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Support Material for Human Factors Case application

EUROCONTROL

EUROPEAN ORGANISATION
FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

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Abstract

This document is a guidance material to apply the updated Human Factors (HF) Case process from EUROCONTROL. 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. Scoping and fact findings
2. Benefits and issues generation
3. Mitigation planning and benefits clarification
4. Human Factors requirements and validation needs
5. HF Case monitoring, management and control

Keywords

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

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EXECUTIVE SUMMARY

The HF Case is a process to systematically identify and treat HF issues and benefits during an ATM project throughout its lifecycle, from concept to decommissioning. The HF Case process is designed to be iterative and elements of it can be reapplied through each lifecycle phase as the project matures. It provides a comprehensive and integrated approach to ensure that the system can deliver the desired performance improvements and that the human performance contribution to these is optimised. The current HF Case is now in its third edition and has been validated and refined since its launch. This Edition 3 of the HF Case retains its emphasis as a simple, practical and effective approach to the consideration of Human Factors. The HF Case has five specific stages. Stages 1-4 provide the human factors integration process within a project. Stage 5 now provides integrated ongoing monitoring and validation throughout Stages 1-4 and provides a potential link to external processes such a Business, Safety Case or management process.

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INTRODUCTION

The HF Case is a practical process to address and manage Human Factors (HF) benefits and issues throughout an ATM project life-cycle. In terms of validation this is a crucial step to ensure that a concept or a system will deliver its intended (human) performance.

The Human Factors Case (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 high level application in European Air Traffic Management (EATM) projects within EUROCONTROL. Lessons learned using the HF Case in a number of EUROCONTROL projects led to the publication of a revised HF Case process known as Edition 2 in 2007. The major revision to Edition 2 was the introduction of five clearly defined stages instead of four, the introduction of a Human Performance Impacts Wheel, and various practical improvements to the process for integrating human factors into operational projects.

Since the publication of the HF Case Edition 2, HF cases have been conducted within various projects including:

- A-SMGCS (Advanced Surface Movement Guidance and Control System)
- CREDOS (Crosswind - Reduced Separations for Departure Operations)
- ERASMUS (En-Route Air Traffic Soft Management Ultimate System)
- FASTI (First ATC Support Tools Implementation)
- New ATCO Rostering System and Night Shift
- N-FDPS (New - Flight Data Processing System)
- TMA 2010+ (Trajectory Management Applications - Improved arrival procedures)
- UAS (Unmanned Aircraft Systems) ATM Integration

The experience gained from these applications and from feedback given by HF Case users indicated some areas for further improvement. Additional descriptive content on how non-HF specialists can practically apply the process, along with lessons learned have been incorporated as good practice guidance in this Edition 3 of the Human Factors Case process. Additionally, since the publication of Edition 2, the European Operational Concept Validation Methodology (E-OCVM)[1] has become a standard for European projects and has been adopted by SESAR (Single European Sky ATM Research). Adoption of the E-OCVM allows more formalised and systematic HF considerations within projects from the early design stage. This in turn will:

- Increase acceptance for an HF focus in projects,
- Promote the HF Case process as a one possible tool for HF integration in various projects,
- Collect and demonstrate HF evidence in preparation for e.g. potential future certification purposes.

[1] (see www.eurocontrol.int/valfor/public/standard_page/OCVMSupport.html)

A European Project named Cooperative Approach to Air Traffic Services (CAATS)[2] was created to support E-OCVM and to improve guidance for the definition of cases[3] as required by E-OCVM. CAATS II has produced easy to use guidance in a good practice guide that fits the needs of designers and managers in the early phases of projects in conjunction with the EUROCONTROL HF Case process. The outputs from CAATS and the core requirements from E-OCVM have been considered in this Edition 3 of the HF Case process.

This document provides support material for HF Case application into ATM projects and is consistent with E-OCVM aims and objectives. Edition 3 of the HF Case is a complete and practical document that describes, step by step:

- Who does what,
- What documents to use and to produce,
- How to produce these documents and when.

As a practical support document, it systematically gives guidance on best practices gathered from practical experience.

The HF Case is a 5 stage process that can be repeated as required according to the project concerned. Each stage has:

a) Goal
A short text gives the main goal and benefits to expect by or after performing the stage.

b) Inputs
A bulleted list of documents and/or expertise required is given and clearly referenced e.g. “Table X in this document”.

c) Process
The steps to follow sequentially are numbered from 1 to n and the associated concrete actions are described. Every definition or concept important for the work is defined and identified by the icon  . A summary of the actions to perform for each step is also accessible following the icon  . The templates used to collect information are also given and clearly referenced e.g. “Table Y in this document”. Whatever the stage, the last step is always a review of the quality of the process and of the outcome of the stage concerned. The aim is to learn lessons but also to decide to go to the next stage or to re-iterate this one. A set of questions are proposed to help review each stage.

d) Outputs
A bulleted list of documents produced is given and clearly referenced e.g. “Table Z” of this document

e) Summary
A 1-page workflow that links the concrete steps with the inputs and outputs (all referenced as in the text) is provided for each stage.

[2] (see www.eurocontrol.int/valfor/public/standard_page/OCVMSupport.html)
[3] case: Structured way to describe the impact of a given concept on a certain stakeholder group

STAGE 1:

FACT FINDINGS AND SCOPING

1.1 GOALS OF STAGE 1

The goals are to collect the necessary information to scope the project, and get an appropriate understanding to start considering human factors matter relevant to the project you are contributing to.

In ATM, a human factors investigation consists of addressing, at least, a complex set of interactions relating to the people, the procedures and the equipment (or technology) within an operational environment (Figure 1).

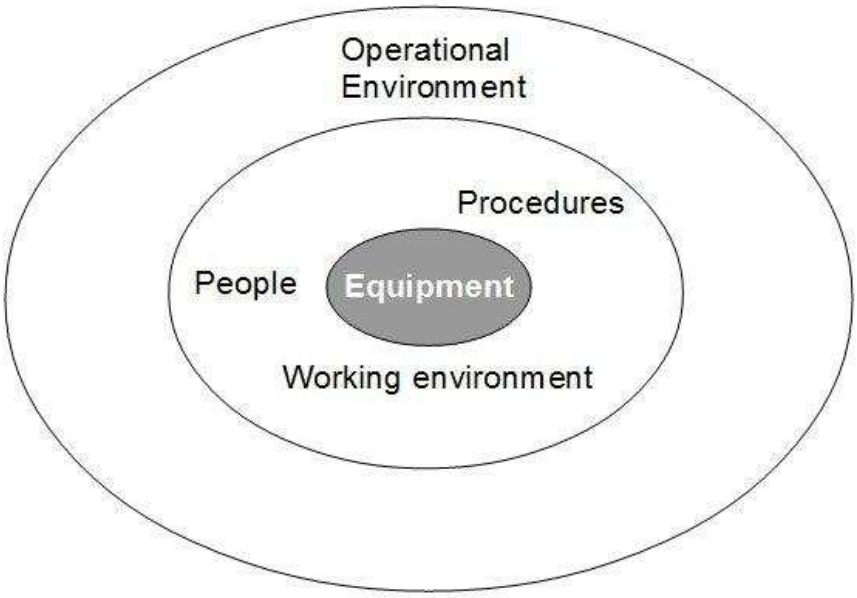

Figure 1: Interaction between components

The number of these interactions increases the complexity of your investigation. For this reason, identifying the "boundaries" of the project you contribute to is essential and must be done as early as possible. Following questions can serve as a guide:

- What is part of the project, i.e. equipment/procedures/people/etc. that will change due to the project?
- What is not part of the project i.e. that will not be impacted due to the project?
- What the interface(s) are between inside and outside of the project boundary, e.g. the adjacent system(s) that influences or is influenced by the project?

As this scoping is performed as early as possible in the project, all information might be not yet available in full detail. However your objective is primarily to find enough detail to understand who the actors are, how they should be affected and the part of the future system that may affect them, as well as what will be impacted in their working environment and/or tasks.

A 'system' includes people, procedures, equipment and organisation;

Scoping consists of outlining the project boundaries and the system(s) under consideration;

The project boundary must encompass all parts of the broader ATM system that will change due to the project, including the people, procedures, equipment, operational environment and parts of the organisation.

1.2 INPUTS FOR STAGE 1

Useful information to contribute to this stage may be found in a variety of documents. For example, the project operational concept document, the project plan, previous studies of this type, technical documents, procedures and regulations. Interviewing the project manager and/or relevant project team members is recommended as they should provide access to all the necessary information.

1.3 PROCESS IN STAGE 1

Stage 1 process encompasses 5 steps:

Step 1: Gather factual information on the project
Step 2: Identify and assess the change to be introduced
Step 3: Capture the performance expectation in terms of Key Performance Areas KPAs
Step 4: Initial human factors assessment
Step 5: Review

1.3.1 Step 1: Gather factual information on the project

All available documents should be reviewed and all relevant project team members should be interviewed to understand the project goal, scope and stakeholder expectations. This information will be also the basis to draw some assumptions on the concept.

The first step in Stage 1 is to gather the information required by Table 1 below and enter this information in the table:

Identification of the project and of the person in charge of the Human Factors Case: project name, start date, project leaders, contact details, etc…

Type of project, whether it concerns a tool for controllers, a new HMI, a change in the communication means, a change in staffing, etc.

High level **project objectives** to identify explicitly what is the aim of the project. The section "Project Background" is documented in this stage to reflect the "history" e.g. other projects that should be implemented first, or at the same time, to allow this one to run, etc.

System lifecycle stage, i.e. the current status of the project in terms of the stage within the lifecycle when starting your investigation, and the targeted lifecycle stage at the end of the

project. The concept lifecycle model (see E-OCVM[4]) provides successive stages against which we can assess maturity of an operational concept and therefore scale the Human Factors actions and expertise required. This information gives insight on the level of maturity of the concept and on the evolution targeted.

Related project. It is important to know if the project is new or if pre-existing projects where developed and tested before this one.

Key documentation to show the foundation of the work and to detail the documentation available or accessible at this time.

Key stakeholders name, role, needs and details. The aim here is to detail all relevant factual information for communication purpose.

Table 1 below proposes a paper-based template to collect all relevant information:

Table 1: Factual information template

<table>
<tr><td colspan="10">HUMAN FACTORS CASE- STAGE 1
FACTUAL INFORMATION</td></tr>
<tr><td colspan="10">Identification of the project</td></tr>
<tr><td colspan="2">Project Name</td><td colspan="4"></td><td colspan="2">Start Date</td><td colspan="2"></td></tr>
<tr><td colspan="2">Project Manager</td><td colspan="2"></td><td>Tel</td><td colspan="2"></td><td>E-mail</td><td colspan="2"></td></tr>
<tr><td colspan="2">Human Factors Case Coordinator</td><td colspan="2"></td><td>Tel</td><td colspan="2"></td><td>E-mail</td><td colspan="2"></td></tr>
<tr><td colspan="10">Type of project</td></tr>
<tr><td colspan="2">Traffic / Situation Display</td><td></td><td colspan="2">Controller Tool</td><td></td><td colspan="2">Communication</td><td></td><td>Navigation</td><td></td></tr>
<tr><td colspan="2">Surveillance</td><td></td><td colspan="3">System Control & Monitoring</td><td></td><td colspan="3">Other (state)</td></tr>
<tr><td colspan="10">Project objectives</td></tr>
<tr><td colspan="3">High-level Project Objectives</td><td colspan="7"></td></tr>
<tr><td colspan="3">Project Background</td><td colspan="7"></td></tr>
<tr><td colspan="10">System life-cycle stage</td></tr>
<tr><td></td><td colspan="3">Early Phases</td><td colspan="2">Middle Phases</td><td colspan="4">Late Phases</td></tr>
<tr><td></td><td>Initiation</td><td>Planning</td><td>Feasibility</td><td>Development</td><td>Pre-operational</td><td colspan="2">Implementation</td><td colspan="2">Local Implementation</td></tr>
<tr><td>Current</td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Target</td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="10">Related projects
(Similar Existing / Predecessor Systems – including Operational Experience and Data)</td></tr>
<tr><td colspan="10">Key documentation
(e.g. Operational Concept Description, Design Documentation, Operational procedures…)</td></tr>
</table>

[4] www.eurocontrol.int/valfor/public/standard_page/OCVMSupport.html)

HUMAN FACTORS CASE- STAGE 1 FACTUAL INFORMATION			
Key stakeholders ✓			
Name	**Role**	**needs**	**details**

During the Step 1, the following actions should be performed:

	Interview the project manager and relevant team members Collect available documents Fill in Table 1: Factual information template with required information

1.3.2 Step 2: Identify and assess the change to be introduced

This step aims to achieve a good understanding of the change(s) foreseen due to the project, and of the impact of the change(s) on the humans involved (the “actors”).

The following questions can serve as a guide:

- What is the change introduced i.e. what element of the system will change?
- What will change with the introduction of the proposed system compared to the existing ATM system?
- Who will be impacted (actors)?
- Are there changes in procedures, changes in the operational system, e.g. adding new tools and functionality?
- What are the potential HF impacts in term of e.g. working conditions, communications, workload, etc. that can already be identified?

In addition, an operational concept sometimes cannot be fully specified from the outset, it is necessary to make a number of explicit assumptions concerning the operational features and settings. Recording the project objectives and assumptions in an initial phase aims to ensure traceability and enable checking their validity in further development of the Human Factors Case. It is important to stress the importance of continually checking these assumptions. The following questions can serve as a guide:

- What problem is addressed?
- What are the most important driving forces for the intended project change?
- What elements will no monger be included in operations when the project is implemented?
- What new elements will be included?
- What would a vision of the future look like?

The second step in Stage 1 is to identify the information required by Table 2 below and enter this information in the table:

Baseline and proposed system comparison. List any system that will change with the implementation of the project and the difference between the planned situation and the baseline situation from a human point of view.

Impact on actor(s). List all actors that are potentially impacted by the change introduced by the project and detail their role as much as possible.

Project objectives and project assumptions. List the project objectives and assumptions to confront HF findings with them at all time. Track any changes.

Table 2: Change assessment template

HUMAN FACTORS CASE – STAGE 1 CHANGE ASSESSMENT			
Baseline and proposed system comparison			
Element that will change	Baseline ATM system	Proposed ATM system	Comments
Notes			
Impact on actor(s)			
Actor impacted by change *	Baseline ATM system	Proposed ATM system	Comments
Notes *Indicate E = Existing actor or N = New actor			
Project objectives and project assumptions statement			
Project objectives			
Project assumptions			

During the Step 2, the following actions should be performed:

Analyse the information collected in step 1;

Fill in the Table 2: Change assessment template with required information;

Re-iterate the step 1 if necessary

1.3.3 Step 3: Capture the performance expectation in terms of Key Performance Areas KPAs[5]

The aim is to capture the initial ideas on the project team's expectations in terms of what should be the future system performance following the implementation of their project. This information should be available in the project documentation. However if this is not the case, it is important to trigger this activity with the support of the project team and potentially with experts from the field. Each KPA is investigated to make an initial guess on where the impact could be and what they could be at least in term of positive impact or negative impact

The 11 KPAs including definitions from the ATM Master Plan[6] can be found in ANNEX 5. A list of Key Performance Indicators (KPIs) for each KPA derived from the ATM Master Plan is provided in

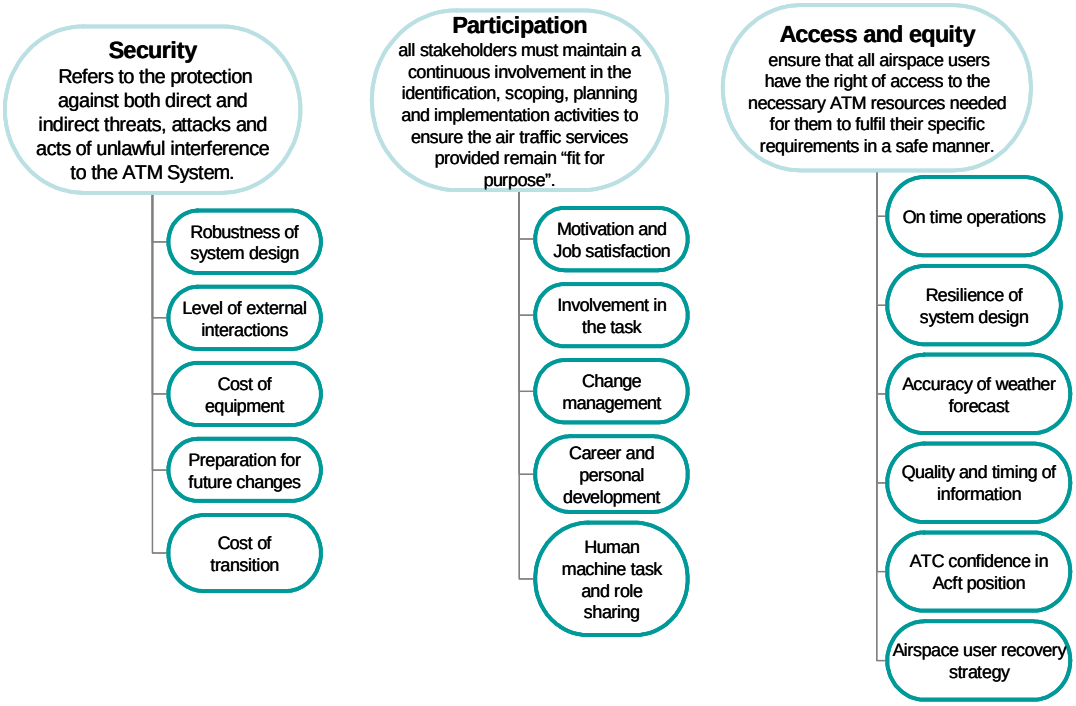

Figure 2 as a support. These indicators or KPIs represent the main performance elements that vary within that KPA.

