the FAA would neither apply nor rely on it as a regulation. The FAA Aircraft Certification Offices (ACO) that certify transport category airplanes and/or the flight deck systems installed on them should attempt to follow this policy, when appropriate. However, in determining compliance with certification standards, each FAA office has the discretion not to apply these guidelines where it determines that they are inappropriate. Applicants should expect that the certificating officials will consider this information when making findings of compliance relevant to new certificate actions.

As with all advisory material, this general statement of policy identifies one means, but not the only means, of compliance.

Background

Recent aviation safety reports underscore the importance of addressing issues related to human performance and flightcrew error in system design and certification. Applicants have demonstrated the effectiveness of using a ''Human Factors Certification Plan,'' or any other certification plan which identifies human factors issues and considerations, to communicate to the FAA their proposed approach to identifying and resolving human performance issues. The FAA previously issued Policy Statement No. ANM–99–2, entitled ''Guidance for Reviewing Certification Plans to Address Human Factors for Certification of Transport Airplane Flight Decks'' (64 FR 54399, October 6, 1999; and 65 FR 19958, April 13, 2000). That policy statement provides guidance on the recommended content of a Human Factors Certification Plan. A Human Factors Certification Plan is not a required document, but may be included as part of a certification project if an applicant so chooses. Policy Statement No. ANM–99–2 recommended that the plan include a list of the ''Methods of Compliance (MOC)'' that the applicant proposes to use to show compliance with each applicable regulation.

The guidance contained in this new policy statement provides further recommendations regarding the review of the applicant's proposed MOCs. These recommendations can be used as a means by which the applicant and the FAA can establish an early and formal written agreement on the methods of compliance for regulations that relate to human factors and that are applicable to the certification project. This will help FAA Certification Teams address the MOCs as early in the certification process as possible, thus decreasing the applicant's certification cost and schedule risk.

This new policy statement is one portion of an overall FAA strategy for developing policies related to human factors in the certification of flight decks on transport category airplanes. Policy development will cover the following areas related to showing compliance with regulatory requirements associated with human factors:

1. *Information on the recommended content of certification plans.* (The FAA previously published this information as Policy Statement No. ANM–99–2). This policy is intended to improve the timeliness and effectiveness of communication between the applicant and the FAA concerning the requirements related to human factors.

2. *Information on how to determine the adequacy of an applicant's proposed methods of compliance.* (This is the information provided in this policy statement.) This policy provides further information on the methods of

compliance that may be proposed in certification plans or other documents provided by the applicant.

3. *Information on how to determine the adequacy of an applicant's proposed human factors test plans intended to support certification.* (The FAA has not yet developed or published this information.) This policy will support the ACO when it determines that test plans related to compliance with requirements related to human factors require FAA review and concurrencethe ACO determines that it is appropriate for the FAA to review and concur with the applicant's test plans relative to human factors requirements.

4. *Information on how to reach agreement on design acceptability for human factors analyses and tests performed to support certification.* (The FAA has not yet developed or published this information.) This policy will improve the process by which the applicant and the FAA jointly agree on how to determine whether the design meets the regulatory requirements. This is especially important for those requirements that rely on subjective evaluations to determine acceptability.

5. *Information on the recommended roles and responsibilities of test pilots, human factors specialists, and other technical specialists in certification programs, with respect to regulations related to human factors.* (The FAA has not yet developed or published this information.) This policy will clarify how these individuals should work together to review and approve the various aspects of the certification project that concern human factors.

Objectives of This Policy Statement

The policy statement is for use by members of FAA Certification Teams, which may include the following individuals:

- Aircraft evaluation group inspectors,
- Avionics engineers,
- Certification Team project managers,
- Flight test pilots,
- Flight test engineers,
- Human factors specialists,
- Propulsion engineers, and
- Systems engineers.

While this policy is focused on providing guidance to these FAA Certification Team members, it may be of use to applicants, as well.

This policy statement addresses the methods by which applicants may show compliance with regulations related to flight deck human factors during a type certificateion (TC), a supplemental type certificateion (STC), or an amended type certificate (ATC) project for transport category airplanes. The objective of this policy is to provide information for the FAA Certification Team to refer to's reference when reviewing the applicant's proposed MOCs. For projects in which a certification plan is not submitted, this policy can stillmay be used useful in discussions between the applicant and the FAA about how applicants may demonstrate compliance with applicable regulations. Although the policy provides information to all members of the FAA Certification Team, test pilots and human factors specialists will normally determine the interpretation of the acceptability of a proposed MOC.

The goal of this policy is to improve the consistency of FAA evaluations of applicants' proposed MOCs. Its purpose is not to standardize the MOC for any given requirement; rather, it provides information about the issues and factors that should be considered when evaluating an applicant's proposed MOCs. The specifics of each certification project will determine the outcome of those evaluations and the acceptability of an applicant's proposed MOCs.

The FAA recognizes that decisions concerning MOCs for human factors issues are complex and context-dependent. Usually, selecting the appropriate MOC for a regulation in a specific project will be based on an understanding of the human factors issues and the capabilities and limitations of the various MOCs with regard to the issues and the regulations. However, it may be appropriate to consider other factors to ensure that the desired MOCs are reasonable for the specific project. These other factors include:

- The complexity of the project.
- The safety implications of the human factors issues.
- The availability and need for test environments (simulators, for example).
- The experience base of the applicant.
- The cost and schedule implications of each MOC.

These factors should be considered as a whole when determining the adequacy of the applicant's proposed MOCs, as well as when determining the need for alternative MOCs.

The Certification Team should strive to agree on MOCs that effectively show compliance with the regulation in a manner that is commensurate with:

- The significance of the human factors safety risks, and
- The complexity of the issues underlying a finding of compliance.

For example, the FAA should not insist on an extensive and costly evaluation of a simple design change that has no significant safety implications. Conversely, the applicant should not request a quick FAA sign-off for a novel, complex design that may have the potential for significant safety-related pilot errors.

This policy statement does not supersede any current or future FAA Advisory Circulars that deal with human factors MOCs. Wherever possible, this policy statement attempts to provide references to relevant existing advisory material. If there are any cases in which there is a conflict between existing Advisory Circulars and this policy statement, the Advisory Circulars take precedence.

The FAA recognizes the current effort of several Harmonization Working Groups, chartered under the Aviation Rulemaking Advisory Committee (ARAC) process, that may develop regulatory or advisory material affecting human factors requirements or MOCs. If these Working Groups develop or modify regulatory or advisory material relevant to human factors issues, the FAA will review this policy statement and update it as necessary to maintain consistency.

Application of the General Statement of Policy

Because this general statement of policy only announces what the FAA seeks to establish as policy, the FAA considers it an issue for which public comment is appropriate. Therefore, as stated previously, we request comments on the following proposed general statement of policy. Resolution of any public comments received will determine how the policy is applied in the long term for future projects.

General Statement of Policy

Guidance for Reviewing Human Factors Methods of Compliance for Flight Deck Certification

The guidance provided in the following sections is intended to help the FAA Certification Team members review the human factors MOCs proposed by an applicant during a certification project. Those MOCs may be identified in a Certification Plan or other document submitted by an applicant. The applicant may wish to provide this information by any number of means, such as:

- Part of a Human Factors Certification Plan or overall Project Certification plan, if submitted;
- A separate, unique document; or
- A briefing or series of briefings and discussions.

Regardless of the medium used for providing information, it should be organized in a way that shows the relationship between the specific human factors requirements and the MOCs used for each. The applicant is under no obligation to provide the information described in this policy statement, except as necessary to demonstrate compliance when certification is requested. However, the FAA considers that early discussions of the proposed MOCs for human factors requirements is beneficial to both the FAA and the applicant, and may significantly reduce certification risk. This policy does not imply that applicants should be required to provide extensive, written justifications of their proposed MOCs. Rather, the information in this policy statement should be used by the FAA Certification Team to evaluate the proposed MOCs, and to provide common reference points for discussions between the applicant and the FAA.

Organization of This Policy Statement

The information provided in this policy statement covers three topics:

1. General information on methods of compliance for regulations related to human factors.
2. Identification of design-specific human factors issues.
3. Identification of regulation-specific human factors issues.

In addition, a list of selected regulations is included in Appendix A. This list contains the same regulations as those cited in Policy Statement No. ANM–99–2 (referred to previously). However, Appendix A of this new policy statement provides a more detailed discussion of MOCs for each of the cited regulations. The FAA also plans to provide the information in Appendix A of this policy statement on an internet web site, where it can become a ''living document'' and can be updated as new regulatory material, information, processes, and technology become available.

1. Methods of Compliance

In the Human Factors Certification Plan, overall Certification Plan, or other certification project documents, the applicant may propose or describe the methods that will be or have been used to demonstrate compliance with the relevant human factors regulations. The review and discussion of the methods of compliance is an opportunity for the FAA and the applicant to work together, early in the certification program, to identify potential certification issues related to human factors. Policy Statement No. ANM–99–2 provided a brief discussion of the MOCs; the section below expands on that information by providing more detailed discussions.

The methods of compliance are not mutually exclusive. The applicant may choose to include any one or a combination of these methods of compliance. The applicant should describe all methods of compliance to be used in a certification project in enough detail to give the FAA Certification Team confidence that the results of the chosen methods will provide the information necessary for finding compliance. Following is a list of MOCs relevant to compliance with human factors regulations:

1.a. *Drawings:* These are layout drawings and/or engineering drawings that show the geometric arrangement of hardware or display graphics. Drawings typically are used when demonstration of compliance can easily be reduced to simple geometry, arrangement, or the presence of a given feature, on a technical drawing.

1.b. *Configuration description:* This is a description of the layout, general arrangement, direction of movement, etc., of the regulated item, or a reference to similar documentation. For example, such a description could be used to show the relative locations of flight instruments, groupings of control functions, allocation of color codes to displays and alerts, etc. Configuration descriptions are generally less formalized than engineering drawings, and are developed in order to point out the features of the design that are supportive of a finding of compliance. Configuration descriptions may illustrate how a design philosophy or concept is implemented in a consistent, easy-to-understand manner. In some cases, such configuration descriptions may provide sufficient information for a finding of compliance with a specific requirement; however, more often, configuration descriptions provide important background information requiring demonstrations, tests, or other means to confirm compliance. The background information provided by configuration descriptions, however, may significantly reduce the complexity and/or risk associated with the demonstrations or tests.

