Elaboration of Guidelines for ATM Occurrence Investigation

Draft Report (Version 1.3: 2/8/2000)

Executive Summary

This document is intended to help ATM providers implement and maintain the EATMP "Safety Occurrence Principles". Occurrence detection is followed by data acquisition. This is followed by occurrence reconstruction. Occurrence reconstruction, in turn, is followed by incident analysis. Recommendations are then proposed on the basis of this analysis. Finally, there is the reporting and exchange of information about an occurrence. Each of these phases is considered in turn and recommended practices are identified.

Document Change Record

Edition	Date	Reason for Change	Sections Affected
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1.1	7/7/2000	First revision based on meeting with EUROCONTROL (2/5/2000) and subsequent correspondence.	All.
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Chris Johnson,
University of Glasgow, Glasgow, Scotland.
E.mail: johnson@dcs.gla.ac.uk,
http://www.dcs.gla.ac.uk/~johnson

Gilles Le Galo and Martine Blaize,
EUROCONTROL, Brussels, Belgium
E.mail: {gilles.le-galo, martine.blaize}@EUROCONTROL.be

Introduction and Preamble

This report introduces detailed guidance for ATM occurrence investigation. This guidance is based on existing practices in European ATM providers and on similar systems in other industries.

The guidelines that are presented in this document are heavily dependent upon the service provider's ability to operate within a non-punitive environment. It is unlikely that any national system will satisfy the ESARR2 requirements if contributors have a justified fear of retribution. In January 2000, MATSE VI recommended that Ministers ensure the timely implementation of the arrangements included in the EUROCONTROL Safety Improvement and Measurement Programme in all ECAC Members States, within "a non-punitive environment". This does not imply that the submission of a report will absolve a contributor from the normal legal sanctions but that the key element to the success of any occurrence reporting system is the trust that contributors should place in the impartiality of their system.

It is also important to emphasise that this guidance material avoids any assumptions about the managerial and organisational structures in particular ATM service providers. The use of terms such as `safety manager' reflect a generic role that might, in practice, be performed by a number of individuals within any particular organisation.

Generic Phases in Occurrence Investigation

A number of generic phases are common to many occurrence-reporting systems. Occurrence detection is followed by data acquisition. This is followed by occurrence reconstruction. Occurrence reconstruction, in turn, is followed by incident analysis. Recommendations are then proposed on the basis of this analysis. Finally, there is the reporting and exchange of information about an occurrence. Figure 1 provides an overview of these generic phases. It also identifies a number of more detailed guidelines that are intended to support these different aspects of occurrence reporting. The following paragraphs describe the guidelines that are associated with each of the generic phases in much more detail. They also identify the individuals who are responsible for implementing these guidelines and a rationale is provided for these different recommendations. Appendix A provides a graphical overview of the different people and groups who help to implement these phases. Appendix B provides a similar illustration for the inputs and outputs during each stage of an occurrence investigation.

