

## JAA Administrative & Guidance Material

### Section Three: Certification Part 3: Interim Policies & Temporary Guidance Material

**Policy Paper Number** : INT/POL/25/14 **Issue 2 Date 6-04-01**  
**Subject** : Human Factors Aspects of Flight Deck Design  
**Regulation Affected** : JAR 25

#### Problem: Novel Flight Deck Technology Introducing New Human Factors Issues

It has been demonstrated by analysis of accidents that the primary risk to flight safety is 'human error' [e.g. CAP 681]. It is also well established that the design of the aircraft flight deck and other systems can strongly influence the likelihood, and result, of an error by the crew. Therefore the design of the flight deck should be assessed to limit the risks arising from human performance considerations [including error]. This should be a priority in addressing safety standards of aircraft design.

Action is needed even to sustain existing safety levels because there are radical new changes in technology, especially the flight deck, in current JAA certification projects. These changes will affect the interaction between the aircraft and the flight crew and this may impact safety. However, the 'human factors' aspects of these novel items is not adequately addressed by JAR 25 existing requirements. Therefore under the terms of JAR 21.16 a Special Condition is needed.

#### Policy: Special Condition for Novel Features

A standard approach should be adopted to address Human Factors issues in flight deck design. This will be applied until the Human Factors Harmonisation Working Group [HWG] reports its findings regarding a permanent regulatory solution.

All JAA Certification and Validation projects should conduct formal consideration of Human Factors issues as follows:

1. Novel Features: Assessment of the flight deck to ascertain whether novel features are present should be conducted in accordance with JAR 21.16. In addition, some supplementary notes to support the interpretation of 'novel' for Human Factors considerations are provided. If no novel features are present the team should proceed without further reference to this Interim Policy.
2. Special Condition: If novel features are present, the Team should raise a Special Condition as follows:
  - a) The design of the integrated Flight Deck Interface must adequately address the foreseeable performance, capability and limitations of the Flight Crew.
  - b) More specifically the Authority must be satisfied with the following aspects of the Flight Deck Interface design:
    - i) ease of operation [including automation]

- ii) the effects of crew errors in managing the aircraft systems, including the potential for error, the possible severity of the consequences, and the provision for recognition and recovery from error
- iii) task sharing and distribution of workload between crew members during normal and abnormal operation
- iv) the adequacy of feedback, including clear and unambiguous:
  - presentation of information
  - representation of system condition by display of system status
  - indication of failure cases, including aircraft status
  - indication when crew input is not accepted or followed by the system
  - indication of prolonged or severe compensatory action by a system when such action could adversely affect aircraft safety

### 3. Implementation

It is envisaged that the Flight Test Panel would manage implementation. A proposal for interpretative material associated to the special condition is attached as appendix B. This will call for:

- i) General Assessment: A general review of Human Factors issues arising from integrated use of the flight deck.
  - ii) Novel features: Careful exploration of specific Human Factors issues arising from novel items in the flight deck.
4. Appoint Assistant Specialist: Where issues raised within the project are significant, the Team may wish to appoint a suitable Human Factors Assistant Specialist to the Flight Test Panel under the existing terms of JAA Certification / Validation Procedures / 1 1996 paragraph M/5.6. The criteria for a suitable individual are identified in Appendix C.

### 5. Appendices

- A Determination of the Need for a Special Condition
- B Guidance Notes on Showing Compliance to the Special Condition
- C Criteria for a Human Factors Assistant Specialist

### 6. Reference Material / Related Documents

- (1) CAP 681 Global Fatal Accident Review 1980 - 96; UK CAA 1998
- (2) FAA Policy Statement Number ANM-99-2 on Guidance for Reviewing Human Factors Certification Plans
- (3) EN ISO 13407:1999 Human-Centred Design Processes for Interactive Systems.

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**APPENDIX A**

**Determination of the Need for a Special Condition**

**A.1 Introduction**

This appendix identifies the method by which the team should determine whether the Special Condition is required.

