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The Human Factors Case: Guidance for Human Factors Integration

EUROCONTROL

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The Human Factors Case: Guidance for Human Factors Integration

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Abstract

This document describes the updated Human Factors (HF) Case process. The HF Case is a comprehensive and integrated approach to ensure that the design and implementation of an Air Traffic Management (ATM) system can deliver the desired performance improvements from a human perspective. The HF Case is a five-stage process:

1. Fact Finding.
2. Issues Analysis.
3. Action Plan.
4. Actions Implementation.
5. Review

Keywords

Human Factors Case (HF Case)	Issues Analysis	Human Factors Integration
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Authors

Úna Mellett, Michael Nendick

Contact Person	Tel	Unit
Úna Mellett	+32 2 7293482	Safety, Security and Human Factors Business Division (DAP/SSH)

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The following table identifies all management authorities who have successively approved the present issue of this document.

AUTHORITY	NAME AND SIGNATURE	DATE
Project Leader	Ú. MELLETT	25 June 2007.
Chairman Human Performance Focus Group (HPFG) Manager Human Factors Domain	M. BARBARINO	28.06.07.
Chairman EATM Human Resources Team (HRT)	A. SKONIEZKI	29/06/07
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EUROCONTROL Headquarters
96 Rue de la Fusée
B-1130 BRUSSELS

Tel: +32 (0)2 729 4715
Fax: +32 (0)2 729 5149
E-mail: publications@eurocontrol.int

CONTENTS

EXECUTIVE SUMMARY

The role of Human Factors (HF) in Air Traffic Management (ATM) system design, evaluation and implementation is critical. With increasing automation and advanced technology it is important to identify and manage human performance related issues as early as possible. This will result in optimised relationships between people, tasks, technologies and the working environment aiming to ensure safe and efficient human performance.

The HF Case is a management process to systematically identify and treat HF issues during an ATM project from beginning to end. It has been developed to provide a comprehensive and integrated approach to ensure that the design of a technical, human, and/or procedural system can deliver the desired performance improvements. The HF Case is designed to be simple, practical and effective, with five specific stages:

- **Stage 1 - Fact Finding:** This stage records the factual information about a project, including its background, system and environment, key stakeholders and documentation. The objective is to scope the project from an HF perspective to identify what will change, who will be affected, and how they will be affected.
- **Stage 2 - Issues Analysis:** This stage is about the identification and prioritisation of the project-specific HF Issues and their potential impacts on the project. HF Issues are classified into six main categories in accordance with the 'HF Pie':
    - Human in System,
    - Organisation and Staffing,
    - Procedures, Roles and Responsibilities,
    - Teams and Communication,
    - Training and Development,
    - Working Environment.
- **Stage 3 - Action Plan:** During Stage 3 an Action Plan is developed which describes actions and mitigation strategies to address the HF Issues identified for the project.
- **Stage 4 - Actions Implementation:** This stage implements the Action Plan. The output is the HF Case Report which provides findings and conclusions from the actions taken to address the HF Issues from Stage 3**.**
- **Stage 5 - HF Case Review:** This stage provides an independent review of the HF Case. It suggests recommendations for improvements to the HF Case methodology.

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1. INTRODUCTION

1.1 Background

The Human Factors (HF) Case was launched in August 2004, supported by the first edition of this document. The primary focus of the original HF Case was for application in European Air Traffic Management (EATM) projects within EUROCONTROL.

Using the HF Case in a number of EUROCONTROL projects highlighted areas where the process could be refined and improved. Additionally, a growing interest in using the HF Case from EUROCONTROL external stakeholders suggested a widening of the original scope.

This second edition incorporates lessons learned from the application of the HF Case so far. It has been adapted to support those wishing to introduce the HF Case methodology into their organisations.

The main change to the updated HF Case is that it now has five clearly defined stages instead of four. A flow chart helps the user to determine where they are within the process and the required inputs and outputs for each stage have been made more explicit. In addition to the familiar “HF Pie” classification tool (which has been slightly modified) to cluster issues organisationally, there is a new “HF Impacts wheel” classification tool to aid assessment of how HF Issues will impact on human performance in the system. Finally the definitions for the HF Issues prompts have been significantly expanded in the appendices.

1.2 Purpose and Scope

The HF Case provides a framework for project managers to effectively accomplish their operational and business objectives by systematically addressing the HF Issues throughout a project life-cycle (e.g. system design, evaluation, implementation and operation).

This document describes the HF Case process. The aim when using the HF Case is not to transform project managers and their teams into HF specialists, but to address HF Issues within their projects and thus to raise their level of awareness of HF concepts, terminology, tools and methods.

1.3 Document Overview

To facilitate readability, this document comprises of four sections:

- **Section 1 - HF Case Introduction**: The HF Case background and purpose.
- **Section 2 - HF Case Concept**: This section outlines the main features of the HF Case approach: what it does, the key contributors, when and where the HF Case is applied, and the major benefits it offers project managers.
- **Section 3 - HF Case Process**: This section describes the objective, process steps, and output for each stage of the HF Case process.
- **Section 4 - Applying the HF Case**: This section provides an overview of the HF Case web-based application tool.

2. THE HF CASE CONCEPT

Designing a complex, automated Air Traffic Management (ATM) system requires the designers to address a wide range of engineering issues that relate to hardware, software, and the operational environment. However, the human aspects of jobs, tasks, and procedures must also be designed. The basic HF question to consider is “How can the hardware, software, and the work environment be optimally designed for effective and efficient use by trained operational personnel?” It is important to understand that there is not a simple answer to this question.

The application of HF is a core part of the system design, evaluation, and timely implementation, but it can be perceived to be complex and difficult. The HF Case provides a practical process to address and manage HF Issues throughout the project life-cycle to improve human performance within the ATM system. Key HF concepts are system usability and acceptability.

This section describes the following:

1. Why the HF Case?
2. What is the HF Case?
3. Who are the main contributors?
4. When is the HF Case initiated?
5. Where is the HF Case applied?
6. What are the major benefits?

2.1 Why the HF Case?

Project managers, when integrating HF into their projects, are faced with the following challenges:

- **HF Issues can be complex and difficult to identify**: There are many facets of HF to consider when looking at the impact of new technology on the job and related human performance on the task, the human needs and aspirations in the workplace, and the organisational structures within which the systems exist.
- **HF interventions made too late**: Modifications to a design (after it has been tested and evaluated) are costly and time consuming. The earlier in the development process that HF Issues are identified, the easier and less costly they will be to address. Identifying potential problem areas early can also help focus on the operational testing and evaluation, and make these tests more effective at identifying potential operational limitations.
- **Justifying resources and budget for HF**: Project managers often find that it is not easy to make a strong case for the HF effort for their project because the added value is not clearly defined. The output is difficult to incorporate into the budgetary process unless a structure is utilised to demonstrate the financial value of HF activities.

- **Acceptance by end-users**: Designing for the ATM workforce requires an understanding of the needs and requirements of the workforce. These needs and requirements are not solely for automated tools and capabilities to support job performance but also for more intangible, though no less important, sources of job satisfaction and peer recognition. The major challenge for designers and project managers is to modernise the operator's tools while retaining an active and involved role for the operator in the system. End-users will be more likely to accept the project outcomes if the HF Issues are appropriately addressed during project development.
- **Applying HF flexibly, not prescriptively**: A challenge for project managers is to deal with HF Issues flexibly to find solutions for potential show-stoppers for their projects.

These challenges faced by project managers led to the following five principles on which to base the structure of the HF Case:

1. A **practical process** to capture HF Issues,
2. A process to enable **timely interventions**,
3. **Facilitation** for project managers to make **a case for HF within a project**,
4. A **structure** to enable expert input as well as end-user involvement,
5. An **adaptable process** to meet different project requirements.

2.2 What is the HF Case?

In basic terms, HF is concerned with designing things for people's use (Chapanis, 1983). Human Factors is the discipline that applies our knowledge of human capabilities and limitations to the design of technological systems. In broader terms HF can be simply defined as "... **concerned to optimise the relationship between people and their activities ..."** (Edwards, 1988). This definition was adopted by ICAO (ICAO, 1998a, 1998b).

HF is a multidisciplinary effort to compile, generate and apply knowledge about people at work, and apply that knowledge to the functional relationships between people, tasks, technologies and the working environment, in order to produce safe and efficient human performance. It is a broad discipline, which considers all the issues that influence human and system performance, such as job or role, procedures and task design, team issues and Human-Machine Interface (HMI) design.

In addition, the impacts of Human Resources (HR) practices are incorporated, such as selection, training, planning, staffing, competency checking and licensing. Figure 1 broadly illustrates the HF Issues considered within the "HF Pie" which is used to categorise HF Issues in the HF Case process.

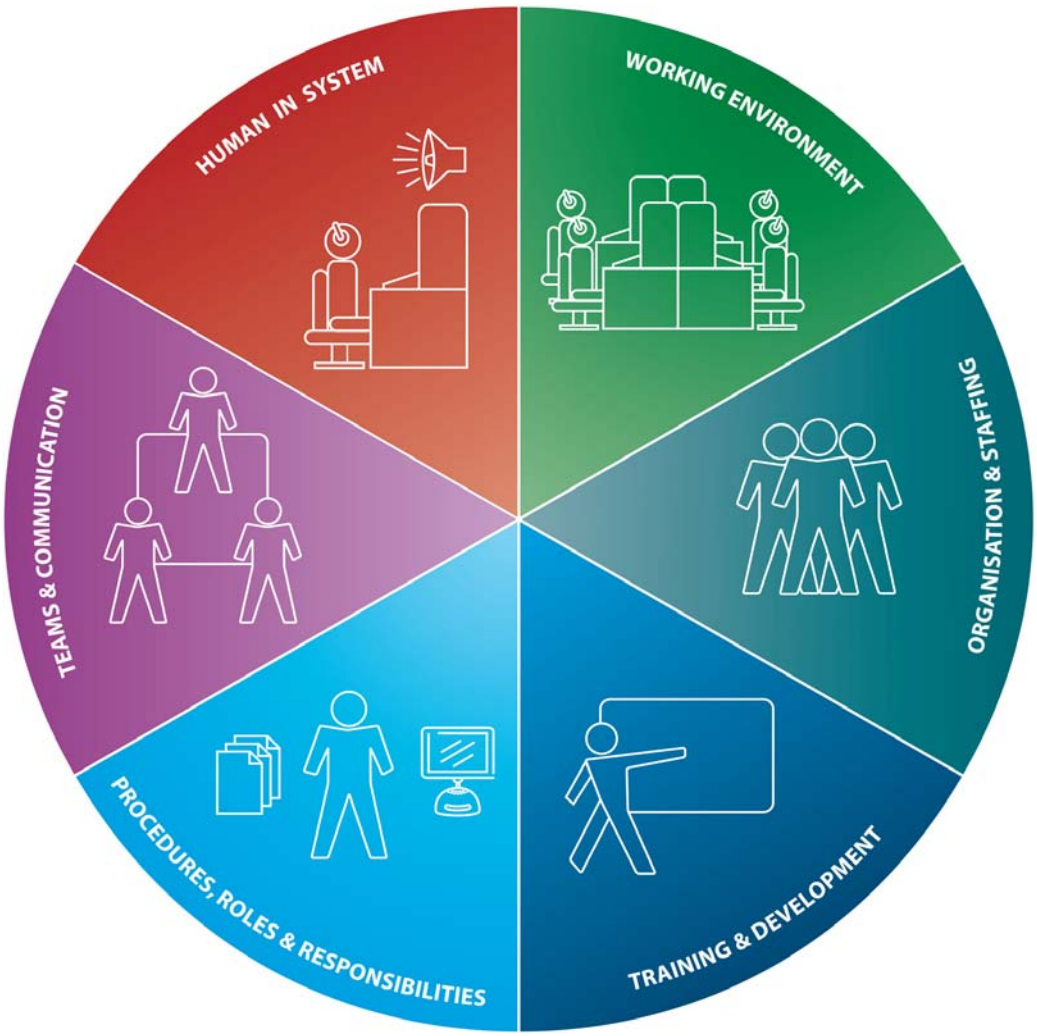

Figure 1: HF Pie

The goal of HF is to better match the system to the human, and the human to the system. Incorporating the wider view of all the HF aspects into the design and ongoing operation of the ATM system increases efficiency, enhances safety, and reduces costs in the long term.

ATM system design must be user-centred and based on operational requirements to make the best use of human strengths and capabilities while compensating to the maximum possible extent for human limitations.

The HF Case has been designed to facilitate managing HF within the ATM system. It is a five-stage process to systematically identify and mitigate HF Issues as early as possible in the project life-cycle. The HF Case stages are:

Stage 1 - Fact Finding: This stage records the factual information about a project, including its background, system and environment, key stakeholders and documentation. The objective is to scope the project from an HF perspective to identify what will change, who will be affected and how.

Stage 2 - Issues Analysis: This stage is about the identification and prioritisation of the project-specific HF Issues and their potential impacts on the project.

Stage 3 - Action Plan: During Stage 3 an Action Plan is developed which describes actions and mitigation strategies to address the HF Issues identified for the project.

Stage 4 - Actions Implementation: This stage implements the Action Plan. The output is the HF Case Report which provides findings and conclusions from the actions taken to address the HF Issues from Stage 3.

Stage 5 - HF Case Review: This stage provides an independent review of the HF Case. It suggests recommendations for improvements to the HF Case methodology.

Figure 2: HF Case Stages

The HF Case **is**:

- a management tool to provide a process to address HF Issues for a project. A phase of the process includes the identification and analysis of HF Issues, their impacts and mitigation;
- the application and integration of Subject Matter Expert (SME) and HF knowledge;
- a qualitative analysis methodology that is as comprehensive as possible.

The HF Case **is not**:

- a quantitative measurement tool;
- intended to be the HF element of a Safety Case[1]. However, addressing the six categories from the HF Pie may lead to the identification of safety-relevant issues that can be used to inform a Safety Case.

The HF Case **focus** is on the HF impacts upon human performance, e.g. augmenting human strengths and compensating for human limitations to improve total system performance. It can answer questions such as:

- Will the operators accept and trust the new/changed system or tool?
- Will they be motivated to use it?
- Will there be excessive training and re-training costs?
- Will a different type of profile be needed to select candidates?
- Will the system fit in with conventional job roles and, if not, have new roles been considered?
- Will the operators have the right skills, and has training been planned?
- Will the operators still be able to take over if/when the system fails or starts to generate bad data?
- Will there be sufficient operators available?

The HF Case looks to **optimise** the human input into the system with safety and efficiency considerations. For example, Stage 4 of the HF Case may identify safety-relevant HF Issues from an in-depth examination of:

- 'human error' (particularly via human error-prediction methods),
- threat and error management,
- human recovery from system failures,
- fatigue,
- workload, etc.

Key **outputs** from the HF Case are:

- HF Action Plan;
- HF findings which can feed back into all aspects of ATM system design, implementation and operations;
- HF Issues to feed into other HF and Safety assessment processes.

[1] *"Primarily the Safety Case is a matter of ensuring that every company produces a formal safety assessment to **assure itself** that its operations are safe. Only secondarily is it a matter of demonstrating this to a regulatory body. That said such a demonstration both meets a legitimate expectation of the workforce and the public and provides a sound basis for regulatory control."*

Lord Justice Cullen - report on the investigation into the Piper Alpha disaster. (Safety Case Development Manual DAP/SSH/091, EUROCONTROL 2006a).

2.3 Who are the main contributors?

- **Project Manager**: The Project Manager is responsible for clearly defining the concept for the new system and ensuring that everybody involved in the HF Case process has the same baseline understanding. The Project Manager should maintain high-level management of the HF activities.
- **HF Case Coordinator**: The HF Case Coordinator should be responsible for the day-to-day implementation of the HF Case process to ensure that the HF Case actions are followed through. The HF Case Coordinator should be solution-oriented but realistic and pragmatic. This role requires a high level of cooperation and involvement. As a key member of the team the HF Case Coordinator should, if possible, remain with the project over its entire life cycle.

  The HF Coordinator should have some expertise in HF matters including knowledge and experience of practically applying HF. However it is more important that this person is able to champion HF within the project, understand the technical aspects of the project, and effectively interface and work with all the key members of the project including the Project Manager and the key stakeholder team.
- **Facilitator**: A trained facilitator should be available to facilitate and moderate the Issues Analysis workshop sessions in Stage 2 of the process. The facilitator should be sufficiently knowledgeable of HF Issues, with at least basic training in HF. Ideally the facilitator should be otherwise independent of the project in order to maintain impartiality while conducting the workshop, where the facilitator's main task is to adhere to the workshop process and timetable. (Ideally the HF Case Coordinator and facilitator should not be the same person).
- **HF Specialist:** An HF specialist may be required when the HF Case Coordinator is not an HF specialist and needs HF expert support from time to time. This person might be available to support the project from internal organisational resources. When such expertise[2] is not available, it may have to be sourced externally as appropriate.
- **Key stakeholder team**: The team should be established at the start of the project. The Project Manager is responsible for identifying the key stakeholders who are likely to include representatives and subject matter experts (SMEs) for design, safety, HF, operations, training, etc. The key stakeholders will meet several times during a project life-cycle. The frequency of the meetings will vary depending on the project size and phase, and HF Case stage, but should be sufficiently frequent to ensure that actions are understood and influence development at the right time.

Table 1 lists the responsibilities and tasks of the main contributors to the HF Case process.

