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# **Human Factors Module**

## **Human Factors in the Investigation of Accidents and Incidents**

**HUM.ET1.ST13.3000-REP-02**

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### Abstract

This document is, within the Human Resources Domain, one of the Human Factors modules. These modules deal with human performance. This module provides the Human Factors perspective in the investigation of accidents and incidents. It describes the Human Factors specialist approach, the basic guidelines for the implementation of a reporting scheme and the investigation of Human Factors as an integrated part of the whole investigation.

### Keywords

Accident	Reporting scheme	Feedback	Human Factors
Incident	Investigation	Follow-up	Approach

<b>CONTACT PERSON:</b>	D. VAN DAMME	<b>TEL :</b> 3567	<b>DIVISION :</b> DED5
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**AUTHORS:** Dominique VAN DAMME, Johan KJÆR-HANSEN and Anne-Laure AMAT

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

AUTHORITY	NAME AND SIGNATURE	DATE
Human Factors Expert - DED5	D. VAN DAMME	17/02/1998
Chairman Human Resources Team	C. P. CLARK	18/02/1998
Senior Director Operations and EATCHIP	W. PHILIPP	18/02/1998

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## **EXECUTIVE SUMMARY**

The European Air Traffic Control Harmonisation and Integration Programme (EATCHIP) Human Resources Domain (HUM) is developing several Human Factors (HF) modules that deal with the management of human performance. This module is about HF in the investigation of Accidents and Incidents (A/I). Its aim is to present the HF approach, the basic guidelines for the implementation of a reporting scheme and the investigation of HF as an integrated part of the whole investigation.

Chapter 1, 'Introduction', defines the scope and purpose of the document and includes the rationale for the investigation of HF in A/I.

Chapter 2, 'The Human Factors Perspective', presents a generic approach for the investigation of HF from the notification of an incident or accident up to the use of its results in the follow-up and feedback process in order to eliminate the risk and to allow learning from experience. It aims to address a wide audience of operational staff, supervisors, management and investigators.

Chapter 3, 'Implementation of the Human Factors Perspective', gives an overview of the implementation of a reporting scheme, reviewing the different steps of the implementation and explaining the different options. It is more specifically aimed at management who wish to install an efficient reporting scheme and establish the policies to support it.

Chapter 4, 'Accident and Incident Investigation', describes the investigation of HF as an integrated part of the whole investigation from the collection of data up to the report writing. It is more specifically aimed at the investigators.

Annex A gives a list of questions concerning the investigation of team-related aspects in A/I. Further annexes give references, further reading, ICAO definitions, abbreviations and acronyms, and contributors.

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## **1. INTRODUCTION**

### **1.1 Scope and Purpose**

The aim of the 'Human Factors in the Investigation of Accidents and Incidents' module is to increase awareness and understanding of the HF aspects in incidents and accidents. It discusses the integration of HF elements into the investigation process from the A/I reporting phase through to the possible uses of the results in the operational environment. The module will consider the different personnel aspects involved and the operational context in which an accident or incident has occurred that need to be considered from the HF perspective.

The module is addressed to all members of the Air Traffic Services (ATS) team including operational staff, supervisors and management as well as those involved in the investigation process from local to national level.

### **1.2 Rationale**

Depending on the reference, statistics reveal that 70-80% of A/I in aviation are due to human error or HF. In a human-based process such results are common. In Air Traffic Control (ATC) as in some other areas of work, e.g. transport, processing industry, etc., the responsibility of safety lies mainly with the human operator.

While investigation often stops at the conclusion of 'human error', investigation of HF aspects aims at going beyond human error, analysing the different facets of the situation and trying to understand the mechanisms and context which led to the error.

Infallible humans do not exist. The days of covering up 'faults' should be over. To look back on what happened is more fruitful than trying to eliminate errors completely. System safety will benefit from a better understanding of human mechanisms and conditions that are error-prone.

The main purpose for investigating an A/I should be to prevent similar event, to understand why it happened, not to search for the person responsible. It is not the attribution of blame, but rather the analysis of the error and its underlying factors that help us to understand why an A/I occurred.

***Let's move from a 'blame culture'  
to a 'reporting and learning culture'***

The overall objective is to advocate improvement, first to reduce the frequency and diminish the consequences of hazardous occurrences, and second to learn how to manage error-prone situations better, as it is not possible to avoid each and every error. The lessons learnt from incident investigation generally help operators and the whole organisation to become better **error managers**.

One of the basic principles in the development of an efficient and effective accident prevention system is the reporting and investigation of incidents.

While current aviation systems have a leading-edge approach to accident prevention, the importance of HF in A/I investigation is only now being more widely appreciated and this is leading to the establishment of concerted initiatives.

An important step in this direction is to make management, operational staff, investigators and regulators aware of the importance of HF. People dealing with the investigation need to have the appropriate background, knowledge and methods to integrate the HF components in the A/I investigation process.

This module offers the opportunity to develop an awareness of the issues and to present generic guidelines on how to investigate the HF elements in A/I.

## **1.3 References**

### **1.3.1 International Civil Aviation Organisation References**

References to A/I investigation in aviation may be found in the following International Civil Aviation Organisation (ICAO) documents:

- Annex 13 to the Convention on International Civil Aviation (1994) defines the objectives of the investigation and describes its process;
- Accident/incident Reporting System (ADREP) Manual (1987) defines the reporting requirements;
- Human Factors Digest No. 7 (1990) on 'Investigation of Human Factors in Accidents and Incidents' outlines in detail a HF approach and suggests a methodology for the investigation.

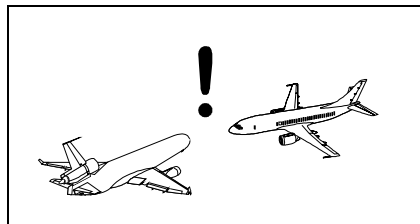
### **1.3.2 European Union Directive 94/56/EC**

The Council of the European Union (EU) Directive 94/56/EC of 21 November 1994 establishes the fundamental principles governing the investigation of civil aviation A/I within the EU in accordance with the ICAO documents.

The references are not specifically ATC-oriented but are applicable in the ATC world.

This module will concentrate more specifically on ATC-related incidents and accidents taking into account the above references as a background.

*The human operator is often considered to be the weak link in the chain. However, he is also the element which thwarts the weaknesses of the system and the organisation, and he is the one who can provide flexibility when necessary.*



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## 2. THE HUMAN FACTORS PERSPECTIVE

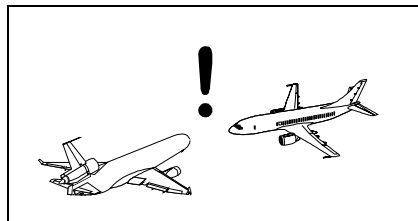
### 2.1 Illustrative Case

The following case will be used to illustrate the approach.

*The controller recognised that he forgot to transmit a change of Flight Level (FL) instruction to an Aircraft (a/c) as he had initially planned because he was overloaded due to an increase in the traffic complexity (heavy thunderstorms) despite flow restrictions. His activity was constantly interrupted by new incoming communications from pilots. The controller was very tired because he had agreed to work overtime as many colleagues were absent due to an influenza epidemic.*

*The supervisor was aware of the traffic situation; he would have liked to split the sector, but he did not have the manpower to do so. One of his staff had just asked to be released because he did not feel well. He had caught the flu and had a very high fever which prevented him from working properly.*

*Shortage in qualified controllers has been a real problem over the last two years in the unit. The forecast for ab initio recruitment five years ago underestimated the real manpower need in operational units. Thanks to the goodwill of the personnel who had agreed to work overtime, the requirement could be met under normal conditions, but, during the last two weeks, many people were ill due to the flu, and the situation was very critical. A similar situation had occurred the year before.*

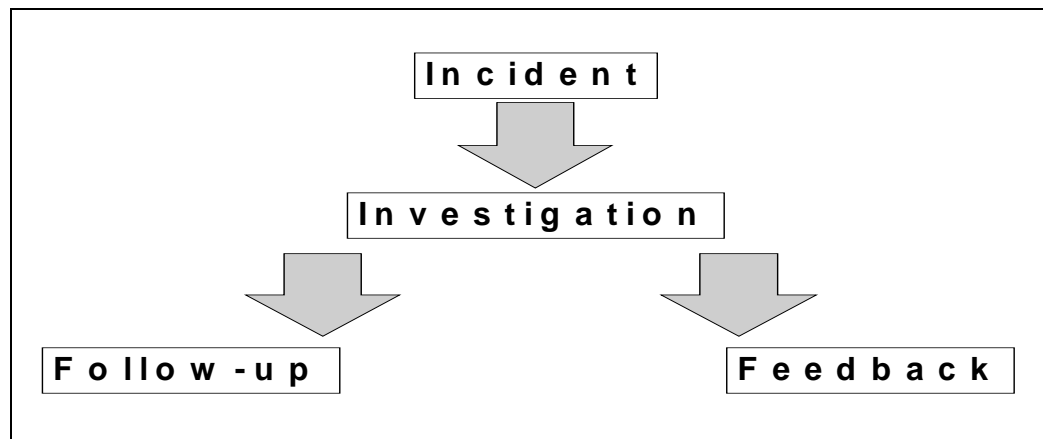


## 2.2 The Approach

### 2.2.1 Overview

Incident investigation should be seen as a bottom-up approach (see [Figure 1](#)):

- The **first step** is the investigation into risk factors that contribute to the occurrence of the incident to be identified.
- The **second step** is to suggest recommendations in order to eliminate as many as possible of those factors in the operational environment.
- In parallel, and as the **third step**, the lessons learned from the investigation should be spread around the entire organisation and more specifically to those affected by the risk factors identified.