**A.2 Identification of Novel Features needing a Special Condition**

The need for a Special Condition should be identified in accordance with JAR 21.16 Special Conditions paragraph (a). This explains that an item is regarded as 'novel' if it has characteristics [in this case, characteristics with HF implications] that did not exist within the 'state of the art' upon which the JAR was based.

Further guidance on the interpretation of sub-paragraphs (1) and (2) on the nature of a novel feature in terms of human factors considerations is provided in section A.3 below.

**A.3 Interpretation of 'Novel Feature'**

In Human Factors terms any change made to a flight-deck has the potential for creating an unforeseen problem, either because of the interaction of the individual elements and the manner of their integration, or simply because a "new" piece of knowledge or technique may be required. To describe any one addition to the flight-deck as a "novel" feature may be an exaggeration, but there are clearly some changes which take place on flight-decks which have not been hitherto envisaged or do not have a parallel of experience in another field on which to judge them.

The definition of a novel feature may address one of several possible options, such as:

- a. Introduction of a new technology.
- b. Introduction of a new concept of interfacing with the crew, utilising either conventional or innovative technology.
- c. Different use of an equipment, with or without its integration in interfaces.
- d. Introduction of a new operational procedure.

If a design feature is novel and introduces a new concept of operation or handling technique, then there may need to be an associated training requirement that forms part of the compliance substantiation.

**i) Novel Technology**

The term novel technology may cover a feature or function introduced into a flight-deck which has not previously been seen as a civil aviation task or capability. Examples might include:

- a. the introduction of a head-up display to enable landing capability in poor weather; or

- b. the introduction of voiceless communications; or
- c. new input devices (CCDs, touch-screen controllers).

In all examples of the introduction of a novel technology there needs to be an awareness of whether the effect will be transparent to the crew because the interface is familiar to them, or whether they will be required to adapt to the technology. This division will determine the approach to the investigation of a novel technology, which is likely to be closely allied to the following definition.

#### ii) Novel Concept

The term novel concept may cover a modification which alters the manner of working of a crew, and may or may not be associated with a new technology. It is most commonly apparent in the use of increased automation to relieve crews of tasks and/or monitoring functions for which they had been previously responsible. Examples might include:

- a. reduction in feedback to crews (less information displays, fewer system controls) on the assumption of high reliability; or
- b. automatic re-configuration of systems following malfunction; or
- c. the introduction of artificial intelligence software into a crew monitoring system.

In each of these cases the JAR may have been written when there was no previous experience of the effect that the concept will have on crews using the equipment and, therefore, there needs to be a level of supporting research, or proof-of-concept testing. This would be intended to show that such introduction has been adequately investigated for any human performance limitations that the new concept may produce, any change to commonly-accepted procedures that crews may have to adopt, an assessment of the errors likely to occur in operation, and a determination of any training or familiarisation that will be necessary.

#### iii) Novel Use of Existing Equipment

An additional view of "novelty" may be seen as the use of an existing installed equipment for a purpose that was not previously intended. Examples may include:

- a. the use for navigation purposes of a terrain / map display from a digital database, not just as the ground proximity warning for which it was intended; or
- b. the use of a traffic collision and avoidance system (TCAS) for maintenance of separation, rather than purely for collision avoidance.

In its original certification the equipment is likely to have been addressed and investigated for a single purpose, and the procedures surrounding it will have been approved on the assumption that crews will behave, and be trained, in an anticipated manner. Should the required usage change, it may be necessary for the system to be re-investigated for any additional safety implications that may emanate from the new use, together with any potential for mis-use, of such equipment.