1.c. *Statement of similarity:* This is a description of the system to be approved and a description of a previously-approved system. The description details the physical, logical, and operational similarities of the two systems in complying with the regulations. Past certification precedents are important; however, this method of compliance must be used with care because the flight deck should be evaluated as a whole, rather than merely as a set of individual functions or systems. For example, two functions that have been previously approved on two different programs may be incompatible when combined on a single flight deck. Also, changing one feature in a flight deck may necessitate corresponding changes in other features, in order to maintain consistency and prevent confusion.

1.d. *Evaluations, assessments, and analyses:* These are conducted by the applicant or others (not the FAA or a designee), who then provide a report of their results to the FAA. Traditionally, these types of activities have been used as part of the design process without formal certification credit. However, when properly performed, these activities can result in better designs that are more likely to be compliant with applicable regulations. In cases where human subjects (pilots, for example) are used to gather data (subjective or objective), the applicant should fully document the selection of participants, what data will be collected, and how it will be collected. This will allow the FAA Certification Team to determine the extent to which the evaluations, assessments, and analyses provide valid and relevant information with respect to finding compliance with the regulations. For a more detailed discussion of how these evaluations, assessments, and analyses can be used and formalized, see Appendix D of this policy statement.

1.d.(1) *Engineering evaluations or analyses*—These assessments can involve a number of techniques, including:

- Procedure evaluations (complexity, number of steps, nomenclature, etc.);
- Reach or strength analysis via computer modeling;
- Time-line analysis for assessing task demands and workload; or
- Other methods, depending on the issue being considered.

Certification Teams should carefully consider the validity of assessment techniques for analyses that are not based on advisory material or accepted industry standard methods, and request that applicants validate any computation tools used in such analyses. If analysis involves comparing measured characteristics to recommendations derived from pre-existing research (internal or public domain), the applicant may be asked to validate the use of the data derived from the research.

1.d.(2) *Mock-up evaluations*—These are evaluations using mock-ups of the flight deck and/or components. Mock-ups are typically used for assessment of reach and clearance and, therefore, they demand a high degree of geometric accuracy. Mock-ups have traditionally been physical representations of the design, which have allowed evaluators to physically interact with the design. In some cases, drawings of controls and indicators, placed on accurately positioned representations of instrument panels, can be beneficial in conducting reach assessments. Using data extracted from computer-aided design (CAD) systems, control panels can now be mocked-up physically in three-dimensional form (a process generally referred to as ''stereo lithography''). These mock-ups can allow more precise evaluations of finger clearances, visibility of labels, etc. Three-dimensional representations of the design in a CAD system, in conjunction with three-dimensional models of the flight deck occupants, also have been used as ''virtual'' mock-ups for certain limited types of evaluations. For example, reach assessments using this technique can use either:

- Statistical samples of relevant body characteristics (for example, limb sizes, joint limits, etc.) or
- Carefully chosen sets of specific combinations of body characteristics.

In the latter case, attention should be given to selecting reasonable worst-case combinations of characteristics (for example, a worst-case might be a 5′2″ pilot with more than proportionally short legs). Care must be taken to determine if the model of the human reasonably represents actual human movement capabilities, especially at extreme body positions or near joint rotation limits. It is important to note that this type of virtual mock-up and, in fact, many types of mock-ups may be of even greater use during the design phase as part of engineering evaluations. They should only be used judiciously as an MOC because they typically represent only certain features of the physical arrangement. For example, a control may be reachable in a given location, but, due to the means of actuation or forces required, it may be too difficult to use when placed there. For many of the compliance issues typically evaluated in mock-ups, final compliance findings often can be found only in the actual airplane or a simulator.

1.d.(3) *Part-task evaluations*—These are evaluations using devices that emulate the crew interfaces for a single system or a related group of systems, using flight hardware, simulated systems, or combinations of these. Typically, these evaluations are limited by the extent to which acceptability may be affected by other flight deck tasks. This MOC is most easily used for stand-alone systems. As flight deck systems become more integrated, part-task evaluations may become less useful as an MOC, even although their utility as engineering tools may increase. A typical example of a part-task demonstrator for an integrated system would be an avionics suite installed in a mock-up of a flight deck, with the main displays and autopilot controllers included. Such a tool may be valuable during development and for providing system familiarization to the authorities. However, in a highly integrated architecture, it may be difficult or impossible to assess how well the avionics system will fit into the overall flight deck without more complete simulation or use of the actual airplane.

1.d.(4) *Simulator evaluations*—These are evaluations using devices that present an integrated emulation (using flight hardware, simulated systems, or combinations of these) of the flight deck and the operational environment. They can also be ''flown'' with response characteristics that replicate, to some extent, the responses of the airplane. Typically, these evaluations are limited by the extent to which the simulation is a realistic, high fidelity representation of the airplane, the flight deck, the external environment, and crew operations. It should be noted that not all aspects of the simulation must have a high level of fidelity for any given compliance issue. Rather, fidelity requirements should be evaluated in view of the issue being evaluated. For additional information, see section 4.b.(1) of FAA Advisory Circular (AC) 25–11, ''Transport Category Airplane Electronic Display Systems,'' dated July 16, 1987.

1.d.(5) *In-flight evaluations*—These are evaluations using the actual airplane. light test generally offer the most realistic and comprehensive environment for evaluating the flight crew interface design in realistic scenarios. Assuming that the airplane is fully configured, the integration of the flight crew interface features can be evaluated in a flight environment, including communication tasks and interaction with the ATC environment. However, Ttypically, these evaluations are may be limited by the extent to which the critical flight conditions (for example, weather, failures, or unusual attitudes) can be located or generated, and then safely evaluated in flight. While evaluations using the actual airplane are the closest to real operations, in some cases not all of the scenarios of interest can be demonstrated. The applicant may not be able to show certain failures or combinations of failures for a variety of technical or safety reasons. In such cases, applicants may find it necessary to combine flight testing with other MOCs in order to gain a complete evaluation. For additional information, see FAA AC 25–11, section 4.b.(1).

1.e. *Demonstrations:* These are similar to evaluations (as described above), but conducted by the applicant with participation by the FAA or its designee. The applicant may provide a report or summary, requesting FAA concurrence on the findings. In each case, the applicant should note the limitations of the demonstration and how those limitations relate to the compliance issues being considered. The FAA should carefully consider which of its specialists will participate (for example, pilots, human factors specialists, or systems engineers), what data will be collected (objective and/or subjective), and how the data will be collected. This is to ensure that the demonstration adequately addresses the compliance issues and that there is participation by the appropriate FAA evaluators. Examples of demonstrations include:

- Mock-up demonstrations.
- Part-task demonstration.
- Simulator demonstration.

1.f. *Inspection:* This is a review of a regulated item by the FAA or its designee, who will be making the compliance finding. This MOC is generally limited to those items for which compliance can be found simply by looking at (or listening to) the feature being considered (for example, the presence or absence of a placard, the direction of control movement, etc.).

1.g. *Tests:* These are tests conducted by the FAA or a designee. Types of tests include:

1.g.(1) *Bench tests*—These are tests of components in a laboratory environment. This type of testing is usually confined to showing that the components perform as designed. Typical bench testing may include measuring physical characteristics (forces, luminance, or format, for example) or logical/dynamic responses to inputs, either from the user or from other systems (real or simulated). For most human factors evaluations, bench tests are insufficient to show compliance, but can provide useful supporting data in combination with other methods. For example, visibility of a display under the brightest of the expected lighting conditions might be shown with a bench test, provided there is supporting analysis to define the expected lighting conditions. This might include a geometric analysis to show the potential directions from which the sun could shine on the display, along with calculations of expected viewing angles. These conditions might then be replicated in the laboratory.

1.g.(2) *Ground tests*—These are tests conducted in the actual airplane, while the airplane is on the ground and stationary. In some cases, specialized test equipment may be used to allow the airplane systems to behave as if the airplane were airborne. Certain failures that would be unsafe to test in flight might be evaluated using ground tests, provided that the test capability can adequately simulate the in-flight failure condition. Another example of a typical ground test is an evaluation of potential reflections in displays. Such a test usually involves covering the flight deck windows to simulate darkness and setting the flight deck lighting to desired levels. This particular test may not be possible in a simulator, due to differences in the light sources, display hardware, and/or window construction.

1.g.(3) *Simulator tests*—[See *Simulator evaluations*, paragraph 1.d.(4), above.]

1.g.(4) *Flight tests*—These are tests conducted in the actual airplane during flight. [See *In-flight evaluations*, paragraph 1.d.(5), above.] In some cases, applicants and the FAA may place too much emphasis on flight testing, to the exclusion of other MOCs. This may be based on the belief that flight testing is the best available method for evaluating the flight deck. While it is true that flight testing can be very powerful, it also has limitations. As described in the section on in-flight evaluations, above, it may not be possible to test all of the important scenarios or conditions. Flight testing provides the least control over conditions of any of the MOCs. In addition, flight testing is extremely expensive and may not allow a thorough, comprehensive evaluation with sufficient numbers of FAA evaluators. While many simple evaluations can and should be handled by a single FAA evaluator, in other cases, the issues are too complex and subjective to be decided by a single person on a few flights, especially for novel designs. For such issues, it is often best to use flight testing as a final confirmation of data collected using other MOCs, including analyses and evaluations. The FAA and the applicant should discuss thoroughly how and when flight tests will be used to show compliance, as well as how flight test results will be supported by other MOCs.

1.h. *Compliance vs. design optimization:* The FAA personnel who are evaluating proposed methods of compliance for rules related to human factors should keep in mind there may be a number of crew interface design features that are compliant with the applicable rules, but could be improved. However, applicants are under no legal obligation to conduct assessments to show that a compliant design is the best that they could implement among feasible alternatives (i.e., is ''optimized'').