[5] KPAs as described in this document relate to those key performance areas identified in the ATM Master Plan. You project may wish to use other key performance areas more aligned with company / project objectives.
[6] European Air Traffic Management Master Plan European Commission, Edition 1 - 30 March 2009

https://www.atmmasterplan.eu/

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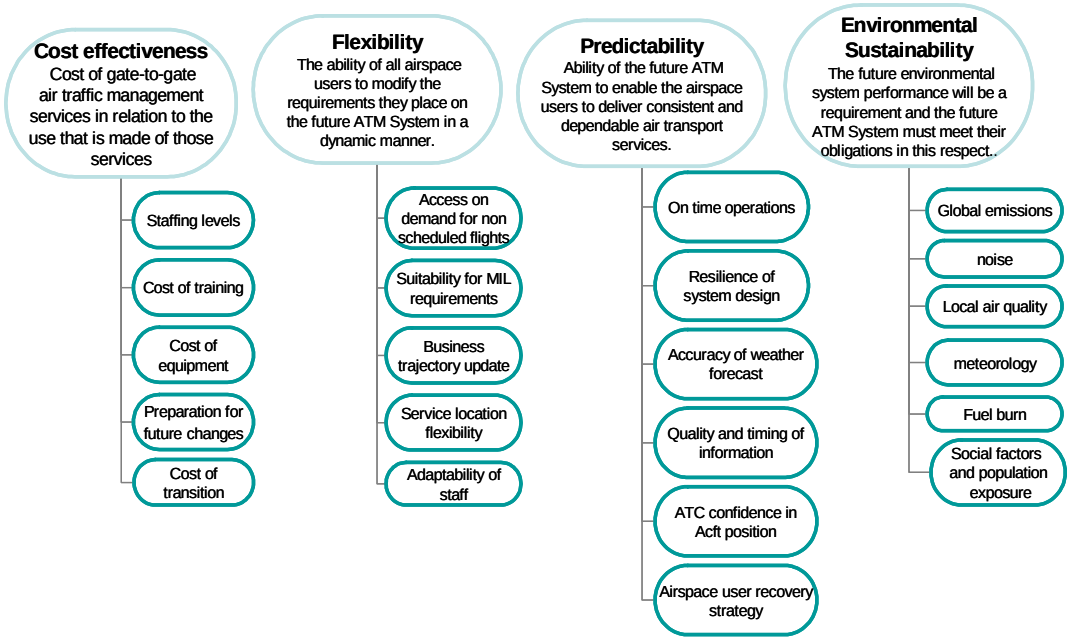
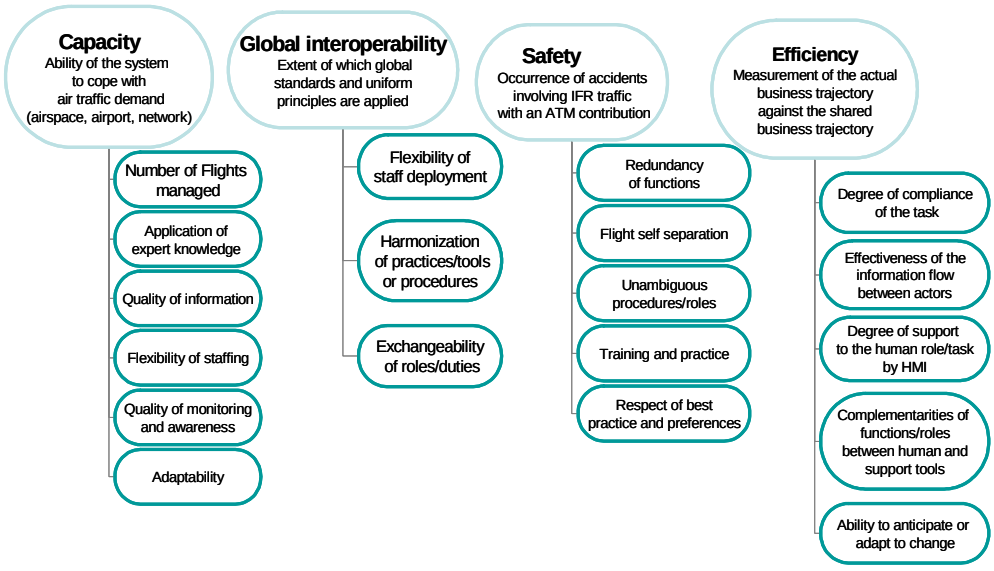

Cost effectiveness
Cost of gate-to-gate air traffic management services in relation to the use that is made of those services
Staffing levels
Cost of training
Cost of equipment
Preparation for future changes
Cost of transition
Flexibility
The ability of all airspace users to modify the requirements they place on the future ATM System in a dynamic manner.
Access on demand for non scheduled flights
Suitability for MIL requirements
Business trajectory update
Service location flexibility
Adaptability of staff
Predictability
Ability of the future ATM System to enable the airspace users to deliver consistent and dependable air transport services.
On time operations
Resilience of system design
Accuracy of weather forecast
Quality and timing of information
ATC confidence in Acft position
Airspace user recovery strategy
Environmental Sustainability
The future environmental system performance will be a requirement and the future ATM System must meet their obligations in this respect.
Global emissions
noise
Local air quality
meteorology
Fuel burn
Social factors and population exposure


Capacity
Ability of the system to cope with air traffic demand (airspace, airport, network)
Number of Flights managed
Application of expert knowledge
Quality of information
Flexibility of staffing
Quality of monitoring and awareness
Adaptability
Global interoperability
Extent of which global standards and uniform principles are applied
Flexibility of staff deployment
Harmonization of practices/tools or procedures
Exchangeability of roles/duties
Safety
Occurrence of accidents involving IFR traffic with an ATM contribution
Redundancy of functions
Flight self separation
Unambiguous procedures/roles
Training and practice
Respect of best practice and preferences
Efficiency
Measurement of the actual business trajectory against the shared business trajectory
Degree of compliance of the task
Effectiveness of the information flow between actors
Degree of support to the human role/task by HMI
Complementarities of functions/roles between human and support tools
Ability to anticipate or adapt to change

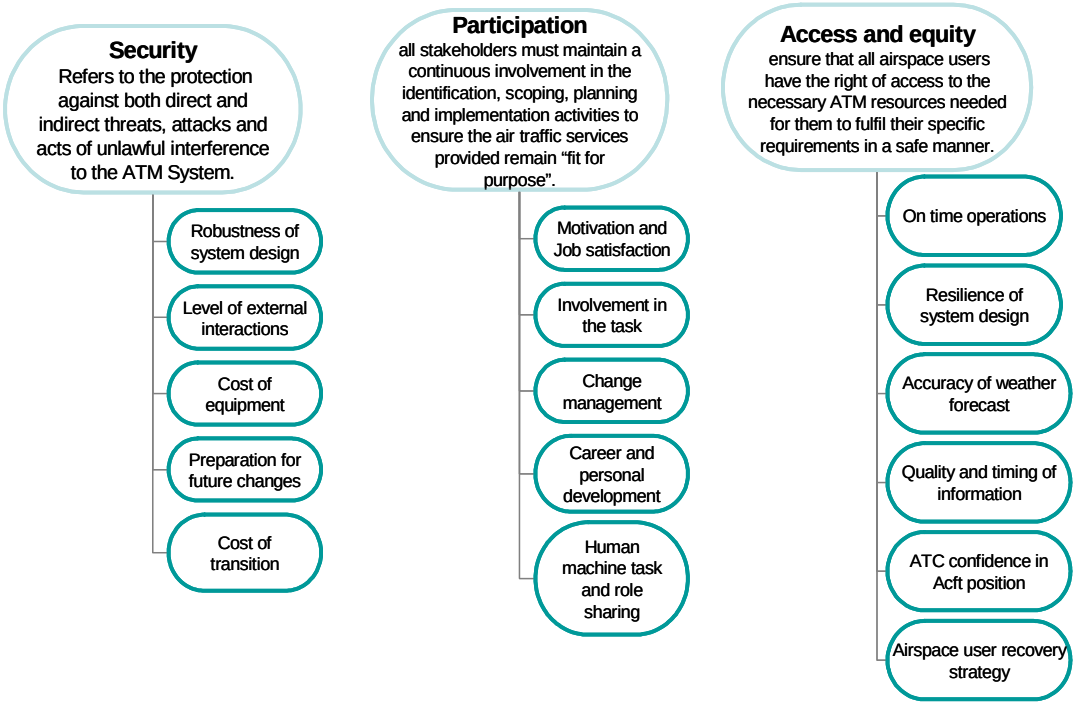


Figure 2: KPAs and main KPIs extracted from the ATM Master Plan

The third step in Stage 1 is to identify the positive/negative impact for KPA under consideration and enter this information in Table 3 below.

Table 3: Positive/negative impacts on KPA template on the example of Capacity

Capacity Ability of the system to cope with air traffic demand (airspace, airport, network) Number of flight managed Application of expert knowledge Quality of information Flexibility of staffing Quality of monitoring and awareness Adaptability	Potential positive impact
	Potential negative impact

During the Step 3, the following actions should be performed:

	Capture the future performance expectation of the project in term of KPA; If necessary, trigger this assessment with team members; Fill in Table 3 for all the relevant KPAs affected.

1.3.4 Step 4: Initial human factors assessment

At this step, the information collected so far should allow you to perform an initial human factors assessment and identify what are the key expectations and the key HF relevant aspects of the project. This step presents the first screening information to be presented to the project leader.

This step requires turning your mind from a “project perspective”, as in previous steps, towards an “HF perspective of the project” to identify and make explicit the change/impact for the human.

First, outline the system from an HF perspective; this will provide a representation / a framework of the system under scrutiny. The objective is to capture the main interactions (human-human, human-system) and main change(s) or impact(s) for the human, which will be further considered in later stage of the Human Factors Case process. Enter this information in Table 4.

Then perform initial human factors assessment. To do so, the Human Factors Case process uses the Human Factors Pie (see Figure 3).

Table 4: Initial human factors assessment template

Initial Human Factors Assessment	
Outline of system description	
(system representation, interactions..)	
Make an initial human factors assessment	
▪ Procedures, Roles and Responsibilities:	%
▪ Team and Communications:	%
▪ Human and System:	%
▪ Working Environment:	%
▪ Organisation and Staffing:	%
▪ Training and Development:	%
Recommendation for Stage 2 Human Factors Case	

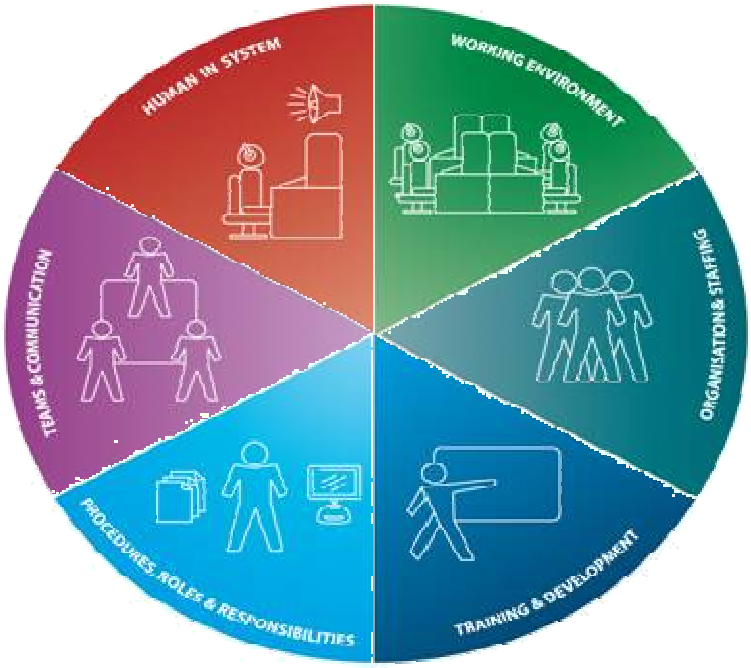


Figure 3: The Human Factors Pie

The six pie categories cover the broader Human Factors/ Human Resources topics, which underpin the focus on Human Performance. Determine with reference to the Human Factors Pie categories where the high level human factors impact (positive or negative) may stand for the project. This step is just a first high level view to give a priority of concern and to raise awareness of project team / concept development team by answering following questions:

- What performance aspect is being restricted or improved?
- What human factors areas will need to be addressed?

This initial assessment can be done though Pareto Vote[7] or by consensus decision according to the number of people involved in Stage 1.

In addition, any information or recommendation (e.g. “do not forget”) that could be of importance for the next Stage 2 of the Human Factors Case should be documented in the last section of Table 4.

1.3.5 Step 5: Review

At the end of each stage the quality of the process and of the outcome should be reviewed (as required by Stage 5 of the Human Factors Case process). Therefore;

1) Review the templates filled in so far to decide if the necessary information to run a Human Factors Case is available,

2) If the necessary information is provided, use Table 5: Guide questions to review in Stage 1 to critically review the information gathered and to determine if this is the right moment to go to Stage 2.

[7] Pareto voting is a technique for prioritising items. It is based on the Pareto principle: approximately 20 percent of the items to be considered by the group will be chosen by approximately 80 percent of the group's participants.

It is recommended that a review meeting is held with the project manager and team members to This meeting is important to maintain commitment and ‘buy-in’ and set the scene for the next stage.

Table 5: Guide questions to review in Stage 1

		Comments
Has the project manager provided all relevant information and background to the project?	Yes / No	
Have other sources of background information been exhausted?	Yes / No	
Are project objectives, assumptions clearly stated?	Yes / No	
Are changes implied by the project sufficiently assessed and captured?	Yes / No	
Have actors and stakeholders been identified with their role and expectation understood?	Yes / No	

1.4 OUTPUTS FROM STAGE 1

- A collection of reference information about the change to assess (Table 1)
- A list of changes for actors -and of procedure, equipment, etc- that will be used to trigger issues and benefits identification in the next stage (Table 2)
- Clear performance expectation(s) according to the project goals (Table 3)
- An initial human factors assessment for the project made with reference to the Human Factors Pie (Table 4)

1.5 SUMMARY OF STAGE 1

Following figure summarises the workflow in Stage 1:

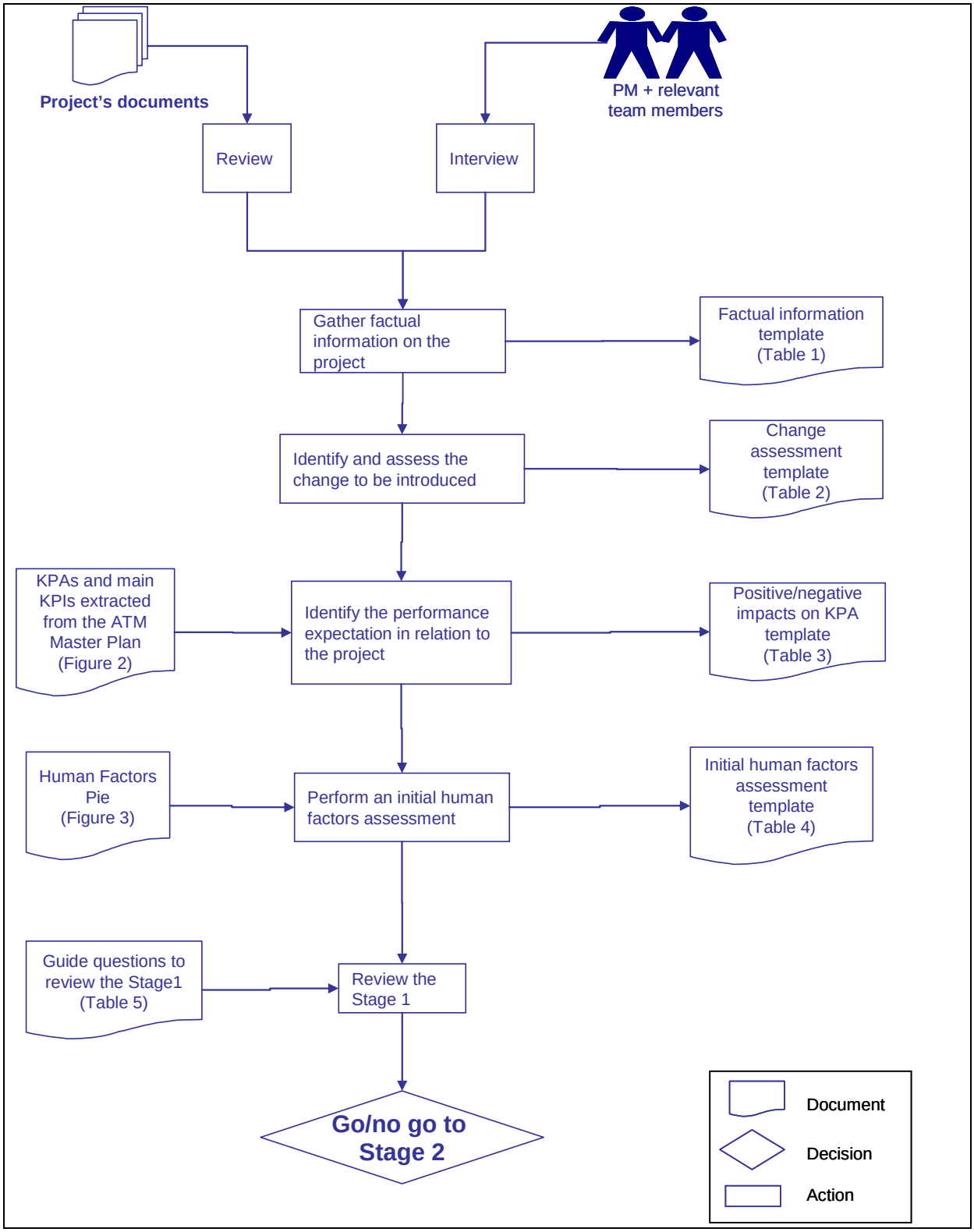


Figure 4: Stage 1 workflow

1.6 NOTE RELEVANT FOR PROJECTS USING THE E-OCVM LIFECYCLE MODEL

If you are using the E-OCVM lifecycle model the Human Factors Case can be applied at the following stages in development.