[Figure 1](#): Approach overview

### 2.2.2 The Investigation

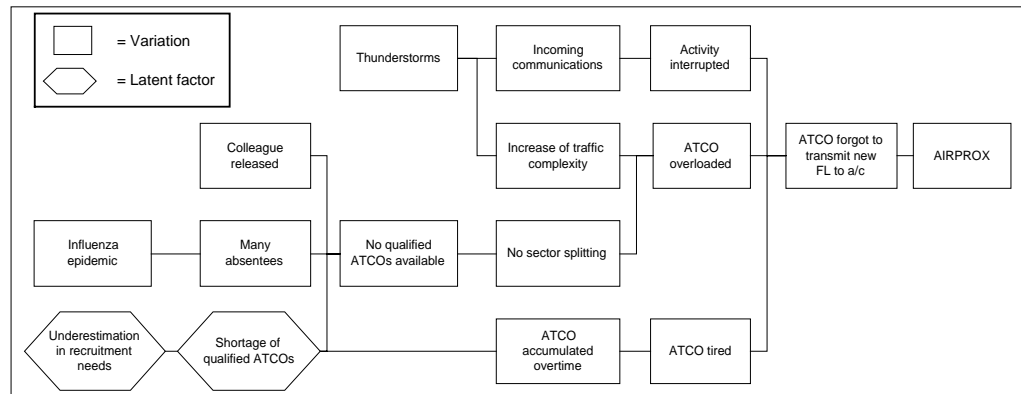
The main purpose is to use the incident as a starting point of the investigation and, in a very open way, to come back up as far as possible in the chain of events, facts or factors that have contributed to the occurrence.

It is a truism that incidents and accidents tend to be the result of a chain of causal and/or contributory events. It is also recognised that some of the factors contributing to the occurrence of an accident or incident are permanently present in normal working conditions.

Looking at these chains of events allows to consider the whole system and not only the individual. HF input involvement is of value because it can be one of the ways in which the scope of error causation is extended from the so-called 'person at the sharp end', to a consideration of the wider aspects underlying the organisation and its structure and function.

The causal tree, as shown in [Figure 2](#), is built on the introductory case and illustrates the approach promoted by HF specialists.

Starting from the incident, the 'why' of each fact has been searched and a logical diagram, 'the causal tree', showing the cause-effect relationship between contributing factors has been constructed.



**Figure 2:** Causal tree of the incident

**Note:** The diagram has to be read from right to left starting with the ultimate fact: the airprox. The elements on the left are the explanatory factors (explaining why) of those on their right.

The causal tree helps to illustrate some of the basic principles of the approach:

- The investigation must go far beyond the human error at the 'sharp end' level (Air Traffic Controller (ATCO) forgot to transmit change level).
- There is a chain of elements/factors that preceded the occurrence and all of them have contributed to the occurrence.
- None of the contributors is sufficient to explain the occurrence.
- Each contributor has by itself increased the probability of the occurrence.
- The combination of all the contributors has led to the incident.
- Some contributing factors are very instantaneous (thunderstorms) while others have existed for a long time (shortage of qualified controllers).
- Some factors exist in a non-incident situation.
- Some permanent factors (shortage of qualified controllers) may become very critical in unusual situations (influenza epidemic).
- Human error can take place at any hierarchical and organisational level of the system (underestimation of operational requirement).

- Understanding why the incident happened is much more instructive and allows a wider range of recommendations and prevention actions than the ultimate human error.

### 2.2.3 Follow-up

Learning from experience is the principle to follow.

Having identified the contributing factors, follow-up procedures will suggest recommendations and set up prevention actions in order to avoid future similar occurrences, to diminish the probability of the same occurrence and to detect comparable incident-prone situations existing in the operational environment.

#### 2.2.3.1 *Based on a Single Incident*

The first step will be to learn from one specific incident.

Table 1 suggests some recommendations and actions that can be applied to reduce the risk of occurrence of the above case.

Table 1 : Recommendations

Identified Factors	Recommendations
ATCO forgot to transmit new FL to a/c	<ul style="list-style-type: none"><li>• Raise supervisors' awareness of error-prone situations</li><li>• Train ATCOs to manage stressful situations better</li></ul>
ATCO tired because of overtime work	<ul style="list-style-type: none"><li>• Establish or review rules to limit overtime</li><li>• Ask supervisors to balance overtime between ATCOs and not allow some to overdo it</li><li>• Ask ATCOs not to overdo their overtime and help them to identify fatigue symptoms</li></ul>
Many absentees because of flu	Next winter - organise a flu vaccination for staff
Underestimate of manpower need	<ul style="list-style-type: none"><li>• Identify the causes of the underestimate and revise the current estimate for future needs</li><li>• Develop a reliable system to better estimate future needs</li></ul>



Recommendations suggested in Table 1 highlight some basic factors:

- More than just one recommendation can be made for each contributing factor.
- There are generally short-term actions that can be applied immediately (brief controllers).
- Some remedial actions require more time to be applied (define or review rules limiting overtime).
- Some are inexpensive (recommendation to supervisors).
- Some suggest more investment (flu vaccination - development of a system for future manpower needs estimation).

Remediation at the individual level is only ever going to be of limited value. At best, it may help the individual to mend his ways, but it is likely to do little in terms of future prevention in more general terms. Overlooking the possibility of system-based antecedents in error occurrence is to overlook the opportunity of taking more far reaching preventative measures.

In general, acting on the more anterior factors (those which are at the left end of the causal tree) will give the best chance to improve safety.

Among the set of all possible recommendations some could be more relevant and efficient than others; that is why they have to be evaluated based on objective criteria, for example:

- priority setting - urgency of the problem,
- feasibility and applicability of the measure,
- expected span of generality,
- effectiveness in solving the problem,
- stability of the measure,
- acceptability of the measure.

### **2.2.3.2 *Based on Several Incidents***

A further step in improving safety will be to learn from several incidents. It will help to identify the most frequent factors contributing to incidents and to identify priorities in action.

For instance, if in regrouping data collected from several incidents, a certain factor reappears frequently (for example: the controller was tired due to overtime), it will emphasise the need to take strict measures on this factor.

The higher number of incidents taken into consideration, the more relevant the safety improvement will be, based on:

- statistics,
- risk inventory,
- specific actions,
- prevention (proactive detection of risk).

## 2.2.4 Feedback

Feedback is a key element in making **all the members** of the organisation more aware of their role and contribution to safety improvement.

The results of the investigation can be used as a learning case for ATCOs, and the whole organisation can learn from it. Illustrated by the case, feedback can be sent to the management, the human resources or medical department, the supervisors, etc.

Who is concerned by the feedback will mainly depend on the kind of results found.

**The lessons learnt from the successful handling of an incident or accident are equally valuable. It is important that successful performance be given as much 'publicity' as inadequate performance for its learning and motivating effect.**

## 2.2.5 Approaches to Safety: Re-action vs. Pro-action

Taking action only after an incident has occurred is not prevention

The risk factor inventory established by the investigation of incidents can be used in normal situations (non-incident) as a risk assessment tool (a kind of internal specific checklist) which enables preventative actions to be taken in order to eliminate the risk before an occurrence. This is real prevention.

Figure 3 shows two approaches to safety.

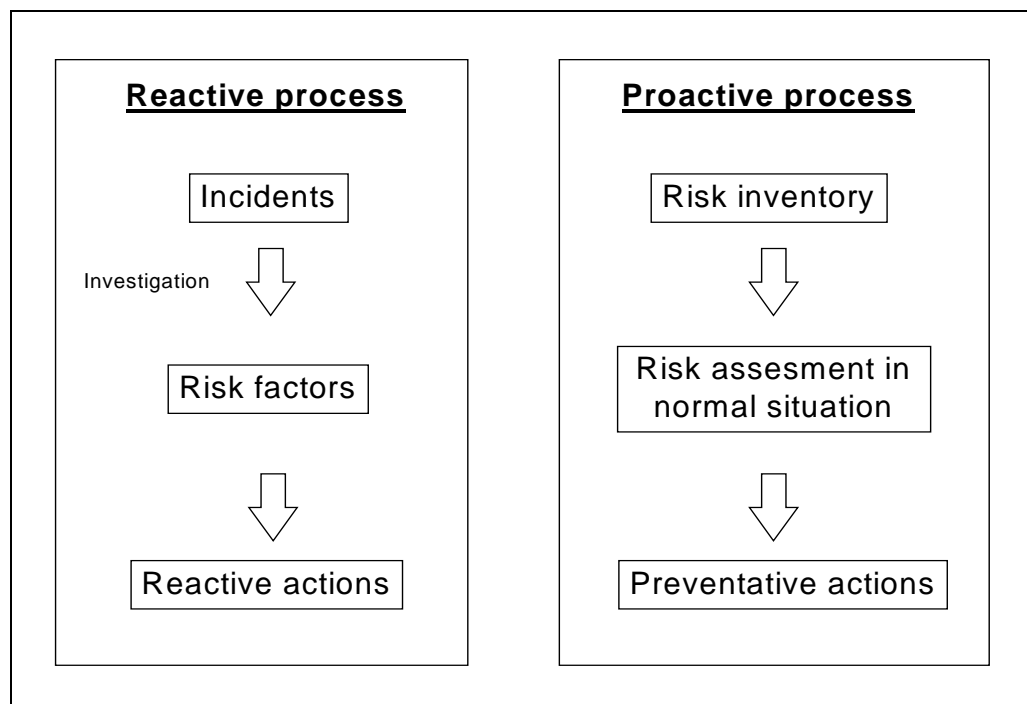
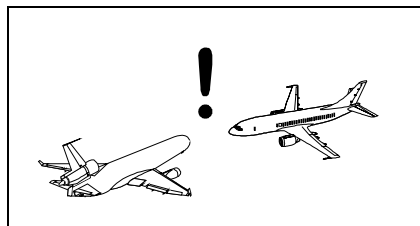


