



**Civil Aviation Advisory
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This is an advisory publication. It describes some options for complying with the Civil Aviation Regulations 1988 (CAR 1988).

Always read this advice in conjunction with the appropriate regulations and any Civil Aviation Orders (CAOs).

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Integration of Human Factors (HF) into Safety Management Systems (SMS)

The relevant regulations and other references:

- Civil Aviation Act 1988
- Section 82.3 and 82.5 of the Civil Aviation Orders
- Civil Aviation Safety Regulations
- CASA CAAP 5.59–(0) Teaching and Assessing Single-Pilot Human Factors and Threat and Error Management
- CASA (2008) Safety Behaviours: Human Factors for Pilots Training Resource
- ICAO (2007) ICAO Safety Management Manual Doc. 9859
- ICAO (1998) Human Factors Training Manual, Doc. 9683
- ICAO (2002) Human Factors Guidelines for Safety Audits Manual, Doc – 9806
- UK Civil Aviation Authority (CAA) CAP 712 - Safety Management Systems for Commercial Air Transport
- Transport Canada (TC) Advisory Circular 107-001 – *Guidance on Safety Management System Development*
- ISO 13407 (1999) Human-centred design process for interactive systems
- ISO/TR 16982 (1992) Ergonomics of human system interaction – Usability methods supporting human-centred design
- ISO 6385 (2004) Ergonomics principles in the design of work systems

Who this CAAP applies to

This Civil Aviation Advisory Publication (CAAP) applies to holders of Air Operator's Certificate (AOC) for Low Capacity and High Capacity Regular Public Transport (RPT) operations.

The Civil Aviation Safety Authority (CASA) recognises that the operations to which this CAAP will apply are numerous and varied, and will endeavour to adopt a flexible approach consistent with the maintenance of good standards. Low Capacity RPT operators should take this into account when reading this document and considering its implications for their style of operations.

This CAAP should be read in conjunction with CAAP SMS 1(0) Safety Management Systems (SMS) for RPT Operations and CAAP SMS 3(0) HF Training and Non Technical Skills Assessment for RPT Operations.

Why this publication was written

This CAAP provides advice and guidance for integrating Human Factors (HF) into an RPT operator's SMS. It is crucial that HF is integrated at every opportunity, and not considered separately.

Status of this CAAP

This is the first CAAP written on this subject.

For further information

For application and policy advice contact CASA's Human Factors Manager (Telephone 131 757) or email humanfactors@casa.gov.au.

Acronyms & Definitions

Acronyms and definitions are contained in CAAP SMS-1 which should be read in conjunction with this CAAP

1. Why Integrate HF into an RPT AOC holder's SMS?

1.1 The integration of HF into the SMS provides a managerial and organisational framework to ensure the systematic identification and analysis of relevant HF issues, and the application of appropriate tools, methods and measures to address such issues.

1.2 CAO 82.3 and CAO 82.5 require RPT AOC holders to ensure that an SMS is established in their organisations and that HF is integrated into their SMS processes. The practical and methodical application of HF within an SMS is essential to ensure compliance and to optimise human performance within their systems.

2. Basic principles for integrating HF into an SMS

2.2 HF principles have been summarised from international standards, best practice and in consultation with system safety and human factors experts. These principles will help address the people and systems challenges in SMS and achieve appropriate and identifiable benefits. The following list summarises the HF principles which are encompassed in the body of this document:

- adopt a holistic and integrated approach;
- put the people at the centre of the system;
- account for human variability;
- ensure transparency of organisational processes and actions;
- take account of social and organisational influences;
- involve staff and respect and value their input;
- encourage timely, relevant and clear two-way communication; and
- ensure fairness of treatment (e.g. the 'just culture' concept).

3. Business benefits for integrating HF into the SMS

3.1 It is recognised that the integration of HF in the SMS will result in safety and business benefits. The integration of HF:

- improves overall safety performance in the organisation and reduces the number of incidents;
- ensures that human performance is optimally managed to improve safety capacity and efficiency;
- helps to meet legal and regulatory obligations;

- demonstrates all reasonable steps have been taken to manage safety and control risk from the perspective of human performance;
- reduces direct costs by considering HF issues in the SMS and as part of any significant change management activity;
- reduces indirect costs (such as staff turnover and stress-related leave);
- reduces duplication of activities and effort (and streamlines changes) resulting in cost reductions;
- improves staff motivation across the organisation; and
- improves staff acceptance of change.

