

2. BACKGROUND

Flight crews make a positive contribution to the safety of the air transportation system because of their ability to assess continuously changing conditions and situations, analyse potential actions, and make reasoned decisions. However, even well trained, qualified, healthy, alert flight-crew members make errors. Some of these errors may be influenced by the design of the systems and their flight crew interfaces, even with those that are carefully designed. Most of these errors have no significant safety effects, or are detected and/or mitigated in the normal course of events,. Still, accident analyses have identified flight crew performance and error as significant factors in a majority of accidents involving transport category aeroplanes.

Accidents most often result from a sequence or combination of errors and safety related events (e.g., equipment failure and weather conditions). Analyses show that the design of the flight deck and other systems can influence flight crew task performance and the occurrence and effects of some flight crew errors.

Some current regulatory requirements mean to improve aviation safety by requiring that the flight deck and its equipment be designed with certain capabilities and characteristics. Approval of flight deck systems with respect to design-related flight crew error has typically been addressed by referring to system specific or general applicability requirements, such as [CS 25.1301\(a\)](#), [CS 25.771\(a\)](#), and [CS 25.1523](#). However, little or no guidance exists to show how the applicant may address potential crew limitations and errors. That is why [CS 25.1302](#) and this guidance material have been developed.

Often, showing compliance with design requirements that relate to human abilities and limitations is subject to a great deal of interpretation. Findings may vary depending on the novelty, complexity, or degree of integration related to system design. The EASA considers that guidance describing a structured approach to selecting and developing acceptable means of compliance is useful in aiding standardised certification practices.

3. SCOPE AND ASSUMPTIONS

This AMC provides guidance for showing compliance with [CS 25.1302](#) and guidance related to several other requirements associated with installed equipment the flight crew uses in operating the aeroplane. Table 1 below contains a list of requirements related to flight deck design and flight crew interfaces for which this AMC provides guidance. Note that this AMC does not provide a comprehensive means of compliance for any of the requirements beyond [CS 25.1302](#).

This material applies to flight crew interfaces and system behaviour for installed systems and equipment used by the flight crew on the flight deck while operating the aeroplane in normal and non-normal conditions. It applies to those aeroplane and equipment design considerations within the scope of CS-25 for type certificate and supplemental type certificate (STC) projects. It does not apply to flight crew training, qualification, or licensing requirements. Similarly, it does not apply to flight crew procedures, except as required within CS-25.

In showing compliance to the requirements referenced by this AMC, the applicant may assume a qualified flight crew trained in the use of the installed equipment. This means a flight crew that is allowed to fly the aeroplane by meeting the requirements in the operating rules for the relevant Authority.

Paragraph 3 - Table 1: Requirements relevant to this AMC.

CS-25 BOOK 1 Requirements	General topic	Referenced material in this AMC
CS 25.771(a)	Unreasonable concentration or fatigue	Error, 5.6. Integration, 5.7. Controls, 5.3. System Behaviour, 5.5.
CS 25.771(c)	Controllable from either pilot seat	Controls, 5.3. Integration, 5.7.
CS 25.773	Pilot compartment view	Integration, 5.7.
CS 25.777(a)	Location of cockpit controls.	Controls, 5.3. Integration, 5.7.
CS 25.777(b)	Direction of movement of cockpit controls	Controls, 5.3. Integration, 5.7.
CS 25.777(c)	Full and unrestricted movement of controls	Controls, 5.3. Integration, 5.7.
CS 25.1301(a)	Intended function of installed systems	Error, 5.6. Integration, 5.7. Controls, 5.3. Presentation of Information, 5.4. System Behaviour, 5.5.
CS 25.1302	Flight crew error	Error, 5.6. Integration, 5.7. Controls, 5.3. Presentation of Information, 5.4. System Behaviour, 5.5.
CS 25.1303	Flight and navigation instruments	Integration, 5.7.
CS 25.1309(a)	Intended function of required equipment under all operating conditions	Controls, 5.3. Integration, 5.7.
CS 25.1309(c)	Unsafe system operating conditions and minimising crew errors which could create additional hazards	Presentation of information, 5.4. Errors, 5.6.
CS 25.1321	Visibility of instruments	Integration, 5.7.
CS 25.1322	Warning caution and advisory lights	Integration, 5.7.
CS 25.1329	Autopilot, flight director and autothrust	System Behaviour, 5.5.
CS 25.1523	Minimum flight crew	Controls, 5.3. Integration, 5.7.
CS 25.1543(b)	Visibility of instrument markings	Presentation of Information, 5.4.
CS 25.1555 (a)	Control markings	Controls, 5.3.
CS 25 Appendix D	Criteria for determining minimum flight crew	Integration, 5.7.