The scoping is initiated in V0 and updated or changed based on information or changes during the concept development (from V1 to V3). What are important at this stage are the traceability of information (as a basis for assumption) and the exhaustiveness of consideration to build good foundation for the Human Factors Case process iterations.

As the project mature and information available become more precise (and concept more detailed) the tasks of Stage 1 reflect more in depth investigation. This is in line with the E-OCVM approach as described in Table 6.

Table 6: Typical tasks per phase (E-OCVM) linked with Stage 1 of the HF Case

Concept development Lifecycle phase	Typical tasks
V1 (Scope)	Establish the broad human implications of the proposed concept. Ensure initial project goals and scope are appropriate for the people-related issues associated with the concept. Scope the proposed change, and determine areas it may affect
V2 (Feasibility) V3 (Pre-industrial Development and Integration)	Determining the boundary of the system under study has been completed and enriched as it may be larger than suggested by a narrow focus on the specific change. Provide information about the potential performance of overall ATM system.
V4 (Industrialisation) V5 (Deployment) V6 (Operations)	Gather realistic human performance information. Establish human implications of the chosen concept and associated technology options.

STAGE 2:

BENEFITS AND ISSUES GENERATION

2.1 GOALS OF STAGE 2

The goals of Stage 2 of the Human Factors Case process are to:

- Identify the project specific human factors benefits and issues,
- Identify their potential impact, prioritise them, and
- Propose idea(s) for mitigation.

Human factors benefits are potentially positive human factors consequences of the new concept/system/tool that should to be verified and/or validated.

Human factors issues are potentially negative human factors consequences of the new concept/system/tool that need further investigation or mitigation.

2.2 INPUTS FOR STAGE 2

The principal inputs to Stage 2 are:

- Change Assessment template filled in Stage 1 (Table 2),
- Positive/negative impacts on KPAs template filled in Stage 1 (Table 3),
- Initial Human Factors Assessment template filled in Stage 1 (Table 4),
- Human Factors Pie used in Stage 1,
- Subject matter experts (SMEs) views and experience.

2.3 PROCESS IN STAGE 2

Stage 2 encompasses 6 Steps:

Step 1: Set the scene
Step 2: Identify operational situations that generate issues and benefits
Step 3: Perform an impact analysis for each benefit and issue related to the project
Step 4: Capture potential issue mitigation ideas
Step 5: Prioritise the identified issues and benefits
Step 6: Review

2.3.1 Step 1: Set the scene

Setting the scene consists in deciding on the most appropriate method you will choose to generate the benefits and issues related to the project, which are dependent on the availability of SMEs, the time given and the project's complexity.
Two methods are suggested:

1) A group workshop,
2) Expert interview,

2.3.1.1 Group workshop

The workshop approach utilises the expertise of SMEs involved in different areas of the project (e.g. operational staff, maintenance staff, human factors expert, management representative, project manager). This helps to identify as many human factors benefits and issues as possible. The technique most commonly used is a structured brainstorm, but other techniques are possible. As a side effect this stimulates commitment and 'buy-in' to resolve human factors issues by other project team members. Depending on the complexity of the project and the number of human factors benefits and issues a workshop will take between 2 and 4 working days. The participants will usually have to be present during the entire workshop.

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. The ANNEX 1 provides additional guidelines for a group workshop.

2.3.1.2 Expert interviews

A second viable option is to interview key SMEs either individually or in pairs. The interviews are conducted progressively i.e. focusing on different elements of the Human Factors 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. More information on using interviews for the benefits and issues analysis is provided in ANNEX 2.

Table 7 provides guidance on choosing the most appropriate approach, knowing that a combination of both can also be planned.

Table 7: Issues and benefits generation –criteria for choosing the methodology

Group workshops

- *Large scale project with many interfaces between departments, groups, other cases, 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

- *The project is still rather immature and the scope has not been sufficiently defined.*
- *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.*

During Step 1, the following actions should be performed:

Decide on the most appropriate methodology/ies.

Organise the sessions.

2.3.2 Step 2: Identify operational situations that generate issues and benefits for the actors

From Stage 1 we have a list of changes both at the actors' level and at the system level (see Table 2: Change assessment template, the table that you filled in Stage 1). This list of change is the starting point of the generation of a kind of scenario, the so called 'operational situation'.

An operational situation is a description by subject matter experts of a relevant situation in their activities which they foresee a potential for an emerging problem or opportunity.

From the list of changes to be introduced through the project, the experts should recall from experience or anticipate combination of events or context depicting a potential impact they foresee for any of the actors. This impact can be either positive (in that case the change will result in a benefit) or negative (in that case the change will result in a concern or an issue). These benefits and issues will be further addressed in Step 3; the objective in this Step 2 is to be systematic and comprehensive in their generation and to link them with realistic operational situations. One of the most systematic ways of doing this is to use a list of idea-generating words, primarily adjectives, to create "what if?" scenarios in facilitated group discussions. As many details as possible should be added to each benefit and issue generated (contextual factors, assumptions, etc...).

In parallel, the Human Factors Pie[8] should be used to exhaust potential areas where human performance is impacted thereby ensuring completeness in the generation of issues and benefits. The Pie identifies six broad slices (categories), each one being successively subdivided into greater degrees of detail. **Error! Reference source not found.** shows the second level of decomposition; the complete breakdown can be found in ANNEX 3. The complete breakdown is a fairly comprehensive list of human performance related areas that the benefits and issues are associated with. By following the sub-divisions of the Pie, the benefits and issues in relation to the project are generated in Steps in which the level of detail for each is gradually improving. When the entire list has been considered, the risk of missing benefits and/or issues is significantly reduced.

[8] The Human Factors Pie is described in Stage 1.

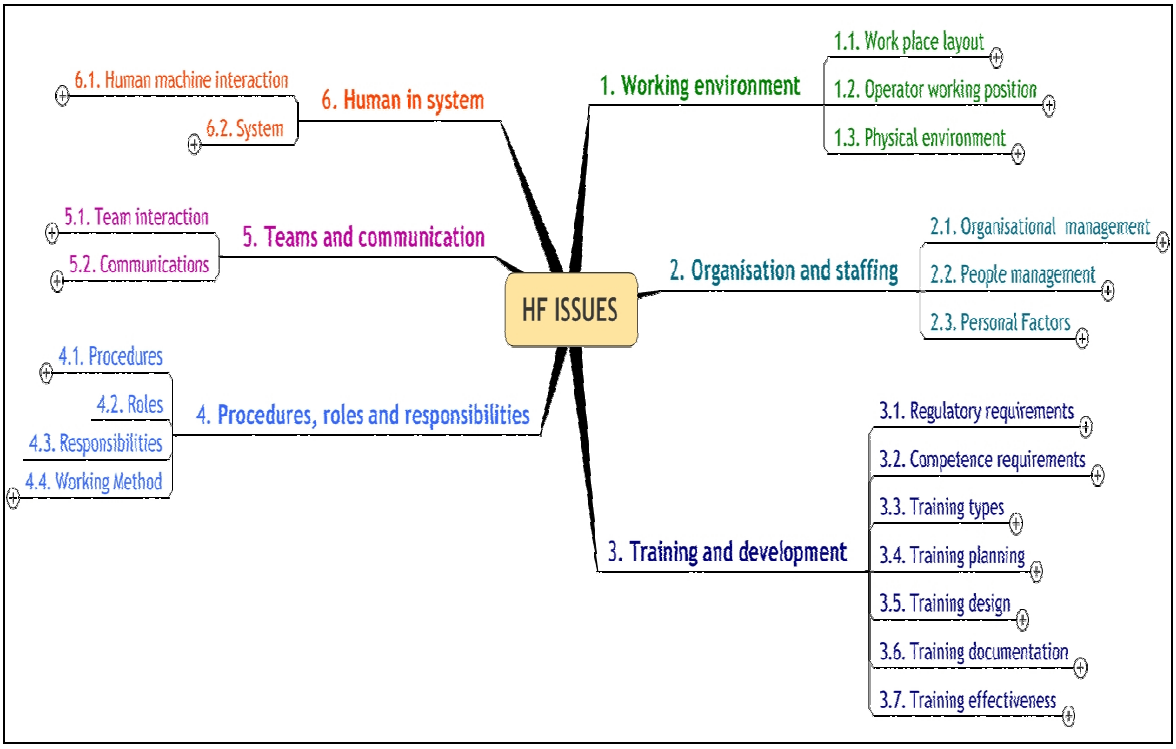


Figure 5: Sub-division of the Human Factors Pie

Figure 6 below depicts the process to follow in this Step 2.

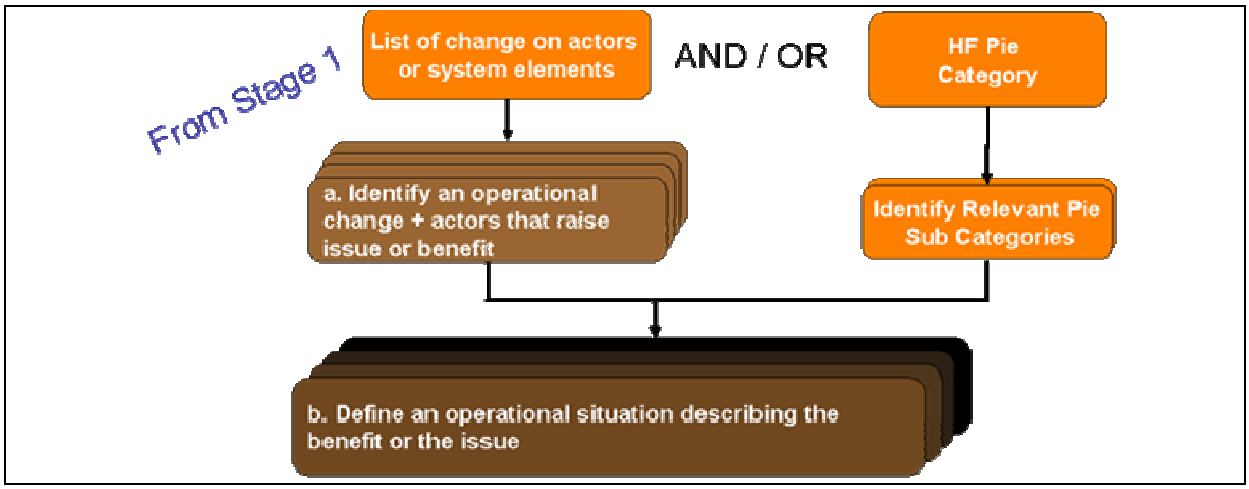


Figure 6: Stage 2, Step 2 process

During Step 2, the following actions should be performed:

For any change identified in Stage 1, list the emergent issues and benefits associated with an operational situation. The Human Factors Pie is used to ensure that all possible areas are considered.

Enter this information in the first column of Table 8. The following columns will be addressed in next steps.

Table 8: Issue and benefit template

ISSUES									
Operational Situation (issue)	**Impact in terms of human performance**	**Impact in terms of overall system performance**	**Idea for potential Mitigation**	**Severity of Impact Score (SOIS) Score 1 - 5**	**Issue Likelihood Score (ILS) Score 1 - 5**	**Overall Issues Score (OIS) = SOIS+ILS**	***Human factors expert review***	***Further human factors investigation***	**Proposed mitigation**
Issue ***Ref number 1 Technology to observe input time not available.***				***4***	***2***	***6***			***Mitigation ref number 1 Description***
Issue ***Ref number # The technology leads to an increase in input time.***				***4***	***2***	***6***			***Mitigation ref number # Description***
BENEFITS									
Operational Situation (Benefit)	**Impact in terms of human performance**	**Impact in terms of project performance**	**Intentionally blank**	**Positive Benefits Impact Score (PBIB) Score 1 - 5**	**Benefit Likelihood Score (BLS) Score 1 - 5**	**Overall Benefits Score (OBS) =PBIB+BLS**	**Intentionally blank**	**Intentionally blank**	**Intentionally blank**
Benefit ***Ref number 1***				***5***	***2***	***7***			
Benefit ***Ref number #***				***4***	***2***	***6***			

You must now add additional information to fill in the rest of Table 8.

2.3.3 Step 3: Perform an impact analysis for each benefit and issue related to the project

The aim is to get a better understanding about why something is a human factors benefit or an issue and in which situation the benefit or issue will have most impact. For each of the operational situations identified in Step 2, an evaluation should be made of the Impact on the human performance and the Impact on the overall system performance.

2.3.3.1 Impact on the human performance

Based on logical reasoning and their practical experience, the SMEs should detail and depict, e.g. using graphical representations, the mechanism of how an issue/benefit impacts on the performance of any of the actors involved. This impact can be either positive or negative.

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 Human Factors Case is concerned with the ability of humans to meet the system's performance standards, including reliability and maintainability, under the conditions in which the system will be employed.

Figure 7 proposes a list of aspects to be considered as potential impacts on the human performance (Definitions can be found in ANNEX 4)

Figure 7: Impacts on Human performance

The questions to answer in Step 3 are:

- Does the issue X (negatively) impact the (future) actor's acceptance and trust? / health and comfort? / errors, slips, lapses and mistakes? / etc.?
- Does the benefit Y (positively) impact workload, wellbeing, safety operations, capacity, etc.
- If yes, how e.g. more? less? earlier? later? modified? Etc.
- How does it work? What is the mechanism behind this impact?

2.3.3.2 Impact on the overall system performance

Having determined the way in which the benefit will impact human performance it is now necessary to consider how it will impact the socio technical system performance. This is based on the assumption that a change in the human performance will lead to a change in global system performance. This step confirms that the change will influence system performance (and related KPAs). The KPA impacted should correspond with a KPA included in the scope (see Table 3: Positive/negative impacts on KPA template on the example of Capacity, you saw in Stage 1). Potentially new KPAs impacted require introduction in a revised scope.

The questions to answer are:

- Does the change in the human performance identified in previous section impact the overall system performance?
- If yes to the question above, how does it impact?
- How does it work? What is the mechanism behind it?

During Step 3, the following actions should also be performed:

Evaluate for each impact (positive or negative) on the potential impact on the human and system performance.

Enter this information in the second and third columns of Table 8.

Note: Steps 2 and 3 can also be performed together by systematically estimating the impact on the human and on the system as soon as an issue or a benefit is generated in Step 2.

The next step is to examine each of the issues to determine potential mitigations.

2.3.4 Step 4: Capture potential issue mitigation ideas

During the generation of the human related issues in Step 2, the SMEs often generate potential ideas to mitigate these issues. This information should be captured. The aim of Step 4 is to ensure an exhaustive review of all issues identified and a systematic generation of mitigation(s) by the SMEs based on their operational and practical experience.

The questions to answer are:

- What could mitigate the issue identified?
- Would it be?
  - A technical solution?
  - A working method?
  - A procedure?
  - A fallback system?
  - A specific training?
  - A change of staffing?
  - A combination of the above?

These proposals for mitigation are essential to the Human Factors Case process and will be a key input to Stage 3. Any additional comments or considerations should also be noted down.

During Step 4, the following actions should also be performed:

Generate potential mitigations for each issue and enter this in column 4 of Table 8

The next step is to prioritise the issues and benefits for further investigation.

2.3.5 Step 5: Prioritise the identified issues and benefits

This Step 5 is to prioritise the benefits, and the issues that require attention first; focusing of the more critical issues initially leaving the less critical issues to be considered at a later stage.

- Examine each issue and assign a Severity of Impact Score (SOIS, 1-5). This is the degree to which the issue will impact negatively on the project performance without the mitigations in place. Next assign the Issue Likelihood Score (ILS, 1-5). This is the likelihood that this issue will occur, without mitigations in place. The Overall Issues Score (OIS) is determined by adding the SOIS and the ILS together. The higher the number, the higher the priority of this issue.
- Examine each benefit and assign a Positive Benefits Impact Score (PBIB, 1-5) this is the degree to which the benefit will impact positively on the future system performance. Next assign the Benefit Likelihood Score (BLS, 1-5). This is the likelihood that this human factors benefit will occur as a result of the system change. The Overall Benefits Score (OBS, 1-5) is determined by adding the PBIB and the BIS together. The higher the number, the greater the human factors benefits that will be achieved from the system change or project.

During Step 5, the following actions should also be performed:

Prioritise the issues and benefits that have been identified according to SMEs evaluate and assign numerical values to this evaluation and enter in columns 5, 6 and 7 of Table 8.

The highest scoring values can be used as a basis for prioritising issues and benefits that may require further investigation in Stage 3.

2.3.6 Step 6: Review

At the end of each stage the quality of the process and of the outcome should be reviewed (as required by Stage 5 of the Human Factors Case process).

It is recommended that a review meeting is held with the project manager and team members to critically review the information gathered and to decide whether to continue with the next stage of the human factors case process. This meeting is important to maintain commitment and 'buy-in' and set the scene for the next stage.

Use Table 9 below to determine if this is the right moment to go to Stage 3.