[2] HF competency can be defined at four levels – from an appreciation of HF, to a specialist with HF expertise. Each level can conceivably build upon the knowledge and experience of the previous level. Examples of indicators of levels of HF expertise are given in Appendix 1:

Table 1: Stakeholder task matrix

Tasks	Project Manager	HF Case Coordinator	Facilitator	HF Specialist	Stakeholder team
Identify relevant stakeholders and project interfaces (e.g. related systems)	Yes	Yes			
Identify key documents	Yes	Yes		Yes	Yes
Determine project staffing (including users and experts)	Yes				
Ensure sufficient budget to deal with HF Issues	Yes				
Ensure that timescales are realistic and life cycle intervention is appropriate to deal with HF Issues	Yes	Yes			
Ensure that effective communication processes are in place	Yes	Yes			
Consider commercial issues (e.g. copyrights, patents)	Yes				
Ensure that appropriate collaboration and partnership take place	Yes	Yes			
Identify project risks and dependencies	Yes	Yes			
Facilitate the Issues Analysis meetings to ensure proper progression			Yes		
Identify HF Issues in Issues Analysis sessions		Yes	Yes	Yes	Yes
Prioritise HF Issues	Yes	Yes		Yes	Yes
Ensure that all analyses are carried out in accordance with the Action Plan	Yes	Yes			
Learn lessons from previous and similar project experiences	Yes	Yes			
Conduct HF studies		Yes		Yes	Yes
Check that HF findings are appropriate	Yes	Yes		Yes	Yes
Review testing and simulation programmes to ensure that they adequately address the HF Issues	Yes	Yes		Yes	Yes
Sign off the HF Case to verify that the work has been conducted	Yes	Yes		Yes	

2.4 When is the HF Case initiated?

The HF Case can be initiated at any stage of the project life-cycle (see Figure 3). The HF Case process should run in parallel with a project as it develops through the phases of the project life-cycle.

The HF Case process assists project managers to gain insights into HF approaches that help to predict and manage threats and opportunities for their projects.

Ideally the HF Case should be initiated at the earliest possible stage in the project life-cycle so that HF Issues are identified and dealt with while opportunities exist to resolve them satisfactorily. Experience shows that the earlier in the project HF interventions are applied the more cost effective they are.

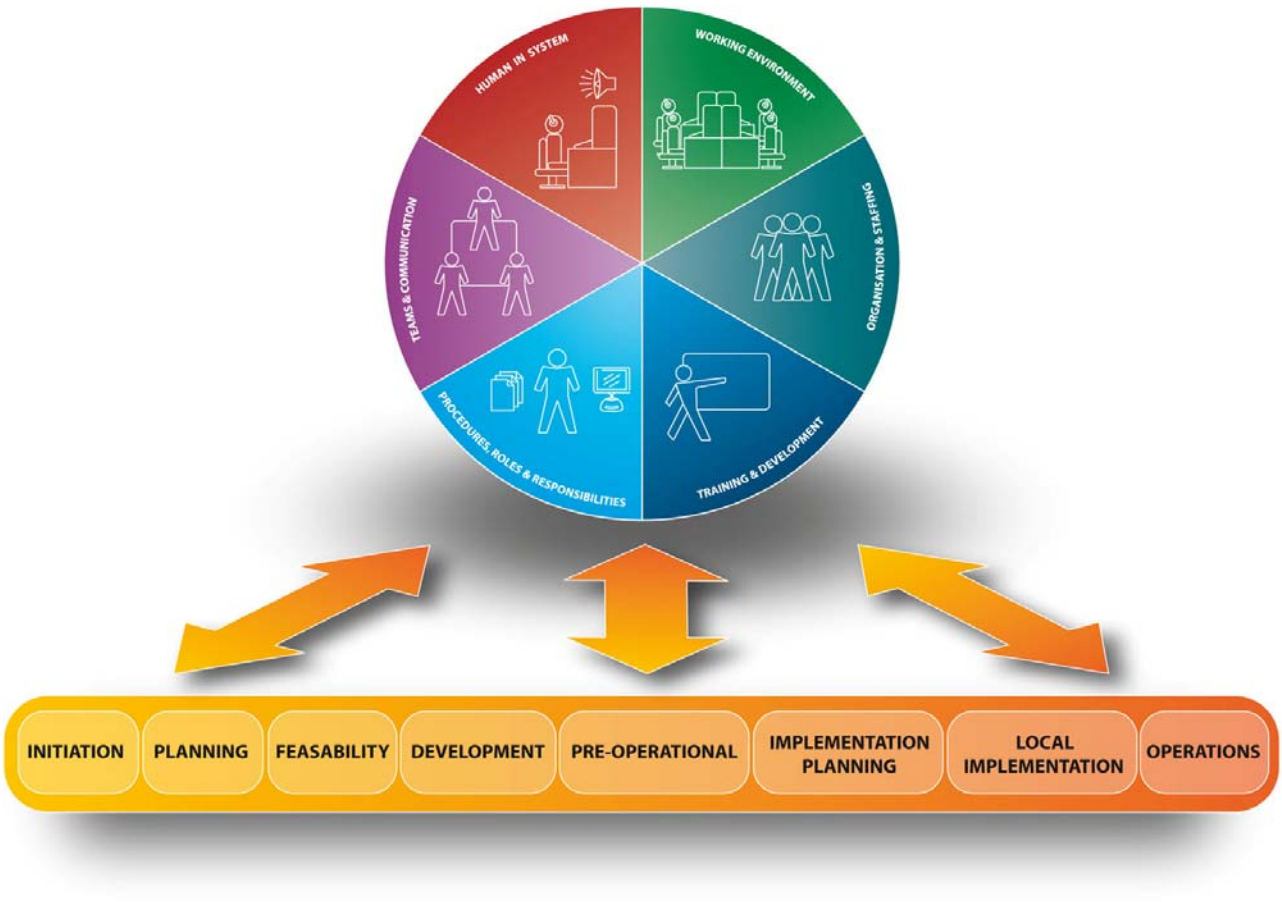

Figure 3: Project life-cycle phases

2.5 Where is the HF Case applied?

An HF Case can be applied to a range of projects, i.e.

- bespoke systems - new, tailor-made systems;
- commercially available systems - 'Commercial Off-The-Shelf (COTS)' systems and products;
- systems implemented elsewhere where the main emphasis is on local implementation issues;
- modified systems that are:
  - extended by new system level functionality;
  - changed to have a new or modified fit, including technology updates;
  - proposed for a change of role or operational use which was not previously envisaged, even where there is to be no change in the system configuration;
  - system upgrades e.g. retrofits.

In addition, a variety of personnel may be considered within an HF Case. These personnel may include Air Traffic Controllers (ATCOs), engineers and maintenance personnel, control and monitoring personnel, trainers, supervisors, management, and support personnel. In short, an HF Case should consider anyone who is affected by system changes and whose performance contributes to the total system performance.

2.6 What are the major benefits?

The major benefits of the HF Case for the Project Manager are:

- **Structured process**: The HF Case provides a simple and straight forward approach to HF integration and helps to ensure that the total system meets its performance objectives.
- **Early awareness**: The HF Case focuses attention at the earliest possible stage of the project life-cycle to planning, training and staffing issues, to help ensure that competencies and resources (e.g. training) are available for the timely implementation of new systems.
- **Delay reduction**: Past experience has demonstrated that many planning and staffing issues are not considered until too close to the promised implementation dates, leading to costly delays.
- **Tangible results**: As the HF Case process clearly defines the deliverables and outputs from each stage of the HF Case, it clarifies the return from investing in HF for the Project Manager and indicates how the results will be incorporated into other project activities.
- **Group-based approach**: The HF Case encourages a group-based approach to capture subject matter expert (SME) end-user input.
- **Flexible process**: The HF Case process is flexible and can be adapted to meet different types of project needs during the project life-cycle.

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3. THE HF CASE PROCESS

3.1 Introduction

This section describes the HF Case process stages. These stages are illustrated in Figure 4. The following aspects are outlined for each stage:

- Objective,
- Process steps,
- Output,
- Support tools.

The Appendices provide the relevant templates and guidelines for the various stages. It should be noted that the structure and contents of the HF Case can be customised to suit specific project requirements.

A website has been designed to assist project teams to apply the HF Case. The website provides an on-line database for all of the material contained in this document, including on-line forms (see Section 4 – The HF Case Application).

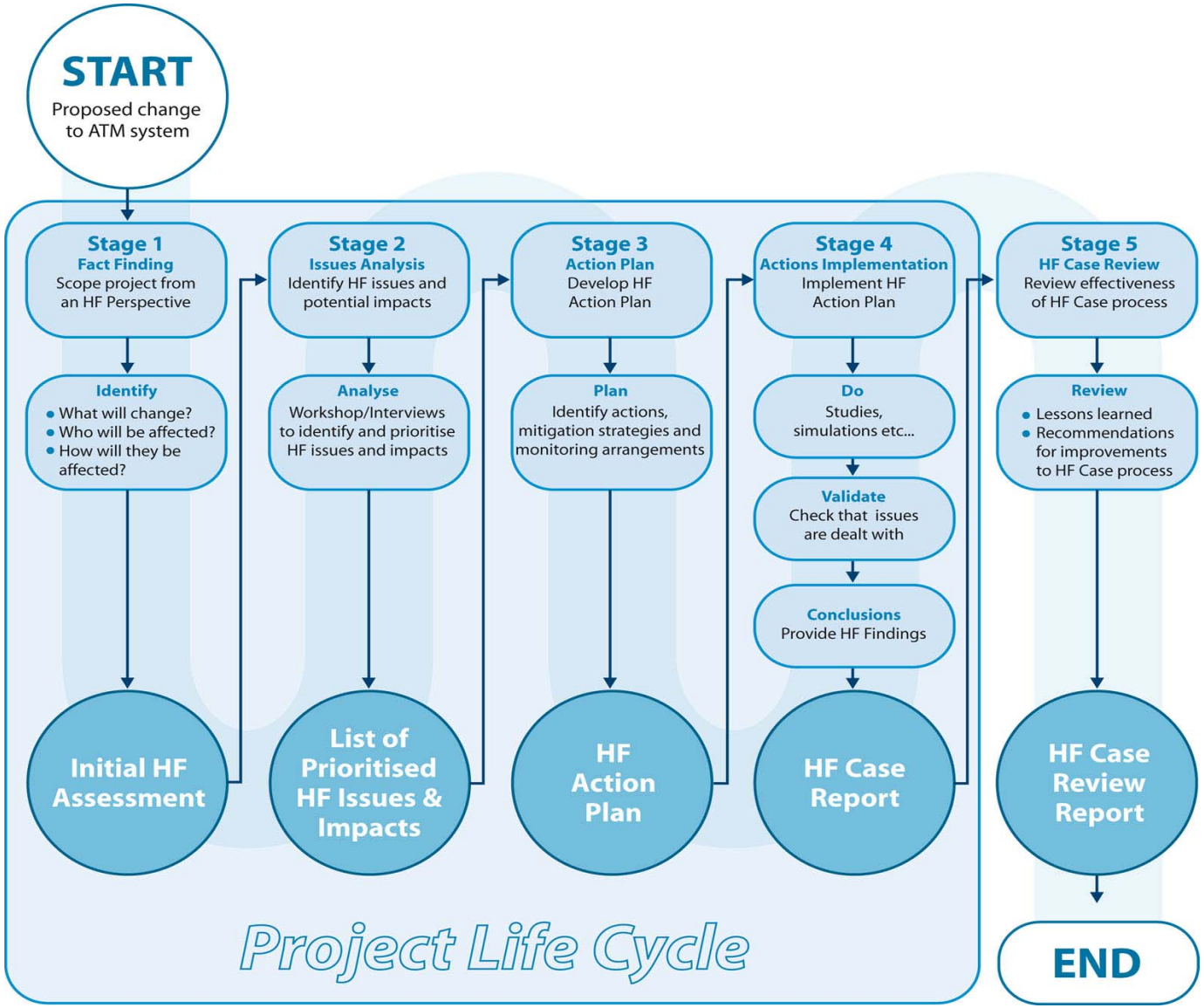


Figure 4: HF Case Process Overview

3.2 Stage 1: Fact Finding

3.2.1 Objective

The objective of Stage 1 of the HF Case process is to scope and understand the project from an HF perspective. The feasibility of applying the HF Case for the project is addressed here.

Table 2: HF Issues

HF Issues	HF Issues are human factors that need to be addressed. The HF Case categorises HF Issues into six broad "HF Pie" segments (see Figure 1). The HF Issues are outlined in Figure 5. A more detailed breakdown and description of each HF Issue is given in Appendix 4.

3.2.2 Process Steps

The fact finding steps are to:

- **Gather information**

  Review project documents and interview relevant project team members to understand the project scope and to identify, in particular:

  - What will change with the introduction of the proposed system compared to the existing ATM system?
  - Who will be impacted (actors)?
  - How will actors be impacted (changes in tasks or work environment)?

  Useful information to contribute to this stage may be found in the project operational concept document or project plan. The Project Manager should provide all the necessary information.

  The information gathered should be summarised in the Fact Finding Template (see Appendix 2). The Fact Finding Template is divided into two parts:

  - PART I, 'FACTUAL INFORMATION', is designed to capture essential information about the project;
  - PART II, 'CHANGE ASSESSMENT', is designed to capture information on what is changing in the system, who and how are they impacted.

- **Make an Initial HF Assessment**
  - Determine the high level HF Issues that exist for the project with reference to the HF Pie categories. Document the initial assessment in the Fact Finding Template.
  - Decide if there is sufficient need to move to Stage 2 of the HF Case process.
- **Carry out a review meeting**

  It is recommended that a review meeting is held with the Project Manager and team members to review the information gathered and to explain the next stage of the HF Case process. This meeting is important to maintain commitment and 'buy-in' and set the scene for Stage 2 of the HF Case.

3.2.3 Output

Initial HF Assessment: An initial assessment of the HF Issues for the project is made with reference to the HF Pie (see Figure 1).

3.2.4 Support Tools

Appendix 2: Fact Finding Template and Guidance for Completion.

3.3 Stage 2 - Issues Analysis

3.3.1 Objective

The objective of Stage 2 of the HF Case process is to identify and prioritise the project specific HF Issues and to consider their potential impact on the project.

3.3.2 Process Steps

The Issues Analysis steps are to:

- Identify the HF Issues and their impacts,
- Prioritise the HF Issues and their impacts.

There are two suggested ways to identify the HF Issues and their impacts:

- **Group workshop**: The workshop approach utilises the expertise of SMEs involved in a number of project areas. This helps to identify as many HF Issues as possible, and gain commitment and 'buy-in' of these HF Issues by other project team members. It usually requires a commitment of three to four days from the participants.
- **Expert interviews**: If a group workshop is not feasible, another approach is to interview key SMEs either individually or in pairs. The interviews are conducted progressively i.e. focusing on different elements of the HF Pie with each interviewee. The interviews should be followed up with a one-day consolidation meeting to provide the Project Manager and SMEs with an overview of the information gathered. The advantage of this method is that it requires less time from each of the SMEs whilst utilising expertise from a number of areas of the project. However, this approach requires more effort from the HF Case Coordinator.

The benefits of using either approach are:

- improved communication and rapport building,
- varied experience and knowledge,
- increased buy-in and commitment.

The workshop acts predominantly as an expert focus group for applying structured analytical thought to ensure that the knowledge of all project members is taken into account. An additional benefit is the potential for creative solutions from brainstorming sessions. (See Appendix 3 for additional Group Workshop guidelines).

Table 3 provides guidance for the Project Manager and the HF Case Coordinator to choose the appropriate approach.

Table 3: Issues Analysis – Process selection

Method	Guidance criteria
Group workshop	▪ Large scale project with many interfaces between departments, groups, etc. ▪ Project output affects more than one target audience group / end-user group. ▪ Project output changes the nature of the roles of the target audiences / user groups and/or end-user groups as compared to current practice. ▪ Novel outcome expected from the project.
Expert interviews	▪ Significant experience of previous similar projects and lessons learned is available. ▪ Project is a relatively small change to an existing system. ▪ Project timescales/costs preclude the use of a group workshop process.

3.3.3 Group Workshop

3.3.3.1 Description

The workshop uses a structured focus group method to identify project specific HF Issues using SME participants, led by a facilitator.

3.3.3.2 Time required

The workshop typically takes three to four days, depending on the scale of the project. Four days should be expected for a comprehensive review for a new system. For a modification to an existing system, less time may suffice. For example, a small change to an existing system may only need two days to analyse the issues. It is suggested that four-day workshops are split into two 2-day sessions to avoid "workshop fatigue" and to allow participant reflection between sessions.

3.3.3.3 Process steps

Before the workshop

⇨ **Define the workshop objectives**

Some objectives will need to be set. For example:

- Identify the HF Issues that are associated with the project (i.e. *What HF Issues may hinder the success of the project?*);
- Determine the potential impact if the HF Issues are not addressed appropriately (i.e. *what would happen if the problem did occur?*);
- Identify the strategies to mitigate the HF Issues.

The information gathered in the Fact Finding Template especially Part II, 'Change assessment' is a key input for this stage. The key elements to outline are:

- What are the changes?

- Who do these changes impact and how?
- Initial HF Assessment.

⇨ **Arrange and prepare for workshop**

Time and effort will need to go into the planning and organisation of the workshop. The time schedule and resources required need to be planned well in advance.

⇨ **Decide on group size and participant roles**

An appropriate number of participants will be required, with a diverse range of knowledge. These stakeholders may be representatives of one or several organisations concerned with the specification, design, construction, testing, and use of the system (see Table 4). The size of the group is important. It is recommended that the group is between six and twelve people (not including the Facilitator, HF Case Coordinator, HF Specialist, and Project Manager). Very small groups can fail to capture all of the pertinent issues, while large groups tend to be difficult to manage.