[**CS 25.1302**](#) is a general applicability requirement. Other CS-25 requirements exist for specific equipment and systems. Where guidance in other AMCs is provided for specific equipment and systems, that guidance is assumed to have precedence if a conflict exists with guidance provided

here. [Appendix 1](#) of this AMC lists references to other related regulatory material and documents.

4. CERTIFICATION PLANNING

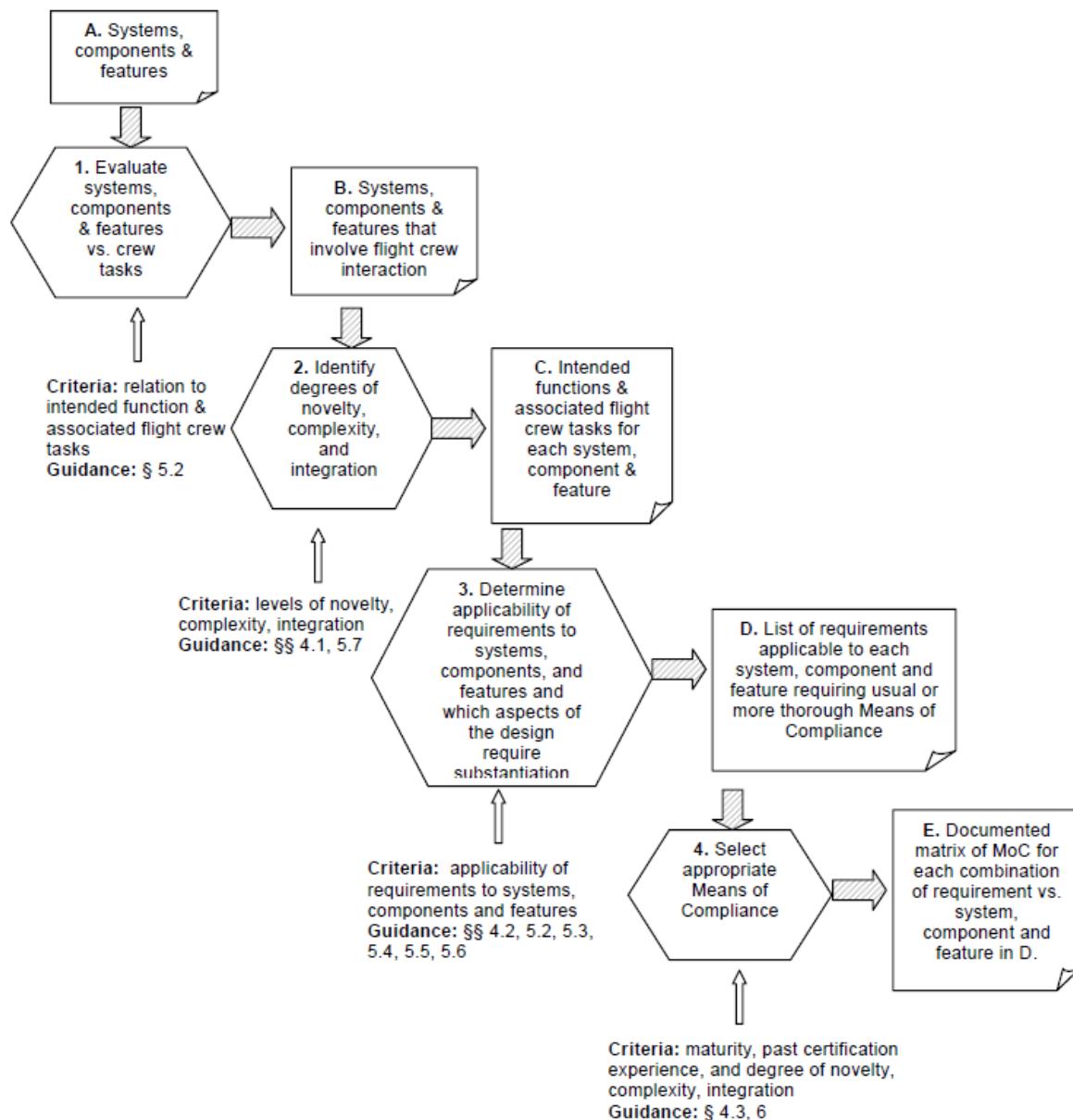
This paragraph describes applicant activities, communication between the applicant and the Agency, and the documentation necessary for finding compliance in accordance with this AMC. Requirements for type certification related to complying with CS-25 may be found in Part 21.