Table 9: Guide questions to review Stage 2

		Comments
Have issues been collected to an extent that is considered exhaustive enough?	Yes / No	
Were the right SMEs available for human performance benefit and issue generation?;	Yes / No	
Was a proper prioritisation from a human performance point of view achieved?	Yes / No	
Have all impacts been sufficiently assessed?	Yes / No	
Were all changes and human factors areas sufficiently considered?	Yes / No	
Are you confident about the comprehensiveness of your benefits and issues list?	Yes / No	
Have assumption and scope from Stage 1 been tested?	Yes / No	
Is there a need for re-iteration of Stage 1?	Yes / No	
Were any interactions/overlap with other processes and cases identified and should they be informed about particular benefits/issues (e.g. safety issues to a Safety Case, Business Case)?	Yes / No	

During Step 6, following actions should be performed

Review the quality and the outputs of Stage 2

Document any information potentially useful for Stage 3

2.4 OUTPUT FROM STAGE 2

The main output is Table 8: Issue and benefit template, which gives:

- A list of prioritized human factors issues and benefits (in the form of a detailed operational situation description with impact on human and on system performance)
- A list of ideas for potential issue mitigation

2.5 SUMMARY OF STAGE 2

The following figure summarises the workflow in Stage 2:

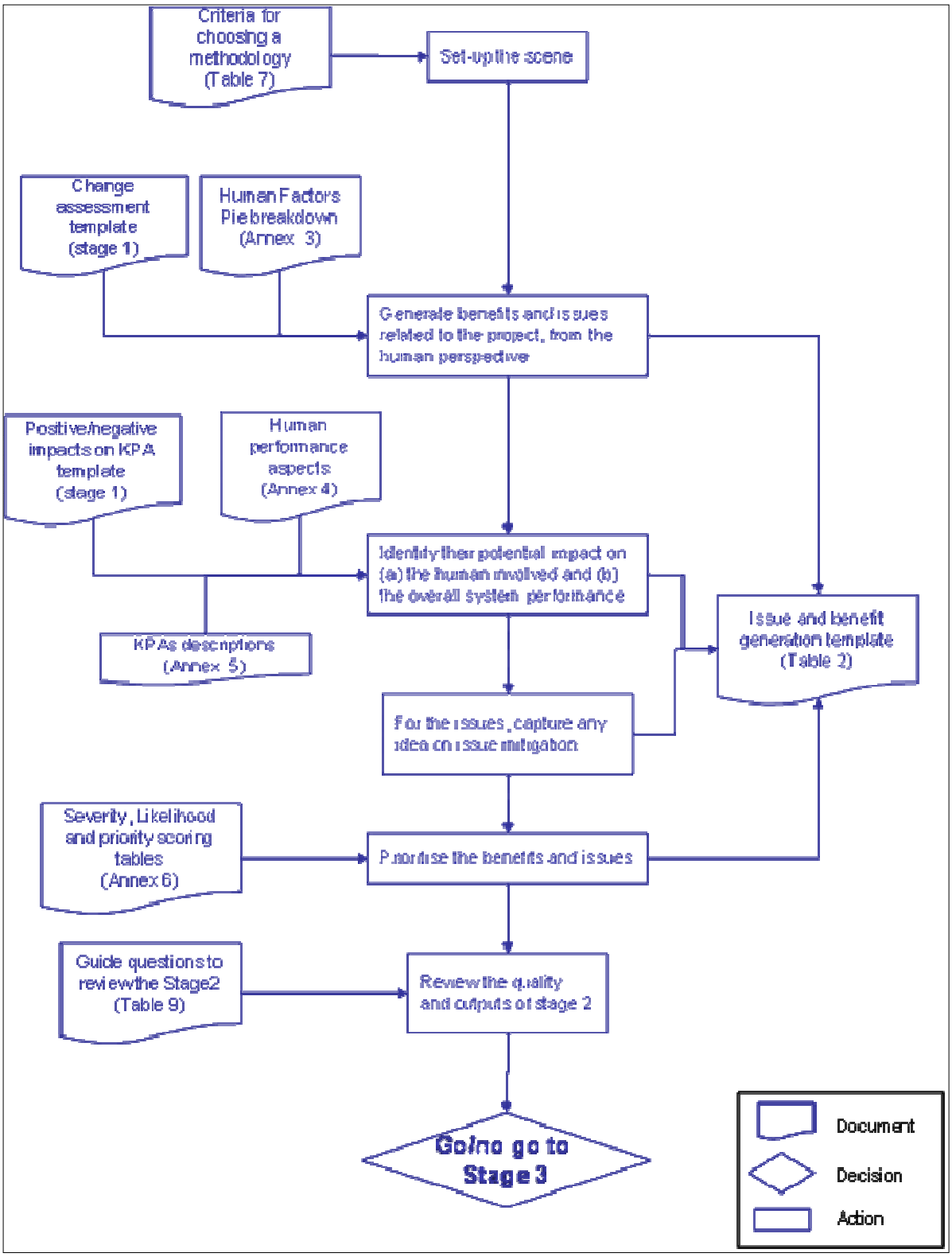


Figure 8: Stage 2 workflow

2.6 NOTE RELEVANT FOR PROJECTS USING THE E-OCVM LIFECYCLE MODEL

The Human Factors Case Stage 2 aims at identifying and analysing key emerging human factors/performance issues that are relevant for early phases of design when the operational concept is not mature enough to have a good representation of the overall system and when conducting a more systematic and formal assessment is not possible.

Once concept mature in later design phases the Human Factors Case Stage 2 check if some issues are still present and the extend of impact of benefits.

The number of human factors/performance issues/benefits raised, and the depth of analysis following, will depend partly on which phase the project is at within the project life-cycle. It is important not to overlook pertinent human factors 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.

STAGE 3:

MITIGATION PLANNING AND BENEFITS CLARIFICATION

3.1 GOAL OF STAGE 3

The main goal of Stage 3 is to refine and finalise the information generated in Stage 2 by bringing together the list of issues, mitigations and benefits with existing expertise, experience and knowledge of Human Factors matters. While elaborating and refining the most important issues and benefits, generated during Stage 2, some human factors investigations will be required; this will also rationalise and validate the information gathered.

Note: the effort related to Stage 3 is very variable and highly dependant on the output of Stage 2.

3.2 INPUT FOR STAGE 3

The inputs for Stage 3 correspond to the information produced at the end of Stage 2:

- List of prioritized human factors issues and benefits (in the form of detailed operational situation descriptions with impacts on human and on system performance)
- List of ideas for potential issue mitigation
- Human Factors expertise and knowledge

3.3 PROCESS STEPS IN STAGE 3

Stage 3 consists of 4 Steps:

Step 1: Review the information generated in Stage 2
Step 2: Get agreement, plan & perform the required human factors investigations and consolidate the information accordingly
Step 3: Rank the final list of mitigations
Step 4: Review

3.3.1 Step 1: Review the information generated in Stage 2

The information gathered during Stage 2 requires further examination in Stage 3. This information should be reviewed from a human factors expert point of view to ensure the information is clear, complete, assumptions are explicit, benefits are clear and the issues and their associated mitigations are feasible and well justified. This requires comprehensive human factors and ATM knowledge. This review should describe any further human factors investigations in order to get more complete information. The human factors expert review comments are entered in column 8 of Table 8. Further human factors investigations should be entered in column 9 of Table 8. Where a mitigation, from column 4, is modified in the light

of the review or further analysis by the human factors expert, this modified mitigation should be entered in column 10 of Table 8.

In preparing the entries to columns 8-10 consideration should be given to:

- The problem being addressed and the objective(s) of the investigation,
- The links among different issues and their mitigations. It may that several issues and mitigations can be addressed with a common investigation.
- Any links between the issues and their mitigations that might affect a benefit e.g. a mitigation that addresses an issue related to a decrease in safety may, as a side affect, also influence productivity.
- Any assumptions should be stated explicitly and checked with the project manager.

It is important in this step to have a precise understanding of the benefits / issues so that their impacts and their relative importance are understood. Furthermore, the next stages of the Human Factors Case are highly dependent on the quality and reliability of this review. Therefore good traceability between the information gathered in Stage 2 and the final information generated in Stage 3 is essential and will be the root for a successful Human Factors Case.

During the Step 1, following actions should be performed:

This human factors expert review comments are entered in column 8 of Table 8.

Further human factors investigations should be entered in column 9 of Table 8.

Where a mitigation, from column 4, is modified in the light of the review or further analysis by the human factors expert this modified mitigation should be entered in column 10 of Table 8.

3.3.2 Step 2: Get agreement, plan & perform the required human factors investigations and consolidate the information accordingly

3.3.2.1 Firstly get agreement.

The need for human factors investigation has been documented in Table 8. The next action is to present it to the PM and to get common agreement. It is important to maintain a good awareness of the project manager on the human factors work and to ensure that human factors plans fit with the project planning, constraints, resources and scope.

3.3.2.2 Then, develop the human factors investigation plan.

The investigations associated to this step depends on the maturity of the project, and can be e.g. a literature review; mock up; field observation; interviews; questionnaires; fast time simulation; lab experiment; prototyping; real time simulation; on site testing; etc… According to the type of investigation, the investigation plan could be more or less meticulous; however,

it should be always defined and documented into a separate document referred as the “human factors investigation document”. This should consist of:

- The objectives (“why”),
- The hypothesis (“what to expect”),
- The participants (“who”),
- The method, variables, conditions and indicators (“what”),
- The setting (“where”),
- The experimental design such as the equipment and procedures (“how”),
- The format of the results and conclusions.

This plan is **not just** a “nice to have” and it should be carefully built up because (a) these investigations require time and effort (e.g. from operational people) that should be planned and agreed with the project manager and (b) results that come too late will be of little or no benefit for the project.

3.3.2.3 Perform, analyse outcome of the investigation(s)

Whatever the type of investigation, this means it is necessary to:

- Conduct the investigation(s),
- Collect, analyse the data and draw conclusion(s),
- Document the “Human Factors investigations document” appropriately,
- Trace these conclusions to the item operational situation (benefits, issues and their associated mitigations) triggering this investigation to ensure the investigation has addressed the benefit of issue raised (traceability),
- Assimilate the output of the human factors investigations into a consolidated report (Table 8).

During the Step 2, following actions should be performed:

Get agreement on the human factors investigations to be performed

Develop the relevant experimental plan(s)

Perform the investigation, analyse the data, draw conclusions

Document the investigations into a "human factors investigation document" aand assimilate the output into a consolidated report (Table 8) that itemises the issues and their associated mitigations (Column 4) or revised mitigations (Column 10).

At the end of this Step 2, you will have a report (completed Table 8) of a complete, realistic and justified set of benefits, issues and associated and revised mitigations that should be implemented by the project.

Note: Step 2 must be repeated for each issue until you get a trustworthy quality of the revised mitigations.

3.3.3 Step 3: Rank the final list of mitigations

Each mitigation action must be evaluated for its importance. This is done by checking the importance of the issue to which it relates (the Overall Issue Score, column 7) If the overall issue score is high relative to other issues then the mitigation is ranked highly. The easiest way is to assign a mitigation score as the same as the Overall Issue Score then Rank these. Where the highest Overall Issue Score receives a rank of 1, the second highest a rank if two and so on.

During the Step 3, following actions should be performed:

Rank the mitigations according to the issue addressed.

This ranking will give a clear indication of the mitigations that must be implemented to those of lesser importance. This will support the decision makers in deciding the order in which to tackle these.

Whilst the ranking gives an idea of which mitigations should be tackled first. All should be carefully examined to determine if the ranking process makes sense for the project. For example a mitigation that requires a major redesign of the project may be ranked first but it may not be possible if budget has been exhausted or time is short. A compromise may need to be found. However, this is not an issue for the Human Factors Case, rather for the project manager.

Additionally, a complementary ranking could be discussed with the project manager, as the implementation of those mitigations will require effort from the project team and could have an effect on the project, e.g.:

- Design impact, according to the amount of re-design is required by a mitigation,
- Effort impact, according to the effort/time required to implement a mitigation,

- Impact on users acceptance, if the mitigation aims at reducing a foreseen resistance,
- Impact on O-date, if the project may have to be delayed.

A project has its own level of acceptability regarding these impacts. This should be addressed with the project manager e.g. delaying the O-date is unacceptable but increasing the effort is acceptable, or increasing the effort is unacceptable whilst delaying the O-date is acceptable, etc.

During the Step 3, following actions should be performed:

Rank the mitigations according to the issue addressed.

Enter this information in Table 8

3.3.4 Step 4: Review

At the end of each Stage the quality of the process and of the outcome should be reviewed (as required by Stage 5 of the Human Factors Case process).

Besides the quality of the output, the quality of the way you managed Stage 3 itself should also be carefully scrutinised so to identify any lesson learnt to improve your next Human Factors Case.

Re-iterate Stage 3 as long as the information required is not there.

Use the Table 10 below to determine if this is the right moment to go to Stage 4.

Table 10: Guide questions to review Stage 3

Are all issues and associated mitigations and benefits clear and documented as required?	Yes/no	Comments
Were the investigations you identified practical and realistic i.e. which could be achieved in a reasonable timeframe?		
Was there appropriate delegation of responsibility for investigation?		
Were the additional resources and time for the investigation properly identified?		
Were the appropriate experts to help you in your investigations (have the right knowledge/are available) properly identified?		
Were investigations properly documented and stored i.e. accessible whenever needed?		
Are mitigations clearly linked with issues and rationalised?		
are mitigations realistic and fitting with the project possibilities?		
Was the communication appropriate with the project e.g. with project manager?		

During the Step 4, following actions should be performed:

Review the information generated in Stage 3 regarding clarity, completeness and justification

Review the completeness and traceability of the documentation related to any investigation performed

Identify the lessons learnt e.g. from your own work, and document it for later Human Factors Cases

3.4 OUTPUT FROM STAGE 3

The main output is the Table 8: Issue and benefit template finalised, with:

- A list of benefits for the human (that have been reviewed by a human factors expert) if the project is implemented, which are clearly described. This will be an input for identifying the validation needs in Stage 4,
- A list of issues and associated ranked mitigations, which are clearly described and linked with relevant issue. This will be an input for developing requirements in Stage 4,
- Additional output is the HF investigations performed, which are documented into the “Human Factors investigations document”.

3.5 SUMMARY OF STAGE 3

Following figure summarises the workflow in Stage 3:

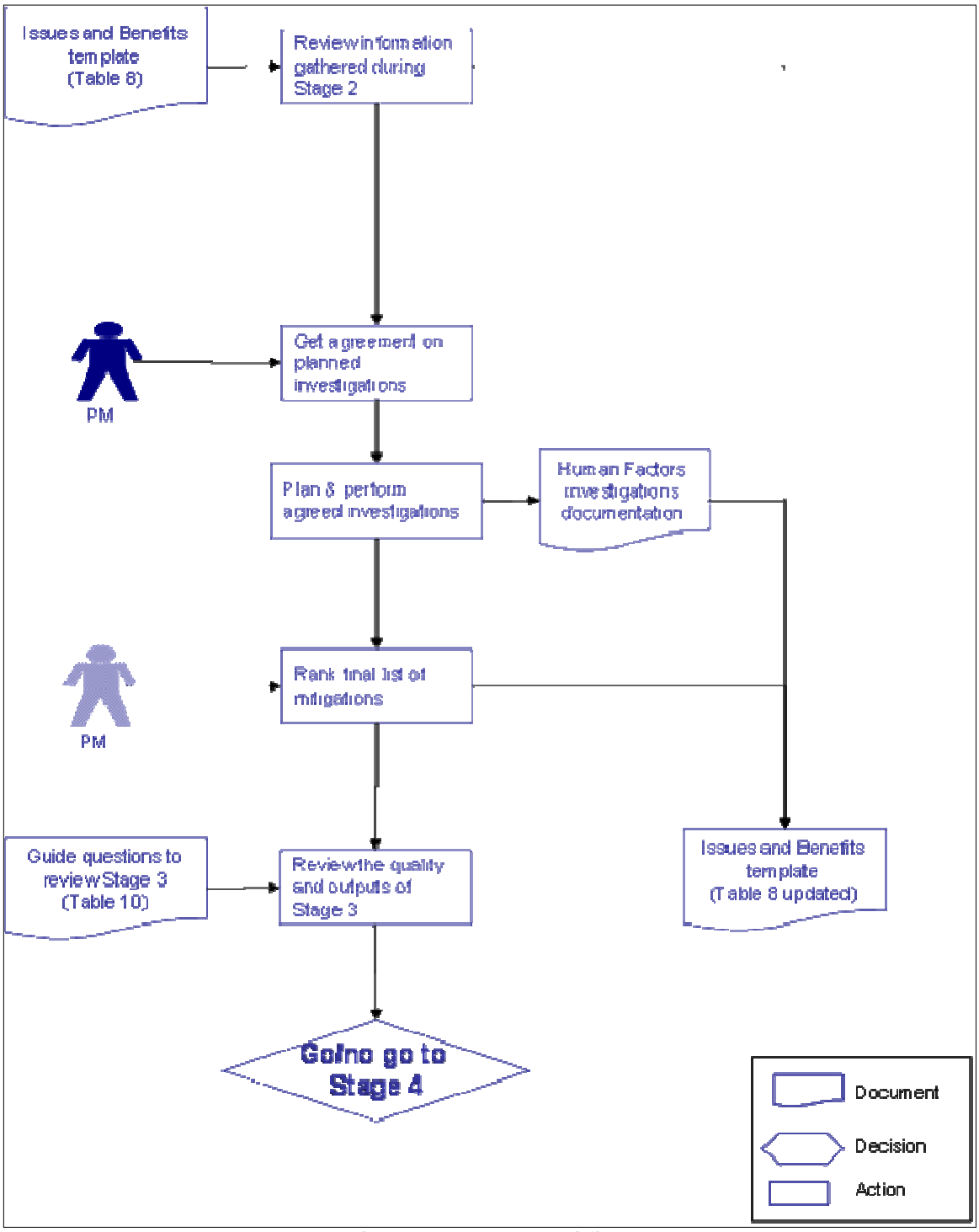


Figure 9: Stage 3 workflow

3.6 NOTE – RELEVANT FOR PROJECTS USING THE E-OCVM LIFECYCLE MODEL

As soon as from V1, on the basis of the proposed ATM change (described in terms of actors and element of HF pie subcategories), (potential) negative impacts on Human Performance

and (potential) positive impacts on Human Performance are collected. In case of alternatives in the change scenario, the HF Impact Assessment has to be carried out for each alternative.