#### iv) Novel Procedures

The introduction of new operational procedures, possibly to enable either a greater capability, a higher density use of the existing air traffic system, or a method perceived to offer safety

enhancements, may allow mis-interpretations to occur if crews are expecting there to be capabilities which do not exist or have not been evaluated. Examples may include:

- a. use of FMS (with or without GPS) to provide apparent precision guidance during approach;  
or
- b. use of FMS (with or without GPS) to establish vertical separation in departure and en-route;

In many cases the programming and system integrity of the technology being used may not be consistent for all the various manufacturers' equipment in use (e.g. software integrity, route leg definitions), and each procedure may require varying levels of crew monitoring or involvement. However, the extent of, and need for, this monitoring may not be apparent to the crew.

It must not be overlooked that, in all of the four previously mentioned cases, the presence of any new technology, new concept, revised usage, or new procedures, is likely to influence and change general crew behaviour patterns for the future. This is most probable in areas of the crews' overall monitoring tasks and attention to detail, and usually will result from misplaced over-confidence in achieved safety levels, together with an increased potential for error.

#### v) Methods of Dealing with Novel Features

Methods used to determine the adequacy, in safety terms, of novel features will depend on the radical nature of the change being anticipated, and the investigator's knowledge of the experience and expertise of the user.

For novel technologies and concepts (with, or without, new technology), it may well be that intuitive interfaces are available, and the operation of the technology is transparent to the user. In this case there would appear to be no significant human factor issue raised on the introduction of a novel feature. However, if commonly-held beliefs and understandings, or conditioned practices and learned procedures, are changed significantly by the introduction of a new technology or concept, then it is clear that a significant amount of proving research is required. This would not only serve to determine the effectiveness of the equipment, via simple usage evaluation under control conditions, but would provide comparative results with current features, so that the benefits, in relationship to the additional effort, adaptation, and training necessary for users to cope with the new concept, would become apparent.

For novel features which incorporate a different use of an equipment, it may again be that the use of the equipment requires no further understanding, merely a reinforcement of the limitations and expectations of the equipment. This may simply be done by experience and the expert judgement of appropriately qualified staff. However, if the implications are not readily apparent, e.g. effect on workload (increase or decrease), maintenance of overall awareness (internal and external), then a substantial investigation may be necessary.

For the introduction of new operational procedures, there will be a dependence on the radical nature of the procedure to be adopted. If it is merely a procedure which mimics a former understanding, a rigorous investigation may not be necessary, provided consideration is made of future conditioning of crews' attitudes. An example of this effect may be seen as attitude that exists currently to autoflight compared to that of 40 years ago. Non-availability of an autopilot is now considered to be a major event, whether or not the handling qualities and tasks to be performed have become significantly easier.

#### vi) Methods of Approach to Investigation

It should be possible to adopt a similar philosophy of investigation to that used for systems evaluation (as is usually covered by §1309 requirements, and their relevant guidance material ) Instead of performing a Functional Hazard Assessment (FHA) a human hazard assessment is required. In essence, the hazard associated with the incorrect operation of any function of the proposed design would need to be determined (for example the selection of an incorrect waypoint in an FMS as the next point on the route might, without additional warning, cause the aircraft to fly into terrain, and would thus be catastrophic).

Having determined that all such opportunities for incorrect or inappropriate operation are identified, the safeguards already in place should be assessed for their effectiveness in preventing the declared level of hazard from occurring, given the frequency at which they are anticipated. However, it should be recalled that, when claiming mitigation of an effect by human intervention, the probability of error remains high. At its absolute best it has to be assumed to be frequent, and at its worst it might be even higher than  $10^{-1}$ . It is not feasible to presume that human performance has perfect reliability as the sole mitigation of Major, Hazardous or Catastrophic effects.

vii) In relation to novel features, the following human error considerations are relevant. The analysis should include, but not be limited to these considerations.

This section is not intended to supersede or replace current rules or guidance such as those laid out in requirements already addressing human performance on the flight deck, for example 25.101(h) and 25.143(b). It is additional guidance on mitigating the effects of crew error.