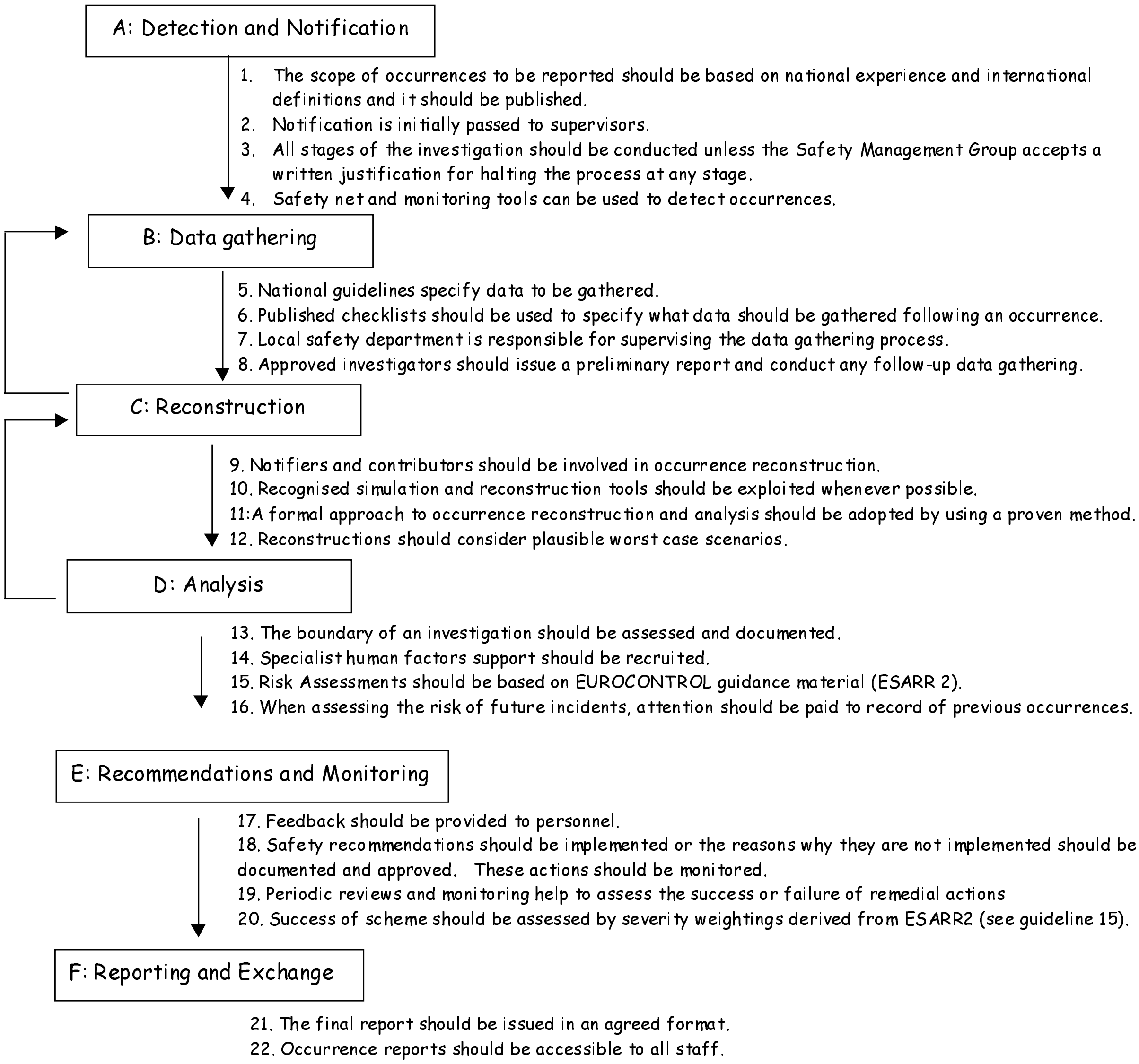

Figure 1: Elaboration of the Generic Phases in Occurrence Investigation

Key Roles in Occurrence Investigation

The previous section provided an overview of generic phases in occurrence investigation. It has already introduced a number of important tasks that contribute to a successful occurrence investigation system. This section briefly discusses these tasks in more detail. We also identify the individuals and groups that may perform these tasks. These names are intended to help the subsequent discussion. They need not directly reflect individuals or groups within a particular service provider. For example, some tasks may be shared between a number of different regional teams.

1. Notification. The initial occurrence report triggers an occurrence investigation. The ATM provider may employ the person who notifies an incident or they may be employed elsewhere within the aviation industry. For example, a member of an aircrew might report an occurrence. Alternatively, members of the public who have witnessed or been involved in an occurrence report some occurrences.

2. Safeguarding service provision and the collation of initial occurrence reporting forms. In the aftermath of an occurrence, some one should be responsible for taking any immediate actions that are necessary to safeguard

ATM services. This involves pastoral responsibilities; notifiers often exhibit a sense of guilt and blame in the aftermath of many occurrences. Someone should also gather together and collate incident reporting forms and forward them to the Safety Management Group. In the following discussion, we assume that the Supervisor performs this role. However, as noted above, there are a number of alternative mechanisms that might also be used to ensure that service provision is safely maintained following an occurrence.