Applicants can gain significant advantages by involving the Agency in the earliest possible phases of application and design. This will enable timely agreements on potential design related human factors issues to be reached and thereby reduce the applicant's risk of investing in design features that may not be acceptable to the Agency.

Certain activities that typically take place during development of a new product or a new flight deck system or function, occur before official certification data is submitted to demonstrate compliance with the requirements. The applicant may choose to discuss or share these activities with the Agency on an information-only basis. Where appropriate, the Agency may wish to participate in assessments the applicant is performing with mock-ups, prototypes, and simulators.

When the Agency agrees, as part of the certification planning process, that a specific evaluation, analysis, or assessment of a human factors issue will become part of the demonstration that the design is in compliance with requirements, that evaluation, analysis, or assessment is given "certification credit".

Figure 1 illustrates the interaction between paragraph 4, 5 and 6 of this AMC. These paragraphs are used simultaneously during the certification process. Paragraph 4 details applicant activities and communication between the applicant and the Agency. Paragraph 5 provides means of compliance on specific topics. Paragraphs 5.2, 5.6 and 5.7 assist the applicant in determining inputs required for the scoping discussions outlined in paragraph 4.1. Paragraphs 5.3 through 5.5 provide guidance in determining the list of applicable requirements for discussion, outlined in paragraph 4.2. Paragraph 6 provides a list of acceptable general means of compliance used to guide the discussions for paragraph 4.3. Paragraph 4.4 lists items that may be documented as a result of the above discussions.



Paragraph 4 - Fig. 1: Methodical approach to planning certification for design related Human performance issues

4.1 Scope of the flight deck certification programme

This paragraph provides means of establishing the scope of the certification programme.

In a process internal to the applicant, the applicant should consider the flight deck controls, information and system behaviour that involve flight crew interaction. The applicant should relate the intended functions of the system(s), components and features to the flight crew tasks. The objective is to improve understanding about how flight crew tasks might be changed or modified as a result of introducing the proposed system(s), components and features. Paragraph 5.2, Intended Function and Associated Flight Crew Tasks, provides guidance.

The certification programme may be impacted by the level of integration, complexity and novelty of the design features, each of which is described in the sub-paragraphs that

follow. Taking these features into account, the applicant should reach an agreement with the Agency on the scope of flight deck controls, information and system behaviour that will require extra scrutiny during the certification process. Applicants should be aware that the impact of a novel feature might also be affected by its complexity and the extent of its integration with other elements of the flight deck. A novel but simple feature will likely require less rigorous scrutiny than one that is both novel and complex.

a) Integration

In this document, the term “level of systems integration”, refers to the extent to which there are interactions or dependencies between systems affecting the flight crew’s operation of the aeroplane. The applicant should describe such integration among systems, because it may affect means of compliance. Paragraph 5.7 also refers to integration. In the context of that paragraph, integration defines how specific systems are integrated into the flight deck and how the level of integration may affect the means of compliance.

b) Complexity

Complexity of the system design from the flight crew’s perspective is an important factor that may also affect means of compliance in this process. Complexity has multiple dimensions. The number of information elements the flight crew has to use (the number of pieces of information on a display, for instance) may be an indication of complexity. The level of system integration may be a measure of complexity of the system from the flight crew’s perspective. Design of controls can also be complex. An example would be a knob with multiple control modes. Paragraph 5 addresses several aspects of complexity.

c) Novelty

The applicant should identify the degree of design novelty based on the following factors:

- Are new technologies introduced that operate in new ways for either established or new flight deck designs?
- Are unusual or additional operational procedures needed as a result of the introduction of new technologies?
- Does the design introduce a new way for the flight crew to interact with systems using either conventional or innovative technology?
- Does the design introduce new uses for existing systems that change the flight crew’s tasks or responsibilities?