#### Influence of Design Characteristics on Potential for Crew Error:

Aircraft design characteristics should be investigated for any tendency in the design to induce systematic errors likely to increase the risk of an adverse outcome, where they affect the ability of the crew, under both normal and non-normal conditions, to:

- a. achieve the scheduled performance,
- b. reliably and consistently achieve the desired flight path during manual or automatic control,
- c. achieve the desired outcome from flight guidance or flight management systems, or
- d. achieve an appropriate state from the on-board systems

#### Influence of Crew on Potential for Human Error:

It should be recognised, during any investigation, that the probability of the crew, individually or when acting together, making inadvertent single errors, or combinations of errors, can never be reduced to below a Probable frequency. Results of investigations to justify a design, together with conclusions reached, should be recorded, to indicate the reasons for the design option chosen. Possible contentious choices should not be based on one sole opinion, nor a very limited sample of opinions, but should be extensively researched, using objective targets and methods involving a representative sample of end users.

In setting minimum standards of performance for any individual crew member, the need for additional specialised training cannot be guaranteed, and acceptability of a feature cannot be predicated on a period of familiarisation, unless it is shown to be a repetitive task or will form part of the normal training.

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**APPENDIX B**

**Guidance Notes on Showing Compliance to the Special Condition**

A general assessment of crew related issues has traditionally been conducted by the Flight Test Panel in accordance with existing requirements and this should continue to be the case. However, where novel features are introduced there may be a need to review the overall design for the possibility of risks arising from 'human factors' concerns. In doing so they may wish to emphasise the need for a general assessment of the flight deck philosophy and human factors aspects of new or novel items.

**B1.1 General Assessment of the Flight Deck Philosophy**

- a) consistency / compatibility of design philosophy across all features
- b) communication of training and procedural assumptions to operators

In showing compliance with the 'risk review' the approach illustrated in Fig.B1.1 may be appropriate.

**i) Consistency / compatibility of design philosophy**

The Applicant should show how they have considered and applied a consistent approach across the flight deck in order to avoid confusion. This may be achieved by the use of a Flight Deck Philosophy Document, that will:

- a. Identify the Applicants Philosophy on design principles such as:
  - i. Crew alerting and prioritisation of aural
  - ii. Use of colour
  - iii. Location of controls
  - iv. Menu structures
  - v. Crew interaction with displays
  - vi. Display reversion
  - vii. Automation principles
  - viii. System feedback to the crew
  
- b. Identify relevant assumptions concerning use of the Flight Deck Interface, such as:
  - i. The pilot accommodation.
  - ii. The pilot role, as Pilot Flying and Pilot Not Flying
  - iii. The operational environment.
  - iv. The aircraft operator [e.g., use of user modifiable checklists, presentation of planning data].
  - v. The availability of support from Air Traffic services, navigation aids and aerodrome facilities.
  - vi. The policy toward achieving compatibility with the operating environment such as Air Traffic Management.
  - vii. The expected baseline qualifications and experience of flight crew [e.g. number of hours, licenses, Crew Resource Management, recurrent

training,], and likewise for maintenance engineers, cabin crew, and ground crew [e.g. refuelling].

- c. Identify the policy toward validation of maintenance procedures and data provided.

## **ii) Communication of Training and Procedural Assumptions to Operators**

The Applicant should show how any training or procedural assumptions made by the design will be communicated to the appropriate persons for them to be applied to operation of the aircraft and the means by which this information will be provided to the relevant parties and currency sustained. This may be achieved by use of an Operations Interface Document, that will identify any items where Flight Crew, Cabin Crew or Maintenance Engineer will be expected to employ procedures, skill or knowledge that exceed or differ from the expected baseline [as stated in the Flight Deck Philosophy document above]. It is not expected, however, that such a document would be formally approved by the certification team. The 'baseline' skill or knowledge refers to the level of training and experience provided by the Licenses, Ratings, and other mandatory training required to be held by any individual who would qualify for the task in service. In the case of procedures or other interventions this refers to the level of skill and knowledge that can be expected with reasonable certainty of those who may define such procedures or interventions. If there are assumptions or restrictions envisaged by the designer that may fall outside of such a 'baseline', then these should be identified for:

### a) Flight Crew

- Training [to be designated Special Training Items e.g. Type Rating, recurrent training, CRM].
- Procedures [to be designated Special Procedural Items for e.g. SOPs].