2. Identification of Design-Specific Human Factors Issues

The MOCs identified above cover a wide spectrum, from documents that simply describe the product, to partial approximations of the system(s), to methods that replicate the actual airplane and its operation with great accuracy. Features of the product being certified and the types of human factors issues to be evaluated are key considerations when selecting which method is to be used. The characteristics described below can be used to help in coming to agreement on what constitutes the minimum acceptable method(s) of compliance for any individual requirement. When a product may need to meet multiple requirements, some requirements may demand more complex testing, while others can be handled using simple descriptive measures. It is important to note that the following characteristics are only *general* principles. They are intended to form the basis for discussions regarding acceptable methods of compliance for a specific product with regard to a requirement.

2.a. *Degree of integration/independence:* If the product to be evaluated for compliance is a stand-alone piece of equipment that does not interact with other aspects of the crew interface, less integrated methods of compliance may be acceptable. However, if the product is a complete flight deck (as in a TC program) or is a single system that is tightly tied to other systems in the flight deck, either directly or by the ways that flightcrews use them, it may be necessary to use methods that allow the testing of those interactions.

2.b. *Novelty/past experience:* If the technology is mature and well-understood, less rigorous methods may be appropriate. More rigorous methods may be called for if the technology is:

- New,
- Used in some new application,
- New for the particular applicant, or
- Unfamiliar to the certification personnel.

2.c. *Complexity/Level of automation:* More complex and automated systems typically require test methods that will reveal how that complexity will manifest itself to the pilot, in normal and backup or reversionary modes of operation.

2.d. *Criticality:* Highly critical systems may require testing in the most realistic environments (high quality simulation or flight test), because any problems are more likely to have serious consequences.

2.e. *Dynamics:* If the control and display features of the product are highly dynamic, the compliance methods should be capable of replicating those dynamic conditions.

2.g. *Subjectivity of acceptance criteria:* If a requirement has specific, objectively measurable criteria, the applicant can often use simpler methods to demonstrate compliance. As the acceptance criteria become more subjective, the applicant will need to use more integrated test methods, so that the evaluations take into account the aspects of the integrated flight deck that may affect those evaluations.

The central point is to carefully match the method to the product and the underlying human factors issues. It is also important for the FAA Certification Team to recognize that several alternative methods may be acceptable.

3. Identification of Regulation-Specific Human Factors Issues

The following steps outline a strategy for identifying the human factors issues associated with each regulation. Two examples are carried through each issue for purposes of illustration. Further detail on a selected set of regulations related to human factors can be found in Appendix A of this policy statement.

3.a. *Identify key human factors issues related to the rule.* While rules may focus on a single concept, there may be several underlying components that must be considered in order to evaluate that issue.

- *Example 1:* Section 25.777 (in part) states that the flight deck must accommodate pilots from 5′2″ to 6′3″ in height. This means that pilots within this range should be able to reach all required controls, see all of the displays, and have sufficient clearance with the structure, panels, etc. Height is not the only variable of interest, because people of the same height may have different lengths of arms, legs, etc. So, consideration must be given to various representative body proportions that fall within the height range identified in the regulation.
- *Example 2:* Section 25.773(a)(2) states that there should be no objectionable reflections in the flight deck. Underlying variables may include the size, brightness, color, dynamics, and location of the reflections.

3.b. *Identify systems, components, and features that are potentially affected by the rule.*

• *Example 1:* Components that are near the expected reach boundaries, as well as those that may be blocked by intervening objects (such as a control that is installed in front of the throttles), should be evaluated for reach. Potential knee contact with the lower edge of the main instrument panel may need to be evaluated for clearance, especially for tall pilots with long legs.

• *Example 2:* Windows, displays, and light sources (all in the correct geometry) may be affected.

3.c. *Look for aspects of those systems, components, and features that need to be evaluated in order to show compliance with the rule* (for example, forces required, readability of labels, and number of discrete actions required). These aspects are likely to vary by system, component, and feature, and by rule.

• *Example 1:* Seat and rudder pedal adjustment ranges should be factored into evaluations of reach and clearance.

• *Example 2:* Light source luminance levels, reflectance of display surfaces, and readability of the display in the presence of the reflections should all be considered.

3.d. *For modifications to existing flight decks or new type designs that are based on or derived from an existing flight deck design, look for ways in which new aspects of the design may compromise compliance with previously certified designs.*

• *Example 1:* Reaching for a new control may result in the inadvertent activation of a previously installed and certificated control. Another example might be the possibility of striking one's head on a newly installed head-up display when reaching for an existing control on the main instrument panel.

• *Example 2:* Placing a new display device in the flight deck may produce new reflections in the windows. In another situation, a new electronic display [for example, a liquid crystal display (LCD)] may be more susceptible to reflections than the electro-mechanical display it replaces.

3.e. *Review past precedents.* In this context, precedents should be reviewed to assess novelty of the design, because novelty of the design will often affect the selection of an appropriate MOC. Similarity to a previously certificated design does not necessarily mean that the new product will be certificated. Rather, that similarity may result in fewer unknowns and a commensurate reduction in the rigor of the evaluations. It is important to assess whether or not there are new issues or interactions that were not present in previously certificated installations. Because it is the *installation* (in the flight deck) that is certificated, not the equipment itself, it is important to look for installation-unique issues when evaluating the relevance of past precedents.

• *Example 1:* Two questions to ask are: If a new control is being added, have other similar controls been installed in the same location on other versions of this flight deck? Are there any other differences that might cause new reach or clearance issues to emerge?

• *Example 2:* Determine whether the actual LCD ''glass'' in the new device is already certificated in similar installations. If so, there may be less concern about unacceptable reflectance characteristics. However, any unique characteristics of the lighting environment in the new installation may increase uncertainty.

3.f. *Assess design novelty.* In addition to the need to fully determine their compliance with existing rules, novel designs may require more rigorous evaluations to ensure that their novel features (not covered by current regulations) do not result in any new safety problems. *Note:* Any evaluations intended to identify such new safety problems, which might require the development of Special Conditions, should be accomplished as early in the project as possible. This will allow the FAA and the applicant to reach a common understanding of the issues, and to allow the applicant sufficient time to show compliance with any resultant Special Conditions.

3.g. *Review the proposed MOCs for each human factors rule and determine if, taken together, they adequately address the compliance issues that have been identified for the relevant systems.* There is no formula for this determination; it is based on the judgment of the FAA Certification Team. It is important to note that this step is not intended to determine if all potential human factors issues have been fully addressed. Instead, it is concerned only with determining if the proposed MOCs address the regulatory compliance issues, including those associated with Special Conditions.

3.h. *If the proposed MOCs do not fully address the human factors issues associated with compliance, determine if the level of effort needed for the MOC preferred by the FAA Certification Team is commensurate with the level of safety risk and the compliance uncertainty.* This step is also based on the judgment of the FAA Certification Team. The Team should carefully consider the regulation-specific issues and the design-specific issues to ensure that onerous MOCs are not demanded for simple, low-risk designs. The MOCs should focus on the compliance and safety issues, rather than on design optimization. However, applicants should be allowed to select (and justify) efficient and low cost MOCs, when appropriate. The applicant and the FAA Certification Team should strive for consensus on the MOCs. An open dialog is an important part of reaching that consensus.

Certification Documentation

This policy statement describes a number of issues that the FAA should consider when evaluating the applicant's proposed Human Factors MOCs. In most cases, it will be beneficial for the applicant to review this policy and use it to structure the explanation or justification for the selection of Human Factors MOCs for the certification project. The applicant may provide to the FAA the information supporting the proposed Human Factors MOCs in any format or media that is mutually agreeable to the applicant and the FAA Certification Team. In general, a formal document is not required, although the applicant may choose to record the information in the relevant Certification Plan(s) or in a separate document. Often, the most effective and efficient means to convey the rationale for the selected MOCs is to hold discussions between the applicant and the FAA. If this latter option is used, it is recommended that the discussion be documented and that the conclusions be jointly approved.

Additional guidance on this policy statement is provided in the following appendices:

• Appendix A: Partial List of 14 CFR part 25 Regulations Related to Human Factors Issues. (This same list was published in Policy Statement No. ANM–99–2. It contains detailed description of the regulation-specific issues, and cites relevant Advisory Circulars.)

• Appendix B: Related Documentation.

• Appendix C: Sample Human Factors Methods of Compliance Briefing.

• Appendix D: The Use of Design Evaluations to Support the Certification Process.

Appendix A—Partial List of 14 CFR Part 25 Regulations Related to Human Factors Issues

This appendix provides a list of current regulations that are related to human factors issues. The list is divided into the following three categories:

1. *General Human Factors Requirements:* Rules that deal with the acceptability of the flight deck and flightcrew interfaces across a variety of systems/features.

2. *Specific Human Factors Requirements:* Rules that deal with the acceptability of a specific feature or function in the flight deck.

3. *Specific Crew Interface Requirements:* Rules that mandate a specific system feature that must be implemented in an acceptable manner.

This list does not include all regulations associated with flightcrew interfaces. However, those listed represent some of the requirements for which demonstrating compliance can be problematic. In some cases, where only subparagraphs are noted, they have been paraphrased for clarity. However, the FAA Certification Team should ensure that the applicant refers to the exact wording of the regulation in all plans and compliance documents.

Where there is associated advisory material, it is cited. In many other cases, there may be no explicit guidance on methods of compliance (MOC). Therefore, it is important for the FAA Certification Team to carefully consider the applicant's proposed MOCs and attempt to come to agreement with the applicant. Rather than specifying an acceptable MOC for any given project, which is the function of advisory material, the information that is provided below for each rule is intended to identify issues that should be considered when reviewing the applicant's proposed MOC. Following each regulatory requirement are the following subsections, where appropriate:

1. *General discussion* of the regulation and issue.

2. *Key questions* to be asked or considered by the FAA Certification Team in order to help identify the MOC issues associated with the requirement. These regulation-specific questions assist the Certification Team to ensure that the applicant has tailored the MOCs to the potential human factors issues for the design being considered. The questions help provide focus on some of the features of designs and the way the flightcrew will use them that typically result in concerns about how to show compliance with the requirement. These lists are not all-encompassing. Rather, they are intended to stimulate the review process and lead to additional questions that are unique to the features of the specific designs. As new technologies emerge, the issues may change and new questions will need to be asked in order to identify the human factors issues related to the requirement.