The outcomes support improving design.

From V2 to V4 the outcomes of Stage 3 support mitigation development and potential corrective actions.

Later in the development phases, Stage 3 focuses on tracking all side effects and secondary issues.

STAGE 4:

HUMAN FACTORS REQUIREMENTS AND VALIDATION NEEDS

4.1 GOALS OF STAGE 4

The objectives of Stage 4 are:

- To derive the HF design requirements that accommodate the issues and their associated mitigations and identify the validation evidence that is required to demonstrate these are achieved,
- Based on the benefits identified in Stage 3; to define the significant benefits to the system performance and identify the validation that is required to demonstrate these are achieved.

4.2 INPUTS FOR STAGE 4

The inputs for Stage 4 correspond to the Table 8 finalised during Stage 3 and :

- The list of benefits for the human which are clearly described. This is an input for identifying the validation needs;
- The list of issues and associated ranked mitigations, which are clearly described and linked with relevant issue. This is an input for developing requirements in Stage 4.

4.3 PROCESS FOR STAGE 4

Stage 4 consists of 3 steps:

Step 1: Turn the mitigations and benefits from Stage 3 into requirements.
Step 2: Define validation needs derived from the benefits
Step 3: Provide the human factors requirements and the validation needs to the project manager for implementation
Step 4 Review

4.3.1 Step 1: Turn the mitigations and benefits from Stage 3 into requirements.

The purpose of the first step is to translate the list of mitigations and expected benefits into requirements. This may require further refinement of the text used for benefits and mitigations due to the format of a requirement.

4.3.1.1 What is a requirement?

The IEEE (1998) characterises a good requirement as one that is:

- ✓ Written as a behaviour of the system being designed,
  i.e. written using following format: *"The system shall .../…"*
- ✓ Written as a complete statement that can be understood on its own (standalone)

  i.e. explicit with no (hidden) assumptions;
- ✓ Unambiguous,
  i.e. everyone understand the same without raising discussion;
- ✓ Clear
  i.e. avoid words such as rapid, easy, simple, adequate, etc. ;
- ✓ Consistent
  i.e. does not contradict another existing requirement
- ✓ Verifiable
  i.e. testable and measurable using defined criteria
- ✓ Traceable
  i.e. where does it come from?

In addition, a rationale (free text) should also be provided to understand why the requirement is stated in its current form. This is particularly important when requirements have to be changed, because it reduces then the risks that change will have unexpected and undesirable effects.

4.3.1.2 What is a human factors requirement?

There are numerous styles in which human factors requirements can be written, such as those conforming to guidelines, meeting human performance criteria, or meeting a quality/level in the human performance output. Each of these styles has its own benefits and drawbacks. However, the human factors specialist must ensure that the requirements match the goals and constraints of the project.

Human factors requirements should avoid ambiguity and avoid terms that have different meanings to different people in different contexts, for example; words like '*easy*, *user friendly* or *usable',*, Therefore it is essential to refine (iteratively) the human factors requirements and operationalise their terms, being clear about exactly what is meant..

In addition to the ambiguity of terms, human factors requirements can be very difficult to test. Users do not often express their needs in testable terms; they just request that the system shall be *easy to use*. Therefore human factors requirements must use well-defined terms that suggest ways that the requirements can be verified and validated.

Human factors requirements usually cover the following requirements:

- ➢ Performance based

A performance-based human factors requirement might be *"The system shall allow technicians to complete the radar diagnostic procedure in an average of 10 minutes or less".* Performance-based requirements can be expressed in absolute terms or relative to existing systems or processes. In either case, the performance criteria should be derived from known performance levels that are measurable.

- ➢ Guidelines and standards

This kind of requirement requires that the system follow an existing user interface guideline or standard. In the FAA, the applicable standard is the Human Factors Design Standard (HFDS [Ahlstrom & Longo, 2003]). For an ATC system, a guidelines-based requirement might be "*The system shall conform to Chapter 8 of the HFDS*".

One benefit of this style is that following the guidelines will provide a base level of usability without significant new research and development costs.

- Usability

The ISO 9241-11 norm on *Ergonomics requirements for office work with visual display terminals* defines usability as "the capacity of a software/tool[9] to be easy to use by a given person to carry out the task for which it has been designed". It means that people can use such a system easily and efficiently to accomplish their own tasks and enable workers to concentrate on their tasks and do real work, rather than concentrating on the system(s) they use to perform their tasks.

The requirements related to usability will ensure that the system under development possesses characteristics such as:

- easy to learn, e.g. less training time
- efficient to use e.g. improved effectiveness/output
- improved safety e.g. provides quick (time to be defined) and efficient (ratio to be defined) recovery from errors
- easy to remember e.g. less training time, less cognitive resource required, improved efficiency
- likely to be accepted e.g. less resistance to change, satisfaction (see next section).

Usability applies to every aspect of a system with which a person interacts (hardware, software, menus, icons, messages, documentation, training, on-line help, etc.). It means that the success of a project not only depends on technical matters but on the integration of the human factor within the lifecycle of the product, i.e. the user perspective.

- Satisfaction

The requirements related to satisfaction require that the system achieve a level of subjective satisfaction from its users.

Satisfaction is especially important for the success of a transition phase from the "old system" to the "new system", where users can choose whether to use the new system or not. In ATC, a subjective satisfaction requirement might be "80% or more of the controllers shall rate their satisfaction as High or Very High."

A requirement related to satisfaction should define how satisfaction is to be measured, typically by rating scales. Because satisfaction can be changeable, a good practice is to require satisfaction measurements be taken at several points in time during the development of a system.

During Step 1 the following actions should be performed:

[9] *In this document, the global term "system" is used, which aims at covering any software, tool, product, etc. being designed.*

Examine each mitigation and its accompanying issue(s) and write requirement(s) for that mitigation. Enter this in Table 11.

Table 11: Mitigation and human performance requirements table

Mitigation	Human factors related requirement for the mitigation referenced
Mit ref number Description Provide Issue reference numbers covered by this mitigation and re	
Mit ref number Description Provide Issue reference numbers covered by this mitigation and re	

4.3.2 Step 2: Define validation needs derived from the benefits description

In this context, the objective of the validation is to demonstrate that the system is "good enough" from human performance perspective. The idea of "good enough" covers the following two claims that must be met[10]:

- The human role in the system is consistent with human capabilities and characteristics
- The contribution of the human supports the expected system performance in terms of KPA

The validation needs aim at building the evidence that these 2 claims are met:

- The issues in relation to the human are mitigated and the mitigation does not provoke consequential issue
- The benefits expected for the human can be verified and contribute to the overall system performance

For traceability purpose, it is recommended to link the validation activities to the claim(s) they support.

The validation needs are expressed via a validation plan, which provide at least:

- The problem(s) being addressed
- The experimental plan(s) if possible or at least advise on methods / indicators (see Stage 3 for more details)

Then the validation team (if not you) will:

[10] see www.eurocontrol.int/valfor/public/standard_page/OCVMSupport.html

- Conduct the study
- Analyse the data
- Draw conclusions

Table 12: Validation needs based on benefits description

Benefit	Validation needs derived from the benefits description
Benefit ref number Description	
Benefit ref number Description	

During Step 2 the following actions should be performed:

Examine each benefit and/or requirement and derive the validation plan.

Enter this in Table 12.

4.3.3 Step 3: Provide the human factors requirements and the validation needs to the project manager for implementation

Requirements & Validation needs document(s) should be delivered to the project manager and ideally a presentation should be made to the overall team to get their feedback.

In addition, the project manager should be clearly informed on what should happen next, i.e. that you need to get the validation results in order to finalise the human factors Case report. Indeed, as the validation activities may be performed by somebody else than you and may occur at a later time than when you achieve your Stage 4, it is essential to trace what is happening, follow-up the results and iterate Stage 4 (or even the entire Human Factors Case) as required, before considering that Stage 4, and therefore the HF Case, as finished.

Some important considerations and challenges in Stage 4

- Writing “good” requirements is challenging, i.e. writing requirements that are standalone, complete, correct, unambiguous, etc.
- Consider the design constraints that are imposed (standards imposed, regulations, etc.)
- Enlist the support of the Project manager and Validation manager to maintain momentum
- Ensure good communication with the person in charge of managing the project’s requirements document
- Take care to have good communication with project team & validation team

4.3.4 Step 4 Review

At the end of each Stage the quality of the process and of the outcome should be reviewed (as required by Stage 5 of the Human Factors Case process). The step 4 review ensures the HF Case is delivering consistent HF requirements to the project and the development lifecycle. Table 13 supports this review process.

Table 13: Guide questions to review Stage 4

Have all requirements to support the HF arguments been expressed?	Yes / No
Have requirements been delivered and integrated in the engineering process?	Yes / No
Are the human factors expectations feasible?	Yes / No
Has a plan for HF validation been delivered?	Yes / No
Have hypotheses been specified and expectations expressed in terms of contribution to KPA and project goal?	Yes / No
Has HF validation plan been checked to use relevant KPI and methods?	Yes / No
Have all requirements been covered by the expressed HF validation needs?	Yes / No

4.4 OUTPUT FROM STAGE 4

- A list of human factors requirements that address each issue to be mitigated, and which should be incorporated into the project's requirement document
- A list of validations needs to be incorporated into the project's validation strategy

4.5 SUMMARY OF STAGE 4

Following figure summarises the workflow in Stage 4.

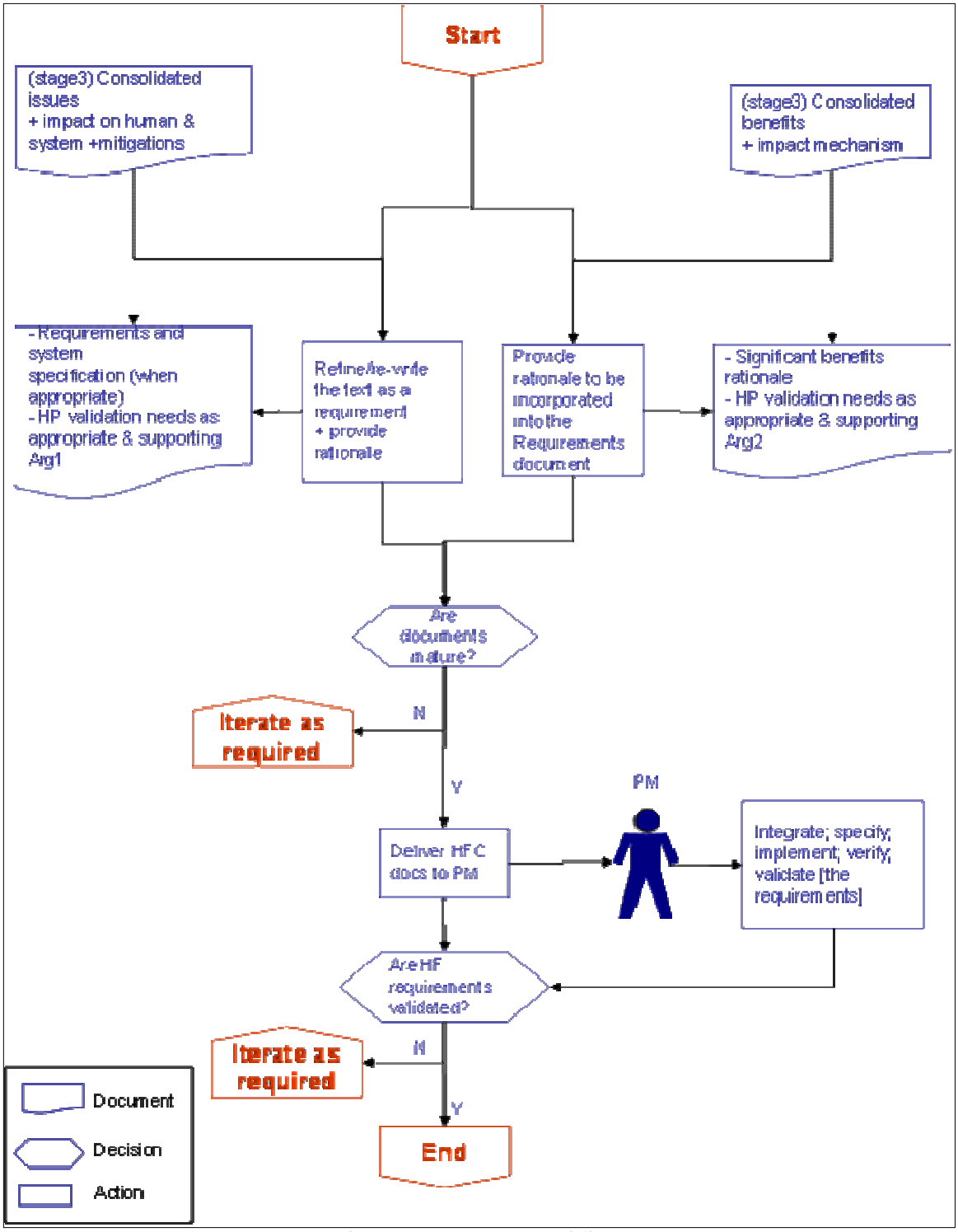


Figure 10: Stage 4 workflow

4.6 NOTE – RELEVANT FOR PROJECTS USING THE EOCVM LIFECYCLE MODEL

The HF design requirements produced by Stage 4 should completely address the interface, operability, human performance, training and standards, and rules required at the end of E-OCVM V3.

People-related requirements produced mature from very generic and high level to detailed element related while concept lifecycle mature.

In early phases of development, the level of uncertainty and the number of possible options to investigate require a lot of efforts to generate few evidences as assumptions are still numerous and untested. When concept matures the assumptions are refined the options reduced and the concept definition more and more precise. The scope can then be defined to the detail enabling in depth analysis and robust evidence. Figure 11 shows the level of outcome expected (in boxes) associatetd with each V phase of the E-OCVM lifecycle.

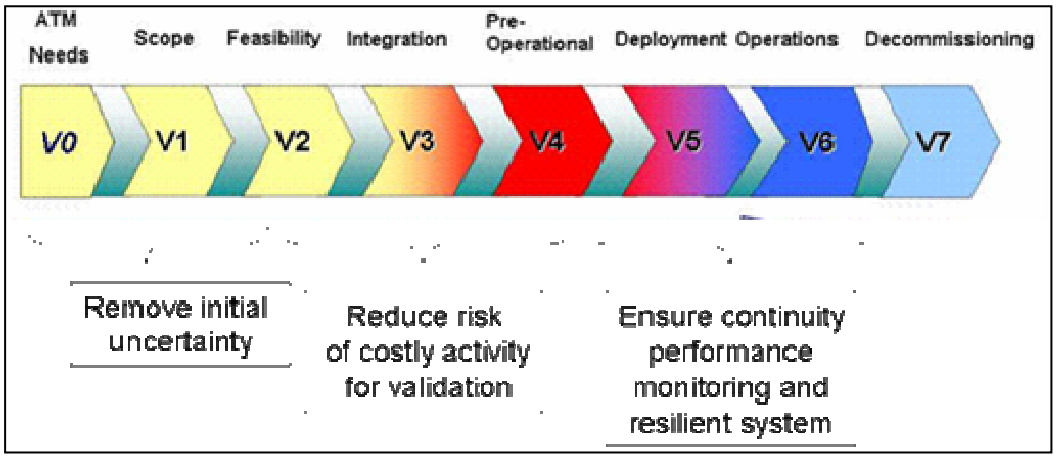


Figure 11: HF Case outcome according to lifecycle stage

STAGE 5:

HF CASE MONITORING, MANAGEMENT AND CONTROL

5.1 STAGE 5 INPUTS

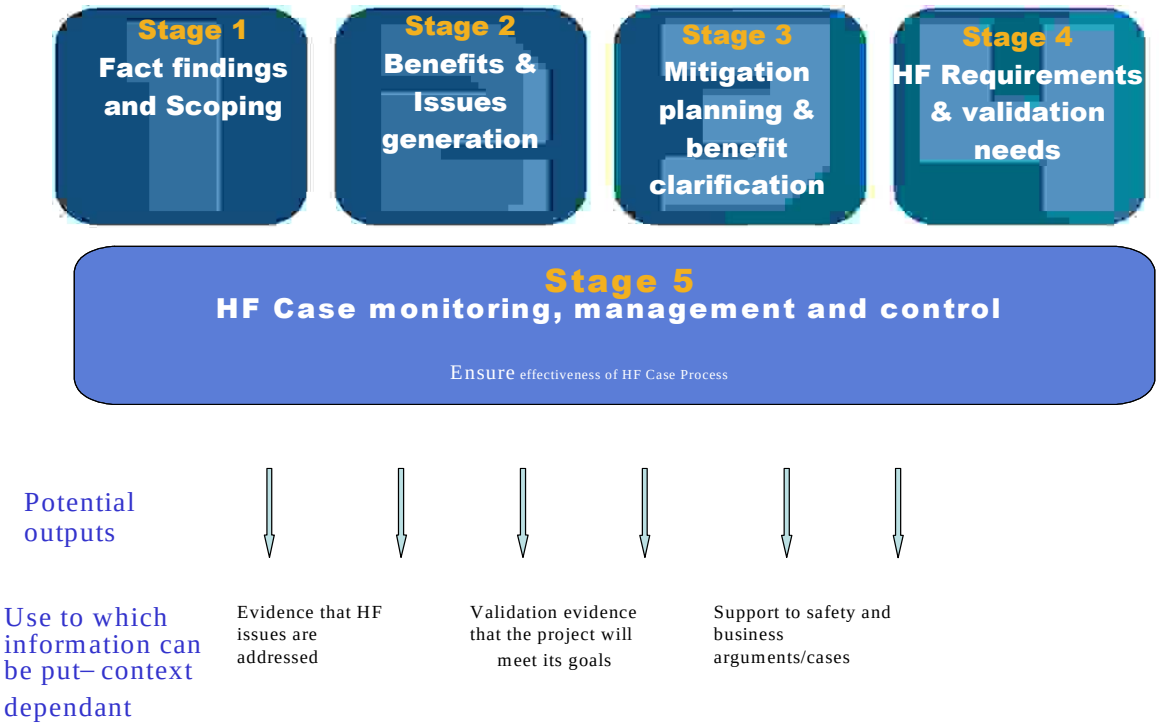


Figure 12: HF Case Stage 5

5.2 OBJECTIVE

In this Edition 3 of the HF Case, Stage 5 is a continuous HF Case monitoring process rather than a review process as it was in Edition 2.