⇨ **Brief the participants**

A briefing note should be sent to all attendees and should include:

- the Fact Finding Template,
- an explanation of why the workshop is taking place,
- the aims and a summary of the workshop process,
- the date, time and location of the workshop.

During the workshop

The following are the main process steps for running the workshop:

1. Set the scene

a) Outline the workshop objective.

b) Describe the project overview and scope.

c) Review key project assumptions (from Part II of the Fact Finding Template).

d) Explain the workshop process.

The Project Manager or HF Case Coordinator will normally open the meeting with the usual preliminary announcements (safety/security announcements, introductions by attendees, timetable, objectives, etc.)

The Project Manager should give a clear and precise presentation of the system, the breakdown of system elements and any assumptions.

The facilitator will then provide a description and explanation of the workshop process and the focus group rules (see Appendix 3 for further information).

Table 4: Potential group workshop attendees

Person	Attendance	Group Workshop role
Facilitator	Essential	Facilitator
HF Case Coordinator	Essential	Coordinator
HF specialist	Essential	Contributor
Project Manager	Essential	Contributor
Users (e.g. controllers, flight data, supervisors)	Essential	Contributor
Safety specialist	Recommended	Contributor
Systems designer	Recommended	Contributor
Training specialist	Recommended	Contributor
Staffing specialist	Recommended	Contributor
Operations specialist	Recommended	Contributor
Selection specialist	Recommended	Contributor

2. Workshop process steps

a) Select and prioritise HF Issue categories from the HF Pie (see Figure 1).

b) Identify relevant HF Issues (see Figure 5 and Appendix 4 for a more detailed list).

c) Complete a 'What if' Analysis for each HF Issue.

The following describes each step of the workshop process:

a) Select and prioritise HF Issue categories from the HF Pie

Depending on the project priorities, the Project Manager, project team or workshop group may wish to examine each HF Pie category in a particular order. This can either be stated in advance of the workshop (from the outcome of Stage 1), or the workshop group can use a voting technique to choose which categories to consider first.

b) Identify relevant HF Issues

HF Issues are represented at different levels of detail, starting at a high level (see Figure 5). A more detailed breakdown of HF Issues is provided in Appendix 4. Using standard techniques such as structured analysis and brainstorming, the group should identify the relevant HF Issues for the project at the appropriate level of detail. It may be worth considering splitting the group, for example:

- two sub-groups could look at all HF Issues for different elements of the system; **or**
- two sub-groups look at different HF Issue categories from the HF Pie for the same system element.

Then each sub-group reviews the work of the other.

Level of concern

Each identified HF issue should then be rated for the level of concern it appears to have in the first instance - high, medium or low. This helps to decide how much time needs to be given to address each issue.

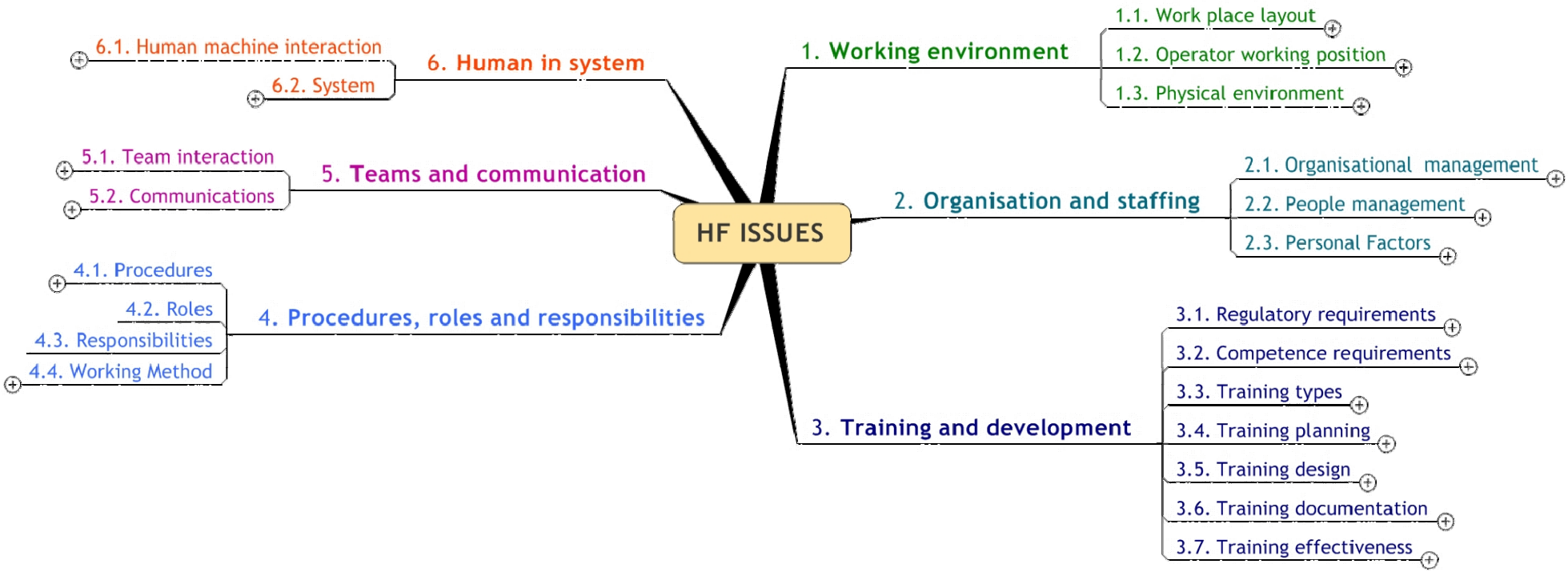


Figure 5: HF Issues - Level 2 [3]

[3] See Appendix 4 for more detailed descriptors

c) Complete a 'What if' Analysis for each HF Issue

The 'What if' analysis should be repeated for all the identified HF Issues.

- **Ask the "What ifs"-** i.e.: 'What if the HF Issue is not addressed adequately? For example, questions that could be asked include:
  - What if the system reacts unexpectedly because the controller does not understand the logic?
  - What if the controller finds some features too difficult to use so he/she stops using them?
  - What if the Operational date (O-Date) changes and people need to be retrained?
  - What if the workload is too high despite the automation?
  - What if the controller does not perceive the automatic coordination?
- **Identify impacts on human performance**. The potential impacts on human performance should be considered for each specified "What if" statement using the 'HF Impact Wheel' in Figure 6. The wheel illustrates twelve critical HF impacts on human performance. The link between HF Impacts and Human Performance is explained in Table 5. A definition for each HF Impact is provided in Appendix 5.
- **Identify impacts on the system**. Examples of potential impacts on the wider system are:
  - Threat to Safety
  - Threat to Security
  - Reduced Efficiency
  - Reduced Capacity
  - Effects on O-Date
  - Training impaired or delayed
  - Project budget and resources
  - Validity of the system information
  - Acceptance of the new system
  - Staffing
- **Identify mitigation strategies**. Mitigation strategies should be proposed to resolve the potential impacts on human performance and the system.
- **Make comments**. Additional comments or considerations should be noted.

Table 5: HF Impacts on Human Performance

Term	Explanation
HF Impacts	HF Impacts are human factors that affect human performance in a significant way.
Human Performance	Human performance is a measurable behaviour that occurs in task situations. It is the extent to which goals for speed, accuracy, quality and other criteria are met by people functioning in work environments. The HF Case is concerned with the ability of operators and maintainers to meet the system's performance standards, including reliability and maintainability, under the conditions in which the system will be employed.

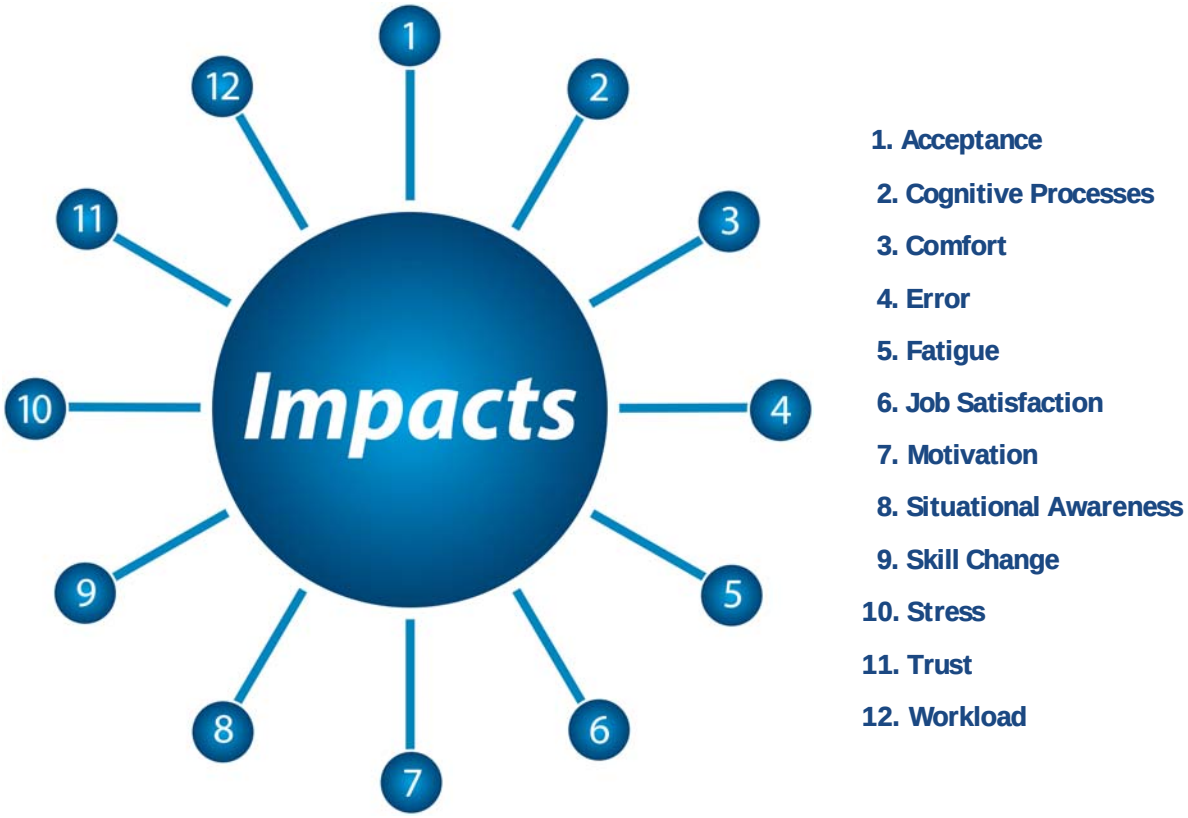
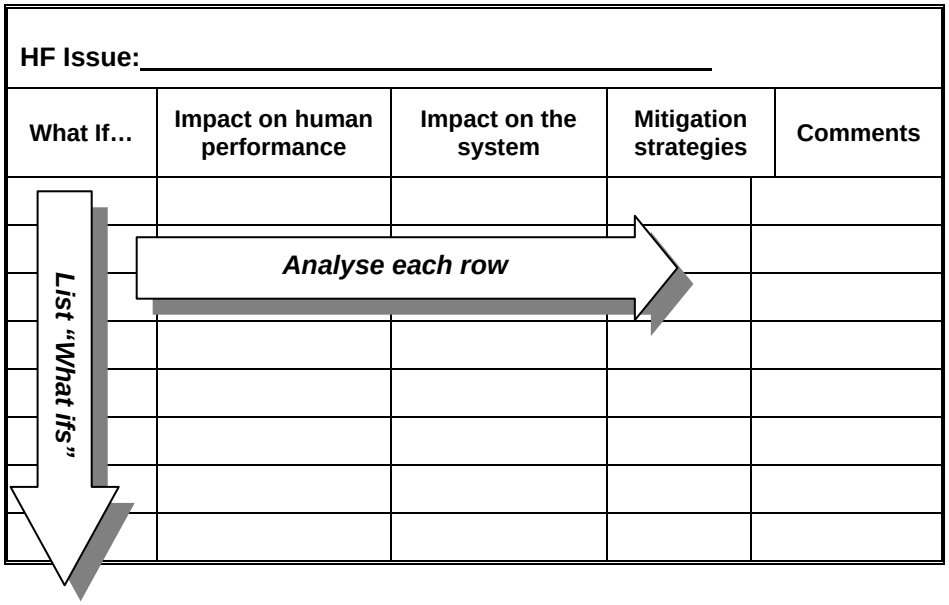


Figure 6: HF Impacts on Human Performance

The What If Analysis Output Table (Table 6) provides a format to capture the results of each HF Issue What if Analysis.

Table 6: What If Analysis Output Table



d) Feedback

At the end of workshop, the group should complete a feedback form. (Appendix 6 provides an example.)

3.3.4 Expert Interviews

3.3.4.1 Description

This process uses structured interviews with individual or paired project SMEs, led by the HF Case Coordinator, to identify project specific HF Issues. A consolidation meeting to share the findings with all participants is recommended when all interviews are completed.

3.3.4.2 Time required

- ⇨ Two-three hours per interview.
- ⇨ One-day meeting to share consolidated findings.

3.3.4.3 Process steps

Before the interviews

The workshop approach steps are adapted to suit the interview setting:

- Define workshop objectives,
- Arrange and prepare interviews,
- Decide on who should be interviewed,
- Brief the participants.

During the interviews

The interview process covers the same aspects as the workshop approach i.e.:

⇨ **Set the scene**:

- Outline interview objective,
- Project overview and scope,
- Review key project assumptions,
- Explain interview process.

⇨ **Interview process steps**:

- Select and prioritise HF Issue categories from the HF Pie (see Figure 1);
- Identify relevant HF Issues (see Figure 5);
- Complete a 'What if' Analysis for each HF Issue.

Considerations

- As there will be a number of interviews planned, the focus may be on covering one HF Pie category per interview, covering a different one for each interview group.
- Any information gathered from a previous interview for a particular HF Pie category can be reviewed and added to by the next interviewee.

3.3.5 Prioritise the HF Issues and their impacts

After the workshop/interviews have been completed the HF Case Coordinator and Project Manager should prioritise the issues and their impacts. There are two steps to follow.

1. Identify and define the criteria to be used.

Possible criteria to consider include:

- Effort required
- Impact on acceptance
- Impact on O-date, and so on (see Table 7 for an example).

Other considerations include:

Leverage

- Which HF Issue has the greatest number of human performance impacts associated with it?
- Which HF Issue provides the greatest leverage (i.e. affects or resolves other issues/impacts)?

Urgency

- Does the HF Issue need immediate action?
- Can this HF Issue be dealt with later?

Order

- Is this HF Issue best dealt with before others?
- Do other HF Issues need to be resolved first?

Resource requirements

- Does this HF Issue have a high overhead associated to deal with it?
- Which HF Issues are the easiest to address?
- Which HF Issues are the most challenging to address?
- Which HF Issues will cost the most to deal with?
- Which HF Issues will take the most time to deal with?

Feasibility

- Is this HF Issue feasible to deal with?

Risk

- Does this HF Issue have a high risk to the project associated with it?

Table 7: Example Criteria and Definitions for High, Medium and Low

Selected criteria	High	Medium	Low
Effort required	Significant impact on staffing (engineering and operations) to resolve this	Likely to have some impact on staffing to resolve this	Minor impact on staffing to resolve this
Impact on Acceptance	New system/tool is not accepted by operations for operational use or the majority of operations staff refuse to work with it.	New system/tool accepted but causes frustration because of the high number of annoyances and some workarounds exist. Significant capacity reductions	Accepted by Operations Staff although some minor annoyances and workarounds exist
Impact on O-date	O-Date delayed by more than 5 months and major knock on effects such as missing the summer schedule, maintenance of current system, significant capacity impacts, and retraining required	O Date delayed by 3 months with some impact on capacity and more training required	1 month delay requiring additional briefings.

2. Prioritise the Issues.

The next step is to prioritise the issues with the selected criteria.
Table 8 provides an example.

Table 8: Example of Assigning Criteria to Issues

Issue: Training and Development
Work area: Training Instructors
Remark: There are designated instructors who also operate in the live environment. This means that they have to operate in two environments for extended periods.

What if -	Effort required	Impact on Acceptance	Impact on O-Date	Overall Priority	Comments
Instructors are confused with functionality between the old and new systems during training?	Low	Medium	Low	Medium	

3.3.6 Draft the Issues Analysis Report

A report should be compiled (see Appendix 7 for a proposed outline) that collates the results of the workshop output and the prioritisation assessment. This report should be circulated to all workshop participants and interviewees for feedback and comment.

When interviews are conducted, a consolidation meeting should be held to discuss the overall findings with the Project Manager and the experts who participated in the interviews.

3.3.7 Output

Issues Analysis Report including prioritised HF Issues categorised by HF Pie and HF Impacts wheel.

3.3.8 Support Tools

- Appendix 3: Group Workshop Guidelines.
- Appendix 4: HF Issues Descriptors.
- Appendix 5: Definitions for HF Impacts on Human Performance.
- Appendix 6: Issues Analysis Approach Feedback Form
- Appendix 7: Issues Analysis Report Outline
- Table 7: Example Criteria and Definitions for High, Medium and Low
- Table 8: Example of Assigning Criteria to Issues

3.4 Stage 3: Action Plan

3.4.1 Objective

The objective of Stage 3 is to select and describe the HF Actions and mitigation strategies necessary to address the prioritised HF Issues list in the Issues Analysis Report. The focus of the Action Plan is on how the identified HF Actions will be managed and how the HF Issues will be resolved.