### b) Cabin Crew

- Training [to be designated Special Cabin Training Items for e.g. Cabin crew competence in actions to be taken during temporary suppression of flight deck alerts,
- Procedures [such as smoke in cabin during take-off]

### c) Other Operator Information

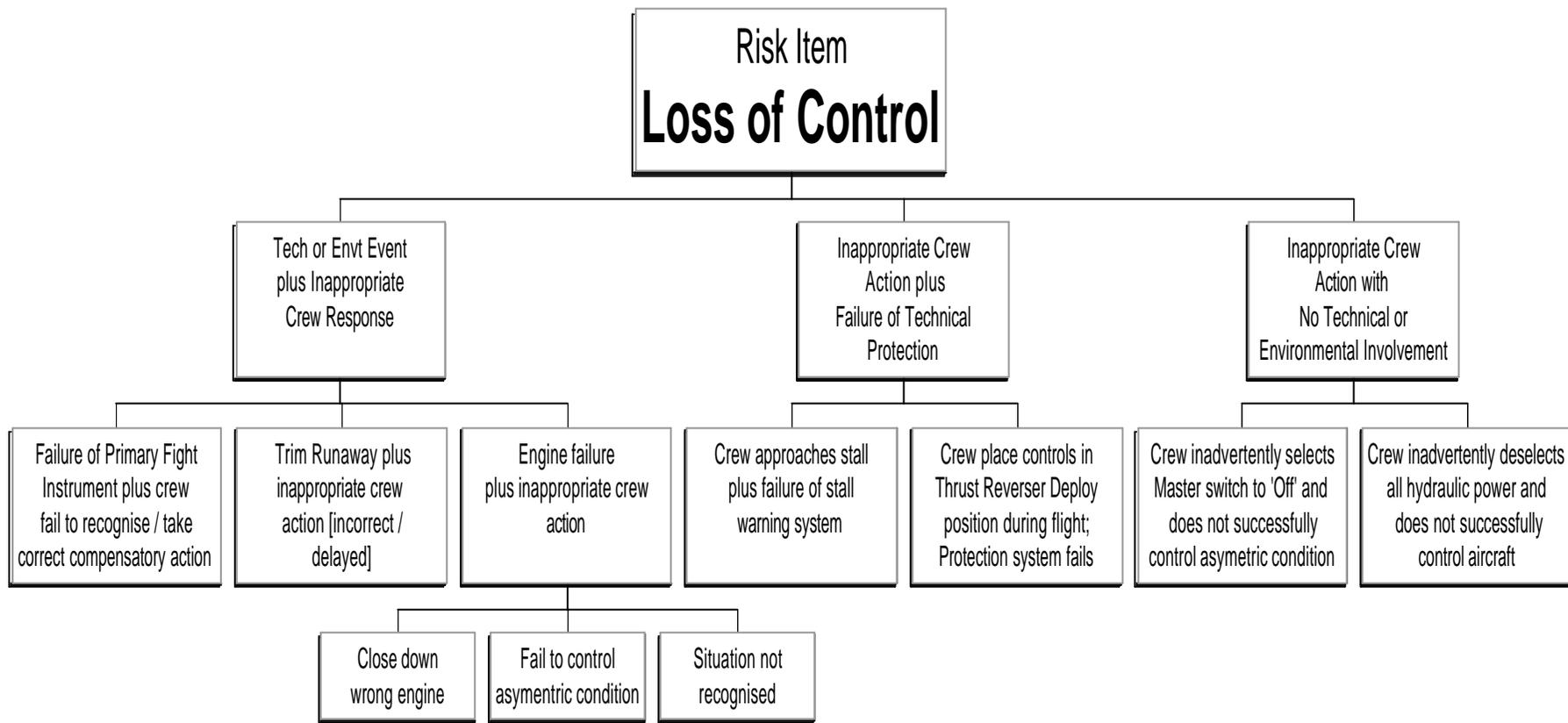
- Interventions [to be designated Special Operator Items for e.g. information needed to support user modification of Electronic Checklists]
- Selections [also Special Operator Items such as selectable or optional features].