It may be seen as a transversal stage that is conducted in parallel to the core process of the case (Stages 1 to 4). Its purpose is to:

- Ensure the quality and the completeness of Stages 1 to 4 through the systematic review step as the HF Case progresses
- Collect and integrate information for external use, e.g. any information contributing to the Safety Case or to the Business Case
- Be used to build a body of evidence to show that (and how) HF has been integrated into the planning/design process
- Ensure regular reporting, traceability of iteration and adequate level of evidence for the stage of development of the concept

- Allow the opportunity to identify missing elements by reviewing - with the project manager (or delegated expert) - each stage prior to completion of HF Case

- Provide a mechanism for extracting management related information that can be used to provide assurance that HF issues are being thoroughly considered

5.3 PROCESS STEPS

5.3.1 Step 1: Examine all Steps within each Stage

The documented evidence of Stages 1 – 4 should be examined within Stage 5 as they become available. Stage 5 should ensure that all steps were followed and all required elements were produced to proceed to the next step. Where necessary, findings may be extracted to justify further iteration or further efforts within a particular stage. This can usefully identify additional benefits as well as any additional issues that may need to be addressed.

By the end of the HF Case process it should be possible to examine the information in Stage 5 to produce evidence that the HF issues and benefits have been considered[11] enough.

5.3.2 Step 2: Control the actions performed by others and the arrangements for the HF effort

The HF Case manager is responsible for maintaining a good overview of the communication processes and data/result exchange across stages, with other cases and validation activities related to the concept under scrutiny in the HF Case.

The HF Case manager has to assign resources, designate the people responsible for specific tasks that feed and complement the HF Case process and results. These aspects should also be controlled via Stage 5.

Documented evidence that enough resources were available; that processes scaled effort to resource available and in general terms that all external relation and actions were achieved successfully should be demonstrated.

5.3.3 Step 3: Ensure quality and coherent results

The HF Case manager in coordination with the Project Manager will ensure that quality and nature of the HF Case documents produced meet the objectives defined at the start of each stage of the HF Case process. The assumptions raised in Stage 1 are also tested to ensure they are still relevant. Stage 5 ensures that each Stage (from 1 to 4) provides outputs that meet the required level of detail to conclude the stage and to proceed to the next stage.

Whatever the stage, the HF Case outputs should be in a form that can be integrated with the contributions of other disciplines (systems engineering, safety, etc). The checklists from Stage 1 to 4 are used to assess the Human Factors Case for adequacy (see Table 5,Table 9,Table 10, Table 13).

[11] If the HF Case is developing evidence for validation the assumptions, goals and information should be consistent with other cases and an interface with validation and project management is essential. Demonstration of “good enough” refers to E-OCVM notion of demonstration of evidence.

5.3.4 Step 4 - Review the process itself to capture lessons learned

It is also useful to make effective use of the very valuable insights and lessons learned throughout the Human Factors Case process, i.e. what worked and what didn't work. This can help to prevent problems, and save resources and in the future prevent similar problems. All relevant problems encountered and success stories from the application should be stored.

During Step 1- 4 the following actions should be performed:

Examine Table 5,Table 9,Table 10, Table 13 and ensure adequacy of the process;

Document any lessons learned

5.4 OUTPUTS FROM STAGE 5

- Significant outputs and success of the HF Case
- Outstanding issues, conclusions, findings and recommendations that can not be addressed within the scope of the present HF Case
- Report of lessons learnt from the application of the HF Case process and derive area of improvement

5.5 NOTE - RELEVANT FOR PROJECTS USING THE E-OCVM LIFECYCLE MODEL

The concept lifecycle model provides successive stages against which we can assess maturity of an operational concept and scale the HF actions and expertise required. The control process, i.e. Stage 5, should ensure the right level of expectation and outcomes from the HF Case as well as controlling the maturity of the case against the maturity of the concept. This transversal stage acts on all others stages and is provided to assure the management of information between the HF Case stages, the project management and any validation process. This includes data exchange and consistency with other cases (e,g. safety or business case or argument) and provision of an independent and permanent assessment of the quality, coherency and adequacy of HF actions and data with the project planning and the validation goals.

Stage 5 can also be used to capture HF related improvements that have an impact on a business case. Where the HF Case is part of an interactive design process and is to be repeated these improvements can show the incremental value added by each HF Case Iteration.

The information generated in Stage 5 can be used by a number of management processes. For example, a safety specialist may use this information to provide an argument in a Safety Case that human performance issues related to fatigue have been addressed. An operations manager may use the information to show that the efficiency gains provided by the system do not lead to an increase in workload on a controller, beyond what is reasonable.

Of course an HF Case can be repeated as project progresses or as the design is adapted. Additionally, when the project has a predetermined life cycle, perhaps over several years then multiple HF cases can be conducted to provide information at different parts of the lifecycle.

In summary, the information extracted from Stage 5 will be dictated by the context in which a particular HF Case is performed. Reports generated at Stage 5 will be tailored to meet this requirement be it a business, safety or efficiency oriented.

ANNEX 1: 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 the participants' backgrounds 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 there is 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[12]

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.

[12] 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.

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ANNEX 2: EXPERTS INTERVIEWS

Description
Semi-structured Interview – Some of the questions and their order is pre-determined. However, the interviewer also allows flexibility in directing the interview, and new issues or topics can be embarked on. Due to their flexibility, the semi-structured interview is the most commonly used type of interview. The analyst uses specific questions to obtain the required data, but also has the scope to probe novel areas further.
The HF Case process uses semi-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.

Time required:

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

Process steps
Before the interviews

- Define 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,
- Identify relevant HF Issues or benefit,
- 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.

Do's	**Don'ts**
Make the relevance of each question	Avoid an over-bearing approach

clear

Record the interview	Do not belittle, embarrass or insult interviewee
Be confident	Do not go over 40 minutes in length
Establish a good rapport with interviewee	Do not mislead or bias the interviewee
Communicate clearly	Do not confuse participants with technological jargon and acronyms
Be very familiar with the topic of interview	

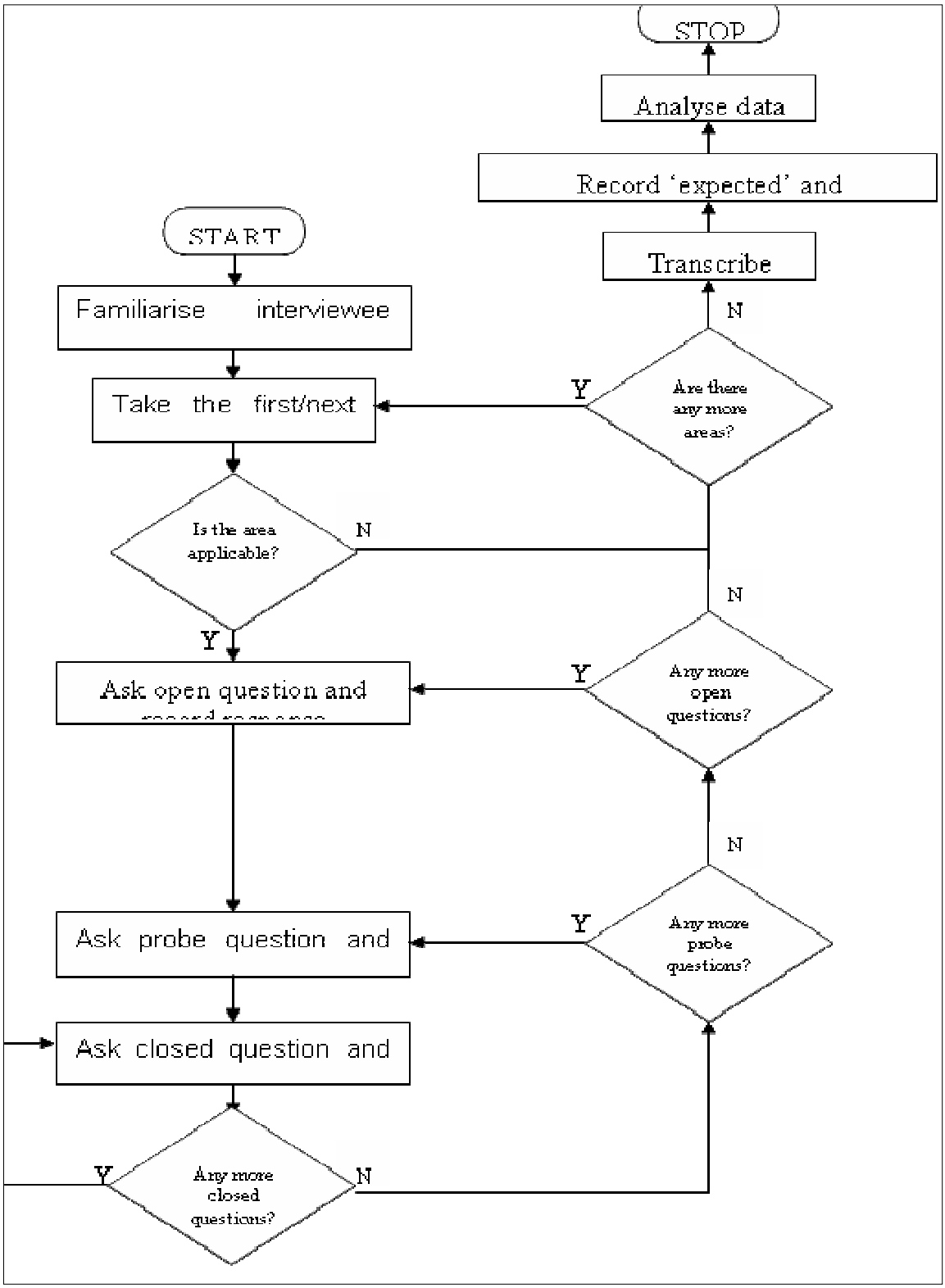
Advantages:

- Interviews can be used at any stage in the design process,
- The use of SME's as interviewees gives interviews the potential to be very powerful,
- The interviewer has full control over the interview and can direct the interview in different ways. This allows the collection of specific data,
- Interviews are a very flexible technique,
- Interviews enable to access people more easily.

Disadvantages:

- No group discussion and consensus building,
- The reliability and validity of the technique is difficult to address,
- Interviews are susceptible to both interviewer and interviewee bias,
- Transcribing the data is a laborious, time consuming process,
- Conducting an interview correctly is a difficult thing to do.

Flowchart


STOP
Analyse data
Record 'expected' and
START
Transcribe
Familiarise interviewee
N
Y
Are there any more areas?
Take the first/next
Is the area applicable?
N
N
Y
Y
Any more open questions?
Ask open question and
N
Y
Any more probe questions?
Ask probe question and
Ask closed question and
Y
Any more closed questions?
N

ANNEX 3: HF PIE COMPLETE BREAKDOWN

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

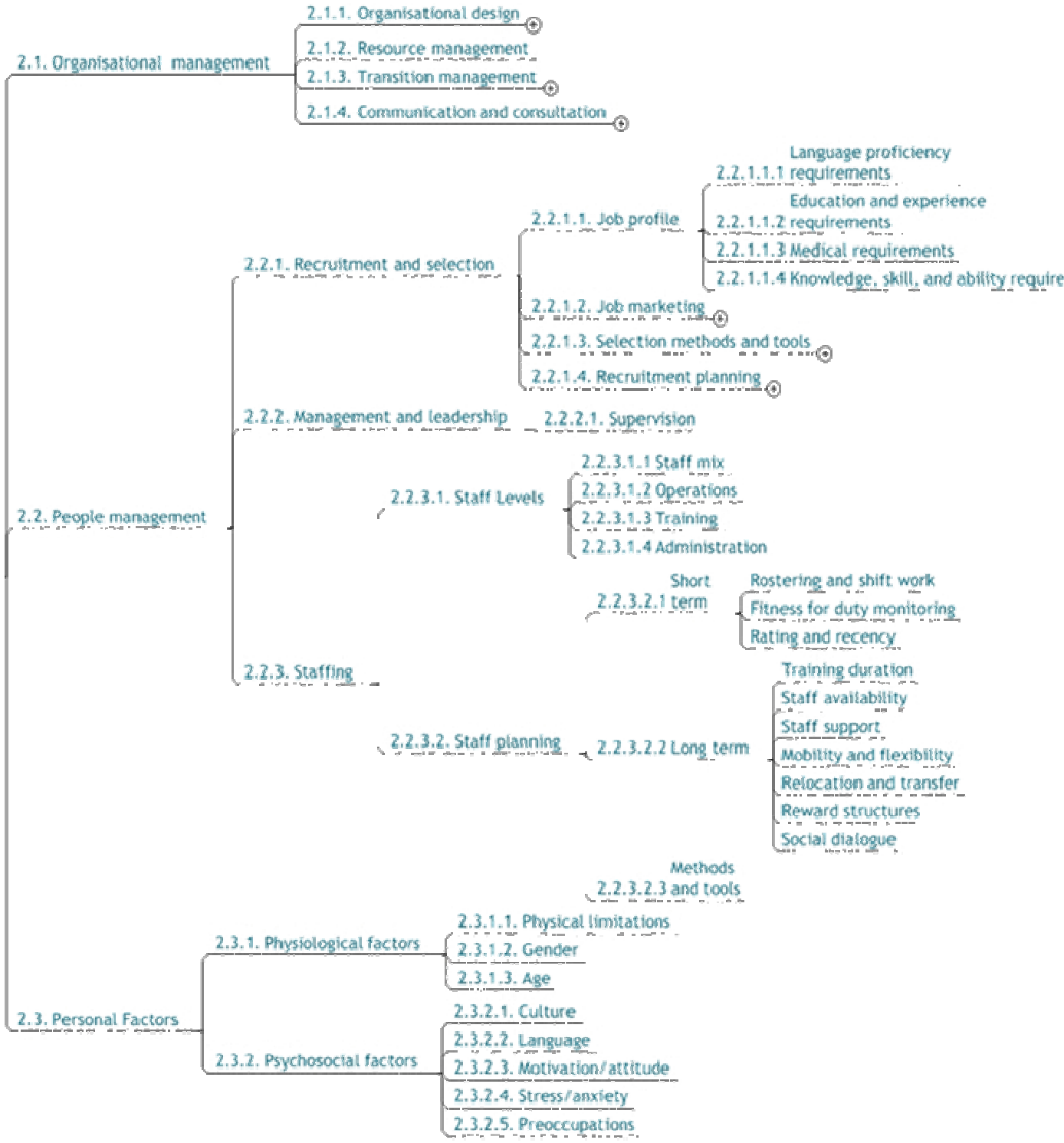


Figure A4-2.1 Organisation and staffing overview

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 © 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 © 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

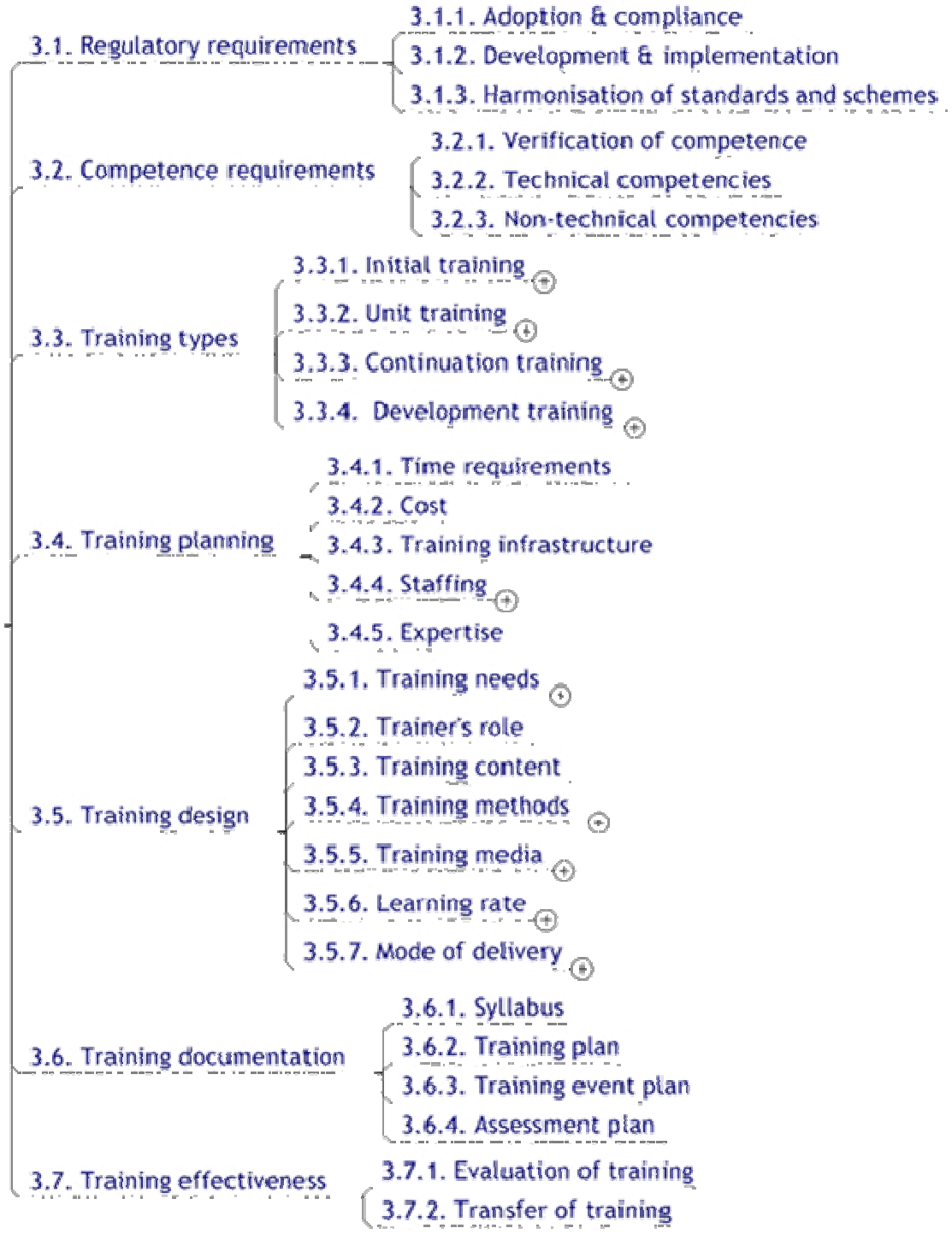


Figure A4-3.1 Training and development overview[13]