3. *Design-related factors*, such as those listed below, are included when appropriate to point out other more generic issues relevant to the MOC for the requirement:

- Novelty and past experience;
- Degree of integration and independence;
- Complexity or Level of automation;
- Criticality;
- Dynamics;
- Level of training required; and
- Subjectivity of acceptance criteria.

It is important to remember that, for the purposes of this policy statement, the information is directed at reviews of the proposed MOCs, not the acceptability of the design itself. More specifically, the focus is on the general types of MOCs that the applicant has proposed. Details of how the compliance assessments are to be conducted (for example, the test designs, and the types of subjects) or the criteria for compliance (i.e., acceptance criteria) are not included. These topics will be the subjects of future policy statements. For example, this appendix discusses whether or not simulation would be appropriate for showing compliance with a given requirement; it does not discuss how the simulator should be used, what data should be collected, or how to determine whether or not the design is acceptable based on the data.

Note that none of the regulations listed below are associated with airplane handling qualities. While such rules obviously have human factors implications, they have traditionally been the responsibility of aeronautical engineers, control system designers, and test pilots. The applicant may, if it so chooses, include such regulations in the Human Factors Certification Plan. However, the methods of compliance are discussed in flight test advisory material and FAA orders, and are outside the purview of this policy statement.

1. General Human Factors Requirements

Section 25.771(a) [at amdt. 25–4]: ''Each pilot compartment and its equipment must allow the minimum flightcrew to perform their duties without unreasonable concentration or fatigue.''

Discussion: The FAA Certification Team should carefully consider the aspects of the flightcrew interface that might require significant or sustained mental or physical effort, or might otherwise result in fatigue. Other factors affecting fatigue, such as noise and seat comfort, may also need to be evaluated. When reviewing the applicant's proposed MOC, the FAA Certification Team should consider the expected sources of fatigue, as well as how and when that fatigue is likely to manifest itself. Applicants have often successfully used comparisons to previously certificated designs, although testing may be warranted for new flightcrew interface designs or functions.

Questions that the FAA Certification Team should ask the applicant when identifying the human factors-related MOC issues are discussed in Table A–1.

TABLE A–1.—§ 25.771(a): QUESTIONS TO IDENTIFY HUMAN FACTORS ISSUES

Question	Discussion
Are there any controls that will require significant peak or sustained muscular exertion.	If the applicant chooses to perform analyses as a way to provide data in support of compliance, the FAA Certification Team should review any strength data and analysis methods to ensure that they can be generalized to the flight deck controls in question.
Are there any displays that will require sustained attention	The FAA Certification Team may determine that the ability to time-share attention to the displays may require testing in a full simulation or in flight, in order to replicate the other tasks. In some cases, it may be possible to measure task performance, but subjective assessments are more frequently used and are likely to be more practical.
Are there any pilot actions that will require sustained mental concentration, especially during high workload flight phases, other than that required as part of normal flying skills.	Simulation and/or flight testing, using subjective measures, are typically proposed for such issues, due to the complex interactions between the various flightcrew tasks.
Is this aircraft intended primarily for low cycle rate, long haul operations, or for high cycle rate, short haul operations.	The effects of multiple cycles per crew per day or long duration flights may need to be factored into MOCs.
Is this a new or modified seat design	It may be appropriate to determine that a new seat design should be tested for long-term comfort, to the extent that discomfort is expected to add to fatigue.
Are there functions of time-shared displays or controls that increase pilot workload.	In some cases, the FAA Certification Team may accept analysis intended to show that there is sufficient time available to use the display for multiple purposes (for example, maintenance display functions time-shared with navigation). However, in many other cases, that information is likely to be usable only as supporting data that must be verified in simulation or flight test, depending on the functions being time-shared and the critical scenarios.

Other factors to consider when reviewing the MOC are discussed in Table A–2.

TABLE A–2.—§ 25.771(a): FACTORS TO CONSIDER

Issue	Discussion
Complexity/Level of automation	Navigating though complex menu trees and deciphering or predicting operating modes for complex automation can lead to high concentration and memory demands. These demands can be especially significant if they occur during high stress or workload portions of the flight (for example, during non-normal conditions, severe weather, etc.). System description information, and an analysis of menu complexity and function accessibility, if provided by the applicant, can yield useful supporting data. However, as complexity and level of automation increases, the need for demonstrations and tests increases.
Criticality	A high demand for concentration, especially on a single issue during a critical flight situation, has been shown to result in ''attention tunneling'' or ''channelized attention'' (focusing of attention on one task to the extent that other important tasks receive little or no attention). This phenomenon has been implicated in numerous accidents. The FAA Certification Team should ensure that the proposed MOCs cover such critical situations, if they exist.
Subjectivity of acceptance criteria	Currently available and accepted methods for assessing concentration and mental fatigue usually involve subjective assessment, although certain applicants have employed physiological methods as methods to collect supporting data. It is often useful to compare the proposed design with previously certificated designs that have been shown in service to result in acceptable levels of concentration and fatigue.

Section 25.771(e) [at amdt. 25–4]: ''Vibration and noise characteristics cockpit equipment may not interfere with safe operation of the airplane.''

Discussion: When reviewing the proposed MOC, the FAA Certification Team should ensure that the applicant has carefully considered the types and magnitudes of vibration and noise that may be present under both normal and abnormal conditions. Then, the tasks that may be affected by vibration (for example, display legibility and the operation of controls) and noise (for example, communication and identification of aural alerts) should be identified. Additionally, the methods that could be used to determine whether the vibration or noise will unacceptably interfere with safe operation of the airplane should be identified.

Unfortunately, there are no widely used and accepted vibration standards or testing methods which directly address whether or not pilots will be able to safely operate the airplane under the expected vibration conditions. Existing standards for workplace vibration primarily focus on injury to the worker after long periods of exposure (days, weeks, months), rather than on the ability to perform the required tasks (i.e., continued safe flight and landing).

Actual testing of pilots in representative vibration environment with actual flight deck equipment (seats, controls, displays) can be extremely involved and expensive, especially if an applicant were to be required to develop a test facility with which the pilots could interact as with the actual airplane. The duration of the tests may also present a problem—it may be difficult to find a group of pilots willing to sit on a shaker table for the maximum duration of an extended twin-engine operation (ETOPS) diversion. As a result, showing compliance with this rule can be especially problematic.

Questions to ask when identifying the human factors-related compliance issues are discussed in Table A–3.

TABLE A–2.—§ 25.771(e): QUESTIONS TO IDENTIFY HUMAN FACTORS ISSUES

Question	Discussion
Are there any controls requiring precise dexterity to operate (for example, cursor control devices, touch screens, etc.).	In some cases, the devices may already be in service for non-essential functions. More thorough testing may be warranted if the devices are to be used for essential or critical functions.
Are there fine details of displays that must be interpreted during turbulence or vibration conditions.	(Self-explanatory.)
What are the characteristics (frequency, acceleration, amplitude) of the expected engine fan blade-loss vibrations or other expected vibratory modes.	Are the vibration frequencies the same as any relevant body resonant frequencies (hand, arm, eye, head, abdomen, etc.)? If the pilots are not likely to be exposed to frequencies at body resonances, then testing may not be needed.
To what extent will the seat design dampen or amplify the vibrations that are transmitted from the seat structure, through the seat cushion, to the pilot.	Relatively minor changes to seat cushion design can significantly affect the transmission of vibrations to the pilot. Such changes may warrant testing, especially if frequencies at known body resonances are expected to be present at the seat pan.

Other factors to consider when reviewing the MOC are discussed in Table A–4.

TABLE A–4.—§ 25.771(e): FACTORS TO CONSIDER

Issue	Discussion
Novelty/past experience	Conventional controls, such as pushbuttons and rotary knobs can generally be shown to be compliant via similarity, providing that they have conventional characteristics (size, force/friction, tactile feedback) and the vibration environment is not expected to be severe (see discussion above).
Criticality	Are the tasks that require a high degree of visual resolution or manual dexterity likely to be critical to continued safe flight and landing in situations that result in flight deck vibration? Such a condition may warrant testing, if the controls/displays are non-conventional or if the vibration is expected to be unusual.
Subjectivity of acceptance criteria	Analysis and testing of components could be used to show that no significant vibration problems are present. However, in cases that cannot be clearly disposed of through similarity or analysis, the FAA Certification Team may wish to request testing with human subjects. There is no standardized and accepted subjective measurement method for this requirement. As of the time of publishing this policy statement, the only certification evaluations in an actual vibratory environment have involved a subjective assessment of the acceptability of the vibration, after a short duration exposure.

Other factors relative to finding compliance with § 25.771(e) are:

1. Improved MOCs and standards for this requirement are being considered for development. As the FAA and applicants become more experienced in dealing with

this issue, the FAA will provide more information on MOCs.

2. The FAA Aircraft Certification Offices (ACO) should use care when assessing the proposed MOCs, due to the difficulty and cost of doing full-scale testing. The ACOs should work closely with the applicant to develop sufficient evidence to make a supportable determination regarding the need for such testing.

Section 25.773(a)(1) [at amdt. 25–72]: ''Each pilot compartment must be arranged to give the pilots sufficiently extensive, clear, and undistorted view, to enable them to safely perform any maneuvers within the operating limitations of the airplane, including takeoff, approach, and landing.''

Discussion: The applicant should carefully consider the methods of compliance described in Advisory Circular (AC) 25.773–1, ''Pilot compartment View for Transport Category Airplanes,'' dated January 8, 1993.

Section 25.773(a)(2) [at amdt. 25–72]: ''Each pilot compartment must be free of glare and reflections that could interfere with the normal duties of the minimum flightcrew.''