### d) Maintenance Engineers

- Maintenance Engineer Training [to be designated Maintenance Training Items e.g. that require specific skills not normally expected of maintenance engineers].
- Maintenance Procedures [to be designated Maintenance Procedure Items e.g. that require unusual procedural considerations or departure from normal custom and practice].

### e) Maintenance schedule

- For those defining the Maintenance Schedule [to be designated Maintenance Schedule Items for e.g. degree of maintenance required to sustain cursor control device to usable accuracy].



**Fig. B1.1: Illustration of one possible approach to risk identification**

## B1.2 Human Factors Aspects of New or Novel Features

### i) Documented Plan

For the novel features of the flight deck, the Applicant should show that in the design they have fully considered human factors issues as raised by the Special Condition. This may be achieved by use of a:

Human Factors Certification Plan, that will

- a. Identify items in the proposed design that are considered new or novel, in accordance with Attachment 1.
- b. Identify how they will address the potential for crew related risk that may arise from these items, including their relationship to conventional features [further considerations also in Appendix A]. For this purpose, they may select to apply the format illustrated in Fig. B1.2, including for each novel item [column headers shown below, underlined]:
  - i. Novel Item name
  - ii. Risk Potential arising from crew interface
  - ii. Design Objectives in managing those risks
  - iii. How Foreseeable Performance of crew will be addressed
  - iv. How Ease of Use will be addressed
  - v. How Effects of Error will be addressed
  - vi. How Task Distribution will be addressed
  - vii. How Adequacy of Feedback will be addressed
  - iv. Other foreseeable concerns
  - v. JAR / FAR paragraphs also relevant
  - vi. Certification credit events where the design will be exposed to the Team for formal evaluation of the item.
- c. Show the planned development schedule including the manufacturer / customer internal assessments and 'proof of concept' activities, which may be observed by some Team members.
- d. Describe the planned resources that will be available for development activity, in particular mock-ups, active representations and simulation.
- e. Show due consideration to items identified in the FAA Policy Statement Number ANM-99-2 on Guidance for Reviewing Human Factors Certification Plans.

Novel Item	Risk Potential	Design Objective	Foreseeable performance	Ease of Use	Effects of Error	Task Distribution	Adequacy of Feedback	Other - e.g. derived from specific risks?	Relevant JAR 25 Para's	Certification Credit Event
<b>Cursor Control Device [CCD]</b>	Poor accuracy or usability may adversely affect pilot access to time critical functions especially busy periods	Pilot access to time critical functions will be as good as previous aircraft Type in all situations including busy periods	No simultaneous access to dissimilar functions. Finite time needed for selection. Inadvertent selection and difficulty in locating target areas are potential problems. Hand / arm strain over prolonged use to be evaluated.	Test pilot evaluation in full motion simulator [Test Plan doc ref]  Iterative development to optimise CCD control laws [Test Plan doc ref]	Philosophy document shows policy on feedback and 'undo' [Philosophy Doc Ref]  Accuracy aided by capture zones.	Review of crew tasks to ensure PF / PNF responsibilities unchanged or addressed, plus part task simulation [two crew] [Review doc ref; Test plan doc ref]	Philosophy document shows policy on feedback for cursor position, error recognition, and system status [Philosophy doc ref]	Time efficiency; evaluation using line pilots and test pilots on scenarios defined to challenge system; time compared to previous variant [Test plan including scenarios doc ref]	Appendix D	Full simulation including failure scenarios [event x] plus subsequent Flight Test [event x]

**Fig. B1.2 Illustration of format by which manufacturer may outline proposed HF activity.**

This figure is a conceptual illustration only and there are potentially many other novel items, and more risks and development activities within a single item, than can be shown here. However the purpose is to show a systematic process by which the novel items, associated risks and plans to manage those risks can be considered and summarised.