4. Safety benefits for integrating HF for the organisation

4.1 Operationally the integration of HF into the SMS facilitates continuous improvements to safety, including:

- promoting a duty of care throughout the organisation;
- increasing understanding and ownership of the safety processes;
- encouraging continued safety improvement and the development of a 'learning organisation';
- promoting the use of good communications and feedback throughout the organisation;
- helping to disseminate appropriate lessons learned;
- establishing, maintaining, and improving the safety culture of the organisation;
- improving the integration of HF training processes within the training goals of the organisation;
- clarifying HF training and assessment criteria expected of the organisation's members with respect to safety, and providing a documented process to ensure that standards are maintained;
- providing HF input to improve effective data collection and analysis methods to support the safety process;
- supporting the efficient allocation of resources to the safety process; and
- Promoting and developing a proactive and predictive management of risk.

5. Integrating HF into the SMS

5.1 Integrating HF is essential in the elements of the SMS dealing with:

- risk management;
- management of change;
- design and procurement of systems, equipment, machinery and their subsequent usability;
- job and task design;
- selection and training of safety critical personnel;
- safety reporting and flight data analysis; and
- incident investigation.

5.1 HF risk management allows an organisation to determine where it is vulnerable to human performance limitations. The potential for human error and its sources should be identified and managed through the risk management process¹.

5.2 SMS documentation should clearly demonstrate how human factors have been considered in the management of risk.

5.3 Various aspects of human performance should be considered when identifying, assessing and controlling hazards. This includes areas such as prevention, initiation, detection, control, escalation, mitigation, and emergency response.

5.4 Of particular relevance are:

- processes to ensure that the potential for human error is explicitly addressed; and
- the inclusion of human error management, including error recovery actions, within the risk assessment process.

5.5 The risk management process does not change, however, it should include all relevant HF issues.

5.6 In addition, the following HF aspects should be considered:

- all the people who interact with the system;
- reasonably foreseeable non-compliance with standard operating procedures;
- paying particular attention to abnormal or infrequent modes of operation;
- solutions that support the detection, correction and management of errors; and
- fatigue.

¹ Also refer to the Safety Risk Management section of CAAP SMS-1(0) – Safety Management Systems for Regular Public Transport Operations.

5.7 Typically, control measures for potential and actual human error might focus on HF aspects such as equipment design and usability, task and job design, workplace design, procedures, training, communication, team work, supervision, and monitoring. The most effective controls are either to remove or modify the hazard.

5.8 HF should also be considered during the implementation of safety management solutions, and any recommendations should only be considered after taking into account the context of local factors in the working environment, as well as organisational, or systemic factors.

5.9 To ensure the effectiveness of the control measures, a process for monitoring and review should be implemented.

6. Management of change

6.1 The purpose of integrating HF into the management of change is to minimise potential risks by specifically considering the impact of the change on the people within a system.

6.2 Change has the potential to introduce new, or exacerbate pre-existing, HF issues. For example, changes in machinery, equipment, technology, procedures, work organisation or work processes are likely to affect performance.

6.3 The magnitude of change, its safety criticality and its potential impact on human performance should be assessed in any change management process.

6.4 Special consideration should be given to the 'transition period'. Any HF issues identified should be clearly documented. In addition the activities utilised to manage these issues should be integrated into the change management plan.

6.5 Some points for consideration:

- The change management effort should be commensurate with the operational risk to the organisation;
- Identify all those affected by the change who have the potential to impact safety;
- Identify how roles and tasks will be affected by the change;
- Identify the risk to human performance associated with the change – including resistance to change;
- Implement risk management strategies to eliminate or mitigate risks associated with the change;
- Assess and monitor any residual risk associated with human performance; and
- Evaluate and review safety performance against stated objectives.

7. Design and procurement

7.1 Design and modification of Human Machine Interfaces (HMI) such as display and control systems, alarm systems, signals and warnings, as well as automated systems may involve significant HF risks.

7.2 Integrating HF and usability principles in the early stages of design, modification and procurement is the most effective way of designing out, or managing, HF risk.

7.3 The design of equipment and machinery can have a major impact on human performance, and steps should be taken to ensure that HMI are designed with the user in mind. A human-centred design approach should be taken, and principles of good HMI design followed.

7.4 The design of safety-related systems should take into account human capabilities and limitations, both physical and cognitive, and be suitable for the tasks assigned to operators and maintenance staff. A typical approach could include:

- considering HF and usability practices and principles in designing modifying and/or procuring systems. For example, international standards for user centred design;
- designing, where possible, systems and equipment to be tolerant of errors made by operators;
- identifying, where possible, all the ways that people may potentially interact with the system;
- assessing any risks associated with those interactions;
- ensuring risk management strategies are in place to manage the identified risks;
- assessing and monitoring any residual risk associated with human interaction; and
- evaluating and reviewing safety performance against stated objectives.