Discussion: The applicant may be able to develop analytical techniques that identify potential sources of glare and reflections, as a means for reducing the risk of problems identified after the major structural features have been committed. Mock-ups also may be a useful means for early assessments. However, analysis results typically should be verified in an environment with a high degree of geometric and optical fidelity. Both internal sources of reflections (for example, area and instrument lighting) and external sources of reflection (for example, shafting sunlight) so should be considered. Compliance can be greatly affected by the relative geometry of the reflective surfaces (windows, glass instrument faces, etc) and the direct/indirect light sources (instrumentation, area lighting, white shirts, etc). In addition, the reflective characteristics of the surfaces (windows, instruments) can vary greatly with material and manufacturing processes. Therefore, it is important that those surfaces are representative of those that will be present in the airplane.

Factors to consider when reviewing the MOC are listed in Table A–5.

TABLE A–5.—§ 25.773 (a)(2): FACTORS TO CONSIDER

Issue	Discussion
Degree of integration/independence	This means that testing or evaluations usually must be conducted using an environment with accurate geometry.
Criticality	If reflections are likely to be present in the forward windshield, they must be carefully evaluated for the possibility of interference with external visual scanning during critical phases of flight (especially takeoff and landing). Similarly, potential reflections on primary flight displays or other important display surfaces should get special attention.
Subjectivity of acceptance criteria	Even though objective standards for reflectivity do not exist, the FAA Certification Team should encourage applicants to measure the intensity of reflections as an objective means for comparison with existing designs.

Section 25.777(a) [at amdt. 25–46]: ''Each cockpit control must be located to provide convenient operation and to prevent confusion and inadvertent operation.''

Discussion: While applicants sometimes use physical mock-ups for preliminary evaluations, such devices often have insufficient fidelity to allow findings of compliance. Simulators, if available, provide a more powerful evaluation environment, because they allow the evaluation to take place in a flight scenario that may influence convenience and inadvertent operation. Simulator evaluations also may reduce the need for flight testing.

Questions to ask when identifying the human factors-related compliance issues are discussed in Table A–6.

TABLE A–6.—§ 25.777(a): QUESTIONS TO IDENTIFY HUMAN FACTORS ISSUES

Question	Discussion
Are there situations in which a pilot will be required to reach across the centerline of the flight deck to operate controls on the other side (for example, the landing gear handle).	Are there other circumstances where the pilot will need to reach past prominent controls in order to accomplish flight deck tasks, whether or not those tasks are ''required'' for operation of the airplane (for example, reaching for something stowed behind a seat, or reaching for food from the flight attendant)? Such cases may provide justification for the FAA Certification Team to request specific evaluations using computer modeling, mock-ups, the flight simulators, and/or the airplane.
Are there safety consequences if the pilot inadvertently activates a similar control that is in proximity to the control in question.	If safety is not a significant issue, and if the error will be obvious and easy to correct, then the MOCs necessary to fully evaluate the possibility of confusion may be reduced.

Factors to consider when reviewing the MOC are discussed in Table A–7.

TABLE A–7.—§ 25.777(a): FACTORS TO CONSIDER

Issue	Discussion
Complexity/Level of automation	The proposed MOC should address the ease of use and inadvertent operation of control functions that are accessed through menu logic.
Criticality	Determine if the controls for which inadvertent operation has significant safety implications have appropriate guards or other means of protection. Such safeguards typically reduce both inadvertent operation and convenience, so the proposed evaluations should include both aspects.

Section 25.777(c) [at amdt. 25–46]: ''The controls must be located and arranged, with respect to the pilot's seats, so that there is full and unrestricted movement of each control without interference from the cockpit structure or the clothing of the minimum flightcrew when any member of this flightcrew, from 5′2″ to 6′3″ in height, is seated with the seat belt and shoulder harness fastened.''

Discussion: While this rule directly addresses body height, other body dimensions, such as sitting height, sitting shoulder height, arm length, hand size, etc, can have significant effects on the geometric acceptability of the flight deck for pilots within the specified height range. These other dimensions do not necessarily correlate well with height or with each other. The MOC should reasonably account for these variables. The applicant may choose to use analytical methods, such as computer modeling of the flight deck and the pilots, for early risk reduction and to supplement certification evaluations using human subjects. Computer modeling allows for more control over the dimensions of the pilot model, and thus, may allow the assessment of otherwise unavailable combinations of body dimensions.

The FAA Certification Team should carefully consider the advantages and limitations of each of these methods when assessing the applicant's proposal to use such data in support of findings of compliance. In addition, the FAA Certification Team should usually require final verification in the airplane, because even simulators rarely reproduce all of the aspects of the flight geometry that may be relevant to this requirement.

Section 25.1301(a) [original amdt.]: ''Each item of installed equipment must be of a kind and design appropriate to its intended function.''

Discussion: The applicant might propose a number of methods for showing compliance with this requirement, with respect to human factors. For example, service experience may be an effective means for assessing systems with well-understood, successful crew interfaces, assuming that other factors, such as changes in the operational environment, do not affect the relevance of that experience. System descriptions can be used to define the intended functions of the systems, along with those of the components or other elements of the system (for example, the intended function of each piece of data on a display). Various requirements analysis techniques can be used to show that the information that the pilot needs to perform key tasks is available, usable, and timely. Simulation may be used to verify that properly trained pilots can adequately perform all required tasks, using the controls and displays provided by the design, in realistic scenarios and timelines. Finally, flight tests can be used to investigate specific normal and abnormal operational scenarios to show that the system adequately supports the pilots' tasks, in accordance with the stated intended functions. For additional guidance on electronic display systems, see FAA AC 25–11, Transport Category Airplane Electronic Display Systems,'' dated July 16, 1987,'' sections 6 and 7, as appropriate.

Section 25.1309(b)(3) [at amdt. 25–41]: ''* * * Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors that could create additional hazards.''

Discussion: The applicant may propose analyses of crew procedures in response to system faults. This can be especially useful in cases where the applicant wishes to take certification credit (for example, in a fault tree analysis) for correct pilot response to a system failure. A crew procedure analysis could be supported by qualitative evaluations that compare actual procedures to procedure design philosophies by developing measures of procedure complexity, or by other techniques that focus on procedure characteristics that impact the likelihood of crew errors. Simulation testing can be helpful in demonstrating that the design is not prone to crew errors.

Section 25.1321(a) [at amdt. 25–41]: ''Each flight, navigation, and powerplant instrument for use by any pilot must be plainly visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he is looking forward along the flight path.''

Discussion: The applicant may wish to perform analyses of the visual angles to each of the identified instruments. Final assessments of the acceptability of the visibility of the instruments may require a simulator with a high degree of geometric fidelity and/or the airplane. For more information on electronic display systems, see FAA AC 25–11, section 7, as appropriate.

Section 25.1321(e) [at amdt. 25–41]: ''If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.''

Discussion: Demonstrations and tests intended to show that these indications of instrument malfunctions, along with other indications and alerts, are visible under the expected lighting conditions will typically use production quality hardware and careful control of lighting conditions (for example, dark, bright forward field, shafting sunlight). Simulators and aircraft are often used, although supporting data from laboratory testing also may be useful.

Section 25.1523 [at amdt. 25–3]: ''The minimum flightcrew must be established so that it is sufficient for safe operation, considering:

(a) The workload on individual crewmembers;

(b) The accessibility and ease of operation of necessary controls by the appropriate crewmember; and

(c) The kind of operation authorized under § 25.1525.''

Discussion: The criteria used in making the determinations required by this section are set forth in Appendix D of 14 CFR part 25. For additional information, see:

- AC 25.1523–1, ''Minimum Flightcrew,'' dated February 2, 1993; and
- AC 25–11, section 5.b.

Section 25.1543(b) [at amdt. 25–72]: ''Each instrument marking must be clearly visible to the appropriate crewmember.''

Discussion: The applicant may choose to use computer modeling to provide preliminary analysis showing that there are no visual obstructions between the pilot and the instrument markings. Where head movement is necessary, such analyses also can be used to measure its magnitude. Other analysis techniques can be used to establish appropriate font sizes, based on research-based requirements. Mock-ups also can be helpful in some cases. The data collected in these analysis and assessments are typically used to support final verification in the flight deck, using subjects with vision that is representative of the pilot population, in representative lighting conditions. For more information on electronic display systems, see AC 25–11, sections 6 and 7, as appropriate. For more information on marking of power plant instruments, see AC 20–88A, ''Guidelines on the Marking of Aircraft Powerplant Instruments (Displays),'' dated 9/30/85.

2. Specific Human Factors Requirements

Section 25.785(g) [at amdt. 25–88]: ''Each seat at a flight deck station must have a restraint system * * * that permits the flight deck occupant, when seated with the restraint system fastened, to perform all of the occupant's necessary flight deck functions.''

Discussion: The applicant may choose to develop a list of what it considers to be necessary flight deck functions, under normal and abnormal conditions. Methods similar to those used to show compliance with § 25.777 also may be appropriate for this paragraph, with the additional consideration of movement constraints imposed by the full restraint system.

Factors to consider when reviewing the MOC are discussed in Table A–8:

TABLE A–8.—§ 25.785(g): FACTORS TO CONSIDER

Issue	Discussion
Dynamics	If the restraint system could lock-up during turbulence or vibration, and thus restrict reach, the MOC may need to include evaluations under these conditions.

Section 25.785(l) [at amdt. 25–88]: ''The forward observer's seat must be shown to be suitable for use in conducting the necessary enroute inspections.''

Discussion: The applicant may choose to develop a set of requirements (for example, what must be seen and reached) based on the expected tasks to be performed by an inspector. The FAA Certification Team personnel may wish to consult with FAA Flight Standards personnel to validate these requirements. Computer-based analysis and/or mock-ups can be used to develop supporting data (for example, visibility of displays); evaluation of enroute inspection scenarios can be used to verify that all required tasks can be performed. Since the geometric relationship between the observer's seat and the rest of the flight deck (including the pilots) is important, the evaluations often must occur in the actual airplane.

Section 25.1141(a) [at amdt. 25–72]: ''Each powerplant control must be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally in the cockpit.''

Discussion: This type of assessment typically requires at least a physical mock-up, due to limitations in the ability to adequately model ''normal'' movement in the cockpit. Evaluations should be designed:

- To include cases in which the pilots must reach across the area surrounding the powerplant controls; and
- To look for places where pilots will naturally place their hands and feet during ingress and egress, and during cruise.