## ii) Addressing specific risks

Known certification experience has shown that the certification plan may not cover all critical HF issues. Therefore, the applicant may want to show to the certification team that a thorough investigation of the most critical issues has been performed in order to prevent the interface in being involved in major identified / possible causes of accidents scenarios.

These potential causes should be examined to consider causes that are:

- purely technical / environmental [refer to FHA and therefore not listed here]
- a technical failure combined with inappropriate crew response [e.g. incorrect / delayed]
- an inappropriate crew action coupled with a technical failure [e.g. of a protection system]
- crew related only with no technical failure involved [may include combinations of e.g. error, workload, distraction, delay, misdiagnosis, poor judgement or flight handling skill]

The means by which the applicant has addressed such risks should be shown. This analysis should include reaction to the event (detected or not, subsequent correct / incorrect action) as well as evaluation of consequences (no consequence, increase risk, additional error,...). The purpose of the analysis is to forecast possible crew behaviours. Trials / simulations as suggested hereafter, should validate the chosen expected crew behaviour.

Planned development activity including the involvement of a representative sample of operational flight crew in trials and part-task simulation shall support the achievement and demonstration of compliance. The JAA Team shall monitor the development process and be invited to attend evaluation trials.

In order to support the JAA team assessment, the evaluation trials shall include demanding scenarios representative of relevant flight phase [Flight preparation, Taxi, Climb, Cruise, Approach, Landing, Go-around, Holding] with standard crew tasks [flight path control, flight path management, communication, aircraft system management] and using all the available interface means [e.g. communication through data-link if that is proposed]. Scenarios shall include normal, abnormal and emergency situations, and minimum dispatch conditions. The manufacturer should propose the means by which these scenarios can be assessed in an environment with an appropriate level of realism.

## **iii) Compliance evaluation**

The compliance of the design to the Special Condition criteria would be evaluated by the Team at the formal certification event designated by the applicant. For each main item, considerations may include:

### Generic knowledge on human performance

- a) Occasional error is a normal characteristic of skilled human performance [e.g., *where a single error would impact safety, the crew should be supported by the design or, where that is not practicable, operating procedures or training*].
- b) Crew capacity is not limitless in terms of working memory [e.g. *crew should not be expected to hold in mind long alphanumeric sequences*] long term memory [e.g. *without regular practice, crew training and skill may fade over time*] and attention [e.g. *supplemental systems may impact safety if they are slow, distracting or difficult to use; the presentation of non-functional information should be avoided; simultaneous tasks and demands on the crew should be minimised.* ]
- c) Available crew capacity may be reduced during failure conditions or under stress; hence the additional need to apply unfamiliar procedures at such a time should be avoided [e.g. *the need to fly without the normally used auto-throttle following a single engine failure; reliance on reversion to*

*rarely used paper checklists during abnormal situations*] Where this cannot be feasibly achieved within the design, regular training in such procedures should be identified in the Operations Interface Document.

- d) Expectation may bias crew perception and thus important information that is contrary to expectation must be particularly explicit.
- e) Cultural differences may exist and could be relevant to some design expectations [e.g. *on use of English alphabet for sequencing; differing application of CRM*].