7.5 Prior to implementing newly designed, modified or procured systems, awareness and/or training of those persons who interact with the system should be undertaken. All interfaces should facilitate good HF practice, and should accommodate the likely level of awareness and/or training of operators (including members of the public where applicable).

8. Job and task design

8.1 Job and task design can contribute to system safety. Improving the design of jobs and tasks, and the workspaces in which they are performed, can significantly improve human performance and reduce the potential for human error.

8.2 Task design is essentially about matching the person and the task – making sure that tasks and activities are appropriate and suited to the human operator's or team's capabilities, limitations and personal needs. For example, tasks that involve excessive time pressure, complex sequences of operations, reliance on memory, are physically or mentally fatiguing etc. are likely to have a negative impact on performance.

8.3 A typical approach may be to:

- identify safety critical tasks, and those who perform them;
- design the task objectives, sequences and actions to be performed;
- structure the task so it supports the safe performance by the individual or team;
- consider the working environment so it supports the safe performance of the task;
- assess the potential risks associated with non compliance, human capabilities and limitations;
- implement risk management strategies to manage identified risks; and
- evaluate safety performance against the stated objectives.

8.4 Examples of design elements that can be included are:

- procedures and rules;
- equipment, tools and materials;
- HMI;
- information requirements;
- manning and workload;
- workspace;
- capabilities and skills required;
- team structures;
- communication links;
- rostering;
- rewards and incentives; and
- supervision.

9. Selection and training of safety critical personnel

9.1 It is essential to take proactive steps to integrate HF into selection, training, and job performance to maximise the ‘task-person fit’ and to reduce the potential for human error.

9.2 It is important to identify and assure the adequacy of training and competency of staff performing critical functions directly affecting safety. A clear demonstration of the adequacy, effectiveness and appropriateness of training and competency should be provided within the SMS; particularly as it relates to HF principles in the organisation’s SMS.

9.3 Once the competencies for a role have been defined, methods need to be developed for selecting and training people based on these competencies. In some instances people will already be selected, in which case these people should be evaluated against the competencies and training requirements identified in order to ‘bridge’ any discernable gaps.

9.4 To identify training requirements, a Training Needs Analysis (TNA) can be performed. For information on the conduct of a TNA plus information on the development and implementation of training, the evaluation and review of training effectiveness and safety performance against stated objectives, please refer to Section 6 of Human Factors Training and Assessment for RPT Operations CAAP SMS-3(0).

10. Safety reporting systems and data analysis

10.1 The main objective of any safety data collection and analysis system is to make events, hazards, safety trends and their contributing factors visible, understandable, and supported by useable data so that effective corrective action can be taken.

10.2 From the HF perspective, the behaviour of individuals or groups involved in incidents or ‘near misses’ may not differ greatly from that observed when accidents occur. Generally, the cognitive failures, problems in decision making, communication breakdowns, distractions, and all the other factors which contribute to the sum total of behaviour in an accident will also be present in incidents.

10.3 It is important that the reporting system, as identified in the SMS, incorporates the identification of contributing HF. In addition, staff should be trained and encouraged to identify and report contributing HF when reporting hazards or occurrences.

10.4 Systems to encourage open reporting based on trust, acceptance and motivation include:

- just culture based, confidential hazard and incident reporting systems;
- a clear and accessible process for reporting issues;
- formal and informal meetings to discuss safety concerns; and

- feedback from management about action taken as a result of hazard and incident reports or safety meetings².

10.5 The classification of operator errors and contributing factors in any accident and incident data collection system should be based on a taxonomy that is carefully aligned with the model or framework used for the investigation and hazard reduction components of the SMS.

11. Investigation

11.1 It is essential that the contribution of HF is properly investigated when incidents and accidents occur. This is done so that the organisation can learn from incidents and near misses in order to protect itself against the consequences of failing to accommodate human limitations in the design and operation of aviation systems.

11.2 The HF component of investigation should be based on a model or framework for systemic investigations considering human error, both at the individual and organisational levels. A number of human error models and frameworks (such as Reason's model) have been developed over the last two decades to aid in understanding how humans err and how accidents/incidents occur in the larger context of the systems in which these accidents/incidents take place.

11.3 Investigators should be trained in basic HF concepts, and procedures should be designed to examine the detail of human performance factors that may have contributed to the event. These include the systemic sources of the failure (e.g. component failures, design deficiencies of equipment and/or infrastructure, inadequate procedures, and lack of training).

² Also refer to the Safety Risk Management section of SMS CAAP SMS 1(0) - Safety Management Systems for RPT Operations.