Subjective assessments by the FAA Designated Engineering Representative (DER) or FAA pilots would be the most typical method for assessing the likelihood and seriousness of any inadvertent operation of the powerplant controls.

Section 25.1357(d) [original amdt.]: ''If the ability to reset a circuit breaker or replace a fuse is essential to safety during flight, that circuit breaker or fuse must be located and identified so that it can be readily reset or replaced in flight.''

Discussion: The applicant may choose to use methods similar to those employed for § 25.777 to demonstrate the ability of the pilot to reach the specific circuit protective device(s). The applicant also should consider how to evaluate the ability of the pilot to readily identify the device(s), whether they are installed on a circuit breaker panel or controlled using an electronic device (i.e., display screen on which the circuit breaker status can be displayed and controlled).

A necessary question to ask when identifying the human factors-related compliance issues is discussed in Table A–9.

TABLE A–9.—§ 25.1357(d): QUESTIONS TO IDENTIFY HUMAN FACTORS ISSUES

Question	Discussion
Are there any crew procedures which require the flightcrew to reset a circuit breaker or replace a fuse.	If not, it may be reasonable for an applicant to state this and to provide verification via published flightcrew specific procedures.

Section 25.1381(a)(2) [at amdt. 25–72]: ''The instrument lights must be installed so that * * * (ii) no objectionable reflections are visible to the pilot.''

Discussion: See the discussion of § 25.773(a), above.

3. Specific Crew Interface Requirements

Section 25.773(b)(2)(i) [at amdt. 25–72]: ''The first pilot must have a window that is openable * * * and gives sufficient protection from the elements against impairment of the pilot's vision.''

Discussion: While the applicant may perform analyses to show the visual field through the openable window, due to the nature of the task (landing the airplane by looking out the opened window), it is likely that a flight test would be the most appropriate method of compliance. Assessment of the forces required to open the window under flight conditions also may be needed.

Section 25.1322 [at amdt. 25–38]: ''If warning, caution, or advisory lights are installed in the cockpit, they must, unless otherwise approved by the Administrator, be—

(a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action);

(b) Amber, for caution lights (lights indicating the possible need for future corrective action);

(c) Green for safe operation lights; and

(d) Any other color, including white, for lights not described in paragraphs (a) through (c) of this section, provided the color differs sufficiently from the colors prescribed in paragraphs (a) through (c) of this section to avoid possible confusion.''

Discussion: Compliance with this requirement is typically shown by a description of each of the warning, caution, and advisory lights (or their electronic equivalents). Evaluations may also be useful to verify the chromaticity (for example, red looks red, amber looks amber) and discriminability (i.e., colors can be distinguished reliably from each other) of the colors being used, under the expected lighting levels. These evaluations can be affected by the specific display technology being used, so final evaluation with flight quality hardware is sometimes needed. A description of a well-defined color coding philosophy which is consistently applied across flight deck systems can be used to show how the design avoids ''possible confusion''. For additional information, see AC 25–11, section 5.a.

Appendix B—Related Documents

1. *Advisory Circulars (AC):* The specified sections of the ACs listed below concern selecting a method of compliance (test, inspection, simulation, etc.), rather than identifying specific design features that will generally be accepted as compliant.

a. AC 25.1309–1B, ''System Design and Analysis'' [draft]: This AC identifies certain human factors assessments that should be done as part of the overall safety assessments intended to show compliance with § 25.1309. Section 9 (subparagraphs on ''Crew and Maintenance Actions'') provides some information on determining if failure indications are considered to be recognizable, and if the required actions cause an excessive workload.

b. AC 25–11, ''Transport Category Airplane Electronic Display Systems,'' dated July 16, 1987: This AC applies to systems using cathode ray tube (CRT)-based technology, but the FAA plans to update it to cover other display technologies [for example, liquid crystal displays (LCD)]. The AC is used to support compliance with a number of regulations, including the following, also cited in this policy statement, that are related to human factors aspects of the flightcrew interfaces:

- § 25.771, Pilot compartment.
- § 25.777, Cockpit controls.
- § 25.1141, Powerplant controls: general.
- § 25.1301, Equipment: Function and installation.
- § 25.1309, Equipment, systems, and installations.
- § 25.1322, Warning, caution, and advisory lights.
- § 25.1381, Instrument lights.
- § 25.1523, Minimum flightcrew.
- § 25.1543, Instrument markings: general.

Several sections of AC 25–11 identify display system characteristics that can be verified by inspection. The information provided in the following sections of the AC may be useful in assessing the applicant's other proposed evaluation methods:

- *Section 4.b.(1): General Certification Considerations, Compliance Considerations, Human Factors.* This section includes a discussion of the use of simulation and in-flight evaluations.
- *Section 6.: Display Visual Characteristics.* Various subsections of this section contain guidance on evaluation and test conditions and methods.

c. AC 20–88A, ''Guidelines on the Markings of Aircraft Powerplant Instruments (Displays),'' dated September 30, 1985: This AC provides information related to marking of aircraft powerplant instruments and electronic displays (cathode ray tubes, etc.). The AC is used to support compliance with a number of regulations, including the following, that are related to human factors aspects of the flightcrew interfaces:

- § 25.1541, Placards and markings: General.
- § 25.1543, Instrument markings: General.
- § 25.1549, Powerplant and auxiliary power unit instruments.

d. AC 25.1523–1, ''Minimum Flightcrew,'' dated February 2, 1993: This AC provides information related to compliance with § 25.1523 and Appendix D of 14 CFR part 25, which contain the certification requirements for the minimum number of flightcrew personnel on transport category airplanes.

e. AC 25.773–1, ''Pilot Compartment View Design Considerations,'' dated January 8, 1993: This AC defines a method for determining the clear view area of the flight deck windows. In practice, this approach can be carried out using direct measurements of an actual flight deck (or high fidelity physical flight deck), or using computer analysis of a 3-D computer aided design (CAD) model of the flight deck. Referenced in this AC is Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 4101/2 (which replaced AS 580B), ''Pilot Visibility from the Flight Deck,'' dated February 1989.

2. Other References

a. Technical Report DPT/FAA/RD–93/5, ''Human Factors for Flight Deck Certification Personnel,'' dated July 1993, which can be ordered through the National Technical Information Service (http://www.ntis.gov/): Key chapters of this document include:

- *Chapter 8:* Timesharing, Workload, and Human Error.
- *Chapter 11:* Workload Assessment.
- *Chapter 12:* Human Factors Testing and Evaluation.

Appendix C—Sample Human Factors Methods of Compliance Briefing

This sample briefing is intended to provide examples of the types of information that could be included in such a briefing. Keep the following in mind while reviewing it:

- It is based on a *totally hypothetical* certification program, and no connection to any real system or certification program is intended or implied. For more information on this hypothetical program, see the FAA policy on human factors certification plans, contained Appendix C of Policy Statement No. ANM–99–2. The extracts from the human factors certification compliance matrix contained in this policy statement are drawn from that appendix.

• This sample briefing should not be considered comprehensive. The examples are intended to be illustrative, but do not necessarily include all of the issues, even for the hypothetical program.

• The methods of compliance are intended to show the methods that a hypothetical applicant might have proposed for the project. It should not be construed as describing an acceptable list of methods for any real program. Such methods would have to be discussed and agreed upon within the context of a specific program.

• The ''Deliverable Products'' column in the compliance matrix identifies what the hypothetical applicant will produce to substantiate compliance. The titles of reports represent examples of how an applicant might choose to package the information.

• Finally, the sample briefing is not intended to specify the format of how this information is provided to the FAA; rather, it is meant to provide guidance only on an acceptable structure and recommended content. Alternative methods for providing this information are acceptable, such as adding it to the Certification Plan or providing it in a separate document. For large, complex projects, it could be a part of the overall project, without being a separate piece. The primary intent is to illustrate how an applicant could provide information to the FAA, explaining why and how the proposed methods of compliance are sufficient.

[Hypothetical]

Human Factors Certification Methods of Compliance for the Electronic Approach Chart System (EACS)

1. Introduction

a. Project: This project seeks a Supplemental Type Certificate (STC) for the installation of an Electronic Approach Chart System (EACS) in Guerin Model 522 airplanes. The intent of the EACS is to provide an alternative to the use of paper approach charts.

b. Installation: The ECAS will be installed so that it is physically and functionally integrated into the flight deck.

c. Data loading: System data will use existing on-board data loading capabilities.

d. System type: The EACS will be certified as a non-essential system.

2. System Description

a. Intended Function: The EACS uses a panel-mounted Active Matrix Liquid Crystal Display (AMLCD) to display approach charts for the pilots to use on the ground and in flight. The key functions include the following:

(1) *During the preflight preparation:*

(a) The pilot will use the system to call up and review the approach charts for the destination airport and selected alternates.

(b) The pilot will be able to ''mark'' the appropriate charts for quick retrieval later in the flight.

(c) If initiated by the pilot, the system will be able to query the Flight Management System (FMS) to pre-identify the appropriate charts, based on the flight plan.

(2) *During flight (normal operations):*

(a) The pilot will quickly access the pre-selected approach charts. Charts that were not pre-selected also will be accessible.

(b) The pilot will be able to manipulate the display of the chart to show only the information relative to the planned route of flight.

(c) The pilot will be able to select the appropriate approach parameters (transition, approach navigation aids, minimums, etc.) using the EACS. Upon pilot initiation, the EACS will load these selections into the other systems on the airplane [for example, the approach navaids will be sent to the FMS for autotuning, and decision height (DH) will be sent to the altitude alerting system and display system]. For a complete list of EACS functions, see the EACS System Description Document.

(3) *During flight (non-normal operations, i.e., requiring an emergency diversion):* In addition to those functions available for normal operations, the EACS provides the following functionality to support emergency diversions:

(a) When the pilot selects the ALTERNATE AIRPORT function on the FMS, the FMS automatically identifies the five nearest airports that meet the landing requirements for the airplane. These airports will be automatically transmitted to the EACS, which will preselect them (mark them for quick retrieval).