Figure 3: Approaches to safety: re-action vs. pro-action

## 2.3 Understanding Human Error

*A study has shown that particular times are error-prone for a controller (Isaac, in press):*

- *in light to moderate traffic conditions and complexity,*
- *when a controller has had less than six years' experience,*
- *after a break,*
- *during controller's first 15 minutes on a position.*



### 2.3.1 What is a Human Error?

A human error may be defined as an unintentional action or lack of action, a decision or lack of decision at any hierarchical or organisational level that is or has been inappropriate in the given situation.

Human errors are not only caused by the distraction of the controller or the lack of communication between the pilot and the controller. They can be found in human activities throughout the whole organisation.

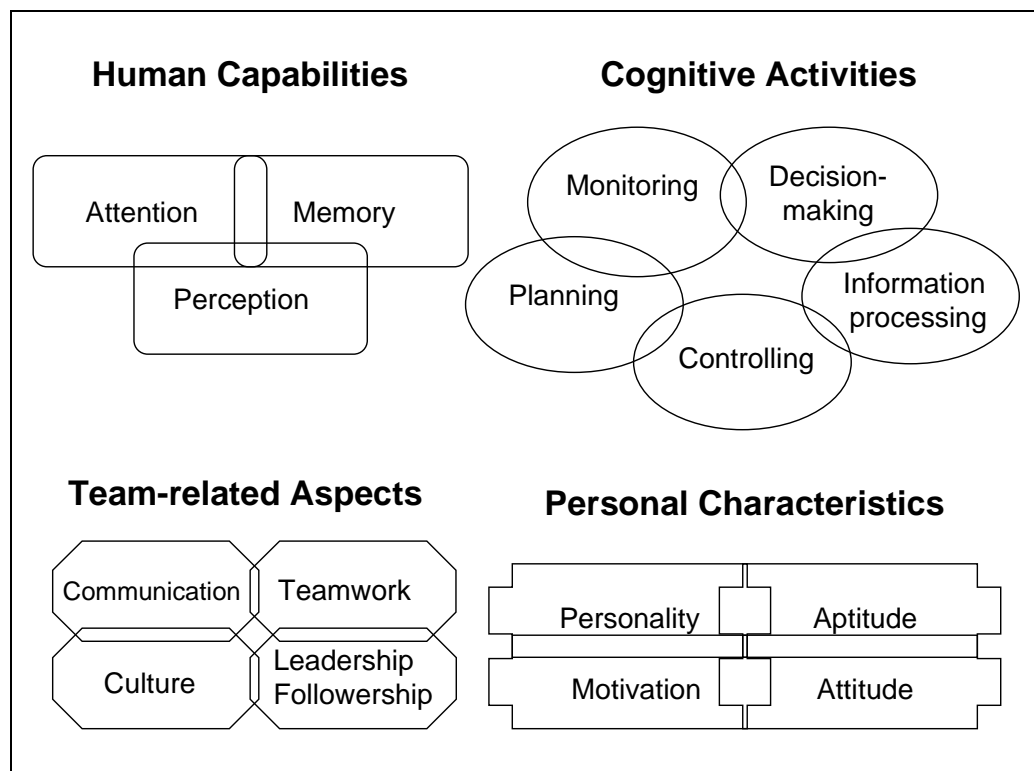
Human errors can be identified at all levels:

- At **managerial level**, they can, for instance, consist of taking a wrong decision to reduce the training budget, or of not taking action when a problem occurs.
- At **design level**, it can be a wrong requirement not suitable for the operation.
- At **maintenance level**, it can be bad quality in maintaining the system.
- At **supervision level**, it can be a non-decision to split a position although it is obvious that the traffic is very dense.

### 2.3.2 Where is the Error?

Humans and their activities are very complex. As shown in [Figure 4](#), errors can be made due to:

- limitation of human capabilities,
- errors in cognitive activities,
- difficulties in team-related aspects,
- inadequacy in personal characteristics,
- or any combination of these elements.



**Figure 4:** Sources of error

Some factors influence human reliability. These include:

- training and experience,
- stress,
- fatigue,
- workload,
- ergonomic factors,
- working hours,
- social climate,
- private factors.

### 2.3.3 Classification of Human Errors

There are five categories of error found in any system or organisation which is managed by people (Maurino et al., 1995):

- attentional slips,
- memory lapses,
- perceptual errors,
- mistakes,
- violations.

The attentional slips, memory lapses, perceptual errors and mistakes are unintended. Violations are deliberate, and some of them can become routine.

Each error category consists of different error types, and can originate from an error source (see [Table 2](#)).

**Table 2:** Human error categories - error types and error sources

<b>Error Category</b>	<b>Error Type</b>	<b>Error source</b>
<b>Attentional slip</b>	<ul style="list-style-type: none"><li>• Intrusion</li><li>• Omission</li><li>• Reversal</li><li>• Misordering</li><li>• Mistiming</li></ul>	<ul style="list-style-type: none"><li>• Human capabilities:<ul style="list-style-type: none"><li>– attention</li></ul></li></ul>
<b>Memory lapse</b>	<ul style="list-style-type: none"><li>• Forgetting intention</li><li>• Losing place</li><li>• Omitting planned action</li></ul>	<ul style="list-style-type: none"><li>• Human capabilities:<ul style="list-style-type: none"><li>– working memory</li></ul></li></ul>
<b>Perceptual error</b>	<ul style="list-style-type: none"><li>• Expectation driven perception</li><li>• Habit driven perception</li></ul>	<ul style="list-style-type: none"><li>• Human capabilities:<ul style="list-style-type: none"><li>– perception</li></ul></li></ul>
<b>Mistake</b>	<ul style="list-style-type: none"><li>• Rule-based mistakes:<ul style="list-style-type: none"><li>– application of wrong rule,</li><li>– misapplication of a good rule</li></ul></li><li>• Knowledge-based mistakes:<ul style="list-style-type: none"><li>– decision-making based on incomplete evaluation of the situation</li><li>– similarity bias</li></ul></li></ul>	<ul style="list-style-type: none"><li>• Human capabilities</li><li>• Cognitive activities</li><li>• Personal characteristics:<ul style="list-style-type: none"><li>– aptitude</li></ul></li><li>• Poor training</li></ul>
<b>Violation</b>	<ul style="list-style-type: none"><li>• Routine violation</li><li>• Rule violation/deviation</li><li>• Procedure violation/deviation</li><li>• Regulation violation/deviation</li><li>• Risk taking</li><li>• Exceptional violation:<ul style="list-style-type: none"><li>– violation forced by circumstances</li></ul></li><li>• Act of sabotage</li></ul>	<ul style="list-style-type: none"><li>• Personal characteristics:<ul style="list-style-type: none"><li>– motivation</li><li>– attitude</li><li>– personality</li></ul></li><li>• Team-related aspects:<ul style="list-style-type: none"><li>– culture</li><li>– leadership/followership</li></ul></li></ul>

### 2.3.4 Examples of Human Error in Air Traffic Control

#### **Attentional Slips**

- Annotating a wrong flight strip.
- Incorrectly annotating flight data display.

#### **Memory Lapses**

- Omitting items in action plan.
- Forgetting to annotate a flight strip.

**Perceptual Errors**

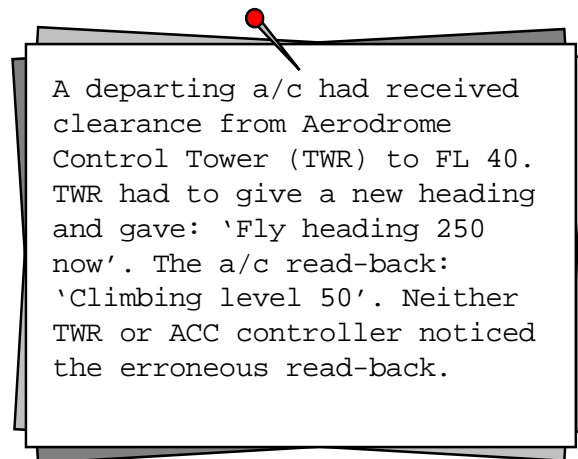
- Error in read-back - hear-back.
- Call sign confusion.
- Misreading of information.