3. Appointment and oversight of investigators. Once reports have been received, the Safety Management Group or a similar body should appoint investigators to co-ordinate further data gathering and analysis. Alternatively, if a decision is made at any stage to halt an investigation then this group should approve of the written justifications for this decision. It is possible to identify a number of skills that should guide the analysis of ATM occurrence investigation. For example, human factors problems may have been provoked by periodic equipment failures. Similarly, ATC workload may have been affected by adverse meteorological conditions. Many of these skills may already be available at a within individual ATM providers. It is important, however, to identify specific techniques that might be recruited to support these local skills. Some of these tools are identified in table 1. There should also be mechanisms that help individual investigators to request specific assistance if they feel unable to successfully analyse the causal factors leading to particular occurrences.

Skill/Knowledge Requirement	**Available Tools/Techniques**
Air Traffic Control Domain Expertise	Ensure that team is led by a qualified ATC manager. This meta-level requirement hides a number of more detailed issues. They should understand the working practices of the team that noted the occurrence. They should have a clear view of relevant legislation, regulation and protocols. They should understand the patterns of traffic management etc leading to the occurrence. They should also be recognised and trusted by employee representatives.
Technical Expertise	This will be essential if equipment failure is an issue. It may also increasingly be important if increasing automation and the integration of advice giving systems (e.g., radar and flight plan information) play any part in an occurrence.
Human Factors Expertise	Given the increasing prominence of human factors in many occurrences and accidents, it may be necessary to identify a source of human factors expertise that teams can call upon. Alternatively, a number of analytical tools, such as HERA, can be used to enable ATC officers to perform some parts of the analysis themselves/

Table 1: Skill Requirements for Occurrence Analysis

4. Ensuring Participation and Consensus in the Investigation Process. A key concern throughout the occurrence investigation process is to encourage participation and consensus. There are many different ways in which this can be achieved. For example, the individuals who report an occurrence can be invited to join the teams of investigators who are responsible for identifying any causal factors. Alternatively, these individuals may be sent copies of the documents that are produced during the investigation, analysis and reporting of an occurrence. Staff representatives may also be kept informed. The key point is that although there may be different routes to consensus, it is critical that procedures and mechanisms are open and accountable. From this it follows, for instance, that key decisions to suspend or continue an investigation should be documented and then confirmed by others within a safety management team.

5. Investigation. Individual investigators are trained to conduct the more detailed analysis that is required following a major occurrence. They receive the notification from the supervisor. They should then determine whether any further data acquisition is required, for instance by interviewing more contributors (see below) or by examining records from other automated logging equipment. The investigators should be trained in occurrence investigation techniques. This specialised training should accompany experience as a controller/instructor. It should also build on an in-depth knowledge of the technical issues that will arise during occurrence analysis; meteorological issues; navigation techniques; human factors expertise etc. The coherent and consistent investigation of occurrences will also require some pre-selection of investigators. They are responsible for drafting the final occurrence report and for submitting it to the appropriate regulatory authority. Recruitment should also focus on appropriate personality traits (meticulous, unbiased etc.).

6. Regulation. It is important to identify a mechanism for monitoring the performance of the occurrence reporting system as part of the ATM provider’s safety management system. For instance, a regulatory group should receive copies of all final reports into occurrences as well as reports from the safety managers that describe the measures that have been taken to implement any safety recommendations. It is also expected that the regulator will initiate periodic investigations into particular problems should they continue to receive occurrence reports about similar occurrences.

Generic Phase A: Detection and Notification

The first generic phase in occurrence reporting focuses on the detection of an occurrence. A controller will report an occurrence as a result of their participation in, or observation of, a set of adverse events. Alternatively, the components of a safety net, such as Short Term Conflict Alert (STCA), may alert controllers that an occurrence has taken place. In either case, detailed guidelines are needed to ensure that an occurrence is reliably reported to responsible authorities once it has been detected.