Based on the above criteria, the applicant should characterise features by their novelty. More novel features may require extra scrutiny during certification. Less novel features must still be shown to be compliant with requirements, but will usually follow a typical certification process that may be less rigorous than the process described below.

4.2 Applicable Requirements

The applicant should identify design requirements applicable to each of the systems, components, and features for which means of demonstrating compliance must be selected. This can be accomplished in part by identifying design characteristics that can adversely affect flight crew performance, or that pertain to avoidance and management of flight crew errors.

Specific design considerations for requirements involving human performance are discussed in Paragraph 5. The applicability of each design consideration in Paragraph 5 will depend on the design characteristics identified in paragraph 4.1.

The expected output of the analysis is a list of requirements that will be complied with and for which design considerations will be scrutinised. This list of requirements will be the basis for a compliance matrix identifying the means of compliance proposed for each requirement.

4.3 Select appropriate means of compliance

After identifying what should be shown in order to demonstrate compliance, the applicant should review paragraph 6.1 for guidance on selecting the means, or multiple means of compliance, appropriate to the design. In general, it is expected that the level of scrutiny or rigour represented by the means of compliance should increase with higher levels of novelty, complexity and integration of the design.

Paragraph 6 identifies general means of compliance that have been used on many certification programmes and discusses their selection, appropriate uses, and limitations. The applicant may propose other general means of compliance, subject to approval by the Agency.

Once the human performance issues have been identified and means of compliance have been selected and proposed to the Agency, the Agency may agree, as part of the certification planning process, that a specific evaluation, analysis or assessment of a human factors issue will become part of the demonstration that the design is in compliance with requirements. Certification credit can be granted when data is transmitted to and accepted by the Agency using standard certification procedures. This data will be a part of the final record of how the applicant has complied with the requirements.

The output of this step will consist of the means that will be used to show compliance to the requirements.

4.4 Certification plan

The applicant should document the certification process, outputs and agreements described in the previous paragraphs. This may be done in a separate plan or incorporated into a higher level certification plan. The following is a summary of what may be contained in the document:

- The new aeroplane, system, control, information or feature(s)
- The design feature(s) being evaluated and whether or not the feature(s) is(are) new or novel
- The integration or complexity of the new feature(s)
- Flight crew tasks that are affected or any new tasks that are introduced

- Any new flight crew procedures
- Specific requirements that must be complied with
- The means (one or several) that will be used to show compliance
- The method for transferring data to the Agency

5. DESIGN CONSIDERATIONS AND GUIDANCE

This paragraph contains a discussion of [CS 25.1302](#) and guidance on complying with it and other requirements.

The applicant should first complete the following steps.

- Identify systems, components, and features of a new design that are potentially affected by the requirements.
- Assess degrees of novelty, complexity, and level of integration using the initial process steps in paragraph 4.

Once these steps have been completed, use the contents of this paragraph to identify what should be shown to demonstrate compliance.

To comply with the requirements of CS-25, the design of flight deck systems should appropriately address foreseeable capabilities and limitations of the flight crew. To aid the applicant in complying with this overall objective, this paragraph has been divided into sub-paragraphs. They provide guidance on the following topics:

- Applicability and Explanatory material to [CS 25.1302](#) (See paragraph 5.1),
- Intended function and associated flight crew tasks(See paragraph 5.2),
- Controls (See paragraph 5.3),
- Presentation of information(See paragraph 5.4),
- System behaviour (See paragraph 5.5),
- Flight crew error management(See paragraph 5.6),
- Integration (See paragraph 5.7),

Each sub-paragraph discusses what the applicant should show to establish compliance with applicable requirements. We are not describing here what might otherwise be referred to as industry “best practices.” The guidance presented here is the airworthiness standard for use in compliance. Obviously, not all criteria can or should be met by all systems. Because the nature of the guidance in this AMC is broad and general, some of it will conflict in certain instances. The applicant and the Agency must apply some judgment and experience in determining which guidance applies to what parts of the design and in what situations. Headings indicate the regulations to which the guidance applies. First, however, we provide a more detailed discussion of [CS 25.1302](#).