**Mistakes**

- Give instruction to an a/c based only on radar screen information without checking the flight strips.
- Lack of monitoring after placing an a/c on direct routings.
- Focusing attention to deal with an urgent situation and not updating information regarding current traffic.

**Violations**

- Non-use of correct phraseology.
- Shortcuts in a/c identification.
- Procedure deviation.



### **3. IMPLEMENTATION OF THE HUMAN FACTORS PERSPECTIVE**

This chapter gives an overview of the way to implement a reporting scheme and will therefore be of particular interest to management.

#### **3.1 General Considerations**

Some points may be made on the implementation of a HF programme on accident and incident investigation:

- While Critical Incident Stress Management (CISM) deals with the emotional consequences of those involved in an incident, HF A/I investigation will concentrate only on the factual aspects. It is therefore very important to establish a clear separation between the two approaches and to ensure that those in charge of CISM and those involved in the HF A/I investigation are different people.
- Experience in the UK, Sweden and the USA has shown that gaining the trust of people in the reporting system is a long and patient process.
- Despite the claim of a no-blame policy within an organisation it may not be perceived as such in practice. It is important, therefore, to enforce the policy in order to establish a climate of confidence within the organisation. Other factors such as the perception of respective roles, power distance, size of the organisation, type of relationships, etc., also affect confidence in the system and consequently the willingness to report.
- Experience has also shown that the benefits of a good safety system are a self-promoting spiral; the investigation of incidents and its feedback will make people more aware of the importance of HF; this awareness will in turn cause an increased demand for safety.
- The more cases are investigated, the more the investigators are able to build up a wide picture of the problems encountered and gain an understanding of any trends. The more data available, the firmer the basis on which conclusions and decisions can be made. Data can be stored in a database and thus provide the investigator with a baseline from which to assess whether subsequent occurrences are a further indication of a known problem or are an unfortunate 'one-off'.
- A negative connotation is often attached to the term and the idea of human error. So the fear of being judged for an erroneous action might still inhibit reporting.
- The best way to encourage reporting and fight the ATCO's resistance to report is to set up a trustworthy and efficient reporting system.

- Information on the purpose of the system and feedback to the user are two key elements for gaining confidence. The established scheme should make clear to everyone that the purpose is to acquire information to prevent similar occurrences. Furthermore, because the effectiveness of the investigation is linked to the level of reporting, the policy should support and encourage open reporting when necessary.
- Feedback should be provided to the controllers involved when a report has been received (notification feedback), and when the investigation is over (feedback on the results, main contributing factors, recommendations made, etc.).

## **3.2 Support from Management**

The setting up of a properly-functioning safety system will not only need resources in terms of manpower and money, but will also require wholehearted support from management. As the activity should be created on the basis of a well-developed HF policy, the support of management, which has a profound influence on the making of this policy, is crucial in order to succeed and maintain the process.

## **3.3 Policy**

The establishment of a policy (principles of action) for A/I investigation is a primary and basic step on the way to including HF in the investigation of A/I. The policy should guide the actions taken and provide a sound basis upon which to make decisions.

Sub-chapters 3.3.1 to 3.5.3 elaborate on aspects to consider in the establishment of a policy, as well as a system for incident reporting and provision of feedback.

### **3.3.1 Non-Punitive System**

*'The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability.'*

*(ICAO, 1994, Annex 13, p. 4)*

It is imperative that controllers develop confidence in the value of reporting incidents, and that they realise the importance of reporting incidents. It should be emphasised that the objective is to learn from previous mistakes so as to improve the future; it is not to find the guilty party and punish them.



The selection of a non-punitive system may be the single, most important decision to make when establishing a safety system. The non-punitive system will, when fully developed and integrated, instil a responsible attitude among personnel towards the importance of incident reporting. The introduction and full appreciation of a non-punitive system is a subtle and long-term quest. Controllers will want to see such a philosophy work before they trust the motives.

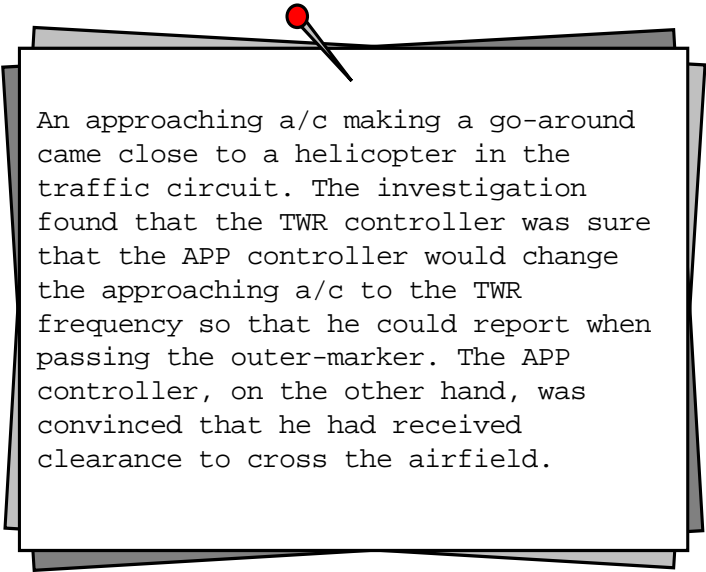
## 3.4 Reporting System

### 3.4.1 What to Report?

Depending on the type of incident, mandatory or voluntary reports can be filed. Based on ICAO requirements (1994), national rules indicate which events should be reported. It is important to establish, within the country concerned, a meaningful definition of what kind of incident is subject to mandatory reporting, even if it is impossible to list exhaustively every single hazard that requires reporting. As regards voluntary reports, it is also crucial to agree at least nationally on a clear policy on what to report.

Few would question the value of accident investigation for improving safety; however, incident investigation provides an equally useful set of HF data.

From the HF perspective, the behaviour manifested by the individuals or groups involved in incidents may not differ greatly from that observed in accident scenarios. The gravity of an accident will add another dimension to the situation in which the controller or pilot finds him or herself, but generally speaking, the cognitive failures, problems in decision-making, communication breakdown, distractions and all the other factors which contribute to the sum total of behaviour in an accident will also be present in incidents.



An approaching a/c making a go-around came close to a helicopter in the traffic circuit. The investigation found that the TWR controller was sure that the APP controller would change the approaching a/c to the TWR frequency so that he could report when passing the outer-marker. The APP controller, on the other hand, was convinced that he had received clearance to cross the airfield.

While it could be argued that a thorough investigation of a small number of accidents would yield data of such 'quality' that decisions could be made on the basis of this small but detailed data set, the focusing of attention on such a limited set of occurrences may overlook the opportunities offered by incident investigation to have prevented such accidents in the first place.

It has also been asserted that 'an incident investigation can often produce better accident prevention results than can an accident investigation' (ICAO, 1993). If this assertion is true, and many investigators believe that it is, it is still necessary to justify the cost and effort involved in the investigation of incidents.

#### **3.4.2 Who Notifies?**

Mandatory occurrence reporting schemes have to be filed by virtually all those involved in aviation, but they cover different types of occurrences and are pre-formatted for different types of information (see, for example, UK CAA (1996), Appendix A) as each person has a different viewpoint of the work system.

Anybody involved in aviation ought to be able to file a voluntary report (e.g. pilots, ATCOs, air traffic engineers, etc.).

In some countries, the investigation is triggered automatically, for instance using the Airborne Collision Avoidance System (ACAS) resolution advisory or Short-Term Conflict Alert (STCA) (Lemerrer, 1993). This simplifies the decision to report (yet a report still has to be done) and unifies the format and contents of the report.

#### **3.4.3 When to Notify?**

It is important to make the notification as soon as possible so that the investigation can start as quickly as possible; fax or internal mail service can be used. Notifications sent by (slow) surface mail may arrive so late that recordings of radar screen, RadioTelephony (R/T), etc., may have been erased. These information sources are only kept for a specified amount of time before being erased.

#### **3.4.4 Reporting Schemes**

Numerous reporting forms exist. National reporting schemes are most of the time produced based on the ADREP standard (ICAO, 1987), ensuring compatibility and international exchange of data.

Currently, in most of the European Civil Aviation Conference (ECAC) States, people involved in A/I are subject to a mandatory programme and complete a report which covers the incident as they saw it. In countries with a more elaborate system, this report includes such aspects as time on shift, shift start, equipment serviceability, etc. This could be extended to include additional subjective data such as perceived workload, distractions and more detailed data on the nature of the incident itself.

The issue of anonymity of reporting schemes is a delicate one; controllers would rather not put their name on a report, but this makes it much more difficult for the investigator to monitor follow-up action. Confidential schemes thus appear to be the solution. In such schemes, the ATCO puts his/her name, which may be communicated to management if desired, but will not be published in the report. For similar reasons, the centre or unit name is not published.

### **3.5 Establishing a Feedback and Follow-up System**

An integral part of establishing a reporting system is the establishment of a feedback system. The reporting provides the information basis upon which recommendations and advice can be given, and actions can be taken. Without a proper feedback system, incident reporting becomes obsolete.

Experience from the USA (Mayberry et al., 1995) shows that an effective response to a controller's first error can keep the error rate down significantly. The recommendations and advice should, however, not only focus on the human. Equally important are the organisation, the procedures and working methods used, and the information processing systems provided.