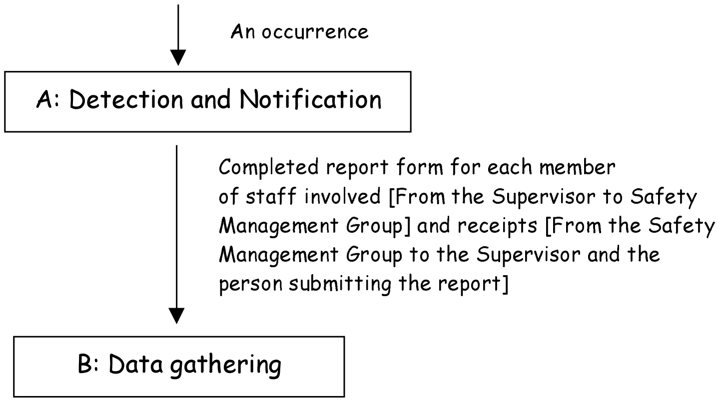

Figure 2: Inputs and Outputs from Generic Phase A (Detection and Notification) of Occurrence Investigation

Guideline 1: The scope of occurrences to be reported should be based on national experience and international definitions. The scope and type of occurrences that are to be reported should also be published.
Rationale: Personnel should be trained to consistently identify those occurrences that should be reported.

The person receiving an occurrence report should perform an initial assessment of whether or not it falls within the scope of the schemes. There are a number of international guidelines on what should be covered within an occurrence reporting system (EUROCONTROL ESARR 2). However, local circumstances may also affect what is and what is not covered by such schemes. For example, experience over time may encourage ATM providers to increase the risks associated with certain types of occurrence, either because they have had a relatively high frequency within their region or because they might have particular severe consequences given their operating parameters. To summarise, the scope of the system should meet the EUROCONTROL minimum criteria for occurrence classification but may also be informed by their local experience.

Guideline 2: Notification is initially passed to supervisors.
Rationale: we should clearly identify the individuals who are involved.

Occurrence can be reported in many different ways. For example, they may be detected through the direct involvement of ATM personnel or from an automated warning within a safety net or through a report from aircrew or by information provided from the general public. In each case, the occurrence should elicit an appropriate response from the ATM service provider.

Individual ATM personnel should report an occurrence to their immediate supervisor. This is critical for a number of reasons. Firstly, all controllers should know who is responsible for initiating the procedures (see below) that are associated with mandatory occurrence reporting. Secondly, the sense of guilt that can follow from an occurrence may impair the controller's ability to continue safe operation. Their supervisor can decide to remove the individual from their position.

It is, however, possible to envisage a number of circumstances in which personnel might submit an occurrence report to other people within an ATM service provider. For example, there is an understandable reluctance to provide reports that might jeopardise an individual's relationship with their immediate superiors, especially if those superiors are implicated by an occurrence. Special provision should be made for such circumstances, although these are not these special provisions are not a focus for the guidance in this document.

During these initial stages of occurrence reporting, it is important that the supervisor should recognise when it is necessary to immediately inform others within the organisation. For instance, some ATM service providers have been forced to respond to direct enquiries by the media before their national safety officers have been informed that an incident has even taken place. Under such circumstance it may also be necessary for the supervisor or their manager to brief the other officers within a unit so that they know an occurrence report has been filed. Such actions are extremely important to preserve confidence in the reporting system and to avoid rumour within a work group.

Guideline 3: All stages of an investigation should be conducted unless the Safety Management Group accepts a written justification for halting the process at any stage.
Rationale: we should clearly document the reasons why an occurrence was not investigated.

The first guideline is intended to ensure that we know the reasons why an occurrence was not investigated any further. The general principle is to assume that an investigation will continue through each of the phases shown in Figure 1. However, it should also be possible to halt an investigation at any point providing a written justification is provided. For low criticality occurrences, a form can be completed. For more complex occurrences, such a decision would require more documentation. The key point here is that it should be possible to review not just those occurrences that were investigated but also those occurrences that might otherwise have been forgotten through lack of subsequent investigation.

The Safety Management Group or an equivalent organisation should approve of any decision to halt an investigation. This is important because subsequent incidents may lead service providers to reconsider such decisions. This may lead to conflict if particular individuals are identified with such important decisions. Collective responsibility helps to minimise the impact of such problems.