3.4.2 Process

The steps to develop the Action Plan are to:

- **Identify HF Actions required**

  The Project Manager and HF Case Coordinator together need to review the prioritised list of HF Issues and identify the appropriate HF Actions required to deal with the HF Issues. Examples of HF Actions include:

  1. Mitigation Strategies – known and accepted practical interventions to minimise the negative effects of the HF Issue.
  2. Simulations – trials in a simulated operational environment to measure the impact of the HF Issue.
  3. Studies - to gather data to understand the HF Issues, for instance:
     - literature review;
     - cognitive task analysis;
     - workload assessment;
     - inspections of workplaces, equipment and practices;
     - direct observation of operations by HF experts;
     - surveys of users' perceptions of HF Issues such as automation, usability, working environment, trust, etc. (e.g. SHAPE questionnaires, EUROCONTROL, 2006b);
     - error investigation and near-miss reporting and investigation systems (sometimes considered as reactive monitoring systems);
     - investigations of errors and incidents such as loss of separation, with HF expertise and tools (e.g. 'The Human Error in ATM Technique (HERA-JANUS, EUROCONTROL, 2003);
     - reporting of actual system problems and hazards (e.g. issues associated with response times, reliability, operability, error 'traps', feedback, etc.);
     - reporting of health issues such as stress or upper limb disorders associated with keyboard or mouse use;
     - weaknesses or omissions in performance standards.

HF Actions such as studies and simulations often require a significant investment in time and resources to complete. The Action Plan should include:

- a description of the HF Actions and how they will be conducted and managed;
- a description of how the results of the HF Actions will be validated.

- **Determine monitoring arrangements for the HF effort**

  This concerns defining how the Project Manager directs and monitors the HF effort and how the contractual efforts will be maintained, influenced and assessed. These arrangements facilitate integrating HF in the project. For example:

  - What are the reporting channels for HF concerns and discrepancies?
  - What relationship does the HF Case Coordinator have with other project team members?
  - How will the HF expert work with contractors?
  - What tasks must be accomplished to set the actions in motion?

  Questions that may need to be addressed include:

  - Will any research need to be done?
  - How much simulation or analysis will be required?
  - How will this be assessed?
  - Who will do it?
  - Is there to be an effort directed toward modelling human performance?
  - Are mock-ups to be developed? What is the HF role in them?
  - Is useful information available from other programmes or stakeholders?
  - What analyses might need to be done by the developer of the system?
  - What coordination is necessary to link up with the logistics or training people and their efforts to capitalise upon work already performed?
  - Will experience with other systems be useful in identifying the general scope of the issues before they are clarified and resolved by the contractor for the specific environment?
  - What processes will be used to fulfil the HF Actions?

- **Draft the Action Plan**

  The final step is to draft the Action Plan. Appendix 8 provides an example of the main elements that should be considered in the Action Plan.

3.4.3 Output

Action Plan

3.4.4 Support Tools

Appendix 8: Action Plan Content and Elements

3.5 Stage 4: Actions Implementation

3.5.1 Objective

The objective of Stage 4 of the HF Case process is to implement the actions defined in the Action Plan, validate the results, and report the HF conclusions and findings in the HF Case Report.

3.5.2 Process

The three steps for the HF Case Coordinator and the Project Manager are to:

1. Carry out and supervise the tasks defined in the Action Plan. Replan and carry out additional tasks as required if HF Issues are not fully mitigated.

2. Validate: Analyse the data and findings from the Actions taken in relation to the issues identified in Stage 3. Consider the findings with evidence, conclusions, any lessons learned, feedback, suggestions for local implementation, changes to system requirements, etc. Table 9 provides a template to record the HF Actions Findings.

3. Draft the HF Case Report: The next step is to draft the HF Case Report for the project. Appendix 9 provides a suggested outline for the HF Case Report.

Table 9: HF Actions Findings Template

Issue: Training and Development
Work area: Training Instructors
Remark: There are designated instructors who also operate in the live environment. This means that they have to operate in two environments for extended periods.

What if -	Actions from Stage 3	Findings with evidence	Conclusions	Reference
Instructors are confused with functionality between the old and new systems during training?	Limit the time working in both the new and old system. Include in the feedback on training effectiveness from instructors	Instructor reports on time spent training and working in operations. Trainees reports and feedback.	Issue was managed within feedback process and mitigation minimised confusion. This is issue is closed.	Instructor and Trainee Report Template and Feedback sheet.

(These HF Actions Findings should be put in an appendix in the HF Case Report).

3.5.3 Output

HF Case Report

3.5.4 Support Tools

Table 9: HF Actions Findings Template

Appendix 9: HF Case Report Outline

3.6 Stage 5: HF Case Review

3.6.1 Objective

Once Stages 1, 2, 3 and 4 have been completed, the HF Case process should be reviewed. The HF Case review is concerned with the quality of the HF Case process.

3.6.2 Review Process

The review should be conducted by an independent HF expert. The HF Case reviewer should be sufficiently qualified to carry out the task, and be commercially and managerially independent from the project, so that the activities can be independently assessed and judged from an HF perspective with no risk of any conflict of interest.

The HF Case reviewer's task is to review the outputs from each stage of the HF Case. Some suggested review criteria include:

- review the project against relevant guidelines;
- review the classification, interpretation and any subsequent refinement of categories in the HF Issues Analysis;
- review a sample of HF analyses of the system;
- check that HF findings are adequately specified and appropriately influence development;
- review whether HF Actions taken adequately addressed the HF Issues.

There are a number of mechanisms that can be used to determine the lessons learned from an HF Case. The following list is not comprehensive, but provides some suggestions, a combination of which may best suit a project's specific needs:

- examination of project and HF Case records and documentation,
- questionnaire or survey of a representative stakeholder sample,
- face-to-face interviews – either one-on-one or groups,
- facilitated feedback sessions with a large group of stakeholders.

It is important that the stakeholders' perceptions of the HF Case are captured. Although different stakeholder groups will have different perceptions of the HF Case, it is important to learn what worked well or could be improved from each perspective.

3.6.3 Draft the HF Case Review Report

The purpose of the HF Case Review Report is to provide feedback on:

- the review of the outputs and success of the HF Case;
- the outstanding issues, conclusions, findings and recommendations;
- improvements to the HF Case process.

Appendix 10 provides an example of the structure of this report.

The reviewer should sign off the HF Case Review Report to acknowledge that the work has been completed.

3.6.4 Output

HF Case Review Report

3.6.5 Support Tools

Appendix 10: HF Case Review Report Outline

4. THE HF CASE APPLICATION

The HF Case has been applied to a number of EUROCONTROL projects and a web-based version of the HF Case is available to assist the application of the process. Application of the HF Case is also supported by the tools available in the HIFA website. 'HIFA' stands for '**H**uman factors **I**ntegration in **F**uture **A**ir traffic management systems'. It concerns the application of HF to the design of future ATM systems (see EUROCONTROL, 2000a, 2000b, 2000c).

4.1 Application experience

Since the launch of the HF Case in 2004, more than a dozen HF Cases have been carried out for EATM projects such as:

- a cockpit tool to improve airborne traffic situational awareness.
- an investigation into phraseology confusion.
- the airborne collision avoidance resolution and advisory system downlink.
- concepts for mixed landing system operations.
- advanced surface movement guidance and control systems (A-SMGCS).
- the implementation of new controller support tools (FASTI).

In 2007, the revised HF-Case is being trialled at Maastricht UAC on the new flight data processing system (N-FDPS).

4.2 On-line HF Case database tool

To support the application of the HF Case process a web-based database tool is available. The HF Case database tool enables the following:

- documentation and tracking of the HF issues for a project as it moves through the various transition life cycle phases,
- online recording of information during the Issues Analysis workshop,
- online report templates.

The HF Case database tool can be accessed by authenticated users at:

http://www.eurocontrol.int/HFCase_Application

4.3 HIFA website

A useful tool for identifying HF Actions is the HIFA website.

The HIFA website supports the HF Case process and contains information concerning HF activities that typically should be performed during the development of an ATM system. The website is an information repository designed to be both a database and tool to help designers and Project Managers consider HF throughout the life cycle of an ATM system. It offers a selection of validated and available HF methods, tools and applications - including examples of how to use them, best practices, success stories, and guidance to users on choosing appropriate HF methods for their project needs. It also provides practical considerations for using each suggested method or tool (e.g. resource requirements and critical prerequisites).

The HIFA website can be accessed at:

http://www.eurocontrol.int/hifa/public/subsite_homepage/homepage.html

4.4 Application guidance material

Comprehensive guidance material for applying the HF Case and using the on-line data base tool will be published in 2008. This will be accompanied by relevant training courses for registered users and coaching on the HF Case methodology.

REFERENCES

Cardosi, K. & Murphy, E. (1995). *Human Factors in the Design and Evaluation of Air Traffic Control Systems*. DOT/FAA.

Chapanis (1983). Engineering Psychology. In: M.D. Dunnette. *The handbook of Industrial and Organizational Psychology*. NY: Wiley, 697-744.

Edwards, E. (1988). *Human factors in aviation*. San Diego, CA, Academic Press.

Endsley, M. R. (1988). *Design and evaluation for situation awareness enhancement.* Proceedings of the Human Factors Society 32nd Annual Meeting, Human Factors Society, Santa Monica, CA, 97–101.

EUROCONTROL (2000a). *Human Factors Integration in Future ATM Systems: Design Concepts and Philosophies*. HRS/HSP-003-REP-01. Edition 1.0. Released Issue. 8 August. Brussels: EUROCONTROL http://www.eurocontrol.int/humanfactors/public/site_preferences/display_library_list_public.html#6

EUROCONTROL (2000b). *Human Factors Integration in Future ATM Systems: Identification of Tasks and Development of Scenarios*. HRS/HSP-003-REP-02. Edition 1.0. Released Issue. 8 August. Brussels: EUROCONTROL http://www.eurocontrol.int/humanfactors/public/site_preferences/display_library_list_public.html#6

EUROCONTROL (2000c). *Human Factors Integration in Future ATM Systems: Methods and Tools*. HRS/HSP-003-REP-03. Edition 1.0. Released Issue. 8 August. Brussels: EUROCONTROL http://www.eurocontrol.int/humanfactors/public/site_preferences/display_library_list_public.html#6

EUROCONTROL (2000d). *Air Navigation System Safety Assessment Methodology (SAM)*. SAF.ET1.ST03.1000-MAN-01-02. Edition 1.0. 17 April. Brussels: EUROCONTROL. http://www.eurocontrol.int/safety/public/site_preferences/display_library_list_public.html#7

EUROCONTROL (2003). *The Human Error in ATM Technique (HERA-JANUS)*. HRS/HSP-002-REP-03. Edition 1.0. Released Issue. 21 February. Brussels: EUROCONTROL. http://www.eurocontrol.int/humanfactors/public/site_preferences/display_library_list_public.html#5

EUROCONTROL (2006a). *Safety Case Development Manual* DAP/SSH/091. Edition 2.2. Released Issue.13 November. Brussels: EUROCONTROL. Available in the Safety Assessment Methodology (SAM) Electronic tool V2.1 downloadable at www.eurocontrol.int/safety

EUROCONTROL, (2006b) SHAPE questionnaires http://www.eurocontrol.int/humanfactors/public/standard_page/Shape_Questionnaires.html

ICAO (1998a). *Human Factors Digest No. 8: Human Factors in ATM*. Circular 241. Montreal: ICAO. http://www.icao.int/anb/humanfactors/Documents.html

ICAO (1998b). *Human Factors Training Manual (Doc 9683-AN/950*). Edition 1.0. Montreal: ICAO http://www.icao.int/cgi/goto_m_f.pl?isbn/index.html

Norman, D.A. (1991). *The Design of Everyday Things*. Doubleday.

Osborn, A. (1953). *Applied Imagination: The Principles and Procedures of Creative Thinking*. New York: Charles Scribner & Sons.

Salas, E., Driskell, J. & Hughes, S. (1996). *Stress and Human Performance*. NJ: Lawrence Erlbaum.

Sanders, M.S. & McCormick, E.J. (1993). *Human factors in engineering and design*. (7th Ed.). New York: McGraw Hill.

Wiener, E.L. & Nagel, D.C. (1988). *Human Factors in Aviation.* San Diego, CA: Academic Press.

GLOSSARY

Attention span: The time for which one can effectively concentrate on a specific issue, object or activity.

Decision-making: The cognitive process leading to the selection of a course of action amongst alternatives.

Human engineering: The application of knowledge about human capabilities and limitations to system or equipment design and development to achieve efficient, effective, and safe system performance at minimum cost and manpower, skill, and training demands. Human engineering assures that the system or equipment design, required human tasks, and work environment are compatible with the sensory, perceptual, mental, and physical attributes of the personnel who will operate, maintain, control and support it.

Human Factors (HF): A multidisciplinary effort to compile, generate and apply knowledge about people at work, and apply that knowledge to the functional relationships between people, tasks, technologies and the working environment, in order to produce safe and efficient human performance.

The broad domain of human factors is an applied science that draws on methods and principles from psychology, other behavioural and social sciences, engineering, ergonomics and physiology.

The ***aim of human factors*** is optimise the performance of individuals and teams in the workplace, reducing error, and improving safety and efficiency through an understanding of human capabilities, limitations and the way people interact with their work environment. This includes the equipment they use, the rules and procedures they work under, and how they communicate with other people to successfully accomplish a wide range of tasks. This knowledge can then be applied to improve training, and the design of the work environment and systems that will reduce the likelihood of incidents and accidents.

A ***human factor*** is any biomedical or psychosocial consideration relating to human characteristics in areas including, but not limited to, human engineering, human-machine interface, personnel selection, training, life support, job performance and human performance.

Human Factors Test and Evaluation (HFTE): The part of the system that tests the effort conducted in accordance with approved test plans. HFTE includes all testing directed toward validation and evaluation of human factors analyses, studies, criteria, decisions, and operational and maintenance design characteristics, and features. These may include engineering design tests, model tests, mock-up evaluations, demonstrations, and subsystem tests conducted to verify system level requirements. HF tests are a part of system developmental test and evaluation and operational test and evaluation.

Human performance: A measure of human functions and action in a specified environment, reflecting the ability of actual users and maintainers to meet the system's performance standards, including reliability and maintainability, under the conditions in which the system will be employed.

Information processing capability: Refers to the ability of the operator to process the type and amount of information within the required timeframe. The information processing requirements should fall within the capabilities of the staff (i.e. within their memory, attention and decision-making capabilities).

Memory: The ability to store, retain, and subsequently recall information. There are several ways to classify memory, based on duration, nature and retrieval of information. From an information processing perspective there are three main stages in the formation and retrieval of memory:

- Encoding (processing and combining received information)
- Storage (creation of a permanent record of the encoded information)
- Retrieval/Recall (calling back the stored information in response to some cue for use in a process or activity)

Procedure*:* A particular course of actions intended to achieve a result. In ATM environment, this term can be characterised as a set of activities that are performed by each actor intervening in the process, according to pre-established rules, to enable a successful operation.

Role*:* A specific behaviour of an actor participating in a particular context which is determined by the tasks that have been previously assigned to that actor.

Responsibility: The fact of being in charge of a certain job or task, facing the situation in case of abnormal functioning in the process in which the actor is involved.

Vigilance: The process of paying close and continuous attention. Staff vigilance may be enhanced by (but not restricted to):

- ensuring that sufficient rest periods are provided;
- ensuring that staff are fit for work;
- ensuring that suitable shift patterns are adhered to;
- providing a suitable working environment, e.g. suitable temperature, air flow and lighting.

ABBREVIATIONS AND ACRONYMS

For the purposes of this document the following abbreviations and acronyms shall apply:

ATC	Air Traffic Control
ATCO	Air Traffic Controller / Air Traffic Control Officer *(US/UK)*
ATM	Air Traffic Management
ATM/CNS	Air Traffic Management systems, and Communications, Navigation and Surveillance
COTS	Commercial Off-The-Shelf
CWP	Controller Working Position
DAP	Director(ate) ATM Programmes *(EUROCONTROL Headquarters)*
DAP/SSH	Safety, Security and Human Factors Business Division *(EUROCONTROL Headquarters)*
EATCHIP	European Air Traffic Control Harmonisation and Integration Programme *(later renamed 'EATMP' and today known as 'EATM')*
EATM(P)	European Air Traffic Management (Programme) *(formerly known as 'EATCHIP')*
EEC	EUROCONTROL Experimental Centre *(Brétigny, France)*
FHA	Functional Hazard Assessment
HERA	Human Error in ATM (Project) *(HSP)*
HF	Human Factors
HIFA	Human Factors Integration in ATM *(HSP)*
HMI	Human-Machine Interface
HRS	Human Resources Programme *(EATM)*
HRT	Human Resources Team *(EATM)*
HSP	Human Factors Sub-Programme *(HRS)*
ICAO	International Civil Aviation Organization
OJT	On-the-Job Training
R&D	Research and Development
RTF	Radiotelephony
SAM	Safety Assessment Methodology *(EUROCONTROL)*
SME	Subject Matter Expert

APPENDIX 1: HF SPECIALIST EXPERTISE

1 (Appreciation of HF)	Has read some fundamental HF texts. Understands the contribution of human factors expertise for: • HF involvement across the system lifecycle. • Performing safety assessment and analysis activities. • Optimising the human role in ATM.
2 (Working knowledge of HF)	Has attended a formal HF-related course. Can contribute to planning for HF activities within ATM projects. Can support system development by identifying areas where HF expertise is required Can apply HF techniques (e.g. for the identification of human error such as HERA), Can apply HF principles in daily ATM activities
3 (Proficient in HF application)	Has an academic qualification in a HF-related discipline. Can provide HF input into a safety case. Can identify HF concerns across the system lifecycle. Can provide technical advice on HF for ATM systems. Has demonstrable experience in the practical application of HF.
4 (HF Specialist)	Has a post-graduate academic qualification in a HF-related discipline. Acknowledged as an expert on HF for complex safety critical systems such as ATM. Contributes to the training of others in HF knowledge and methods. Can provide HF safety analyses across the lifecycle of ATM systems. Keeps up to date with new HF tools and techniques, and is involved in the development of these. Has a broad and comprehensive experience in the practical application of HF.