(b) At the pilot's request, the EACS will display a listing of the diversion airports and allow the pilot to quickly review the approach charts and select the desired approach. As in normal operations, this selection will be automatically transmitted to the FMS and other using systems.

Note: For more detail on the EACS, see the Human Factors Certification Plan and System Description Document.

3. Proposed Methods of Compliance

a. The following slides provide a discussion of the proposed Method of Compliance for each of the human factors rules identified in the EACS Human Factors Certification Plan.

b. The rules are organized into the following categories for discussion:

(1) Flightcrew workload.
(2) Noise and vibration.
(3) Internal/external vision.
(4) Flight deck lighting.
(5) Flight deck arrangement.
(6) System failures and alerting.
(7) Miscellaneous.

4. Simulator

a. A rudimentary PC-based simulator will be used for some evaluations.

b. The simulator has representative (generic) flight controls, autopilot, and performance models. (The EACS has no interaction with aircraft performance, so high fidelity is not needed.)

c. The simulator includes the same flight management computer (FMC) and main displays as the STC configuration. The EACS will be installed only on the captain's side in the simulator. Any evaluations requiring participation by both crew members will be conducted on the test airplane.

d. Installation geometry of the simulator is approximately equivalent to the actual installation. Any evaluations requiring accurate installation geometry will be conducted on the test airplane.

e. Because EACS does not interact with other airplane systems (pressurization, hydraulics, etc), those systems are not replicated in the simulator. It will be possible to fail the EACS, simulating an electrical bus failure.

f. The simulator will be used primarily to assess EACS/FMS interaction and to perform comparisons between use of paper charts and EACS.

5. Flightcrew Workload

Section [amdt.level]	Human factors requirements	Method(s) of compliance	Deliverable product
25.771(a) [at amdt. 25–4].	Each pilot compartment and its equipment must allow the minimum flightcrew to perform their duties without unreasonable concentration or fatigue.	• Analysis • Simulator evaluations • Flight test	Workload Certification Report.
25.1523 [at amdt. 25–3].	The minimum flightcrew must be established so that it is sufficient for safe operation, considering: (a) The workload on individual crewmembers; (b) The accessibility and ease of operation of necessary controls by the appropriate crewmember; and	• Simulator demonstration • Flight test	• Demonstration Report. • Flight Test Report.

Section [amdt.level]	Human factors requirements	Method(s) of compliance	Deliverable product
	(c) the kind of operation authorized under § 25.1525. The criteria used in making the determinations required by this section are set forth in Appendix D of 14 CFR part 25.		

a. The EACS functions are centered around the selection and review of approach charts. Although we do not anticipate any certification issues with respect to showing compliance with the above rules (workload reduction is a central goal for this system), we will perform a workload evaluation in order to show the benefits of the system.

b. Analysis will be used to identify all of the pilot activities associated with identification, retrieval, review, and use of the charts, along with any other tasks necessary for operation of the EACS.

c. Simulator evaluations or demonstrations will be used to measure task times and error rates for conventional charts and the EACS. Subjective measures of task difficulty and workload will be taken. Normal and non-normal scenarios will be included. Subjects will include DER and customer pilots.

d. Limited flight tests with FAA pilots will be used to confirm the analyses and simulator tests.

6. Vibration and Noise

Section [amdt.level]	Human factors requirements	Method(s) of compliance	Deliverable product
25.771(e) [at amdt. 25–4].	Vibration and noise characteristics of cockpit equipment may not interfere with safe operation of the airplane.	Flight test	Flight Test Report.

a. Controls are conventional in design and similar to other certificated systems:

(1) Function keys [similar to keys on current Master Control Display Unit (MCDU)].

(2) Touch screen [similar to certain Aircraft Communications Addressing and Reporting System (ACARS) units].

(3) Brightness control (conventional rotary knob).

b. The EACS is a supplemental system, so we suggest that full testing of usability in high vibration and turbulence is not required (pilot can revert to paper charts).

c. During flight test program, turbulence will be sought out for pilot subjective evaluations of EACS usability. However, certification will not be contingent upon testing in turbulence.

7. Internal/External Vision and Flight Deck Lighting

Section [amdt.level]	Human factors requirements	Method(s) of compliance	Deliverable product
25.773(a)(1) [at amdt. 25–72].	Each pilot compartment must be arranged to give the pilots sufficiently extensive, clear, and undistorted view, to enable them to safely perform any maneuvers within the operating limitations of the airplane, including takeoff, approach, and landing.	Similarity	Vision Certification Report.
25.1321(a) [at amdt. 25–41].	* * * Each flight, navigation, and powerplant instrument for use by any pilot must be plainly visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he is looking forward along the flight path.	• System description • Analysis • Flight test	• Installation Drawings • Vision Certification Report • Flight Test Report.
25.1543(b) [at amdt. 25–72].	Each instrument marking must be clearly visible to the appropriate crewmember.	Ground test	• Vision Certification Report • Ground Test Report.

a. Because this system will be fully integrated into the existing instrument panels, external vision will be unaffected by the installation.

b. Because all pilots are intended to position themselves at the Design Eye Reference Point (DERP), there will be little pilot-to-pilot variability with respect to the visibility of the display. Thus, visibility will be easily confirmed during flight test. Risk for this installation is expected to be very low.

c. The visual angles from the DERP to the EACS will be determined and compared to other display systems, as well as the clipboard where pilots currently place their paper charts.

d. Readability will be assessed (using a questionnaire) in the airplane during ground testing, concurrently with the lighting tests. This will allow evaluation of readability under all expected lighting conditions.

8. Flight Deck Lighting

Section [amdt.level]	Human factors requirements	Method(s) of compliance	Deliverable product
25.773(a)(2) [at amdt. 25. 72].	Each pilot compartment must be free of glare and reflections that could interfere with the normal duties of the minimum flightcrew.	Ground test	Lighting Certification Report.
25.1321(e) [at amdt. 25–41].	If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.	• Similarity • Flight test • Ground test	• System Description and Statement of Similarity. • Flight Test Report.
25.1381(a)(2) [at amdt. 25–72].	The instrument lights must be installed so that (ii) no objectionable reflections are visible to the pilot.	Ground test	Flight Test Report.

a. This system uses a conventional normally white Active Matrix Liquid Crystal Display (AMLCD) display.

b. The AMLCD is provided by a vendor who has produced similar display glass for other previously certificated flight deck systems.

c. In general, visibility/lighting risk should be low for this display.

d. Ground tests will cover the following lighting cases:

(1) Night (windows will be covered), and

(2) Shafting sunlight (using a hand held spotlight).

e. Flight tests will cover the following lighting cases:

(1) Bright forward field (flying into brightly lit clouds), and

(2) Bright forward point light source (flying toward the sun).

f. Reflections that might be caused by the EACS, or that might be present on the EACS display, will be assessed subjectively during the ground test.

9. Flight Deck Arrangement

Section [amdt.level]	Human factors requirements	Method(s) of compliance	Deliverable product
25.777(a) [at amdt. 25–46].	Each cockpit control must be located to provide convenient operation and to prevent confusion and inadvertent operation.	• Ground test • Flight test	Flight Deck Anthropometry Certification Report.
25.777(c) [at amdt. 25–46].	The controls must be located and arranged, with respect to the pilot's seats, so that there is full and unrestricted movement of each control without interference from the cockpit structure or the clothing of the minimum flightcrew when any member of this flightcrew, from 5′2″ to 6′3″ in height, is seated with the seat belt and shoulder harness fastened.	Ground test	Flight Deck Anthropometry Certification Report.

a. Reach to the EACS will be shown by using a representative sample of people within the required height range.

b. Ground tests will show that the EACS does not interfere with use of the nose wheel steering tiller and oxygen masks (the only controls in the vicinity of the EACS).

10. Miscellaneous:

Section [amdt.level]	Human factors requirements	Method(s) of compliance	Deliverable product
§ 25.1309(b)(3) [at amdt. 25–41].	. . . Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors that could create additional hazards.	÷ Hazard assessment • Simulator demonstration	• Fault Tree Analyses. • Demonstration Report.
§ 25.1322 [at amdt. 25–38].	If warning, caution, or advisory lights are installed in the cockpit, they must, unless ortherwise approved by the Administrator, be— (a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action); (b) Amber, for caution lights (lights indicating the possible need for future corrective action); (c) Green for safe operation lights; and (d) Any other color, including white, for lights not described in paragraphs (a) through (c) of this section, provided the color differs sufficiently from the colors prescribed in paragraphs (a) through (c) of this section to avoid possible confusion.	Configuration description	System Description Document.

Section [amdt.level]	Human factors requirements	Method(s) of compliance	Deliverable product
§ 25.773(b)(2)(i)[at amdt. 25–72].	The first pilot must have a window that is openable * * * and gives sufficient protection from the elements against impairment of the pilot's vision.	Ground test (to verify no interference with window opening)	Flight Test Report.
§ 25.1301(a) [original amdt.].	Each item of installed equipment must be of a kind and design appropriate to its Document intended function.	• System description • Simulator demonstration	Flight test • System Description Document. • Demonstration Report. • Flight Test Report.

a. Regarding § 25.1309(b)(3):

(1) The EACS failure annunciations, along with their associated crew procedures, will be demonstrated in the simulator.

(2) The annunciation, data transfer inhibits, and crew procedures are very simple and straight-forward. We believe this to be a very low risk issue.

b. Regarding § 25.1301(a):

(1) A checklist of all functions (listed in the System Description Document) involving flightcrew interfaces will be developed.

(2) The DER and FAA pilots will use this checklist throughout the demonstration and test program to verify that all intended functions are satisfactorily implemented.