As described in the Background and Scope paragraphs of this document, flight crew error is a contributing factor in accidents. [CS 25.1302](#) was developed to provide a regulatory basis for, and this AMC provides guidance to address design-related aspects of avoidance and management of flight crew error by taking the following approach:

First, by providing guidance about design characteristics that are known to reduce or avoid flight crew error and that address flight crew capabilities and limitations. Requirements in sub-paragraphs (a) through (c) of [CS 25.1302](#) are intended to reduce the design contribution to such

errors by ensuring information and controls needed by the flight crew to perform tasks associated with the intended function of installed equipment are provided, and that they are provided in a usable form. In addition, operationally relevant system behaviour must be understandable, predictable, and supportive of flight crew tasks. Guidance is provided in this paragraph on the avoidance of design-induced flight crew error.

Second, [CS 25.1302\(d\)](#) addresses the fact that since flight crew errors will occur, even with a well-trained and proficient flight crew operating well-designed systems, the design must support management of those errors to avoid safety consequences. Paragraph 5.6 below on flight crew error management provides relevant guidance.

5.1 Applicability and Explanatory Material to [CS 25.1302](#)

CS-25 contains requirements for the design of flight deck equipment that are system-specific (e.g., [CS 25.777](#), [CS 25.1321](#), [CS 25.1329](#), [CS 25.1543](#) etc.), generally applicable (e.g., [CS 25.1301\(a\)](#), [CS 25.1309\(c\)](#), [CS 25.771 \(a\)](#)), and that establish minimum flight crew requirements (e.g. [CS 25.1523](#) and CS-25 Appendix D). [CS 25.1302](#) augments previously existing generally applicable requirements by adding more explicit requirements for design attributes related to avoidance and management of flight crew error. Other ways to avoid and manage flight crew error are regulated through requirements governing licensing and qualification of flight-crew members and aircraft operations. Taken together, these complementary approaches provide a high degree of safety.

The complementary approach is important. It is based upon recognition that equipment design, training/licensing/ qualification, and operations/procedures each provide safety contributions to risk mitigation. An appropriate balance is needed among them. There have been cases in the past where design characteristics known to contribute to flight crew error were accepted based upon the rationale that training or procedures would mitigate that risk. We now know that this can often be an inappropriate approach. Similarly, due to unintended consequences, it would not be appropriate to require equipment design to provide total risk mitigation. If a flight-crew member misunderstands a controller's clearance, it does not follow that the Agency should mandate datalink or some other design solution as Certification Specifications. Operating rules currently require equipment to provide some error mitigations (e.g., Terrain Awareness and Warning Systems), but not as part of the airworthiness requirements.

As stated, a proper balance is needed among design approval requirements in the minimum airworthiness standards of CS-25 and requirements for training/ licensing/ qualification and operations/procedures. [CS 25.1302](#) and this AMC were developed with the intent of achieving that appropriate balance.

Introduction The introductory sentence of [CS 25.1302](#) states that the provisions of this paragraph apply to each item of installed equipment intended for the flight crew's use in operating the aeroplane from their normally seated positions on the flight deck.

"Intended for the flight-crew member's use in the operation of the aeroplane from their normally seated position," means that intended function of the installed equipment includes use by the flight crew in operating the aeroplane. An example of such installed equipment would be a display that provides information enabling the flight crew to navigate. The phrase "flight-crew members" is intended to include any or all individuals comprising the minimum flight crew as determined for compliance with CS 25.1523. The phrase "from their normally seated position" means flight-crew members are seated at their normal duty stations for operating the aeroplane. This phrase is intended to limit the scope of this requirement so that it does not address systems or equipment not used

while performing their duties in operating the aeroplane in normal and non-normal conditions. For example, this paragraph is not intended to apply to items such as certain circuit breakers or maintenance controls intended for use by the maintenance crew (or by the flight crew when not operating the aeroplane).

The words “This installed equipment must be shown...” in the first paragraph means the applicant must provide sufficient evidence to support compliance determinations for each of the [CS 25.1302](#) requirements. This is not intended to require a showing of compliance beyond that required by Part 21A.21(b). Accordingly, for simple items or items similar to previously approved equipment and installations, we do not expect the demonstrations, tests or data needed to show compliance with [CS 25.1302](#) to entail more extensive or onerous efforts than are necessary to show compliance with previous requirements.

The phrase “individually and in combination with other such equipment” means that the requirements of this paragraph must be met when equipment is installed on the flight deck with other equipment. The installed equipment must not prevent other equipment from complying with these requirements. For example, applicants must not design a display so that information it provides is inconsistent or in conflict with information from other installed equipment.