APPENDIX 2: FACT FINDING TEMPLATE

Initial HF Assessment Fact Finding Template - Part 1

HUMAN FACTORS CASE **PART I – FACTUAL INFORMATION**							
Date							
Project Name							
Project Manager		Tel		E-mail			
HF Case Coordinator		Tel		E-mail			
Type of Project ✓							
Traffic / Situation Display		Controller Tool		Communication		Navigation	
Surveillance		System Control & Monitoring		Other (state)			
High-level Project Objectives							
Project Background and System Description							

System Life-cycle Stage ✓							
Early Phases			*Middle Phases*		*Late Phases*		
Initiation	Planning	Feasibility	Development	Pre-operational	Implementation	Local Implementation	Operations

Related Concepts (Similar Existing / Predecessor Systems – including Operational Experience and Data)

Key Documentation (e.g. Safety – e.g. previous Functional Hazard Assessment (FHA) Documentation, Safety Case/Assessments, Design and Testing Documentation - e.g. Design Documentation, Trial/Simulation Data)

Key Stakeholders			
Name	**Role**	**Tel**	**Email**

Initial HF Assessment - Fact Finding Template - Part II

HUMAN FACTORS CASE PART II – CHANGE ASSESSMENT			
Baseline and proposed System Comparison			
ELEMENT	BASELINE ATM SYSTEM	PROPOSED ATM SYSTEM	COMMENTS
Notes			
Impact on Actor(s) ***Indicate E = Existing actor or N = New actor** ****Indicate if change is ˆ Role ˆ Responsibility ˆ Task ˆ Working Method**			
ACTOR	BASELINE ATM SYSTEM	PROPOSED ATM SYSTEM	COMMENTS
Notes			
Initial HF Impact Assessment			
▪ Procedures, Roles and Responsibilities: %			
▪ Team and Communications: %			
▪ Human and System: %			
▪ Working Environment: %			
▪ Organisation and Staffing: %			
▪ Training and Development: %			
Recommendation for Stage 2 HF Case			

Guidance on completing the Fact Finding Template

Part	Key elements	Description
PART 1: FACTUAL INFORMATION	High-level project objectives	A concise summary of the high-level project objectives.
	Project background and system description	A short description of the project background and basic system architecture. It should include some information on the context into which the system will be integrated and the likely external factors that might affect it. This may include a description of the relevant Air Traffic Management (ATM) context (e.g. traffic characteristics, aircraft performance and equipment, adjacent centre capabilities, airport infrastructure), as well as relevant environmental characteristics outside the ATM domain (e.g. weather, environmental constraints).
	Life-cycle phase	The phase in the project life cycle which the project has reached.
	Related concepts	Identify related or predecessor systems concepts.
	Documentation	Identify any key documentation related to the project, i.e. safety documentation (e.g. safety assessments), key design and testing documentation (e.g. functional specifications, test plans, etc.).
	Stakeholders	Define the roles and responsibilities of the persons, departments and organisations involved in the HF Case process. These stakeholders may include, for instance: - Project Manager, - HF Case Coordinator, - System designer / software engineer, - Engineer, - Safety expert, - Training expert, - Manpower expert, - Selection expert, - Users (e.g. ATCOs, flight crew), - Maintenance, - Sponsor / customer.

Guidance on completing the Fact Finding Template (cont'd)

Part	Key elements	Description
PART 2: CHANGE ASSESSMENT	Baseline and proposed system comparison	A high-level description of the baseline versus new system for the project (note that the list might not be exhaustive): and it is really to help the project team members focus to identify the HF Issues.
	Impact on actor(s)	Identify the key actors who will be impacted and how their responsibility/role/task may change. A clear relationship exists among these three terms. Each actor appearing in the ATM system has assigned one or several responsibilities. As a consequence of these responsibilities, that actor applies some procedures constituted by a set of tasks. Finally, the role performed by each actor will be defined by activities executed when those procedures applied.
	Initial HF Assessment	In gaining an understanding of who maybe impacted and how (at a high level), identify which areas of the pie may be most impacted and need investigation. Also indicate the potential scale of the HF activity which should be depicted using the pie.
	Conclusion and recommendation for Stage 2 HF Case	The key questions to ask here are: ▪ 'Has all the necessary information required for completing Stage 1 been gathered and analysed? ▪ Are there any recommendations to consider prior to proceeding to HF Case Stage 2? Indicate what information may be missing and any specific items that need to be highlighted for Stage 2. Any feedback received from discussion during the review meeting should also be recorded here.

APPENDIX 3: GROUP WORKSHOP GUIDELINES

A combination of structured analytical thought and brainstorming can be used to determine and describe each HF Issue. Time per issue should be limited within the overall workshop time constraints (e.g. fifteen to thirty minutes per issue). Participants should be allowed to think widely, imaginatively, and initially without criticism during HF Issue brainstorming. Participants should be encouraged to think "outside the box".

Participants may use any form of words that raises an HF-related question or statement that needs to be addressed by the project. The six HF Pie segments are designed to address both immediate or active issues, and long-term or latent conditions.

It is important that the HF Issues are documented clearly. The facilitator needs to be skilled in re-phrasing the HF Issues as concisely as possible. The facilitator also needs to ensure that the group does not linger over details. Similarly, the recorder needs to be skilled and experienced in listening, understanding the issues, and in capturing the output (preferably using the website on-line) quickly and accurately.

The number of HF Issues raised, and the depth of analysis following, will depend partly on which phase the project is at in the project life-cycle. It is important not to overlook pertinent HF Issues at the early and middle phases, even if the impacts etc. are unclear at this stage. This will ensure that potential issues are not forgotten.

Group Dynamics

- ***Understand participant's background and motivation for attendance*.** Participants should have a common purpose. Circulate a pre-meeting briefing to clarify this, and repeat during the introduction on the day. Allow some time for introductions, asking participants to provide some information on their backgrounds and current roles.
- ***Maintain an optimum group size*.** Groups should be between six and ten (including facilitator and recorder). Very large groups tend to split into sub-groups while very small groups may not have the necessary breadth of expertise and experience.
- ***Understand potential subtle differences in people's behaviour when in group settings.*** Behaviour in a group setting varies according to personality, status and often nationality. For example, in collectivist societies such as those found in South-peripheral Europe, close consultation is required for decision-making, and open conflicts are avoided - solidarity and harmony are valued. In South and East Europe, there tends to be a need to resolve ambiguity and uncertainty quickly, and also reduced tendency to question or contradict superiors directly. Hierarchical relationships between individuals should be taken into account when selecting participants to avoid dominance and reticence. It is vital to allow all participants equal opportunity to contribute.
- ***Overcome defensiveness*.** Participants closely involved in system development may find it hard to admit potential problems. It should be made clear that the identification of potential issues should not be seen as a criticism of any work carried out.
- ***Be aware of confidentiality issues.*** The facilitator needs to be aware of any issue that may affect open discussion, particularly where representatives of different organisations are present.

Meeting Practicalities

- ***Consider location and session timing*.** To minimise inconvenience and travel cost.
- ***Consider space, comfort, visibility and audibility*.** An oval or horse-shoe shape (with the facilitator at the open end) is usually the best arrangement. Ensure sufficient open area at the back of the room or elsewhere for coffee, etc.
- ***Provide adequate breaks and refreshments.*** Consider the attention span and fatigue of the facilitator and recorder, as well as participants.
- ***Make allowance for participants being unavailable at the last minute.*** Travel problems or operational duties may result in some participants being unavailable on the day. Potential substitute participants should be kept in reserve if possible.
- ***Provide adequate visual aids.*** On-line projection is an effective and efficient way to record the group Issues Analysis. However, posters, white boards or flipcharts are useful to note other issues such as study boundaries and assumptions, and to provide a 'parking lot' for issues to be addressed later.
- ***Consider varying the presentation of the session.*** In order to maintain attention and motivation, it may be useful to vary the style of presentation (e.g. use of visual aids), timing of breaks, and to change facilitator/recorder roles.

Adapted from EUROCONTROL Safety Assessment Methodology (EUROCONTROL, 2000d)

Brainstorming Rules[4]

When introducing the technique of formal brainstorming to a group, spend a little time discussing the value of suspended judgement. Then ask each participant if he/she is willing to follow these ground rules. If one or more members are not, encourage the group to modify the ground rules to fit the needs of all members.

Everybody's contribution is worthwhile,

- even weird ideas,
- even confusing ideas,
- especially silly ideas.

Suspend judgement:

- We won't evaluate each other's ideas,
- We won't censor each other's ideas,
- We'll save these ideas for later discussion.

We can modify this process before it starts or after it ends but not while it is underway.

[4] The inventor of brainstorming as a technique for stimulating creativity was Alex Osborn. His classic, "Applied Imagination", has spawned more than one hundred variations of brainstorming.

Facilitator tips for brainstorming

Do	Don't
Do a lot of mirroring using a flip chart. to keep things moving	Don't interrupt.
Do encourage people to take turns.	Don't say "We've already got that one".
Do treat silly ideas the same as serious ideas.	Don't say '"oh good one".
Do move around to create a lively feeling.	Don't say "Hey, you don't really want me to write that one, do you?"
Do say 'Lets see if I've got it right so far' if a person is difficult to follow.	Don't favour the 'best' thinkers.
Do repeat the purpose often.	Don't use frowns, raised eyebrows or other non-verbal gestures that signal disapproval.
Do start a new flipchart page before the previous one is full.	Don't give up the first time the group seems stuck.
Do give a warning that the end is approaching.	Don't simultaneously be the leader, facilitator and the chart writer.
Do expect a second wind of creative ideas after the obvious ones are exhausted.	Don't start the process without clearly setting the time limit.
	Don't rush or pressure the group. Silence usually means that people are thinking.

Focus groups

(adapted from Gibbs, A. (1997). Focus Groups. From a review of focus group methodology conducted for the Department of Social Medicine at Bristol University in March 1997. Accessed October 2006 at http://www.soc.surrey.ac.uk/sru/SRU19.html)

- Focus group research involves organised discussion with a selected group of individuals to gain information about their views and experiences of a topic.
- Focus group interviewing is particularly suited for obtaining several perspectives about the same topic.
- The benefits of focus group research include gaining insights into people's shared understandings of everyday life and the ways in which individuals are influenced by others in a group situation.
- Problems arise when attempting to identify the individual view from the group view, as well as in the practical arrangements for conducting focus groups.
- The role of the moderator is very significant. Good levels of group leadership and interpersonal skill are required to moderate a group successfully.

What are focus groups?

Powell, Single and Lloyd (1996: 499) define a focus group as a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research.. Focus groups are a form of group interviewing but it is important to distinguish between the two. Group interviewing involves interviewing a number of people at the same time, the emphasis being on questions and responses between the researcher and participants. Focus groups however rely on interaction within the group based on topics that are supplied by the researcher. (Morgan, 1997: 12)

Hence the key characteristic which distinguishes focus groups is the insight and data produced by the interaction between participants.

Merton and Kendall's (1946) influential article on the focused interview set the parameters for focus group development. This was in terms of ensuring that participants have a specific experience of or opinion about the topic under investigation; that an explicit interview guide is used; and that the subjective experiences of participants are explored in relation to predetermined research questions.

Why use focus groups and not other methods?

The main purpose of focus group research is to draw upon respondents' attitudes, feelings, beliefs, experiences and reactions in a way in which would not be feasible using other methods, for example observation, one-to-one interviewing, or questionnaire surveys. These attitudes, feelings and beliefs may be partially independent of a group or its social setting, but are more likely to be revealed via the social gathering and the interaction which being in a focus group entails. Compared to individual interviews, which aim to obtain individual attitudes, beliefs and feelings, focus groups elicit a multiplicity of views and emotional processes within a group context. The individual interview is easier for the researcher to control than a focus group in which participants may take the initiative. Compared to observation, a focus group enables the researcher to gain a larger amount of information in a shorter period of time. Observational methods tend to depend on waiting for things to happen, whereas the researcher follows an interview guide in a focus group. In this sense focus groups are not natural but organised events. Focus groups are particularly useful when there are power differences between the participants and decision-makers or professionals, when the everyday use of language and culture of particular groups is of interest, and when one wants to explore the degree of consensus on a given topic (Morgan & Kreuger, 1993).

The role of focus groups

Focus groups can be used at the preliminary or exploratory stages of a study (Kreuger 1988); during a study, perhaps to evaluate or develop a particular programme of activities (Race, Hotch & Parker, 1994); or after a programme has been completed, to assess its impact or to generate further avenues of research. They can be used either as a method in their own right or as a complement to other methods, especially for triangulation (Morgan, 1988) and validity checking.

Potential and limitations

Kitzinger (1994, 1995) argues that interaction is the crucial feature of focus groups because the interaction between participants highlights their view of the world, the language they use about an issue and their values and beliefs about a situation. Interaction also enables participants to ask questions of each other, as well as to re-evaluate and reconsider their own understandings of their specific experiences.

The benefits to participants of focus group research should not be underestimated. The opportunity to be involved in decision making processes (Race et al 1994), to be valued as experts, and to be given the chance to work collaboratively with researchers (Goss & Leinbach, 1996) can be empowering for many participants. If a group works well, trust develops and the group may explore solutions to a particular problem as a unit (Kitzinger, 1995), rather than as individuals. Not everyone will experience these benefits, as focus groups can also be intimidating at times, especially for inarticulate or shy members. Hence focus groups are not empowering for all participants and other methods may offer more opportunities for participants. However if participants are actively involved in something which they feel will make a difference, and focus group research is often of an applied nature, empowerment can realistically be achieved.

Although focus group research has many advantages, as with all research methods there are limitations. Some can be overcome by careful planning and moderating, but others are unavoidable and peculiar to this approach. The researcher, or moderator, for example, has less control over the data produced (Morgan, 1988) than in either quantitative studies or one-to-one interviewing. The moderator has to allow participants to talk to each other, ask questions and express doubts and opinions, while having very little control over the interaction other than generally keeping participants focused on the topic. By its nature focus group research is open ended and cannot be entirely predetermined.

On a practical note, focus groups can be difficult to assemble. It may not be easy to get a representative sample and focus groups may discourage certain people from participating, for example those who are not very articulate or confident, and those who have communication problems or special needs. The method of focus group discussion may also discourage some people from trusting others with sensitive or personal information. In such cases personal interviews or the use of workbooks alongside focus groups may be a more suitable approach. Finally, focus groups are not fully confidential or anonymous, because the material is shared with the others in the group.

The practical organisation of focus groups

Organising focus group interviews usually requires more planning than other types of interviewing as getting people to group gatherings can be difficult and setting up appropriate venues with adequate recording facilities requires a lot of time.

The recommended number of people per group is usually six to ten (MacIntosh, 1993), but some researchers have used up to fifteen people (Goss & Leinbach, 1996) or as few as four (Kitzinger, 1995). Numbers of groups vary, some studies using only one meeting with each of several focus groups (Burgess, 1996), others meeting the same group several times. Focus group sessions usually last from one to two hours.

It is not always easy to identify the most appropriate participants for a focus group. If a group is too heterogeneous, whether in terms of gender or class, or in terms of professional and ‘lay’ perspectives, the differences between participants can make a considerable impact on their contributions. Alternatively, if a group is homogenous with regard to specific

characteristics, diverse opinions and experiences may not be revealed. Participants need to feel comfortable with each other. Meeting with others whom they think of as possessing similar characteristics or levels of understanding about a given topic, will be more appealing than meeting with those who are perceived to be different (Morgan, 1988).

Once the types of participant have been decided, locating them is the next challenge. Recruitment of participants can be time consuming, especially if the topic under consideration has no immediate benefits or attractions to participants. It is likely that people with specific interests will have to be recruited by word of mouth (Burgess, 1996), through the use of key informants, or by advertising (Holbrook & Jackson, 1996), or through existing social networks.

The role of moderator

Once a meeting has been arranged, the role of moderator or group facilitator becomes critical, especially in terms of providing clear explanations of the purpose of the group, helping people feel at ease, and facilitating interaction between group members.

During the meeting moderators will need to promote debate, perhaps by asking open questions. They may also need to challenge participants, especially to draw out people's differences, and tease out a diverse range of meanings on the topic under discussion. Sometimes moderators will need to probe for details, or move things forward when the conversation is drifting or has reached a minor conclusion. Moderators also have to keep the session focused and so sometimes they may deliberately have to steer the conversation back on course. Moderators also have to ensure everyone participates and gets a chance to speak. At the same time moderators are encouraged not to show too much approval (Kreuger, 1988), so as to avoid favouring particular participants. They must avoid giving personal opinions so as not to influence participants towards any particular position or opinion.

The role of the moderator is a demanding and challenging one, and moderators will need to possess good interpersonal skills and personal qualities, being good listeners, non-judgmental and adaptable. These qualities will promote the participants' trust in the moderator and increase the likelihood of open, interactive dialogue.