The follow-up system should contain means for checking if the recommendations given in the incident report are followed. It is important that the recommendations identify who should implement them. The system should systematically check and evaluate the implementation of recommendations. The responsibility of doing the follow-up should best be placed with the personnel who are empowered to act in the operational unit.

Some recommendations may have been followed, some may not. In the first case, the implementation should be evaluated to ensure that it really deals with the aspects identified. In the latter case, explanation should be sought as to why the recommendation was not followed.

As a result of increased privatisation, one of the problems seems to be that ATS providers and a/c operators want to try to limit the publicity around incidents as this may damage their reputation in the industry.

*'An incident or accident from which no lessons are learned is an incident or accident which has been wasted in air safety terms.'*

*(Weston & Baker)*

The purpose of investigating A/I has to be clear from the outset in establishing a safety system, i.e. to prevent similar accidents and incidents in the future.

ICAO Annex 13 recommends the establishment of a formal incident reporting system to facilitate the collection of information of actual or potential safety deficiencies (see [Sub-chapter 2.2.5](#)).

The findings can be utilised in a number of ways:

1. Feedback at local level.
2. Feedback at national level.
3. Annual report summarising events and trends.

### **3.5.1 Feedback at Local Level**

At the local level, feedback may be given at different stages. One should consider giving feedback:

1. To the controllers.
2. To the management.
3. On the human-machine system.
4. On the training system.
5. On the safety system.

#### **3.5.1.1 *Feedback to Controllers***

A meeting should be set up with controllers involved, soon after the release of the preliminary report. At the meeting, the investigation could be carried out by discussing the unfolding of the occurrence in order to ensure that the controller obtains full understanding of the chain of events.

The feedback should contain the briefing of the controller involved and other relevant persons.

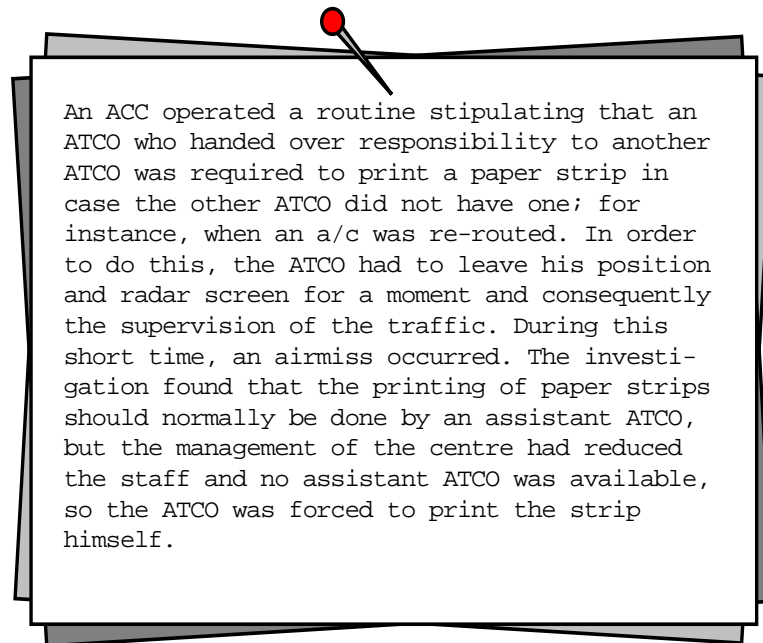
It is important that the treatment appears equal for everybody. This increases confidence.

#### **3.5.1.2 *Feedback to the Management***

As already touched upon in the introduction, the management may be in a better position to act on issues related to the overall structure of the operation. It is therefore essential to provide the relevant management sections with feedback.

#### **3.5.1.3 *Feedback on the Human-Machine System***

The analysis and consequent conclusions drawn from the investigation may reveal shortcomings in the system supporting the controller in his work. These shortcomings may range from system malfunctions to the inadequate design of the system. The investigator should be alert to the possibility of suggesting changes to the human-machine system in order to exclude similar occurrences in the future.



#### **3.5.1.4**      *Feedback on the Training System*

Feedback on the training system may include changes and improvements to the following types of training:

- *ab initio* training,
- Team Resource Management (TRM),
- continuation training,
- emergency training.

#### **3.5.1.5**      *Feedback on the Safety System*

The maintenance and improvement of the safety system requires feedback from the event. Experience shows that an internal control system may significantly increase the feedback at the organisational level. Part of the investigation will therefore have to audit the internal control system.

### **3.5.2**      **Feedback at National Level**

The incident report produced at the local level should be circulated to the national safety committees and ministries (such as the Ministry of Transport).

### **3.5.3**      **Periodical Reporting**

Summary reports should be issued periodically at regular intervals. The summary report should provide less detail on each A/I, but should summarise the events and provide some conclusive analysis. The periodical reports should include a summary of the type of causes and some basic statistics.

### 3.6 The Investigation Team

Flight safety approach, national standards and investigation procedures vary from a country to another.

Investigation work for a particular accident or incident is not only shared between local and national authorities, but also within each team. Many task distribution combinations are possible.

The choice is related to the incident, the national and local culture, and the resources available. It should be set in the stated policy. The level of investigation into an occurrence should be determined not by the cost of damage repair but by the mishap's potential to endanger flight safety.

#### 3.6.1 Level of Authorities Investigating

The investigation starts at a local level as data showing the facts are kept at the unit involved. The investigation can be kept at a local level, or transmitted to central ATS provider headquarters or the national regulatory body. Both alternatives have advantages and disadvantages as shown in [Table 3](#). The level of investigation, and how much should be done at local level will largely be determined by the stated policy.

**Table 3:** Local vs national level of authority

Local Investigation Team	National Investigation Team
Advantages	Advantages
<ul style="list-style-type: none"> <li>• Good knowledge of: <ul style="list-style-type: none"> <li>– the unit culture</li> <li>– local habits</li> <li>– local procedure</li> <li>– operational staff</li> </ul> </li> <li>• Less time consuming</li> <li>• Reduced pressure on the interviewees</li> <li>• Fast process (investigation can be initiated on the spot)</li> </ul>	<ul style="list-style-type: none"> <li>• Has more experience as involved in more investigations</li> <li>• Neutral position to staff and management</li> <li>• Identifies local deviations from procedure more easily</li> </ul>
Disadvantages	Disadvantages
<ul style="list-style-type: none"> <li>• May not be able to identify local routines which deviate from procedure</li> <li>• Less experience (due to fewer cases)</li> <li>• Difficulty in sharing lessons learned with other centres</li> <li>• Less objective if the team knows the person involved</li> </ul>	<ul style="list-style-type: none"> <li>• Has to visit units in order to do a good investigation</li> <li>• Travel expenses</li> <li>• More time consuming to understand local aspects</li> </ul>

**Whatever its level, it is crucial that the investigation team is independent and acts on behalf of the head of the organisation.**

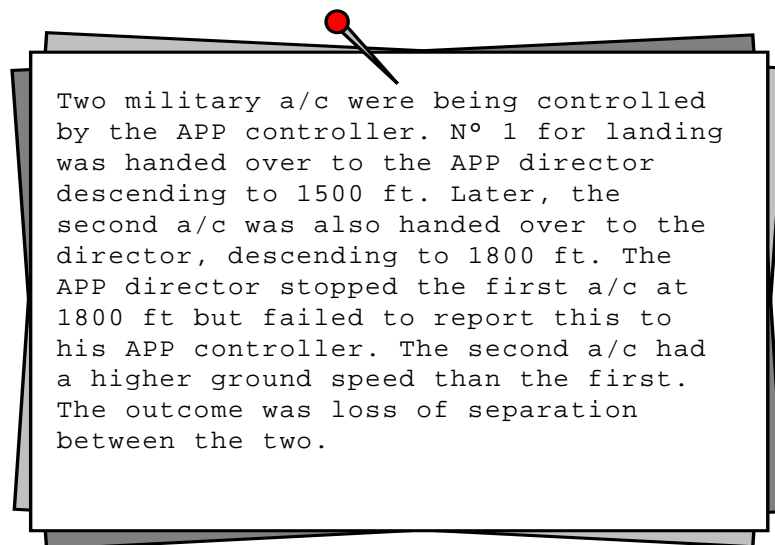
### 3.6.2 Human Factors and the Investigation Team

The investigation of HF aspects should be integrated within the global investigation process. From the start, the occurrence should be considered from a HF perspective by a member of the investigation team.

The ideal configuration is to have a HF specialist taking charge of this aspect of the investigation and co-operating with the other team members. In this case, each A/I reported is 'covered' from the HF viewpoint.

An alternative to the inclusion of a HF specialist within the team is to train generalist investigators in HF so that they can recognise HF problems, assess their relevance to the incident and identify cases where a HF specialist is needed. The HF analysis may be less thorough. However, some aspects may be underestimated, and the decision to hand over to a specialist is left to the discretion of the generalists. This configuration of the investigation team can still produce quite satisfactory results.

Whatever the alternative chosen, the HF specialists should be selected carefully, taking into consideration their experience in aviation psychology, ergonomics, medicine, and with the ATC workplace and tasks in particular.