Appendix D—Information on the Use of Applicant-Conducted Human Factors Evaluations, Assessments, and Analyses in Support of Certification

1. What Are the Benefits of Evaluations?

The FAA recognizes the benefits of early and continuing human factors evaluations, assessments, and analyses (from here on referred to as ''evaluations'') during the applicant's design process. Such evaluations have several potential benefits:

a. *Human factors or flight crew interface problems can be identified in a timely manner,* so changes can be made with acceptable technical, schedule, and economic impacts. This can help foster better designs with fewer certification risks and fewer last minute design changes. Design changes that are incorporated early also are more likely to be well-integrated into the design, rather than quick ''patches'' needed to ''plug holes.''

b. *Good aspects of the design can be confirmed early,* which can increase applicant and FAA confidence. Such confidence, especially with respect to human factors issues, can reduce the amount of more costly testing (especially flight testing).

c. *Cooperation between the FAA and the applicant* on these evaluations can give the FAA more overall confidence in the applicant's methods and processes with respect to human factors issues.

d. *The applicant may choose to conduct evaluations using a variety* of pilots, with different backgrounds and levels of experience. Such tests and evaluations can provide valuable insights into how the well the airplane or system will function with line pilots.

2. Are Evaluations Required?

While such human factors evaluations are not required by current FAA regulations or advisory material, many applicants routinely perform them as part of their normal design development processes. The FAA should encourage all applicants to conduct such evaluations, when warranted by the nature of the design being developed. This policy does not establish any new requirements for such evaluations. Instead, the FAA wishes to provide incentives by establishing an explicit process by which applicants can use these evaluations to reduce certification risk if they choose to do so.

3. Are Evaluations Necessary To Show Compliance?

These evaluations, in and of themselves, should never be considered to be necessary or sufficient to show compliance with the regulations. However, in situations where compliance or non-compliance is not obvious and clear-cut, applicants may wish to use such data to support compliance decisions. The FAA personnel should take note of the results of evaluations presented for consideration by applicants, providing that the FAA agrees the results are relevant to the compliance findings.

4. How Should the Evaluations Be Conducted?

Because these evaluations can take a variety of forms, the FAA and the applicant should discuss them fully to understand the capabilities and limitations of the evaluations and the conclusions that can be drawn from them.

This policy will not establish a specific set of recommendations for these evaluations. The requirements for any specific evaluation that an applicant might propose would be influenced by several factors, including those listed as follows. The FAA and applicant should discuss these factors.

- The level of similarity between the tested flightcrew interface (including displays, controls, procedures, system performance) and the expected characteristics of the system (hardware and software) that will be certified.
- The areas of certification risk related to human factors. The design characteristics and the related regulations should both be considered.
- The pilots (or others) that will be used in the evaluations.
- The types of data that will be collected (objective vs. subjective, performance vs. opinion).
- The types of conclusions that the applicant hopes to derive, based on the evaluations.

5. When Should the Evaluation Be Planned and Coordinated With the FAA?

It would be desirable for the applicant to identify the types of evaluations that will be conducted when certification planning is in progress, if the applicant wishes to use such evaluations as part of their overall data collection effort in support of certification. Applicants should be encouraged to discuss in some detail with the FAA the evaluations they are developing. In most cases, it is appropriate for FAA personnel to ask for an opportunity to review the tested configuration and the test scenarios. This will allow the FAA personnel to determine whether the evaluations are appropriate and relevant for the compliance issues under consideration.

However, the FAA recognizes that such evaluations may be conceived and planned later during the development cycle. In such cases, it is acceptable for the applicant to communicate such plans to the FAA as they develop, so that agreement can be reached on the appropriateness of the evaluations with respect to certification. If the applicant has already developed a certification plan, it may be useful to update the certification plan as a way to document the intent to use such evaluations.

Finally, the FAA recognizes that the applicant may collect data during evaluations without intending to use the evaluations to support certification, but may achieve results that are subsequently believed to be relevant to certification. Under these circumstances, it is acceptable for the applicant to describe the evaluations to the FAA and request consideration of the results, even though the evaluations were not part of the certification plans.

6. How Should Evaluation Results Be Interpreted?

In order for applicants to consider such evaluations to be a way to reduce rather than increase certification risk, some latitude in interpreting evaluation results must be permitted, especially in view of the issues described above.

For example, the applicant should feel confident collecting and then presenting evaluations that include data from subjects who experienced difficulties or who provided negative comments on the design. Such data should be considered a normal part of such development testing, and in some cases, point out the strength and value of such testing. In such situations, applicants should be given the opportunity to explain causes of the reported problems and how the features of the design have been modified to account for the problems. Unlike conventional certification testing for systems, the applicant should not be expected to repeat the evaluations in order to ''prove'' that the problems have been mitigated. Rather, the nature of the problems, the explanations, and the design modifications can all be used to form the basis for the FAA's overall assessment of the results and the relevance of those results to certification.

7. Summary

In summary, this policy is intended to provide an incentive to applicants, so that they will conduct effective human factors evaluations during the design phase of a program. Involvement of the FAA during the design phase is also a desired, but not a required, outcome.

This policy should not be used by FAA personnel to force such evaluations as part of the certification process. In other words, there should be no penalties, either formal or informal, for an applicant who chooses not to use such evaluations as part of their certification effort.

However, if the applicant chooses to submit the results of such evaluations, and the FAA agrees that the evaluations were appropriate, then the FAA should consider the results of the evaluations as part of their overall determination of the amount of additional testing (or other methods of compliance) required to show compliance with the regulations.

Applicants should be encouraged to keep the FAA involved. This will improve the quality and value of the evaluations (with respect to certification), foster FAA confidence in the applicant's evaluation methods and processes, and maximize the benefit of the evaluations.

Issued in Renton, Washington, on May 8, 2001.

D.L. Riggin,

Acting Manager, Transport Airplane Directorate, Aircraft Certification Service.

[FR Doc. 01–12275 Filed 5–17–01; 8:45 am]

BILLING CODE 4910–13–U

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

Final Environmental Impact Statement; Douglas County, CO

AGENCY: Federal Highway Administration (FHWA), DOT.

ACTION: Notice of availability.

SUMMARY: In compliance with the National Environmental Policy Act of 1969, the FHWA, in cooperation with the Colorado Department of Transportation (CDOT), have prepared a Final Environmental Impact Statement (EIS) for proposed transportation improvements in the South I–25 Corridor and US 85 Corridor of the Denver, Colorado metropolitan area. The project is within Douglas County. The Final EIS identifies the Preferred Alternative and the Other Alternative and their associated environmental impacts. Interested citizens are invited to review the Final EIS and submit comments. Copies of the Final EIS may be obtained by telephoning or writing the contact person list below under Addresses. Public reading copies of the Final EIS are available at the locations listed under Supplementary Information.

DATES: A 30-day public review period will begin on May 11, 2001 and conclude on June 11, 2001. Written comments on the alternatives and impacts to be considered must be received by CDOT by June 11, 2001. Two public hearings to receive oral comments on the Final EIS will be held in Castle Rock and Sedalia.

ADDRESSES: Written comments on the Final EIS should be addressed to Wes Goff, Project Manager, Colorado Department of Transportation, South I–25 Corridor and US 85 Corridor, 18500 East Colfax Avenue, Aurora, CO 80011. Requests for a copy of the Final EIS may be addressed to Ms. Wes Goff at the address above. Please see Supplementary Information section for a listing of the available documents and formats in which they may be obtained. Copies of the Final EIS are also available for public inspection and review. See Supplementary Information section for locations.

FOR FURTHER INFORMATION CONTACT: To request copies of the Final EIS or for additional information, contact: Mr. Scott Sands, FHWA, Colorado Division, 555 Zang Street, Room 250, Lakewood, CO, 80228, Telephone: (303) 969–6730 extension 362; or Mr. Wes Goff, Colorado Department of Transportation, Region 1, 18500 East Colfax Avenue, Aurora, CO 80011, Telephone: (303) 757–9647.

SUPPLEMENTARY INFORMATION:

Hearing Dates and Locations:

Tuesday, June 5, 2001: Louviers Village Club House (5 p.m.–7:30 p.m.)

Thursday, June 7, 2001: Douglas County Building (5 p.m.–7:30 p.m.)

Copies of the Final EIS are available in hard copy format for public inspection at:

- City of Lone Tree, 6399 S. Fiddlers Green Cr., Ste. 102, Greenwood Village, CO 80111, 303–779–4525
- CDOT Arapahoe Residency, 359 Inverness Drive South, Suite K, Englewood, CO 80112, 303–790–1020
- CDOT Office of Environmental Services, 1325 South Colorado Boulevard, Suite B400, Denver, CO 80222, 303–757–9259
- CDOT Region 1, 18500 E Colfax Avenue, Aurora, CO 80010, 303–757–9371
- Douglas County Planning Department, 100 Third Street, Castle Rock, CO 80104, 303–660–7490
- Federal Highway Administration, 555 Zang Street, Room 250, Lakewood, Co 80228, 303–969–6730
- Highlands Ranch Library, 48 West Springer Drive, Littleton, CO 80129–2314, 303–791–7703
- Lone Tree Library, 8827 Lone Tree Parkway, Lone Tree, CO 80124–8961, 303–799–4446
- Louviers Library, 7885 Louviers Boulevard, Louviers, CO 80131–9900, 303–791–7323
- Parker Library, 10851 South Crossroads Drive, Parker, CO 80134–9081, 303–841–3503
- PBS&J, 5500 Greenwood Plaza Blvd., Suite 150, Englewood, CO 80111, 303–221–7275
- Philip S. Miller Library, 961 S Plum Creek Road, Castle Rock, CO 80104, 303–688–5157
- Town of Castle Rock, 100 Wilcox Street, Castle Rock, CO 80104
- The document is also available on the project Website: www.southi25.com

Background

This Final EIS provides a detailed evaluation of the South I–25 Corridor and US 85 Corridor improvement project. The project corridors both lie within Douglas County, Colorado. The I–25 Corridor extends from C–470 at approximate milepost 195 to the southern limit of Castle Rock at approximate milepost 178 and the US 85 Corridor extends from C–470 at approximate milepost 200 to Castle Rock at approximate milepost 184. This Final EIS includes an examination of the purpose and need, alternatives under consideration, travel demand, affected environment, environmental consequences, and mitigation measures as a result of the improvements under consideration. Three alternatives, including the No-Action Alternatives, are considered for improvements.

The FHWA, the CDOT, and other local agencies invite interested individuals, organizations, and Federal, State, and local agencies to comment on the evaluated alternatives and associated social, economic, or