Finally, the degree of control and direction imposed by moderators will depend upon the goals of the research as well as on their preferred style. If two or more moderators are involved in the facilitation of a focus group, agreement needs to be reached as to how much input or direction each will give. It is recommended that one moderator facilitates and the other takes notes and checks the recording equipment during the meeting. There also needs to be consistency across focus groups, so careful preparation with regard to role and responsibilities is required.

References

Burgess, J. (1996). 'Focusing on fear', *Area* 28 (2): 130-36.

Goss, J.D., & Leinbach, T.R. (1996). 'Focus groups as alternative research practice', *Area* 28 (2): 115-23.

Holbrook, B. & Jackson, P. (1996). 'Shopping around: focus group research in North London', *Area* 28 (2): 136-42.

Kitzinger, J. (1994). 'The methodology of focus groups: the importance of interaction between research participants', *Sociology of Health* 16 (1): 103-21.

Kitzinger, J. (1995). 'Introducing focus groups', *British Medical Journal* 311: 299-302.

Kreuger, R.A. (1988). *Focus groups: a practical guide for applied research*. London: Sage.

MacIntosh, J. (1981). 'Focus groups in distance nursing education', *Journal of Advanced Nursing* 18: 1981-85.

Merton R.K., & Kendall P.L. (1946). 'The Focused Interview', *American Journal of Sociology* 51: 541-557.

Morgan, D.L. (1988). *Focus groups as qualitative research*. London: Sage.

Morgan, D.L. (1997, 2nd Edition). *Focus groups as qualitative research*. London: Sage.

Morgan, D.L. & Kreuger, R.A. (1993). 'When to use focus groups and why' in Morgan D.L. (Ed.) *Successful Focus Groups*. London: Sage.

Powell, R.A., Single, H.M., & Lloyd, K.R. (1996). 'Focus groups in mental health research: enhancing the validity of user and provider questionnaires', *International Journal of Social Psychology* 42 (3): 193-206.

Race, K.E., Hotch, D.F., & Parker T. (1994). 'Rehabilitation program evaluation: use of focus groups to empower clients', *Evaluation Review* 18 (6): 730-40.

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APPENDIX 4: HF ISSUES DESCRIPTORS

HF Pie Category: 1. Working Environment

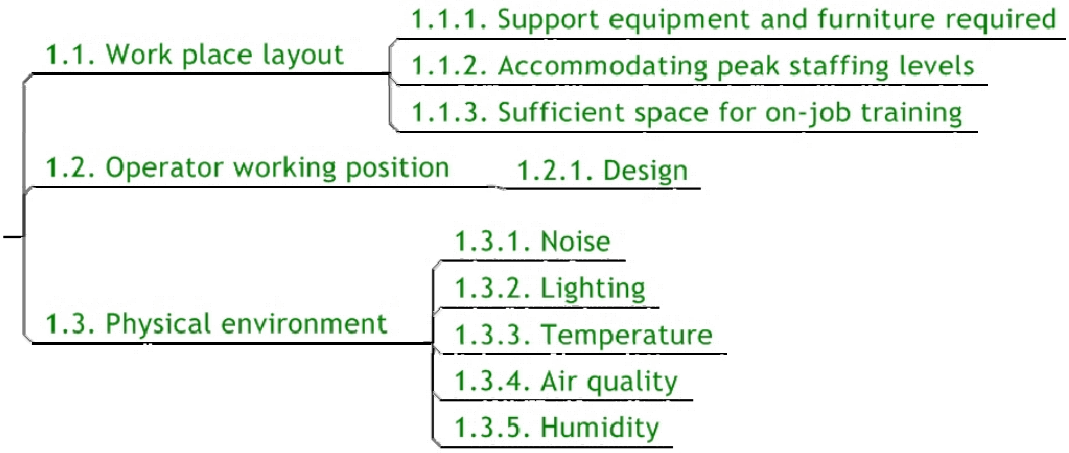

Figure A4-1 Working environment overview

HF Issue	Descriptor
1. Working environment	The ATM working environment includes the working space, general equipment and furniture used, and physical environment in which people work.
1.1 Workplace layout	Layout of the working positions in the operational area including: 1.2.1 Required support equipment and furniture, 1.2.2 Accommodation of peak staffing levels, 1.2.3 Sufficient space for On-the-Job Training (OJT).
1.2 Operator working position	Layout and design aspects of the Controller Working Position (CWP) other than those mentioned under input and output devices. The layout and design of the room usually includes consideration of a number of items, including (but not limited to): • workplace, • workstation, • equipment, • seating.
1.3 Physical environment	Physical factors in the environment, such as: 1.3.1 noise, 1.3.2 lighting, 1.3.3 temperature, 1.3.4 air quality, and 1.3.5 humidity that impact on human performance when they are outside the physiological comfort and tolerance range.

	Noise levels within the working environment must be at a level to promote effective communication. They must also fall below the maximum levels defined in the appropriate European directive. Lighting levels and location should be sufficient to allow staff to carry out their duties effectively. Lighting levels should fall within the guidance defined in BS EN ISO 29241, 'Ergonomic requirements for office work with visual display terminals'. Thermal comfort is dependent on a number of factors including air temperature, relative humidity, air movement, clothing and the level of physical activity. These factors must be considered in relation to one another, and must be within acceptable limits in order to achieve thermal comfort of the staff.

HF Pie Category: 2. Organisation and Staffing

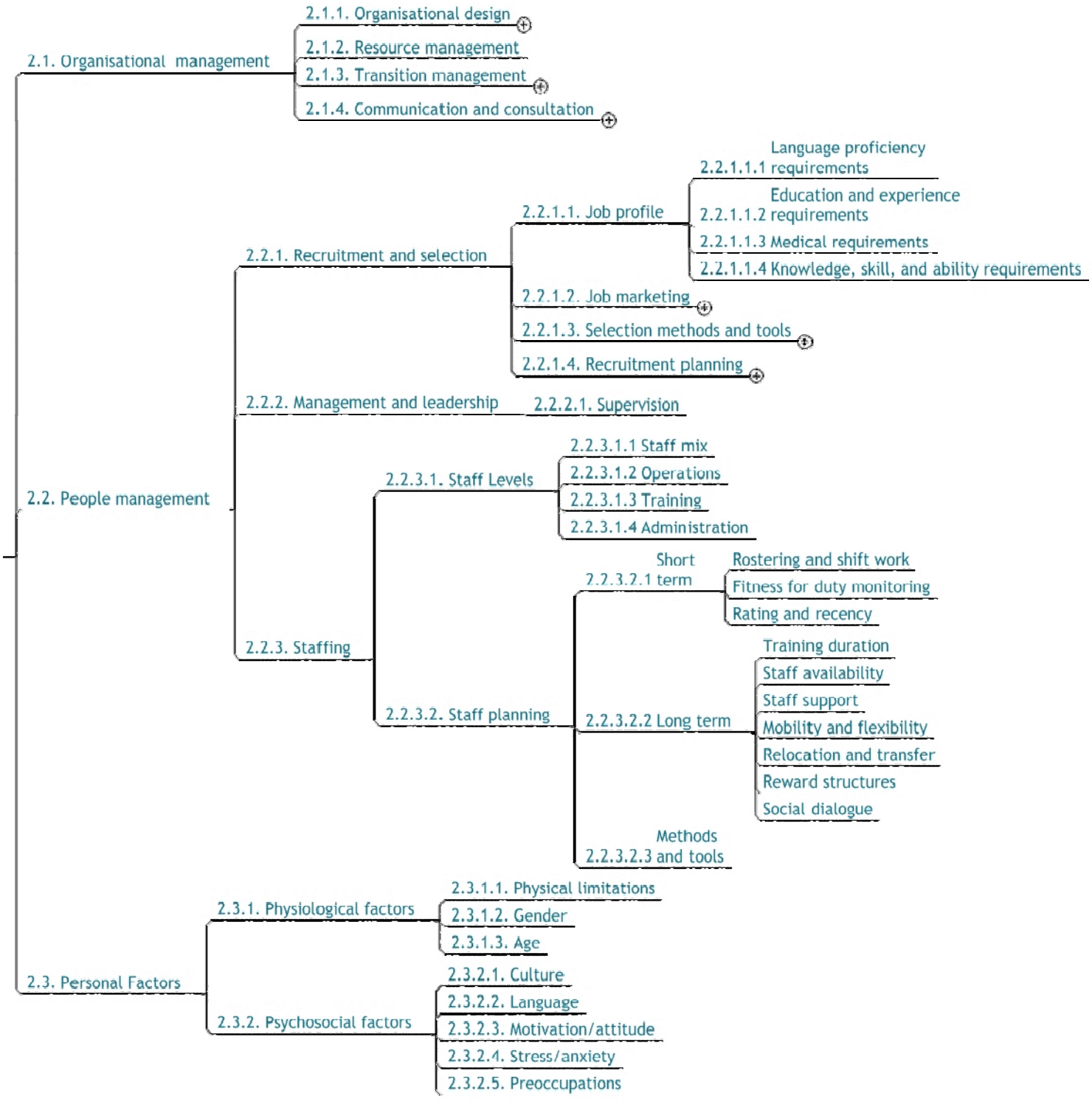

Figure A4-2.1 Organisation and staffing overview

HF Issue	Descriptor
2. Organisation and Staffing	Consists of Organisational management, People management, and Personal Factors
2.1 Organisational management	Consists of Organisational design, Resource management, Transition management, and Communication and Consultation
2.1.1 Organisational design	Refers to issues associated with organisational structure, including the responsibilities, authorities and accountabilities of key management and operational personnel.
2.1.1.1 Reporting structure	This includes the formal and informal lines of communication and reporting between organisational roles and positions both within the hierarchical and matrix organisational structures.
2.1.2 Resource management	Issues associated with the management of staff and resources.
2.1.3 Transition management	Issues associated with the transition from an old to a new situation. The process to ensure acceptance and confidence in the system. This can include perception of individual situation, personal needs, motives and drives, internal and external perceived (felt) barriers, perceived conflicts. General attitudes to change, perceived ability to change, group impacts as reference system for values and feelings; cultural and language issues.
2.1.4 Communication and consultation	Two-way communication on project progress and the transition refers to issues associated with the way that information relating to relevant HF Issues is communicated within the organisation or to other organisations.
2.2 People management	Consists of Recruitment and selection, Management and leadership, and Staffing
2.2.1 Recruitment and selection	The whole process from attracting and assessing the aptitude of applicants to the selection decision and employment of selected applicants for training or work.
2.2.1.1 Job profile	Includes job attractiveness, language proficiency requirements, job profile/level, selection and recruitment criteria, career development, impact on new skills, knowledge, attitudes, and abilities.
2.2.1.2 Job marketing	Includes demography, job attractiveness, strategy and target groups, and media.
2.2.1.3 Selection methods and tools	Includes selection strategy, development, application and infrastructure, and validation
2.2.1.4 Recruitment planning	Includes cost, expertise, and time required for development and recruitment

2.2.2 Management and leadership	Management values/ethics; management style/culture, leadership, commitment of leaders and managers, competence in managing the change, communication strategies and information policy and management
2.2.2.1 Supervision	Related to first-line supervision of employee performance. As well as performance monitoring, includes activities such as coaching, feedback, briefings and employee support. Effective supervision covers: ▪ Planning: The supervisor should ensure that sufficient staff are available and sufficient rest periods provided. ▪ Monitoring: The supervisor should oversee and communicate with operators and trainees on a frequent basis to ensure that operations are being effectively and safely carried out. ▪ Delegating: The supervisor is responsible for delegating responsibility, such as the merging and splitting of sectors, and should not perform the operator's task themselves. ▪ Conflict management: The supervisor is responsible for avoiding or resolving conflicts emerging e.g. between operators.
2.2.3 Staffing	Consists of Staff levels and Staff planning
2.2.3.1 Staff levels	Staff mix, Operations, Training, and Administration
2.2.3.2 Staff planning	Short term, Long term, Methods and tools
2.2.3.2.1 Short term	Includes Rostering and shiftwork, Fitness for duty monitoring, and Rating and recency
2.2.3.2.1 (a) Rostering and shiftwork	Potential impacts on health, fatigue, concentration, vigilance, stress and working patterns on shift design. Rostering is the organisation of shift patterns and includes consideration of: - timing of shifts (e.g. start/finish times), - shift handover requirements, - duration of shifts, - rotation of shifts (e.g. fast/slow, retarded/advancing). Rest breaks and recovery periods (e.g. versus time on shift). Roster management refers to the flexibility that supervisors and staff have to increase, change and/or swap shifts on a day-to-day and hour-to-hour basis.
2.2.3.2.1 (b) Fitness for duty monitoring	Refers to issues with the monitoring of an individual's fitness for duty, relating to issues such as general well being, health/medical status, fatigue or use of alcohol, drugs or medications. Management and individuals should be responsible for ensuring that operators are fit and ready for work. Management also have a responsibility to ensure that they themselves are fit for work. Each individual should be: - alert, - well rested, - sober, - in the 'right frame of mind' (e.g. emotional state), - physically fit.

2.2.3.2.1 (c) Rating and recency	Rating: An authorisation entered on or associated with a licence and forming part thereof, stating special conditions, privileges or limitations pertaining to such rating. Recency: Issues associated with maintaining ratings and keeping endorsements valid.
2.2.3.2.2 Long term	Includes Training duration, staff availability, staff support, mobility and flexibility, relocation and transfer, reward structures, and social dialogue.
2.2.3.2.2 (c) Staff support	Refers to situations where operational personnel are not provided with appropriate support networks or facilities to deal with personal or work-related difficulties such as employee assistance programs.
2.2.3.2.2 (e) Relocation and transfer	Issues related to relocation and transfer; relocation policies; contractual and employment; family situation; housing and living, individual social and community activities; commuting policies and possibilities; social impacts on partner, job issues of partner, social dialogue.
2.2.3.2.2 (f) Reward structures	Remuneration, reward issues or other incentives to conduct the task effectively. Includes situations where personnel are provided with reward structures which facilitate risk-taking behaviours.
2.2.3.2.2 (g) Social dialogue	A social dialogue can be any communication activity involving social partners intended to influence the arrangement and development of work related issues. This can be direct relations between the social partners themselves (“bipartite”) or relations between governmental authorities and the social partners (“tripartite”). Examples of social dialogue activity include mutual information, open discussion, concertation (on-going tripartite dialogue), exchange of opinions, consultation and negotiation (agreements /common opinions). European social dialogue is enshrined in the Treaty establishing the European Community (articles 138 and 139; ex 118a and 118b) and it is promoted by the European Commission as an instrument for a better governance and promotion of social and economic reforms.

2.3 Personal Factors	Consists of age, physical limitations, gender, culture, language, motivation/attitude, stress/anxiety, and preoccupations.
2.3.1.1 Physical limitations	Any physical or sensory limitations which are part of the individual’s normal disposition and differ from the average population, i.e. visual ability, hearing ability, strength, or reach.
2.3.2.1 Culture	Factors associated or impacted by culture.
2.3.2.2 Language	Factors associated or impacted by age, gender and language.
2.3.2.3 Motivation/ attitude	Situations in which an individual’s motivation or attitude contributes to an individual action. Includes low levels of motivation, complacency, poor morale, low levels of job satisfaction, learned helplessness, lack of pride in work, overconfidence, lack of confidence, misplacing primary task goals with personal goals, risk taking, macho aggression, lack of assertiveness, anti-authoritarian, perceived licence to bend the rules.
2.3.2.4 Stress/anxiety	Stress or anxiety that influences the job performance. The problems might be work related (job insecurity) or not (domestic relationship problems). More refers to ongoing problems than task-specific demands.
2.3.2.5 Preoccupations	Situations where an individual’s attention is focussed on non task related topics.