### 3.7 Creating Awareness throughout the Organisation

The process of creating awareness towards HF and the topics covered should be conceived in several steps. It takes time for the awareness to settle in. Below are a number of initiatives to be taken on the path from initial awareness to structured training programmes:

1. **Newsletters and Periodicals:** provide a first introduction to HF. Subsequent issues may detail specific areas of HF.
2. **Bulletins and Stand-up Briefings:** incidents are published among the controllers preferably followed by a briefing to discuss the HF and how to prevent future occurrences.
3. **TRM:** training courses on HF and teamwork issues.

Findings from the USA (Mayberry et al., 1995) suggest that air traffic centres which have implemented TRM programmes have relatively low operational error rates. An example of requirements for a TRM training programme can be found in 'Guidelines for Developing and Implementing Team Resource Management' (EATCHIP, 1996).

### 3.8 Training the Investigator

If the investigator is not a HF specialist, he/she should receive training in HF so as to understand its major components and significance. Basic training should include following items:

- \* **Interview Techniques.**
- \* **Human Factors Knowledge:**
  - Team-related aspects (TRM):
    - communication,
    - leadership,
    - teamwork;
  - Cognitive aspects:
    - human performance and limitations,
    - perception,
    - vigilance and attention,
    - memory,
    - decision-making process,
    - situational awareness;
  - Working conditions aspects and their constraints:
    - environmental aspects (noise, light, etc.),
    - working time (shift schedule, breaks, etc.),
    - stress and fatigue,
    - workload.

It is equally essential that the HF specialist has a knowledge of ATC.



### 3.9 Aviation Accident and Incident Databases

A database of A/I may be introduced as part of the safety system to keep track of the trends and to provide the basis for statistical analysis.

The nature of such a database depends on the type of report it is intended to record. Reporting methods can be mandatory, voluntary or automatic. Mandatory or voluntary reports can be confidential or anonymous.

Several A/I databases are currently in use in aviation, e.g.:

- Air Traffic Services Investigations System (ATSIS) (UK);
- Confidential Human Factors Incidents Reporting Programme (CHIRP) (UK);
- Mandatory Occurrence Reporting Scheme (MORS) (UK);
- Confidential Aviation Incident Reporting (CAIR) (Australia);
- Aviation Safety Reporting System (ASRS) (USA);
- European Co-ordination Centre for Aircraft Incident Reporting Systems (ECC-AIRS) (EC).

The only database dedicated to ATS is ATSIS (UK).

ICAO provides the ADREP database (ICAO, 1987), which is a system enabling the recording of a series of factors describing what happened as well as a series of factors explaining why it happened.

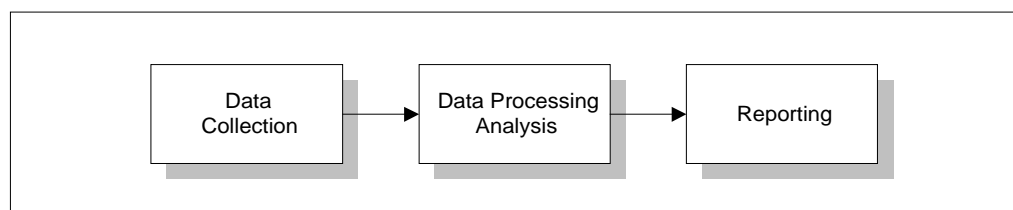
In establishing a HF database system, care should be taken to ensure user-friendliness. Experience shows that in order to facilitate the design of a good database, good communication should be established among database designers and operational, technical and HF specialists.

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## 4. ACCIDENT AND INCIDENT INVESTIGATION

### 4.1 Human Factors Investigation as an Integrated Part of the Investigation

The task of the A/I investigator(s) can be seen as a three-step process (see [Figure 5](#)). Data collection and analysis allow a better understanding of the occurrence. Reporting is a way to transmit the lessons which can be learned and provide feedback in order to improve safety.



**Figure 5:** Overview of the incident or accident investigation process

The investigation of HF elements is not a separate process: it follows the same steps and is triggered by the same event than any investigation. The only difference with traditional investigation is the focus put on the human-related factors. It is crucial to consider the HF investigation as an integrated part of the investigation.

Efficient teamwork within the investigation team is therefore required. When the analysis from the HF viewpoint is made by a HF specialist, the draft report issued on the results of the analysis can be discussed within the investigation team. Comments and versions provided by other team members may help in giving the human aspects their rightful place. Yet A/I investigation is a teamwork, and interactions and exchanges with other team members can be very fruitful, and are necessary.

### 4.2 Data Collection

In this sub-chapter we address the nature of the data examined and the tools or techniques used to gather it.

#### 4.2.1 What Data?

##### 4.2.1.1 *The Facts*

As a first step, the HF investigation attempts to reconstruct the sequence of events that happened and seeks evidence of the facts. The main sources of information about what can be seen as the links in the A/I chain are:

- reporting schemes (mandatory or voluntary);
- R/T recordings (or transcripts);
- telephone and intercom recordings;
- open microphone (voice recording between executive controller and planner controller may be relevant);
- radar data (plot and legal recording);
- Flight Progress Strips (FPS) and Flight Plans (FPL);
- interview;
- visit to units in case of national investigation team.

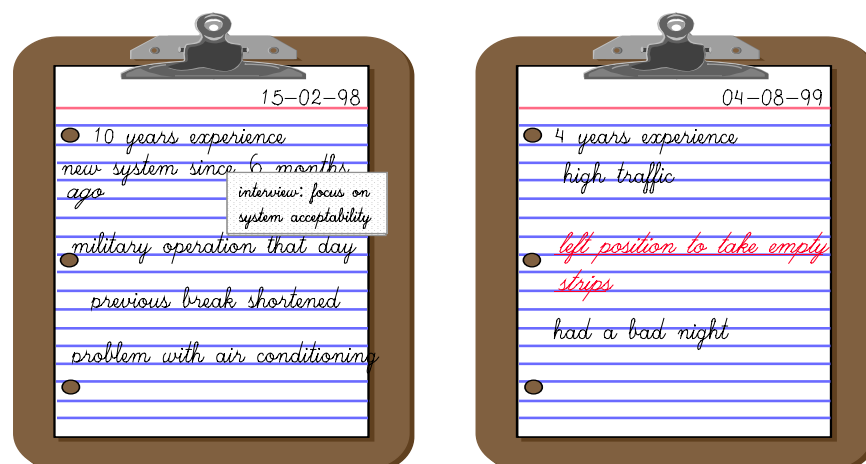
#### 4.2.1.2 *The Context*

As a second step, the HF investigator tries to reconstruct the context and to look under the surface. The information sought is not only concerned with *what* happened but also with *why* it happened.

Depending on its complexity, an event may include several causes, and the need for obtaining a large amount of information will vary accordingly. Moreover, the temporal dimension in the incident or accident is important; the explanation of the occurrence requires an understanding of its dynamic. For instance, information must be collected in order to understand when the occurrence started, and what its important phases were.

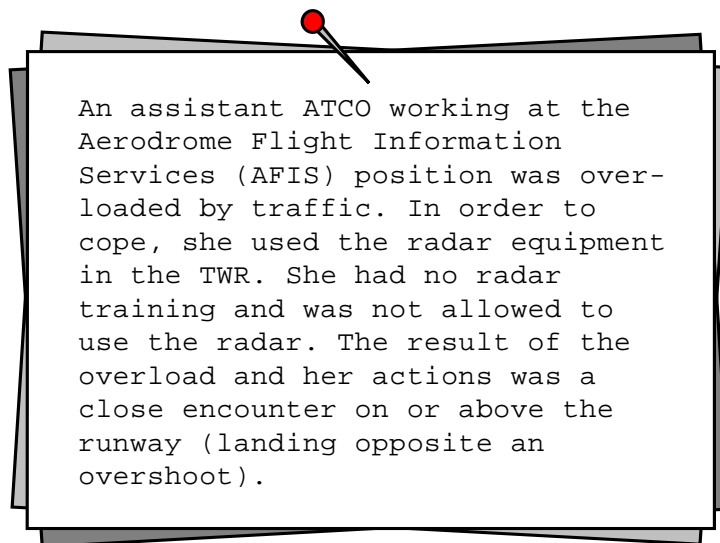
Initial assessment of the A/I will allow the investigators to focus on the collection and analysis of those data which are most relevant.

Data to be collected may relate to operations room ergonomics, local operating instructions (what do the rules say) including temporary operating instructions, local unwritten rules (what is usually done), personal practice, personal data (age, education, experience...) and any relevant background information.



#### 4.2.1.3 *When to Stop Collecting Data?*

When searching for information, it might sometimes be difficult to identify when to stop tracing back and looking for more data. Indeed, it is hardly ever possible to claim that all relevant information has been collected. It is thus the investigator's responsibility to balance the effort required against further refinement and to decide when the data collected is sufficient to provide an explanation.



#### 4.2.2 **How to Collect Data?**

Manuals and charts in use at the time of the incident, visits to units, R/T, reporting schemes, re-enactment tools and interviews are the main sources of operational and HF-related information. As it is particularly fruitful, interview technique is treated separately in Sub-chapter 4.2.3.

**Reporting forms** completed by personnel involved in the occurrence can add substantially to the global picture of the event. Free text boxes are the most valuable field in reporting schemes as they allow personnel to highlight and mention factors that may be presented in the pre-defined form (such as subjective workload).

In the case of investigations performed by a central body, **visits to units** can help as they enable investigators to see the ergonomics of the system used, as well as the manuals and any other forms describing local regulations, and to have a better idea of the organisational climate.