[13] 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

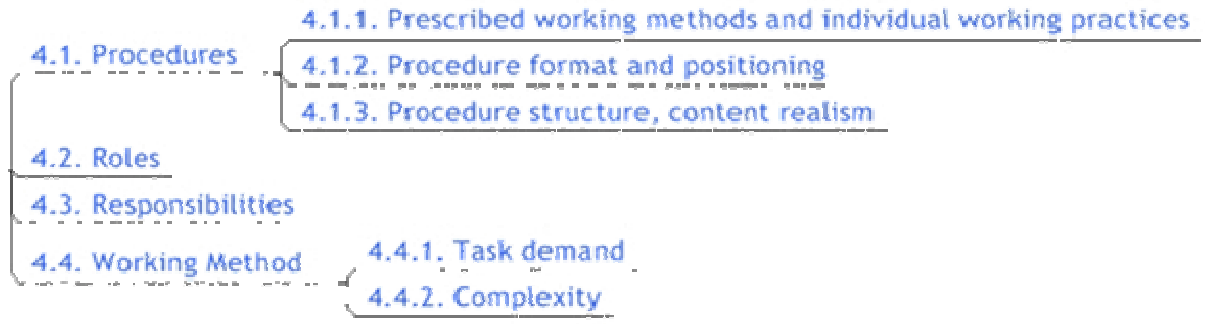


Figure A4-4 Procedures, Roles and Responsibilities overview

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

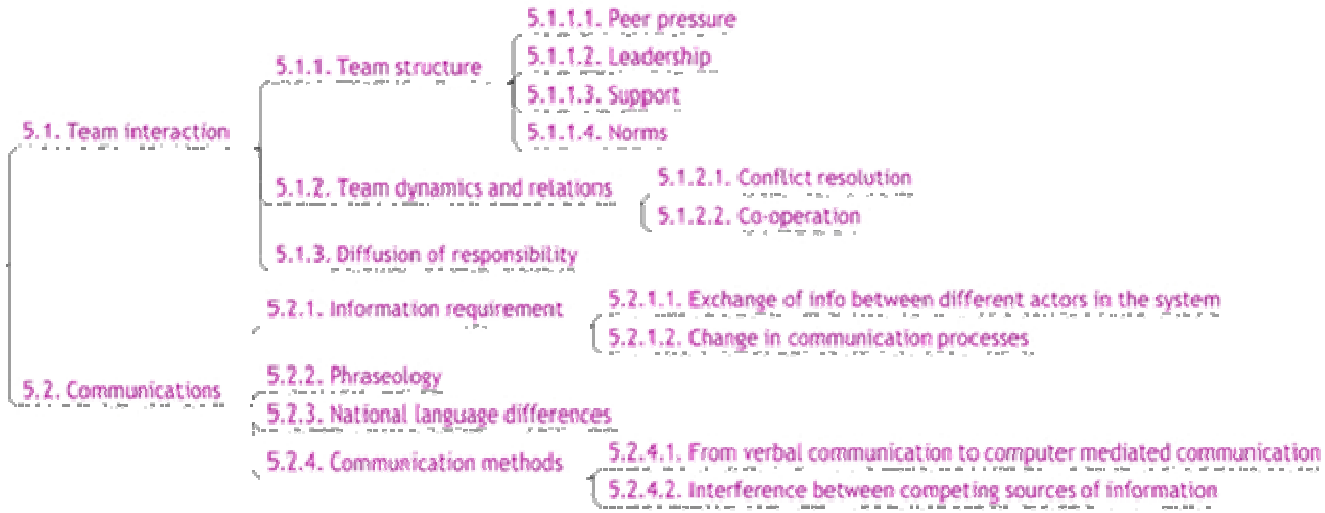


Figure A4-5 Teams and Communication overview

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	Automation The independent accomplishment by a device or system of a

new technology	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.

ADDITIONAL ISSUES DETAIL

HF Pie Category: 2. Organisation and Staffing

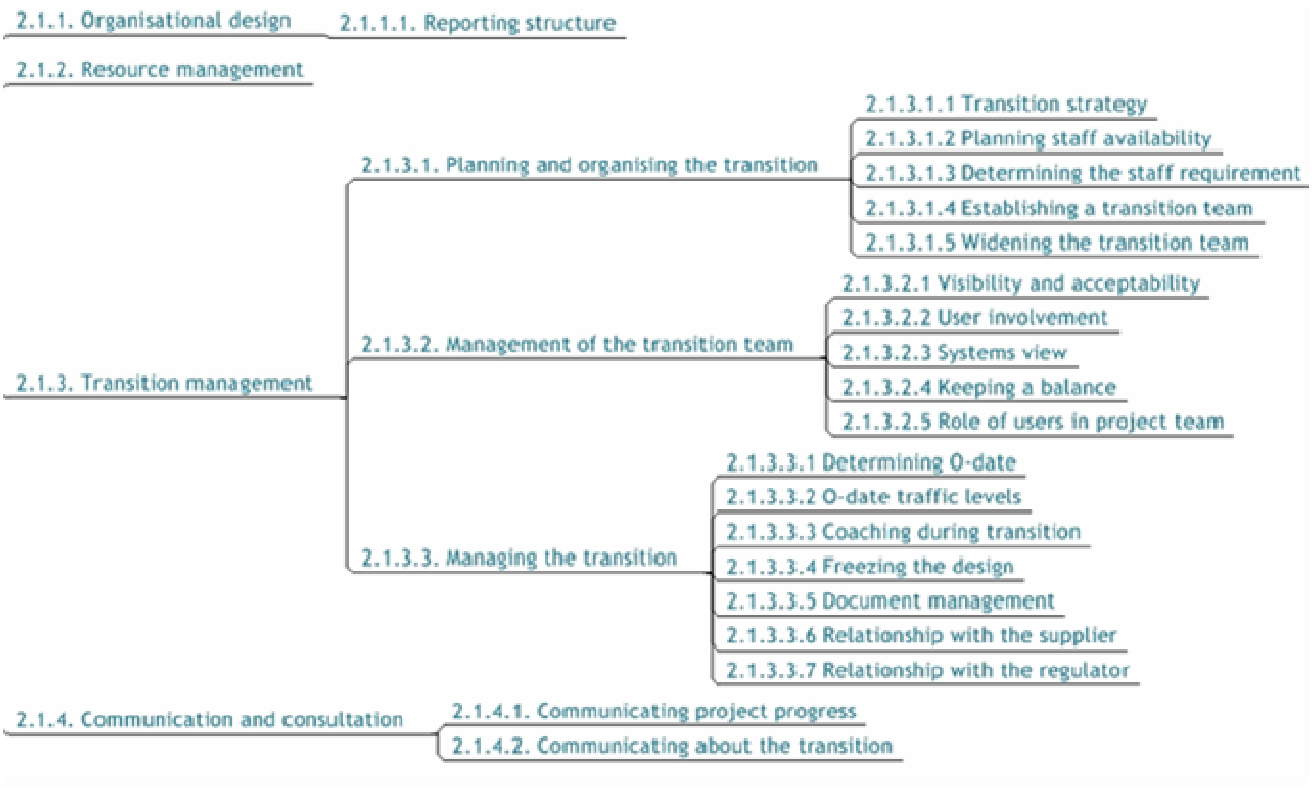


Figure A4-2.2 Organisational management detail

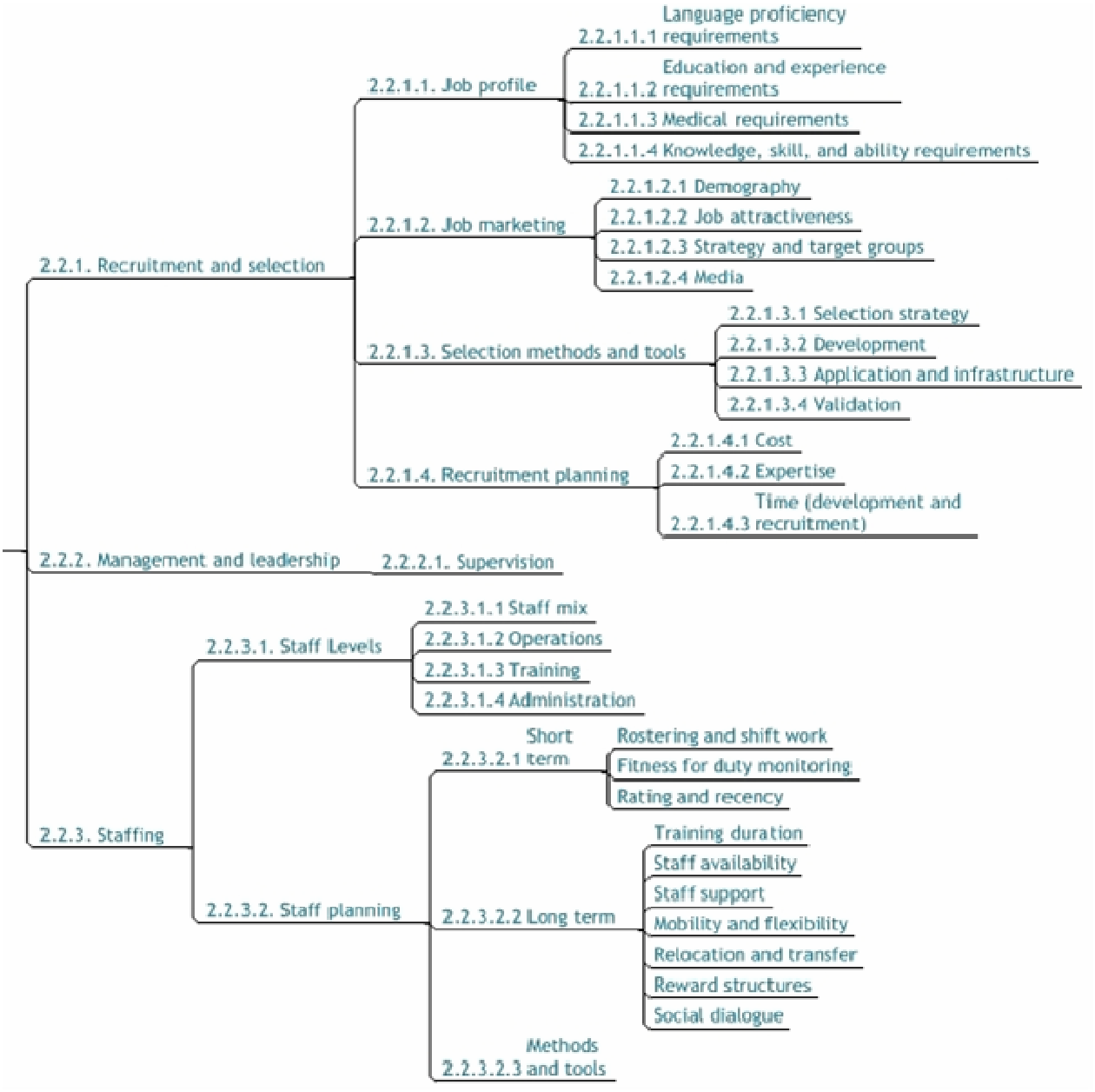


Figure A4-2.3 People management detail

HF Pie Category: 3. Training and Development

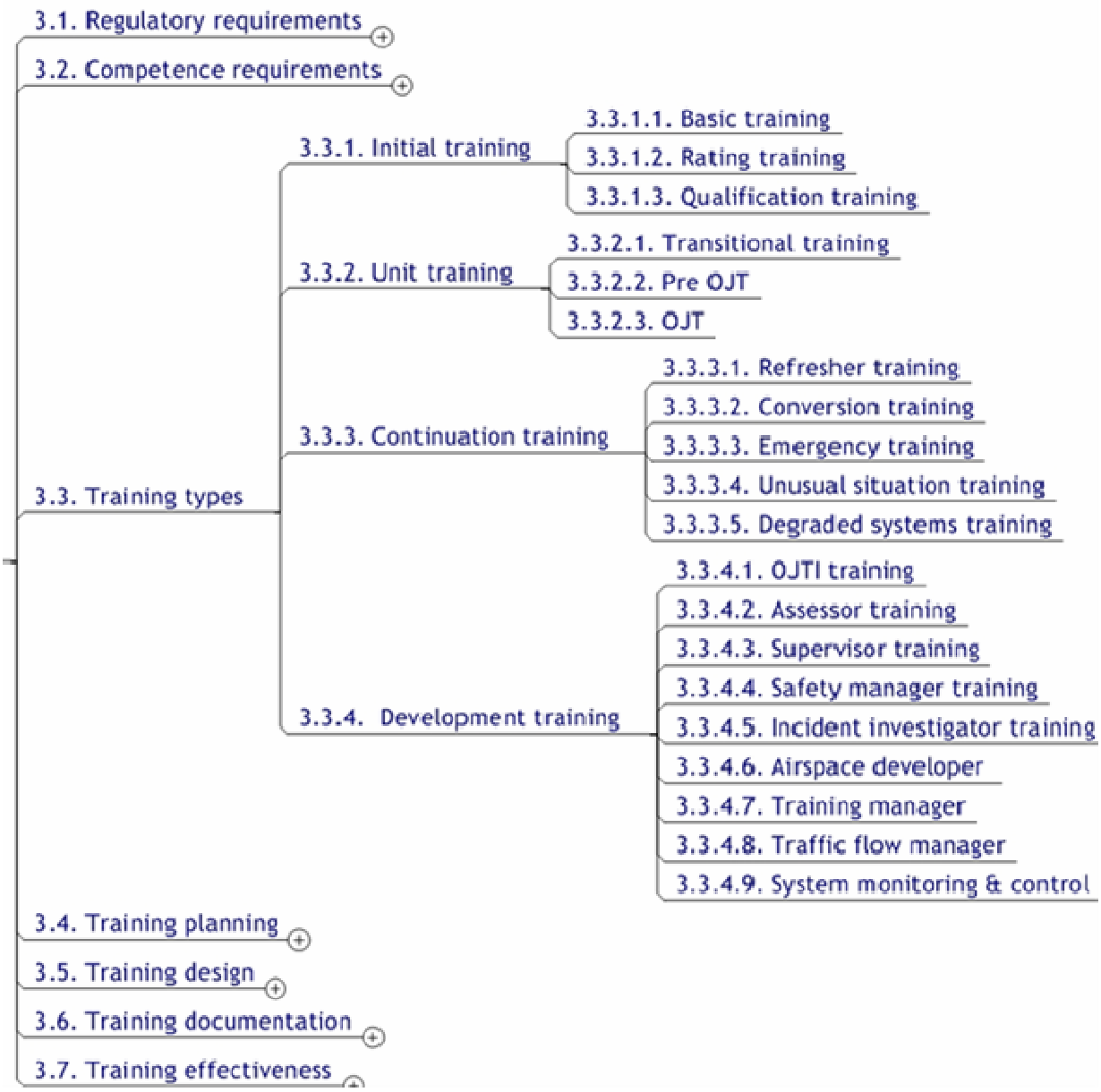


Figure A4-3.2 Training types detail

3.3.1.1 (a) ATCO Basic training	Training designed to impart fundamental knowledge and skills to enable student Air Traffic Controllers to progress to specialised ATC training
3.3.1.1 (b) ATSEP Basic training	Fundamental knowledge and skills appropriate to the discipline to be pursued in the Communication, Navigation and Surveillance / Air Traffic Management (CNS/ATM) environment
3.3.1.2 Rating Training	System/equipment-related knowledge and skills leading to recognised competency.
3.3.1.3 Qualification training	Provision of knowledge and skills related to a job category and appropriate to the discipline to be pursued in the ATS environment.
3.3.2 Unit training	Includes transitional, pre-OJT, and OJT training.
3.3.2.1 Transitional training	The phase following basic training during which site specific theoretical knowledge and understanding will be transferred to the trainee using a variety of methods and during which skills will be developed through the use of site specific simulations.
3.3.2.3 On the Job Training	The integration in practice of previously acquired knowledge and skills under the super- vision of a qualified instructor in a live situation
3.2.2.2 Pre On-the-Job Training	Phase of locally based training during which extensive use of simulation using site specific facilities will enhance the development of previously acquired routines and abilities to an exceptionally high level of achievement
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.
3.3.3.1 Refresher training	The process of further training in work currently performed in order to improve job performance. Also further training given in skills previously acquired but in which the individual may not currently be up to standard.
3.3.3.2 Conversion training	Provision of knowledges and skills appropriate to change in jobs category, environment and systems.
3.3.3..3 Emergency training	Training given on a regular basis for serious, unexpected, and often dangerous situations requiring immediate action.
3.3.3..4 Unusual situtation training	Training given on a regular basis for circumstances that are neither habitually or commonly experienced. The element of danger or serious risk is not necessarily immediately present.
3.3.3..5 Degraded systems training	Training given on a regular basis for unusual situations that are the result of a system failure or malfunction leading to a loss of system redundancy or service elements and system performance.
3.3.4 Development training	Includes OJTI, assessor, supervisor, safety manager, incident investigator, airpsace developer, training manager, traffic flow manager, and system monitoring and control training.