HF Pie Category: 3. Training and Development

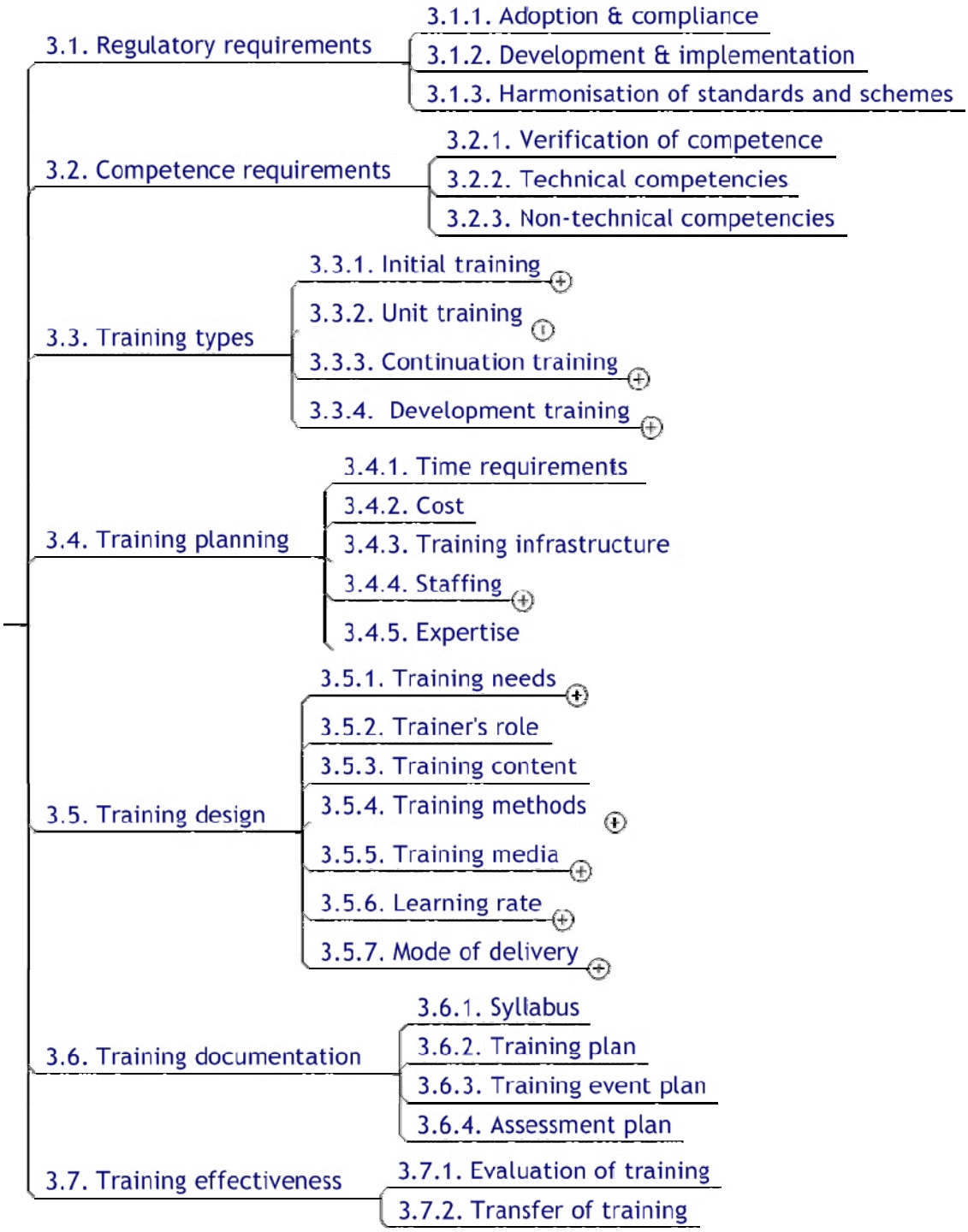

Figure A4-3.1 Training and development overview[5]

[5] For further ATM Training definitions see EUROCONTROL (2004). *EATM Training Progression and Concepts*. HRS/TSP-006-GUI-07.

Issue	Descriptor
3 Training and development	The systematic development of the knowledge, understanding, skill and attitude behaviour patterns required by an individual in order to adequately perform a given task
3.1 Regulatory requirements	The applicable restrictions, licenses, and laws imposed by the appropriate authorities.
3.1.1 Adoption & compliance	The fact of being taken up and accepted, and thence acting in accordance with the applicable regulatory requirements.
3.1.2 Development & implementation	The process of developing material and the action of implementing it into effect.
3.1.3 Harmonisation of standards and schemes	To reconcile and bring into agreement one quality standard, or formalised plan or classification system, with another.
3.2 Competence requirements	A competence requirement is the specification of the knowledge and skill, and the application of that knowledge and skill, to the standards of performance required in the workplace. Competency on the task requires a match between the operator's competencies and the competencies required to safely and effectively perform that task.
3.2.1 Verification of competence	Proof of ability to safely and adequately perform the task as specified. Includes Evaluation, Assessment, and Certification.
3.2.1.1 Evaluation	Evaluation is used to monitor learning progress during instruction and to provide continuous feedback to both student and instructor concerning learning successes and failures. The results are typically not used to certify mastery of intended learning outcomes.
3.2.1.2 Assessment	Assessment typically comes at the end of a unit of instruction. It is designed to determine the extent to which the instructional objectives have been achieved and is used primarily for certifying mastery of intended learning outcomes against a defined standard.
3.2.1.3 Certification	Documentation of the successful completion of a course of training.
3.2.2 Technical competencies	Technical competencies are behaviours directly related to the control of equipment and technical proficiency.
3.2.3 Non-technical competencies	Non-technical competencies are behaviours that are not directly related to the control of equipment and technical proficiency. They encompass aspects of behaviour such as cognitive skills (e.g. situational awareness, decision-making, error management, etc.) and interpersonal skills.

3.3 Training types	The main training types in ATM are Initial, Unit, Continuation, and Development training.
3.3.1 Initial training	Initial training consists of Basic (ATCO and ATSEP), Rating and Qualification training
3.3.2 Unit training	Includes Transitional, pre-OJT, and OJT training.
3.3.3 Continuation training	Training given to personnel designed to augment existing knowledge and skills and/or to prepare for new technologies. It includes refresher, conversion, emergency, unusual situtation, and degraded systems training.
3.3.4 Development training	Includes OJTI, assessor, supervisor, safety manager, incident investigator, airspace developer, training manager, traffic flow manager, and system monitoring and control training.

3.4 Training Planning	Planning for the training programme should account for the time required, the cost, the training infrastructure, staffing issues (including numbers and continuity of instructors, roles and instructor training), and expertise needed.

3.5 Training design	Training design incorporates the Training needs, Trainer's role, Training content, Training methods, Training media, Learning rate, and Mode of delivery.
3.5.1 Training needs	Includes identifying the training requirements and determining who needs to be trained, and when they need to be trained. Training should be tailored to the needs of staff roles and responsibilities. It should be provided on a regular basis, as determined by safety criticality and frequency of operation. The competency of workers should be assessed to ensure the training has been effective.
3.5.2 Trainer's role	The level of training, responsibility and competence required of the trainer.
3.5.3 Training content	Training content is divided into subjects, themselves divided into topics that are in turn subdivided into sub-topics. This structure is used to create and classify the objectives – one general objective is linked to each subject and one or several objectives are linked to each sub-topic. Optionally a main objective is linked to a topic.
3.5.4 Training methods	The relationship between the matter, the learner and the instructor (lecture, lesson/demonstration, case study, exercises, facilitation, interactive training, supervised practices, pre-simulation, simulation, briefing, debriefing, tutoring, role play etc): - Which media to use to carry the training message? - Is the learning rate free or restricted or real? - Is the training individual or in a group?
3.5.5 Training Media	The physical means by which an instructor or a training designer communicates a message. One media can use several supports (for instance, a Multimedia Computer (MMC) could use a diskette or CD-ROM, and video

	can use tape, CD or DVD). e.g. Real Equipment, High-Fidelity Simulator, Simulator (Sim), Part-Task Trainer, Other Training Device, Multimedia Computer, Network, Video , Visual Aids ,Audio Aids ,Text, etc
3.5.6 Learning rate	Learning is the acquisition of knowledge, skills and attitudes. A basic concept in learning is that a change in behaviour occurs as a result of the acquisition. Learning rate includes self-paced learning, time-restricted learning, and real time.
3.5.7 Mode of delivery	Includes individualised training and group training, e-learning and problem-based learning.

3.6 Training Documentation	Includes the syllabus, training plan, training event plan, and assessment plan.
3.6.1 Syllabus	Listing of subjects, topics, elements and items showing the training necessary to fill the training gap and achieve the course aim. It indicates time to be devoted to each part but usually neither methods nor order.
3.6.2 Training plan	A document detailing an outline of the training requirements, methods of achievement and time scale for achievement. It provides an earlier and more general view than the day-to-day training programme.
3.6.3 Training event plan	A document used by the instructor when preparing and providing the training. It provides the objectives of the training event and its type, a timeline, material references and additional advice for performance.
3.6.4 Assessment plan	A document identifying how the assessment will be performed for each subject, topic and objective. Test performance is linked to the performance objective.

3.7 Training effectiveness	Includes the evaluation of training, transfer of training, and interference from old working methods.
3.7.1 Evaluation of training	To evaluate training is to determine its value and benefit to the trainees and to the organisation. To properly evaluate training requires one to think through the purposes of the training, the intended results of the training, and the purposes of the evaluation.
3.7.2 Transfer of training	Positive transfer of training: An enhancement in performance that occurs when skills from a previous work environment are applicable in the new environment. Negative transfer of training: A performance decrement that occurs when skills or experiences from one working environment contribute to human error in a new environment; that is the old skills interfere with learning and using the new skills required (interference between old and new methods of operation).

HF Pie Category: 4. Procedures, Roles and Responsibilities

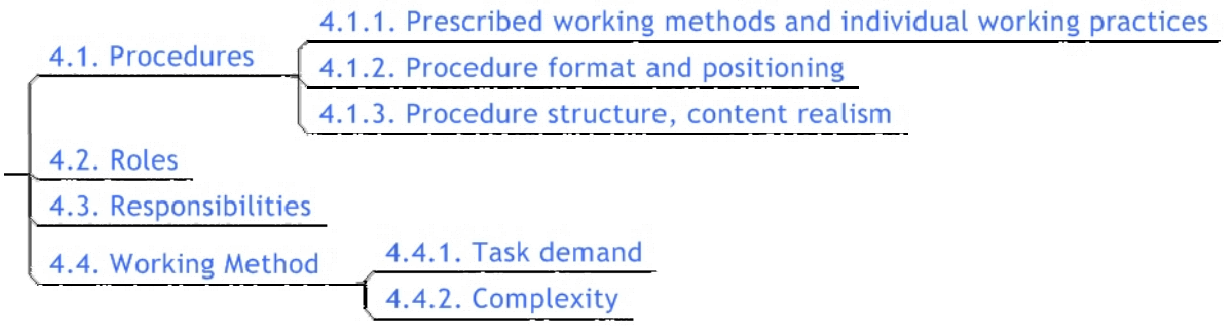

Figure A4-4 Procedures, Roles and Responsibilities overview

Issue	Descriptor
4 Procedures, Roles and Responsibilities	
4.1 Procedures	▪ Procedures represent the organisation's accepted working methods. A procedure is a particular course of actions intended to achieve a result. In the ATM environment, this term can be characterised as a set of activities that are performed by each person intervening in the process, according to pre-established rules, to enable a successful operation. e.g. ▪ standard procedures – Design availability and consistency of procedures ▪ abnormal and emergency procedures. Issues in relation to procedures are: ▪ 4.3.1 Variance in prescribed working methods and individual working practices ▪ 4.3.2 Procedure format and positioning ▪ 4.3.3 Procedure structure, content realism.
4.2 Roles	The position(s) or purpose(s) that someone has in an organisation. The typical or characteristic function performed by someone relating to the tasks that have been assigned to them.
4.3 Responsibilities	Things that are your job or duty to deal with. Having responsibilities means to have a duty to make certain that particular things are done.

4.4 Working Method	The way in which individuals perform their tasks. Prescribed working methods and individual working practices
4.4.1 Task demand	Task: A composite of related activities (perceptions, decisions, and responses) performed for an immediate purpose, written in operator/maintainer language. ATM tasks include monitoring, searching, planning, problem solving, decision-making, predicting, communicating, discussing, coordinating, liaising, instructing, verifying, understanding, remembering, handling and structuring information, scheduling work, and managing resources. These may include some combination of visual, auditory, analytic, and/or response requirements. Task demand: The amount of effort required to perform a task. It differs between people depending on their skills and experience, and is a component of perceived workload. It is influenced by: ▪ High workload: Situations where the number or complexity of task demands exceeds the ability of the individual to perform effectively. ▪ Time pressure: Situations where the demands to complete a specific task or tasks by a specific time influences the ability of the individual to perform effectively. ▪ Distractions: Situations of specific interruptions, distractions, problems or other events, which are not of primary task importance, interfere with the ability of the individual to perform effectively. ▪ Low workload: Situations where task demands are low and the level and duration of the demands is such that it can interfere with an individual's concentration and therefore task performance. ▪ Other: Low workload/boredom and task inconvenience.
4.4.2 Complexity	Involving a lot of different but related parts, complicated and difficult to understand.

HF Pie Category: 5. Teams and Communication

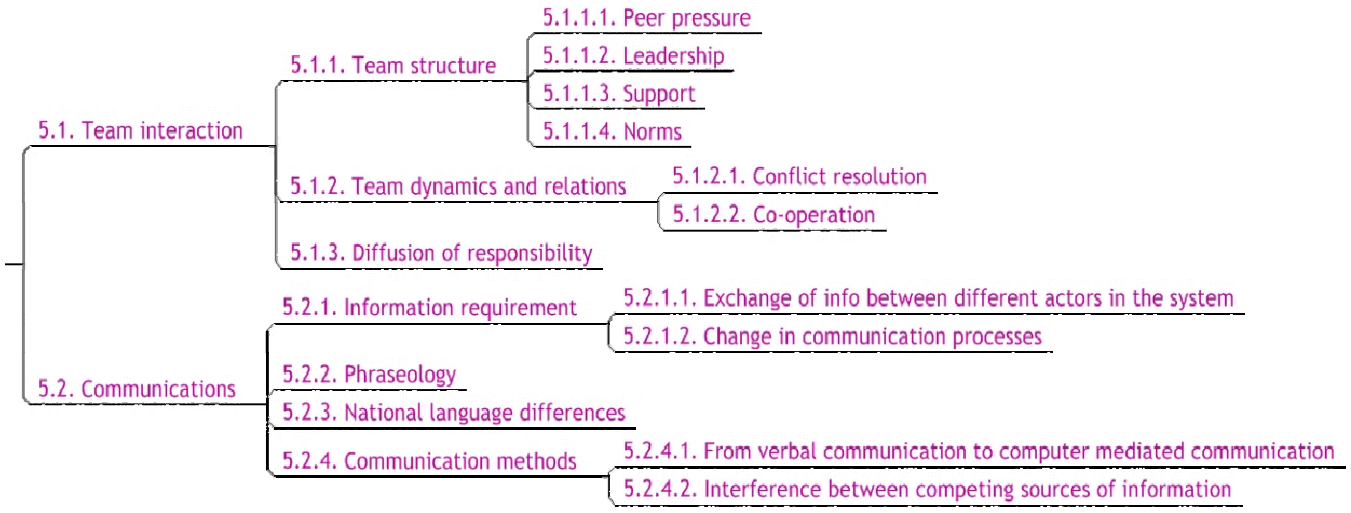

Figure A4-5 Teams and Communication overview

Issue	Descriptor
5. Teams and communication	How people work and communicate with each other on shared goals and tasks.
5.1 Team interaction	The way in which individuals perform their tasks. Prescribed working methods and individual working practices
5.1.1 Team structure	The impact on the team structure (supervision, team formation)
5.1.1.1 Peer pressure	Peer pressure is the influence that one person in a similar role or of a similar age exerts over another.
5.1.1.2 Leadership	Leadership relates to the ability of an individual to influence, motivate, and enable others to contribute toward the goals of the team and their effectiveness and success within the organisation.
5.1.1.3 Support	Support relates to the assistance team members can give to the leader and each other to achieve the team goals.
5.1.1.4 Norms	A norm is a behaviour or a judgement rule shared and accepted by a group. Individuals that do not behave according to the norm can be excluded or marginalised from the group. Usually norms are informal rules that are not written down and a rarely openly discussed (implicit rules). However they have a powerful influence on behaviours of the group members.
5.1.2 Team dynamics and relations	Issues associated with a change to team dynamics and relations (e.g. from dual controller to single controller) which can also impact 5.1.2.1 conflict resolution and 5.1.2.2 co-operation.

5.1.3 Diffusion of responsibility	Situations where responsibility for action is divided between two or more individuals and each assumes that somebody else is taking the necessary action.

5.2 Communications	The timely process of passing information between people completely and accurately so that it is received and understood.
5.2.1 Information requirement	Requirement to exchange information between different actors in the system (e.g. as part of collaborative decision-making). Typically this will include communications between controllers and: ▪ other controllers, ▪ pilots, ▪ technical personnel, ▪ supervisors, ▪ managers.
5.2.2 Phraseology	Issues associated with the application of standard phraseology and terminology in ATM.
5.2.3 National language differences	These include dialects and accents. ATCOs are required to have proficiency in the English language. Language performance requirements can include: ▪ the ability to produce intelligible messages in unusual situations; ▪ the ability to communicate in plain language (English) even under stress; ▪ understanding and making appropriate responses to pilots' messages; ▪ adherence to ICAO phraseology; ▪ resolving misunderstanding in communication (e.g. by understanding cultural differences).
5.2.4 Communication methods	▪ Changes in communication methods, e.g. from verbal communication to computer-mediated communication. ▪ Interference between competing sources of information.

HF Pie Category: 6. Human in System

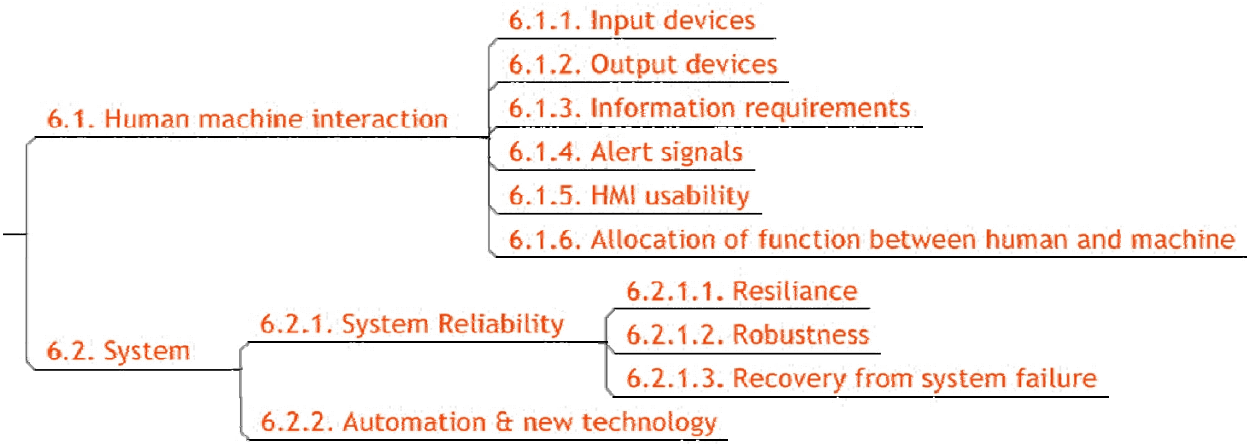

Figure A4-6 Human in System overview

Issue	Descriptor
6 Human in System	This emphasises that the human is a key part of the system
6.1 Human-machine interaction	The actions, reactions, and interactions between humans and other system components. This also applies to a multi-station, multi-person configuration or system.
6.1.1 Input devices	How information is entered into the system, e.g. keyboard, mouse, roller ball, touch screen or microphone.
6.1.2 Output devices	How information is received from the system: mainly visual display units, but also Radiotelephony (RTF) headset and phone. Comprises not only hardware but also the way information is provided (e.g. layout of information windows on the screen, use of colour).
6.1.3 Information requirements	Information to be displayed including the information content, form and timeliness. Prioritisation and categorisation of information.
6.1.4 Alert signals	Alarm handling, display of alarms, alarm philosophy/policy.