**R/T** is very interesting not only for the content of the communication but also because the voice pitch and speed delivery provide a good understanding of stress and workload. Moreover, R/T can show evidence of a lack of communication, low attention span, etc.

**Re-enactment tools** synchronising radar and communication recordings can be effective when combined with an interview, or more generally for assessing workload and other factors. Auto-confrontation (the involved controller takes the seat and the scene is re-played) can be very fruitful, as the involved controller may then realise what the problem was and why the event occurred; yet it can also be very stressful for the interviewee. An interview provides the opportunity to elicit supplementary clues (e.g. non-recorded elements, such as the mental picture of the situation, the intention of the controller, etc.), and thus arrive at a better understanding of the event. It can also help to formulate, confirm or debate a hypothesis.

Classification schemes or **checklists** related to the 'Software - Hardware - Environment - Liveware' (SHEL) model (Hawkins, 1975), or ADREP can be used as a reminder of the various groups of factors to be taken into consideration, and can serve as a basis for gathering information during interviews (ICAO, 1993). Some caution should be exercised, however, as the data may be limited to the contents of the checklist rather than reflecting the nature of the specific incident, and some components such as cognitive aspects are less likely to be taken into account.

### 4.2.3 Interview

The interview remains the most appropriate technique for assessing behavioural and contextual data.

#### 4.2.3.1 *People Involved in Interviews*

##### **Who Conducts the Interview?**

In order to avoid putting too much pressure on the interviewee, it is recommended that the investigation team co-ordinates its interview(s) and refrains from performing too many of the same person. The quality of the information supplied could be reduced. A solution would be to perform one integrated interview, prepared by the whole team and led by an investigator during which specialists may also contribute.

##### **Who Is Interviewed?**

The interviewees will usually be ATCOs. They can be accompanied by a peer or a management representative if desired. Investigators should be aware that the presence of a management representative (during an interview) can be counterproductive as it may inhibit the interviewee in some circumstances. As a general rule, it is beneficial both to the interviewees and to the investigators to equalise the number of people from both 'sides' participating in the interview. In fact, such a balance reduces pressure on the interviewee, and allows the interviewers to introduce some variation in the interview style and to

use colleagues as a backup if needed. Management and supervisors can also be interviewed in order to obtain information about the culture of the unit, the reporting chain, the attitude towards HF, etc.



#### **4.2.3.2**      *Conducting Interviews*

##### **Preparation**

Investigators have to be prepared to deal with details of a more private nature concerning the interviewee, if this is related to the incident. Interview preparation is very important, not only to avoid re-interviewing but also to obtain the best possible collaboration and good quality HF information without having to go into too much detail at a private level.

It is beneficial to gather as much information as possible before the interview, to listen to the R/T, look at the radar record and plan the questions<sup>1</sup> to ask. Explaining the interview structure to the interviewee may also help him to understand the aims and phases of the interview.

##### **Interview Duration and Atmosphere**

It should be kept in mind that interviews ought not to be too long (two hours maximum) and performed as soon as possible, as the interviewee may forget the details of the occurrence. Moreover, the rationalisation<sup>2</sup> bias could increase if there is a long time between the event and the interview.

During the interview, it is important to set a tone that is not too far from the expectations of the interviewee in order to create confidence without causing confusion about the role of the investigator. The place should be comfortable, with style and vocabulary adapted to the interviewee. However, it is important

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<sup>1</sup> A list of questions that can be used for the investigation of teamwork-related aspects is provided in Annex 2.

<sup>2</sup> Tendency to find a plausible -rational- explanation or justification of the facts occurred.

to maintain a professional approach. As stated earlier, the investigation interview is distinct from the CISM interview, even if some of the facts discussed are the same.

### **Information Elicitation and Storage**

Effort should be made to ask **open questions** and use leading (or closed) questions only for intended purposes, for instance, reformulating of the interviewee answer. Open questions usually start with the words 'what', 'who', 'when', 'why' or 'how' ('How was your stress level then?'), whereas leading questions prejudge the response, can usually be answered by yes or no, and start with a verb ('Didn't you feel that you were quite stressed?'). Active listening is another key element in interviewing technique; it implies paying attention to what is said and to body language, and consists of repeating or re-wording the interviewee's answer in order to avoid misunderstanding but also to elicit as much information as possible.

One might also consider the use of some means to prompt the recall while talking; for instance, a drawing (or a print) of a radar picture, transcripts of communications, photos (or a video) of the reconstruction. HF checklists (ICAO, 1993) could also be used for guiding the discussion as HF are grouped by clusters and presented in a hierarchical way (Feggetter, 1982).

During interviews, as during the whole investigation process, it is important not to jump to conclusions. It is equally important to search for elements which might disprove the hypothetical explanation of what happened rather than confirm it.

It could be useful to keep track of interviews by tape recording them or by taking notes. However, this may change the atmosphere and even be counterproductive as interviewees may express themselves less easily. When recording or note-taking, it is important, in order to establish a climate of confidence, to give the interviewee right of access to the recorded material. National legislation may cover this point in the case of an accident.

## **4.3 Human Factors Data Processing - Human Factors Analysis**

### **4.3.1 Aim and Scope of the Analysis**

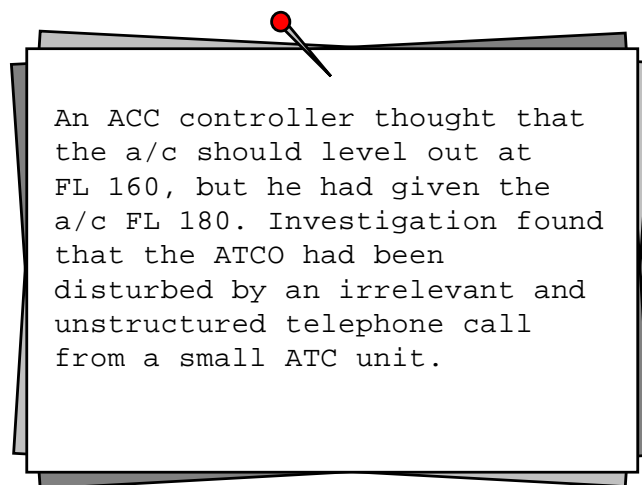
When enough data have been gathered, the analysis can start. According to the policy and the nature of the occurrence, data processing can either consist of searching for one scenario where each piece of information previously collected makes sense, or of considering the various clusters of information and their interaction, i.e. establishing a causal network to explain the context of the occurrence.

Whatever the chosen approach, the purpose of the investigation is to prevent a re-occurrence of the event. This consideration sets the scope of the analysis.



### 4.3.2 Methods and Tools

The investigator's HF knowledge and expertise are often the prime resource for analysing the HF data collected. There is no proven method for leading 'human factors investigations'. Investigators may use HF frameworks such as the SHEL model or human error models (Wiegmann et al., 1997) or any psychological theories (on situational awareness, communication, etc.) as a way of structuring their thoughts or interviews. This also makes them follow a more systemic approach. Such models can also be used for crosschecking hypothesis. However, they all have limitations that need to be kept in mind.



### 4.3.3 Human Factors for the Human Factors Investigator

The investigation into the HF aspects of an occurrence often brings to light both the strengths and the limitations of the human being (controllers, technicians, management, designers, etc.). Investigators are human beings too; they may therefore be subject to bias, and the same strengths and limitations as the interviewees.

The uncertainty of the logical relations considered during the analysis phase means that inductive reasoning might not be very reliable. Moreover, deductive reasoning could also be difficult because of the number of factors that have to be taken into consideration. Furthermore, investigation of HF aspects deals with qualitative rather than quantitative data, which makes it even more difficult to draw unequivocal conclusions.

Investigators could also be fooled by biases (Green, 1992) such as confirmation or belief biases: they could have the tendency to look for information that confirms the current hypothesis and overlook the clues going against it.

During interviews, the investigator may misjudge factors elicited due to his perception of the interviewee.

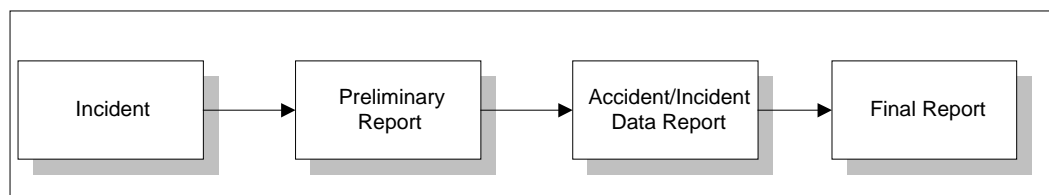
Investigators should be aware of these phenomena because awareness is one of the best protections against bias. They should also try to remember that they must only stick to the facts and avoid speculation as much as possible.

## 4.4 Report Writing

The circular issued by ICAO (1990) on the 'Investigation of Human Factors in Accident and Incidents' is considered to be the common reference for the reporting of A/I. While regarded as a major guideline on the subject, it is not directed towards ATS in particular, and current practice shows that it is normally only used in case of accidents or major incidents.