In addition, provisions of this paragraph presume a qualified flight crew trained to use the installed equipment. This means the design must meet these requirements for flight-crew members who are allowed to fly the aeroplane by meeting operating rules qualification requirements. If the applicant seeks type design or supplemental type design approval before a training programme is accepted, the applicant should document any novel, complex, or highly integrated design features and assumptions made during design that have the potential to affect training time or flight crew procedures. The requirement and associated material are written assuming that either these design features and assumptions, or knowledge of a training programme (proposed or in the process of being developed) will be coordinated with the appropriate operational approval organisation when judging the adequacy of the design.

The requirement that equipment be designed so the flight crew can safely perform tasks associated with the equipment’s intended function, applies in both normal and non-normal conditions. Tasks intended for performance under non-normal conditions are generally those prescribed by non-normal (including emergency) flight crew procedures. The phrase “safely perform their tasks” is intended to describe one of the safety objectives of this requirement. The requirement is that equipment design enables the flight crew to perform the tasks with sufficient accuracy and in a timely manner, without unduly interfering with other required tasks. The phrase “tasks associated with its intended function” is intended to characterise either tasks required to operate the equipment or tasks for which the equipment’s intended function provides support.

[CS 25.1302\(a\)](#) requires the applicant to install appropriate controls and provide necessary information for any flight deck equipment identified in the first paragraph of [CS 25.1302](#). Controls and information displays must be sufficient to allow the flight crew to accomplish their tasks. Although this may seem obvious, this requirement is included because a review of CS-25 on the subject of human factors revealed that a specific requirement for flight deck controls and information to meet the needs of the flight crew is necessary. This requirement is not reflected in other parts of the rules, so it is important to be explicit.

[**CS 25.1302\(b\)**](#) addresses requirements for flight deck controls and information that are necessary and appropriate so the flight crew can accomplish their tasks, as determined through (a) above. The intent is to ensure that the design of the control and information devices makes them usable by the flight crew. This sub-paragraph seeks to reduce design-induced flight crew errors by imposing design requirements on flight deck information presentation and controls. Sub-paragraphs (1) through (3) specify these design requirements.

Design requirements for information and controls are necessary to:

- Properly support the flight crew in planning their tasks,
- Make available to the flight crew appropriate, effective means to carry-out planned actions,
- Enable the flight crew to have appropriate feedback information about the effects of their actions on the aeroplane.

[**CS 25.1302\(b\)\(1\)**](#) specifically requires that controls and information be provided in a clear and unambiguous form, at a resolution and precision appropriate to the task. As applied to information, “clear and unambiguous” means that it:

- Can be perceived correctly (is legible).
- Can be comprehended in the context of the flight crew task.
- Supports the flight crew’s ability to carry out the action intended to perform the tasks.

For controls, the requirement for “clear and unambiguous” presentation means that the crew must be able to use them appropriately to achieve the intended function of the equipment. The general intent is to foster design of equipment controls whose operation is intuitive, consistent with the effects on the parameters or states they affect, and compatible with operation of other controls on the flight deck.

Sub-paragraph [**CS 25.1302\(b\)\(1\)**](#) also requires that the information or control be provided, or operate, at a level of detail and accuracy appropriate to accomplishing the task. Insufficient resolution or precision would mean the flight crew could not perform the task adequately. Conversely, excessive resolution has the potential to make a task too difficult because of poor readability or the implication that the task should be accomplished more precisely than is actually necessary.

[**CS 25.1302\(b\)\(2\)**](#) requires that controls and information be accessible and usable by the flight crew in a manner consistent with the urgency, frequency, and duration of their tasks. For example, controls used more frequently or urgently must be readily accessed, or require fewer steps or actions to perform the task. Less accessible controls may be acceptable if they are needed less frequently or urgently. Controls used less frequently or urgently should not interfere with those used more urgently or frequently. Similarly, tasks requiring a longer time for interaction should not interfere with accessibility to information required for urgent or frequent tasks.

[**CS 25.1302\(b\)\(3\)**](#) requires that equipment presents information advising the flight crew of the effects of their actions on the aeroplane or systems, if that awareness is required for safe operation. The intent is that the flight crew be aware of system or aeroplane states resulting from flight crew actions, permitting them to detect and correct their own errors.