6.1.5 Human-Machine Interface (HMI)	HMI refers to the modes by which the human user and the machine communicate information and by which control is commanded, including areas such as information presentation, displays, displayed information, formats and data elements; command modes and languages; input devices and techniques; dialog, interaction and transaction modes; timing and pacing of operations; feedback, error diagnosis, prompting, queuing and job-performance aiding; and decision aiding. HMI also defines the properties of the hardware, software or equipment which constitute the conditions for interactions. *HMI usability* is the extent to which a system allows people to achieve goals (tasks) in an effective, efficient and satisfactory way. Aspects of the system that might ensure or compromise its usability. This often includes a number of usability principles such as: ⇨ The equipment should: ▪ match the job or task, i.e. be logically organised / laid out. ▪ comprise consistent screens, messages, terminology, and appearance. ⇨ The computer interface should: ▪ provide helpful information; ▪ require an operator to recognise information rather than to recall information from memory; ▪ keep the user informed of the current status; ▪ allow the user to drive the software; the interface should provide a mechanism to 'undo' or 'exit' a function; ▪ minimise the risk of a user making a safety significant error (i.e. requires action confirmation); ▪ provide accelerators for use by more experienced operators (e.g. shortcuts); ▪ be simple to follow.
6.1.6 Allocation of function between human and machine	This includes the responsibility for command and control, ability to monitor (human to technology and technology to human), responsibility for checking, and intervention. Consider the impact of changes in the allocation of function (e.g. automated tasks) on situational awareness, workload and skill change – (be it enhanced or degraded).
6.2 System	A set of functions designed to meet a goal or set of related objectives. Key components or automated systems are hardware, software, people, and procedures.
6.2.1 System reliability	How well the design or manufacture of equipment, plant or infrastructure achieves the intended design purpose, not relating to a technical failure of one or more components. This includes factors such as: ▪ 6.2.1.1 Resilience: Ability to quickly return to a previous good condition, recovery. ▪ 6.2.1.2 Robustness: Strong and unlikely to break or fail. ▪ 6.2.1.3 Recovery from system failure: Degree to which system failures are immediately evident in all operating conditions and all modes of operation. Potential for an individual to mitigate the system failure.

6.2.2 Automation and new technology	Automation The independent accomplishment by a device or system of a function that was formerly carried out by a human. The level of automation refers to the extent to which tasks are under the control of the computer versus those that are under the control of the operator. Factors to consider in relation to automation include: - task complexity and demand on operators, - safety significance of the tasks, - output of investigations / formal studies, - changes in function and/or perform requirements of the system, - mode awareness, - timely response requirements, - automation complacency, - monitoring, - revision under system degradation. New technology (i.e. software tools and capabilities) that support the operator's information processing and decision-making activities. Technology level refers to the maturity of the equipment from new/novel technology through to established equipment.

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APPENDIX 5: DEFINITIONS FOR HF IMPACTS ON HUMAN PERFORMANCE

IMPACT	PRACTITIONERS DEFINITION	ACADEMIC REFERENCE
Acceptance	The fact to consider something or someone as satisfactory.	Refers to the experience of a situation without an intention to change that situation. Does not require that change is possible or even conceivable, nor does it require that the situation be desired or approved by those accepting it. Indeed, acceptance is often suggested when a situation is both disliked and unchangeable, or when change may be possible only at great cost or risk (wikipedia).
Cognitive processes	How people think, make judgements and problem solve on the job. This includes information processing capability, memory, decision-making, vigilance and attention span (see glossary).	The mental processes of an individual that can be understood in terms of information processing, especially when a lot of abstraction or concretisation is involved, or processes such as involving knowledge, expertise or learning are at work (wikipedia).
Comfort	How people physically perceive and experience their working environment.	A state of physical well-being, with freedom from pain and satisfaction of bodily needs; the condition of being comfortable.
Error	A generic term to encompass all those occasions in which a sequence of mental or physical activities (intended or unintended) results in an *undesired* outcome.	Any action (or non-action) that potentially or actually results in negative system effects, where more than one possible course of action is available. (HERA definition, see EUROCONTROL, 2003).
Fatigue	The need for recuperation of the resources being used for the task in hand. Our focus is on fatigue and 'alertness' and how it affects human performance, not physical or 'mental' fatigue.	A feeling of weariness, tiredness, or lack of energy. The inability to continue functioning at a prescribed work rate.
Job satisfaction	A term used to describe how content an individual is with their job (wikipedia)	The feelings or 'affective response' someone experiences in a job role.
Motivation	Enthusiasm for doing something. The reason a person has for acting in a particular way.	Motivation is a temporal and dynamic state relating to the initiation, direction, intensity and persistence of behaviour. It is the (conscious or unconscious) stimulus for action towards a desired goal, especially as resulting from psychological or social factors; the factors giving purpose or direction to human behaviour.
Situation awareness	The accurate perception of what has happened, what is currently happening, and what is therefore likely to happen next.	Refers to "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Ensley, 1988).

Skill change	Skill is the ability to do an activity or a job well, especially because you have practised it. Skill change is the gaining or losing of skills, mostly through practice or the lack of practice.	Skill is a proficiency or facility that is acquired or developed through training or experience.
Stress	When perceived demands exceed performance capability. A subset of subjective workload where it is appraised as negative.	Our main task performance focus is that of stress-induced error in high demand settings. Psychological definitions of stress focus on the stimulus environment, the response of the individual and the relationship between the person and the environment. A combination of these gives a definition such as “stress is a process by which certain environmental demands evoke an appraisal process in which perceived demand exceeds resources and results in undesirable physiological, psychological, behavioural or social outcomes” (Salas, Driskell & Hughes, 1996). Our main interest is probably acute stress, that which is sudden, novel, intense, and of relatively short duration, disrupts goal-oriented behaviour, and requires a proximate response.
Trust	The extent to which the user is willing to act on the basis of the recommendations, actions and decisions of a computer-based tool or decision aid.	To increase user’s trust in automation, automation performance should be: a) reliable and predictable with minimal errors; b) robust (able to perform under a variety of circumstances); c) familiar (use terms and procedures familiar to the user); and d) useful.
Workload	The effort invested by the human operator into task performance. Varies as function of ability, skill, training and experience. Workload relates to objective workload (task demand) and subjective workload (individual perceptions).	Cardosi & Murphy (1995) make the point in relation to ATM workload evaluation that both the observable (objective) and perceived (subjective) aspects of demand on the controller need to be considered and that there is no absolute workload independent of skill and experience. They point out that it is imperative to define the term workload in context as there is no single agreed definition, and it relates to both quantifiable task demands versus time available, plus non-observable mental tasks such as planning and problem solving.

APPENDIX 6: ISSUES ANALYSIS APPROACH FEEDBACK FORM

Thank you for attending the Issues Analysis workshop/interviews. We are always trying to improve the service we offer and would be grateful for your comments and experiences.

You are welcome to provide as much or as little information as you feel appropriate. You do not need to enter your name or email address if you wish your comments to remain anonymous.

YOUR DETAILS	
First name	
Last name	
Preferred email address	

WORKSHOP FEEDBACK		⇩ OPTIONAL COMMENTS
Was the pre-workshop/interview briefing appropriate and helpful?	Yes ❑ No ❑	
Were you provided with adequate notice of the workshop/interview?	Yes ❑ No ❑	
Did the workshop start at a suitable time?	Yes ❑ No ❑	
Was the process appropriate for the workshop/interview?	Yes ❑ No ❑	
Did the workshop/interview meet your expectations?	Yes ❑ No ❑	

Were there any elements missing from the workshop/interview that should have been included?	Yes ❑ No ❑	
Was the duration of the workshop/interview appropriate?	Yes ❑ No ❑	
Did the facilitator present each stage of the process clearly and succinctly?	Yes ❑ No ❑	
Were there sufficient break periods during the workshop/interview?	Yes ❑ No ❑	
Did the facilitator manage the group effectively?	Yes ❑ No ❑	
Did you find easy to follow the flow of the workshop/interview?	Yes ❑ N/A ❑ No ❑	
What do you consider went well?		
What do you consider could be improved?		
Which aspect of the workshop/interview did you find most valuable?		

APPENDIX 7: ISSUES ANALYSIS REPORT OUTLINE

Element	Explanation
Executive summary	
Introduction	Overview of the programme – Outcome of Stage 1 findings
Approach	▪ Overview of the HF Case approach for the project ▪ Where Issues Analysis fits ▪ Interview or workshop approach
Description of workshop/ interview	▪ Workshop/interview objectives ▪ Workshop/interview process ▪ Who attended (names of the participants) ▪ When the workshop/interview took place
Workshop/interview results	▪ Project assumptions ▪ Prioritisation of HF Issues ▪ Table 1 – HF Issues identified ▪ HF Issue analysis – Main issues, main likely impacts, main HF impact on human performance ▪ Appendix 1 – Detailed list of issues and their impact
Review meeting (interviews)	Any feedback or discussion
Next steps	Outline next steps and input to the Action Plan
Appendices	▪ List of HF Issues per work areas of HF Pie ▪ List of HF Issues clustered into HF impact on human performance.

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APPENDIX 8: ACTION PLAN CONTENT AND ELEMENTS

Headings	Element	Content
Background	Project summary	Brief description of the project Concept of operation and maintenance
	Project schedule	Overview of project schedule
	Target audience	Who will be affected (key users)?
	HF Case development	Attach result of fact finding – summarise key aspects. Outline output of Stage 2 - including list of issues identified as an appendix.
Action Plan development	Review of HF impacts, and identification of actions	Summarise identified issues and impacts with associated actions to address these.
	Action Plan objectives	What objectives does the Project Manager wish to achieve? Examples of objectives for the Action Plan are as follows: ▪ Define/scope the HF activities for the project; ▪ Identify the actions to be taken to resolve each issue.
	Approach	Define who will be responsible for the HF activities. Set out to what extent contractor support is required. Define how the HF Case Coordinator will support the Action Plan activities.
	Issue description	Describe the issue or problem background, importance, and consequences.
Actions	Actions	Identify actions to be taken to resolve issues.
Activities	Activity description/ schedule	Identify for each action: 1. Objective. 2. Input. 3. Expected outcome. 4. Benefits. 5. Planning and approach. 6. Tasks plus timeline. 7. Stakeholder's involvement. 8. Budget.
	Risks/constraints	Identify any risks and how they can be mitigated. Identify any constraints and impact, and how they could be overcome.
	References	Identify relevant references needed for a full understanding of the Action Plan (using appendix as appropriate).
Review, approval & distribution	Review/approval	Identify administrative handling procedures. Identify update schedule and procedure. Identify review and approval authority and procedures.
	Distribution	List the people to whom the Action Plan should go.

Some key characteristics of the Action Plan are:

- **Iterative document**: The Action Plan should be updated at various stages during the project life-cycle. Subsequent updates to the plan further define and refine the human parameters of the project and ensure identification and remediation of HF problems and issues in the project.
- **Living document**: The Action Plan is a living document. It should follow the progress of issue resolution during design, development, acquisition, pre-operational and implementation activities.
- **Document tailored to specific project requirements**: As each project is unique in its pace, cost, size, complexity, and human system interaction, the Action Plan will vary from project to project. It should be tailored to specific project requirements, procurement strategy and key decision points. As development occurs some system and HF recommendations may change. The planning steps and their sequence should be tailored as necessary.
- **Project management controls**: Deciding how the Project Manager will control the HF activities entails outlining the people, methods, and process that the Project Manager will employ to get the work done.
- **Products**: Determining the products of the HF efforts entails identifying what needs to be known and how that information will be acquired. The more specific these tasks/activities are, the sharper the HF focus will be. Identifying specifics will lead to increased efficiency of the developer/vendor HF effort and thus a higher-quality and less costly response.

APPENDIX 9: HF CASE REPORT OUTLINE

Section	Description
Executive Summary	Overall summary of the HF Case for the project.
Introduction	Includes a brief description of the background, objective, scope, and approach taken for the project which together outlines the context for the HF Case application within the Project lifecycle. Describe the rationale for undertaking an HF Case for the project
HF Case Achievements	Describes the achievements relevant for Stages 1 to 4 of the HF Case process for the project. Summarises the main outcomes and points to note from each stage. In particular this highlights: • What was done? • Who was involved? • What were the results?
HF Case Findings and conclusions	Lists the HF Issues, actions taken and findings with evidence. Lists the HF Case conclusions and recommendations for the project. May include a list of any actions needed for monitoring human performance post implementation of the project, and identification of any risks that will transfer to an operational area and who will take on responsibility for monitoring them.
HF Case Performance	This section focuses on the lessons learned and the benefits of using the HF Case process in the project. Can they be applied to other projects? How can this information best be disseminated for others to learn from? This may include a summary of the actual performance of the HF Case against the planned performance. ▪ **Performance against planned actions:** Were all planned actions achieved, to what degree? If some actions have not been achieved give details as to when the actions are anticipated to be achieved and who is responsible for their ongoing measurement and reporting of progress towards their achievement. ▪ **Performance against outputs:** Describe the actual performance of the HF Case in relation to the delivery of the outputs. Were all planned outputs delivered, to what degree? Were they all accepted? Did the quality of the outputs meet expectations? ▪ **Performance against schedule:** Describe the actual performance of the HF Case against the project schedule. ▪ **Performance against budget:** Describe the actual performance of the HF Case against the project / HF Case budget.

Closure activities	If required this section should cover the various activities required to close the HF Case. Where relevant, the sub-sections should include: ▪ **Issues management**: Identify any outstanding issues and who will continue to progress the issues. ▪ **Records management**: Identify the arrangements that have been put in place for the storage, security and backup of hard (paper) and soft (electronic) records and project documents. ▪ **Post-project responsibilities**: List any matters that are outstanding, what actions are required to address them and who is responsible. This should include such things as outputs yet to be achieved, outputs not yet delivered, maintenance of the outputs or other operational matters such as meeting future training requirements that are outstanding or have not been formally agreed prior to this stage. Where appropriate, if the HF Case is to be repeated at another time, identify how the report will be utilised as a tool for continuous improvement.
Appendices	This section is optional. Where necessary, appendices can be attached to provide any relevant supporting information, such as: ▪ A list of the stakeholders who participated in the HF Case. ▪ Any information to promote improvement of future HF Cases of a similar nature.

APPENDIX 10: HF CASE REVIEW REPORT OUTLINE

Section	Description
Executive summary	General summary of findings.
Background	Briefly describe the background to the project for the HF Case. Briefly describe each stage of the HF Case process for the project. Describe the main outcomes and points to note from each stage.
Summary of recommendations	List the recommendations that appear in this report.
HF Case performance	Summarise the actual performance of the HF Case against the planned performance. All projects vary to some extent from the original plan; these variations should be identified and the reasons for the variance described. Describe the actual performance of the HF Case in relation to the delivery of the outputs. • Were all planned outputs delivered, to what degree? • Were they all accepted? • Did the quality of the outputs meet expectations?
Lessons learned	What worked well? • Describe the project management and quality management processes that were perceived to be appropriate and/or effective for the HF Case, as reflected by the stakeholders and the project records/ documentation. What could be improved? • Describe the project management and quality management processes that were perceived to be inappropriate and/or ineffective for the HF Case, as reflected by the stakeholders and the project records/documentation.
Recommendations	List any recommendations to improve the HF Case process.
Appendices	Where necessary, appendices can be attached to provide any relevant supporting information, such as: ▪ A list of the stakeholders who participated in the HF Case review. ▪ Any information to promote improvement of future HF Cases of a similar nature.

CONTRIBUTORS[6]

NAME	ORGANISATION / STATE
HF CASE USER GROUP (EUROCONTROL MEMBERS)	
Barbarino Manfred	EUROCONTROL Headquarters, DAP/SSH
Dehn Doris	EUROCONTROL Headquarters, DAP/SSH
Drogoul Fabrice	EUROCONTROL EEC, Brétigny
Dusire Sophie	EUROCONTROL Headquarters, DAP/SSH
Mellett Úna	EUROCONTROL Headquarters, DAP/SSH
Nendick Michael	EUROCONTROL Headquarters, DAP/SSH
Nijhuis Herman	EUROCONTROL Headquarters, DAP/SSH
Rathje Hermann	EUROCONTROL Headquarters, DAP/SSH
EXTERNAL CONTRIBUTORS	
Heinz Alexander	DFS Deutsche Flugsicherung GmbH
DOCUMENT CONFIGURATION	
Hellinckx Carine *(external contractor)*	EUROCONTROL Headquarters, DAP/SSH

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