As shown in [Figure 6](#), the ICAO Annex 13 (1994) specifies up to three separate reports for any one accident or incident:

1. A preliminary report.
2. An A/I data report.
3. A final report.



**Figure 6:** Reports suggested by ICAO (1994), Annex 13

ICAO (1990) suggests the following structure for the investigation report:

1. **Factual information:** What happened, including information pertinent to the understanding of the circumstances surrounding the occurrence.
2. **Analysis:** Development of the reasons why the circumstances resulted in the accident, creating the bridge between factual information and conclusions.
3. **Conclusions:** Should follow logically from the analysis and should be consistent with the analysis. All hazards should be appropriately identified.

The digest specifies that the preliminary report should be submitted to the appropriate States and to ICAO in one of its official languages within 30 days of the date of the accident (unless the A/I data report has already been sent). The final report should, in the interest of prevention, be submitted as soon as possible.

#### 4.4.1 Current Practice

Widespread practice shows that the ICAO guidelines are only used in the case of accidents or serious incidents. In all other cases, the reporting may consist of only two reports:

1. A preliminary report.
2. A final report.

The investigator should establish a time schedule for the report writing and adhere to it.

The **preliminary report** should be issued as soon as possible, e.g. within two weeks of the incident, allowing for the collection of data about the event and an initial meeting with the controller involved. It may be beneficial to allow the controller to bring a peer to the meeting. For the sake of maintaining the controller's trust in the investigation mechanism, it is equally important that management representatives are neither present nor involved in the meeting.

It is recommended that the local investigation end after a few days or even a few hours if possible. At national level, it should not last too long.

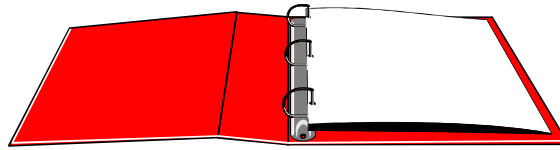
The people involved in the incident should be allowed to check the draft before the report is issued.

The **final report** should be issued after further processing and consultation. It should be released within two months of the event.

The final report, after removing all identification data, should be distributed to all personnel involved, all ATC units, the flight safety authorities and other involved services (e.g. the air carriers involved). In special circumstances, the reports may be sent to administrations and services in other countries.

#### 4.4.2 Report Contents

The report should only refer to data relevant to the explanation of the incident. The report should be addressed to management, but the perspectives of the other readers should be kept in mind. The table of contents shown in Figure 7 may serve as a template for the report.



The report should explore:

1. Why the incident happened.
2. What was going wrong (e.g. human or system failure).
3. What should be done to make the system safe (see Sub-chapter 3.5).

Graphical traffic representations can be inserted in the report to facilitate the understanding of the ATC situation.

The non-exhaustive table of contents in [Figure 7](#) gives a basic idea of the report structure.

<b>Table of Contents</b>	
<b>1. Introduction</b>	
<b>2. Statement of the facts</b>	
2.1	The event
2.2	ATS personnel involved
2.3	A/c involved
2.4	Airspace involved
<b>3. Analysis</b>	
3.1	Regulations involved
3.2	Course of events
<b>4. Other observations</b>	
<b>5. Summary</b>	
<b>6. Conclusion</b>	
6.1	Probable causes
6.2	Contributing causes
<b>7. Measures already taken</b>	
<b>8. Suggested measures</b>	

[Figure 7](#): Table of contents of an accident/incident report

## **4.5 Conclusion**

With its specificity, the investigation of HF deserves to be totally integrated in the investigation process. Its complementarity with the other points of view generally allows a better understanding of the occurrence.

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## **ANNEX A LIST OF QUESTIONS CONCERNING THE INVESTIGATION OF TEAM-RELATED ASPECTS<sup>3</sup>**

This list of questions was issued by the Working Group (WG) on 'Teamwork and the Investigation of Accidents and Incidents' organised during the Second EUROCONTROL Human Factors Workshop on 'Teamwork in Air Traffic Services' held in May 1997 in Luxembourg (EATCHIP, 1998).

### **Team Characteristics**

- How long has this team been working together?
- Has this team been involved in an A/I before?
- Do they feel, think and behave as a team?
- Do they blame one member for the incident?
- Could the same have happened with another team?
- Has each team its own characteristics?
- How was the balance between risk, safety and job satisfaction?
- How was the team balance broken?
- Why did it happen?

### **Team Roles and Organisation**

- Are the tasks, role and responsibility of each team member clearly defined?
- Is every team member aware of his or her role in the team?
- Is there a team leader?
- Is she or he a formal or informal team leader?
- What is his or her role?
- Was all information available and obtainable by the controller?
- Where was the error/failure?
- Who should/could have noticed the error(s)?
- What would have been the right way to act?

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<sup>3</sup> This list does not cover all HF; cognitive aspects, working conditions, personality traits, etc., should also be considered by the investigator

- Was the team size appropriate for the task?
- What was the workload and task demand at the time of the incident and just before?
- Was any particular team member overloaded?

**Team Relationship**

- Did the team members get on?
- Was there any conflict of personality?
- Did the team leader ask for input from the others?
- Was there a chance to challenge the decisions?
- What was the relationship between the various teams involved?

**Training Level of the Team and Team Members**

- Have the team members an adequate skill level and experience?
- Have the team members proper qualifications?
- Was TRM or team-building training provided and accepted by the team members?
- Did each team member have a good knowledge and the same understanding of the procedures?

**Communication**

- How was the communication (style and content) and co-ordination amongst the team members?
- Was there any chance to talk about conflicts?
- Was there a breakdown in the tacit understanding?
- Were the controller and pilot communicating with and understanding each other properly?



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## ICAO DEFINITIONS

For the purpose of this document, the following ICAO definitions shall apply:

- |                 |   |
|-----------------|---|
| <b>Accident</b> | 'An occurrence associated with the operation of an a/c which takes place between the time any person boards the a/c with the intention of flight until such time as all such persons have disembarked, in which a person is fatally or seriously injured, the a/c sustains damage or structural failure, or the a/c is missing or is completely inaccessible' (ICAO, 1994). |
| <b>Incident</b> | 'An occurrence, other than an accident, associated with the operation of an a/c, which affects or could affect safety' (ICAO, 1994).  |

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## ABBREVIATIONS AND ACRONYMS

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

a/c	Aircraft
ACAS	Airborne Traffic Collision Avoidance System
ACC controller	Area controller
ADREP	Accident/incident Reporting System
AFIS	Aerodrome Flight Information Services
A/I	Accident/Incident
APP controller/director	Approach controller/director
ASRS	Aviation Safety Reporting System
ATC	Air Traffic Control
ATCO	Air Traffic Controller/Air Traffic Control Officer (US/UK)
ATS	Air Traffic Services
ATSA	Air Traffic Services Authority
ATSIS	Air Traffic Services Investigations System
CAA	Civil Aviation Authority
CAIR	Confidential Aviation Incident Reporting
CANAC	Computer-Assisted National Air Traffic Control Centre (B)
CENA	Centre d'études de la Navigation aérienne (F)
CHIRP	Confidential Human Factors Incident Reporting Programme
CISM	Critical Incident Stress Management
CRNA	Centre régional de la navigation aérienne (F)
DED	Directorate EATCHIP Development
DEL	Deliverable
EATCHIP	European Air Traffic Control Harmonisation and Integration Programme

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EC	European Communities
ECAC	European Civil Aviation Conference
ECC-AIRS	European Co-ordination Centre for Aircraft Incident Reporting Systems (EC)
Ed.	Editor
Eds	Editors
EEC	EUROCONTROL Experimental Centre (F)
ET	Executive Task
EU	European Union
EWP	EATCHIP Work Programme
FL	Flight Level
FPL	Flight Plan
FPS	Flight Progress Strip
GUI	Guidelines
HF	Human Factors
HUM	Human Resources (Domain)
IANS	Institute of Air Navigation Services
ICAO	International Civil Aviation Organisation
MORS	Mandatory Occurrence Reporting Scheme
REP	Report
R/T	RadioTelephony
SHEL Model	Software - Hardware - Environment - Liveware Model
ST	Specialist Task
STCA	Short-term Conflict Alert
TRM	Team Resource Management
TWR	Aerodrome Control Tower
TWR controller	Tower controller
WG	Working Group



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## CONTRIBUTORS

<i>Name</i>	<i>Organisation/Country</i>
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### Chairman

Mrs Dominique VAN DAMME	EUROCONTROL, DED5
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### Co-ordinators

Dr Johan KJÆR-HANSEN	EUROCONTROL, DED5
Ms Anne-Laure AMAT	EUROCONTROL, DED5

### Members of the study group

Mr Andrea ANDREEV	CAA, Bulgaria
Dr Sue BAKER	CAA, Gatwick, U. K.
Mr René DE WISPELAERE	CANAC, Belgium
Mrs Sylvie FIGAROL	CENA, Toulouse, France
Mr Daniel JOUSSE	CRNA/SO/QS, Merignac, France
Mr Antony JOYCE	EUROCONTROL, EEC, France
Mr Eoin McINERNEY	EUROCONTROL, IANS, Luxembourg
Mr Olof NORLÉN	Luftfartsverket, Sweden
Ms Andrea PECHHACKER	AUSTRO CONTROL, Austria
Mr Emil TZENOV	CAA, Bulgaria
Mr Alexandar TZVETANOV	ATSA, Bulgaria
Mr Ian WESTON	CAA, Gatwick, U. K.

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