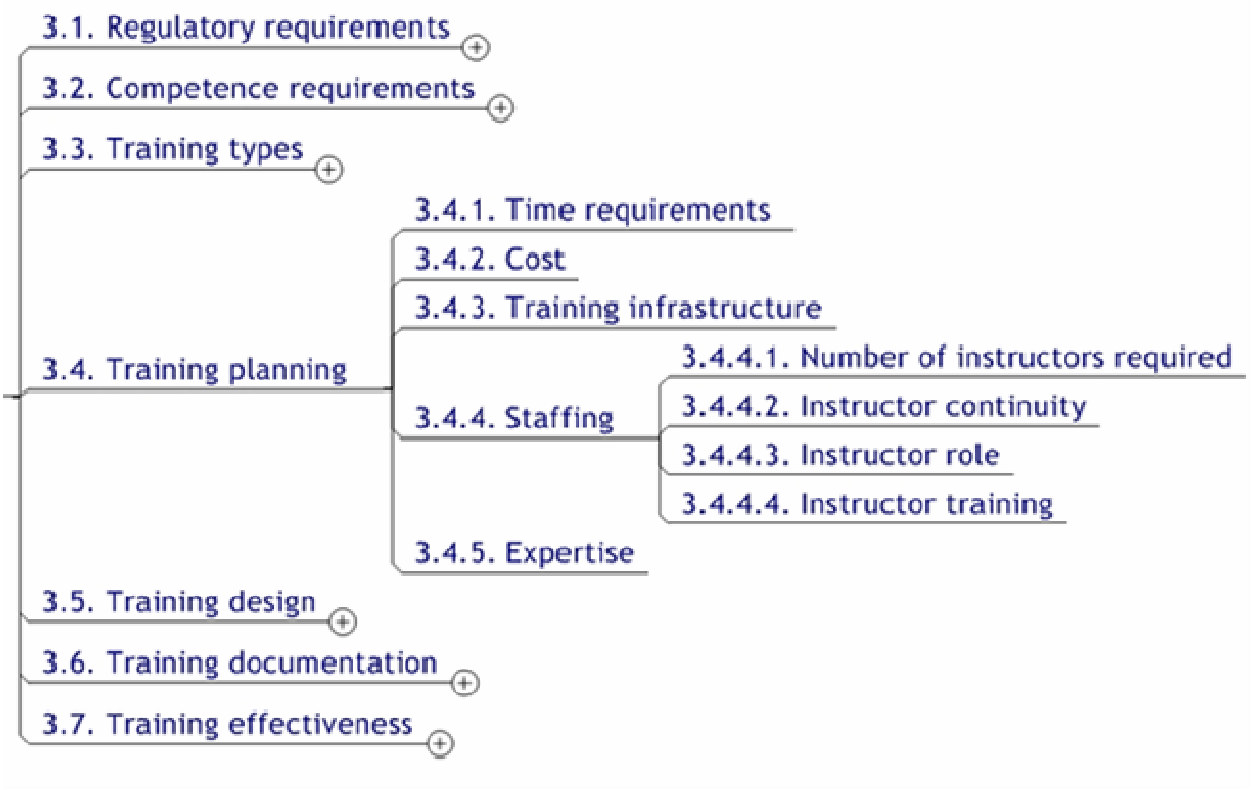


Figure A4-3.3 Training planning detail

Figure A4-3.4 Training design detail

3.5.4.1 Lecture	A direct talk or exposition, possibly using visual or other aids, without group participation other than questions, usually at the conclusion.
3.5.4.2 Lesson/Demonstration	A number of instructional techniques designed to ensure the participation of the learners to reach the specified behavioural objectives.
3.5.4.3 Case Study	A training method in which a real or fictional situation is presented to learners for their analysis and consideration of possible solutions or problems identified. Their findings can be compared to what actually occurred.
3.5.4.4 Exercises	The provision and consolidation of knowledge and skills through the performance of a series of tasks prescribed or performed to attain proficiency.
3.5.4.5 Facilitation	Process facilitation helps people achieve results using facilitation techniques.
3.5.4.6 Interactive Training	The provision of knowledge and skills by means of a computer with numerous interactions, learner response analysis in a self-paced manner.
3.5.4.7 Supervised practices	Manipulations of equipment where the instructor provides the necessary feedback.
3.5.4.8 Pre-Simulation	Restricted or real-time practice of part of the skills necessary for the operational task in a possibly unrealistic environment. Involves either Skill Acquisition (SA) or Part-Task Practice (PTP)
3.5.4.9 Simulation	Provision of knowledge, skills and attitudes by means of a representation of air traffic responding to any student action as real air traffic. Simulation always includes briefing, tutoring and debriefing.
3.5.4.10 Briefing	An introduction to a training event during which the interruption of the learner's activity is not normally anticipated.
3.5.4.11Debriefing	A review and discussion on the outcome of a training event based on a formative evaluation of that event.
3.5.4.12 Tutoring	Additional knowledge and guidance given to an individual or small group of learners in an off-the-job informal training situation.
3.5.4.13 Role-Play	Learners act out a real world human situation as an interacting group.
3.5.5.2 High-Fidelity Simulator (Hi Fi Sim)	A full-size replica of Controller Working Position (CWP) including all equipment and computer programmes necessary to represent full tasks of the sector or the tower and their environment. A spare operational position used as simulator is a good example of Hi Fi Sim. In the case of aerodrome it

	includes an out-of-the-tower view.
3.5.5.3 Simulator (Sim)	A device that presents the learner with a representation of the important features of the real situation and reproduces the operational conditions under which the learner can practise real-time tasks directly.
3.5.5.4 Part-Task Trainer (PTT)	A training machine for the learner to practise some operational functions independently of other functions not represented there, although they are necessarily associated to the first ones in the operational task.
3.5.5.5 Other Training Device (OTD)	A training machine which presents the learner with some operational functions on a non-realistic reproduction of the operational devices. It includes a generic MMC.
3.5.5.6 Multimedia Computer (MMC)	A (networked or stand-alone) multimedia computer or workstation dedicated to one learner or to a small cell. The hardware is off-the-shelf and has not been deeply modified for specific ATC purposes.

Reference. EUROCONTROL (2004). EATM Training Progression and Concepts. HRS/TSP-006-GUI-07.

ANNEX 4: 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).
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.
Health	Health is the general condition of a person in all aspects. It is also the level of functional and/or metabolic efficiency of the organism	According to the World Health Organization, the main determinants of health include the social and economic environment, the physical environment and the person's individual characteristics and behaviors. Generally, the context in which an individual lives is of great importance on his life quality and health status. The social and economic environment are key factors in determining the health status of individuals.
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).
Slips, lapses and mistakes	Slips can be thought of as actions not carried out as intended or planned, e.g. "finger trouble" when dialling in a frequency or "Freudian slips" when saying something. Lapses are missed actions and omissions, i.e. when somebody has failed to do something due to lapses of memory and/or attention	Slips lapses: – skill based (Rassmussen) – diverted attention Mistakes: - knowledge based - misinterpretation/misapply of a rule

IMPACT	PRACTITIONERS DEFINITION	ACADEMIC REFERENCE
	or because they have forgotten something, e.g. forgetting to lower the undercarriage on landing. Mistakes are a specific type of error brought about by a faulty plan/intention, i.e. somebody did something believing it to be correct when it was, in fact, wrong, e.g. switching off the wrong engine.	
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.
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.
Job satisfaction	A term used to describe how content an individual is with their job.	The feelings or 'affective response' someone experiences in a job role.
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.
Perception, Memory and decision makings	How people perceive, make judgements and problem solve on the job. This includes information capture, processing capability, memory, decision-making, vigilance and attention span (see glossary).	human is communication channel, taking input and generating output, with the overlap being the amount of transmitted information. it is very useful to describe human memory as a set of STORES which are "places" to put information, plus a set of PROCESSES that that act on the stores. A very simple model might contain 3 different stores: - The Sensory Information Store (SIS) - The Short-Term Store (STS) - The Long-Term Store (LTS)

IMPACT	PRACTITIONERS DEFINITION	ACADEMIC REFERENCE
		... and 3 processes - Encoding (putting information into a store) - Maintenance (keeping it "alive") - Retrieval (finding encoded information) 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).
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.
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.

ANNEX 5: KPA DESCRIPTION

ICAO KPA definitions

1	Access and Equity	A global ATM system should provide an operating environment that ensures that all airspace users have the right of access to ATM resources needed to meet their specific operational requirements; and ensures that the shared use of the airspace for different airspace users can be achieved safely. The global ATM system should ensure equity for all airspace users that have access to a given airspace or service. Generally, the first aircraft ready to use the ATM resources will receive priority, except where significant overall safety or system operational efficiency would accrue or national defence considerations or interests dictate by providing priority on a different basis.
2	Capacity	The global ATM system should exploit the inherent capacity to meet airspace user demand at peak times and locations while minimising restrictions on traffic flow. To respond to future growth, capacity must increase, along with corresponding increases in efficiency, flexibility, and predictability while ensuring that there are no adverse impacts to safety giving due consideration to the environment. The ATM system must be resilient to service disruption, and the resulting temporary loss of capacity.
3	Cost Effective-ness	The ATM system should be cost-effective, while balancing the varied interests of the ATM community. The cost of service to airspace users should always be considered when evaluating any proposal to improve ATM service quality or performance. ICAO guidelines regarding user charge policies and principles should be followed.
4	Efficiency	Efficiency addresses the operational and economic cost-effectiveness of gate-to-gate flight operations from a single-flight perspective. Airspace users want to depart and arrive at the times they select and fly the trajectory they determine to be optimum in all phases of flight
5	Environ-ment	The ATM system should contribute to the protection of the environment by considering noise, gaseous emissions, and other environmental issues in the implementation and operation of the global ATM system.
6	Flexibility	Flexibility addresses the ability of all airspace users to modify flight trajectories dynamically and adjust departure and arrival times thereby permitting them to exploit operational opportunities as they occur.
7	Predict-ability	Predictability refers to the ability of the airspace users and ATM service providers to provide consistent and dependable levels of performance. Predictability is essential to airspace users as they develop and operate their schedules.
8	Safety	Safety is the highest priority in aviation, and ATM plays an important part in ensuring overall aviation safety. Uniform safety standards and risk and safety management practices should be applied systematically to the ATM system. In implementing elements of the global aviation system, safety needs to be assessed against appropriate criteria, and in accordance with appropriate and globally standardised safety management processes and practices.
9	Security	Security refers to the protection against threats, which stem from intentional (e.g. terrorism) or unintentional (e.g. human error, natural disaster) acts affecting aircraft, people or installations on the ground. Adequate security is a major expectation of the ATM community and of citizens. The ATM system should therefore contribute to security, and the ATM system, as well as ATM related information, should be protected against security threats. Security risk management should balance the needs of the members of the ATM community who require access to the system, with the need to protect the ATM system. In the event of threats to aircraft or threats using aircraft, ATM shall provide responsible authorities with appropriate assistance and information.
10	Partici-pation	The ATM community should have a continuous involvement in the planning, implementation, and operation of the system to ensure that the evolution of the global ATM system meets the expectations of the community.
11	Inter-operability	The ATM system should be based on global standards and uniform principles to ensure the technical and operational interoperability of ATM systems and facilitate homogeneous and non-discriminatory global and regional traffic flows.

From SESAR master plan:

KPA	Expectations of the Future ATM System
Access & Equity	The future ATM System should provide an operating environment to ensure that all airspace users have the right of access to the necessary ATM resources needed for them to fulfil their specific requirements in a safe manner. Although not a direct characteristic of the operating performance of the future ATM System, it is a principle, which enables the relevant performance to be achieved in other areas.
Capacity	The future ATM System should provide the capacity to meet the demand at the times when and where it is needed. This is a key operational performance area which must be considered in conjunction with the need for efficiency, flexibility, and predictability, whilst, in particular, ensuring that there are no adverse impacts on performance in the areas of safety and environmental sustainability.
Cost Effectiveness	The price of the air traffic services provided by the future ATM System should be cost-effective with respect to meeting the individual needs of the relevant airspace user.
Efficiency	Efficiency addresses the operational and economic cost-effectiveness of flight operations from a single-flight's perspective and will be central to achieving the environmental performance targets, which will be placed upon the future ATM System. Clearly it is a key area for assessing operational performance and is at the heart of being able to achieve success through flying the business trajectory. In addition to single flight perspective, the overall network efficiency is considered as well.
Environmental Sustainability	The lack of a high level of environmental sustainability performance could impact stakeholders' reputation. The future environmental system performance will be a requirement and the future ATM System must meet their obligations in this respect. Although not a direct characteristic of the operating performance of the future ATM System, performance criteria will be defined as part of the requirements placed upon aviation as a whole and therefore, the contribution that the ATM System must make, and should be seen to make, to minimise the impact.
Flexibility	Flexibility addresses the ability of all airspace users to modify the requirements they place on the future ATM System in a dynamic manner. Clearly it is a key area for assessing operational performance and is also at the heart of being able to achieve success. In this case it is having the ability to make changes to the business trajectory, thereby permitting operational opportunities to be exploited as they occur.
Interoperability	The functionality and design of the future European ATM System must be based upon the use of global standards and uniform principles to ensure technical and operational interoperability of ATM Systems can be achieved. Although not a direct characteristic of the operating performance of the future ATM System, it is a principle, which enables the relevant performance to be achieved in other areas since, for example, failing to do this will clearly have a financial impact on aircraft equipage and hence, investment costs.
Participation	As changes to factors which will affect the performance of the future ATM System, either directly or indirectly, are identified, all stakeholders must maintain a continuous involvement in the identification, scoping, planning and

	implementation activities to ensure the air traffic services provided remain “fit for purpose”. Although not a direct characteristic of the operating performance of the future ATM System, it is a principle which enables the relevant performance to be achieved in other areas, especially with respect ensuring future changes to the ATM System are identified, scoped, planned and implemented in a manner which ensure its performance will be to the maximum benefit of all stakeholders.
Predictability	Predictability refers to the ability of the future ATM System to enable the airspace users to deliver consistent and dependable air transport services. It is essential to airspace users as they develop and operate their business trajectories. Clearly it is a key area for assessing operational performance and is also at the heart of being able to achieve success by offering a high quality of service to the end customers.
Safety	Safety is afforded the highest priority in aviation and the provision of air traffic services plays a key role in ensuring overall aviation safety. Society will always expect zero accidents from the aviation industry as a whole and performance from this perspective sets the end customers’ confidence in air transport. The lack of a high level of safety performance would impact stakeholders’ reputation and thus, influence customer choice. Improvements in safety will also impact the cost of air transport. The safety performance of the future ATM System must play a key part in enabling aviation to meet society’s expectation and therefore, it is a key area of overall operational performance. Uniform safety standards, risk assessments and safety management practices must be applied rigorously and systematically to the design and performance of the future ATM System to deliver high quality products.
Security	Security aspects can be considered in a very similar manner to the way in which safety has been considered. Security refers to the protection against both direct and indirect threats, attacks and acts of unlawful interference to the ATM System. Unlawful interference can occur via direct interference with aircraft, or indirectly through interference with ATM service provision (e.g. via attacks compromising the integrity of ATM data or services) Society will always expect zero accidents and incidents due to breaches of security from the aviation industry as a whole and performance from this perspective will also set the end customers’ confidence in air transport. The lack of a high level of security performance would impact stakeholders’ reputation and thus, influence customer choice. Improvements in security will also impact the cost of air transport. The performance of the future ATM System must contribute to ensuring a high level of security is achieved by the aviation industry as a whole. Expectations are that this can be achieved not only by ensuring that the infrastructure which makes up the ATM System is itself resilient to attack, but that the System will provide information which can be used by other organisations who can also act to protect air transport and aviation as a whole.

The ICAO KPAs are the definitive set, but there is still some variability in interpretation.

The KPAs used by SESAR are virtually identical to the ICAO set, but with differences of wording and emphasis. Other earlier or evolutionary subsets do not require further consideration.

Adding ‘economy’ at the socio-economic (national or regional) level would have minimal impact on the scope of Human Factors assessment required.

‘Sustainability’ is an important dimension not currently included in the ICAO KPAs, but within Human Factors assessment it should be handled as the ‘time dimension’ for assessment of other factors. The parts of the HF pie most likely to be affected are the societally linked ones (Organisation & staffing, Training & development).

ANNEX 6: LIKELYHOOD, SEVERITY RANKING TABLES

LIKELYHOOD RANKING SCALE

Very rare	rare	sometimes	often	Very often
1. Only a few cases reported in the lifetime of the system	**2.** Occurs once per year or less and even if operators are aware of the event they hardly have experienced it themselves	**3.** Occurs frequently enough to be reported. Only a portion of the staff had real experience with it.	**4.** Occurs frequently enough that each operator experiences it and recalls the situation	**5.** Occur at least once a week or once in a period short enough to be considered as habitual

SEVERITY RANKING SCALE

Very low severity	Low severity	Medium severity	High severity	Very high severity
1. Impact on performance is negligible	**2.** impact is minor and noticed only on specific and non frequent situations	**3.** Impact on KPA that can deteriorate the performance without any risk to harm people	**4.** major impact on one KPA or high impact on many (other than safety)	**5.** Impact on many KPAs and HP aspects, very high impact on safety that can endanger the system integrity

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