#### HF cockpit design issues

- a) Established practices and conventions may influence crew actions, especially under stressful conditions. [e.g. *if a certain location on the flight deck has been associated with a particular function in many previous aircraft, it is foreseeable that some crew may erroneously reach to that position for the function even if trained to find it elsewhere.*]
- b) Compelling information displayed on the flight deck is likely to be believed by crew whether or not it is regarded by the manufacturer as 'reliable'.
- c) A high rate of false warnings is likely to reduce the effectiveness of genuine warnings.
- d) Adequacy of Feedback
  - 1. Consistent application of feedback philosophy.
  - 2. Evaluation of effectiveness of method and format of feedback.
  - 3. Relationship to aircraft flight control system.
  - 4. Sub-categories as outlined below:
    - i) presentation of information  
*Examples: Awareness of activity on system between crew; symbol readability in vibrating conditions; display colour philosophy; compelling presentation where differing from expected and safety relevant; presentation suggestive of existing limitations on use (if any).*
    - ii) representation of system condition by display of system status  
*Examples: Awareness of system status despite reduction of continuously available feedback from overhead panel; draws attention to status change.*
    - iii) indication of failure cases, including aircraft status  
*Examples: Potential obscuration of information by pop-up menus.*
    - iv) indication when crew input is not accepted or followed by the system  
*Examples: Awareness between crew of which display is 'live' and cross crew awareness issues.*
    - v) indication of prolonged or severe compensatory action by a system when such action could adversely affect aircraft safety  
*Examples: Automated flight control that may be designed such that the adjustment reaches the end of its travel before the crew is made suddenly aware of the situation.*

#### Recommendations for developing a sound HF analysis methodology

- a) Iterative involvement of test pilots and operational pilots in the development of such systems is likely to result in an improved product; this should include representations [e.g. simulation] that have a degree of realism appropriate to the level of assessment and the use of scenarios including those that are most likely to address system vulnerability and risk related situations.
- b) The systematic assessment of the contribution of the effects of error to safety risk in the operational environment. The applicant may identify risk situations and demonstrate how the effects of crew error as a contributor to such situations have been addressed. This may include design features that reduce the likelihood that the error would occur, and the ease with which errors could be detected and recovered.
- c) Error in routine tasks [such as data entry or misreading digits] is a normal characteristic of human performance, and such errors are considered probable.
- d) The recognition that the absence of a particular crew error during development simulation activity does not prove that such an error can never occur in service.

*Examples: To include crew response to system failure, and also error during normal (and abnormal) operations that do not occur during a response to a failure of the system on which the error is made. It is not acceptable to assume that all errors (e.g., simple slips and lapses) can be eradicated by training.*

e) Task Distribution considerations

1. The introduction of new or novel design features may potentially affect workload or awareness between crew or across time; some tasks may become more time consuming or exclusive. Such effects should be explored.
2. The quantity, similarity and function of tasks that are conducted through a single device or access point should be investigated for peaks or 'bottlenecks' at busy or critical periods.
3. The risk from task interruption [and potentially remaining incomplete] may also be related to design characteristics [such as the need to withdraw from one menu to access another in an automated system].

*Examples: Time taken to access features of systems that are time critical; time taken head down during busy phases of flight (especially where lookout required); time sharing of devices for dis-similar tasks (e.g. Multi-Function Display); critical task times in comparison with previous designs; system status following interrupted tasks. Cross-crew awareness of status and actions taken.*

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**APPENDIX C**

**Criteria for a JAA Human Factors Assistant Specialist**

For inclusion on a JAA Type Certification Team as a Human Factors Assistant Specialist the individual should at have at least:

1. Specific training in:
  - a) human factors in design
  - b) the effects of design on the likelihood and outcome of crew performance / error, including superficial control / display features and underlying architecture / logic
  - c) human performance characteristics
  - d) statistical and sampling theory
  - e) measurement / recording of performance and opinion
  - f) assessment of design against a standard or requirement
  - g) aviation applications
  
2. Direct experience of:
  - a) flight deck development activities, design programs and practices
  - b) user evaluations and extrapolation of design recommendations
  - c) JAA certification activity
  - d) pressures of time and commercial interest as they exist in
    - i) moving from application to certification
    - ii) the operating environment