The resources that are available to incident investigation are clearly finite. It can also be difficult to determine whether or not an enquiry should be conducted a priori. As a result, trained staff can be used to filter occurrence reports. It is important that these Gatekeepers document the reasons for their decision to filter out an occurrence. Their decisions and the overall impact of these interventions should be monitored to avoid under-reporting and bias. The filtering should therefore be open and auditable. In particular, it is important to demonstrate that reporting systems consider occurrences that have the potential to reduce the level of ATM service provisions in addition to occurrences that directly affect aircraft themselves.

Guideline 4: Safety net and monitoring tools can be used to detect occurrences.
Rationale: these systems can help to ensure that occurrences are detected and reported. However, it is critical that this application of technology should gain staff acceptance if it is to be accepted.

Previous guidelines have placed the priority on occurrence reports that are submitted by human operators. As reporting systems become more established, however, it is also possible to use automated tools to supplement this source of reports. For example, safety nets provide an important means of structuring the risk assessments that support ATM service provision. These networks comprise both ground and airborne systems, including ground proximity warning systems (GPWS), minimum safe altitude warning (MSAW), short-term conflict alerts (STCA), aircraft proximity warning (APW) and aircraft collision avoidance system (ACAS). They provide an additional barrier that can be used to predict the potential for adverse occurrences and should not be relied upon to preserve the safety of an application. Operators may become progressively less and less careful if they rely too much on these systems. However, the components of a safety net can perform a dual role. Firstly, they warn operators about a safety occurrence that is taking place or about the potential for a more severe occurrence. Secondly, they can be used to monitor and trigger occurrence-reporting procedures when they automatically detect that certain adverse circumstances have occurred. For example, supervisors might be expected to complete a report whenever one of these systems generates a warning. Tables 2 and 3 illustrate the distinctions between the airborne and ground-based components of such a safety net. Each of these classes of systems will produce slightly different notifications. For example, mechanisms and procedures that are identified in JAA-NPA ACJ XX handle a GPWS warning. Such events may only be notified to an ATS provider if the crew decide that this action is appropriate, and specifically when the GPWS warning enabled to identify an ATM-related occurrence. However, ACAS warnings clearly and more systematically fall in the scope of most ATS occurrence reporting systems. ATS provider should determine the procedures by which STCA, MSAW and APW events are to be handled and analysed within an occurrence reporting system. Table 3, in particular, illustrates the way in which each ATS provider should determine their policy on the whether STCA, MSAW and APW events are to be handled within an occurrence reporting system.

	Reported by pilot	Reported by ATM
GPWS	(see JAA-NPA ACJ XX)	Yes (if notified by pilot)
ACAS	YES	Yes (if notified by pilot)

Table 2: Airborne components of a Safety Net

	Reported by pilot	Reported by ATM
STCA	N/A	As defined locally (unless it is determined that it was a false alert)
MSAW	N/A	As defined locally (unless it is determined that it was a false alert)
APW	N/A	As defined locally (unless it is determined that it was a false alert)

Table 3: Ground-based components of a Safety Net

It is important to emphasise that there are a number of problems with this use of automated systems. Firstly, it can be difficult to ensure staff acceptance if new generations of monitoring tools are used in addition to the core components of the safety net, mentioned above. Secondly, spurious alarms can de-motivate personnel and create hostility to the reporting system that would jeopardise its future success. One solution to these problems is to allow supervisors to allow supervisors to decide not to further investigate any occurrences that are notified by an automated system. If this path is followed, it is again important that a written justification be provided to the Safety Management Group.

The components of a safety net should not reduce the number of incidents being investigated. These tools provide short-term protection by helping operators to detect and potentially avoid certain types of occurrences. However, ATM service provides should investigate the underlying causes of the problems that these systems detect. If the warning is the result of a false alarm then that should also be investigated.

Supervisors and staff should be clear about the required procedures. The operators involved in an occurrence should be removed from their control position. The supervisor should, obviously, then safeguard continued service provision. The supervisor is also responsible for safeguarding automated data sources, including radar and traffic logs that will be needed during any subsequent investigation. They should then perform an initial data gathering exercise by issuing standard report forms to the staff involved; see Appendix A for an approved EUROCONTROL form. The information that is requested by these reporting forms can be summarised as follows:

Topic of question:	**Examples of information requested**
Identification information:	Name, working team or unit, control centre information, current status of license.
Shift information:	When did the occurrence occur? When was their last break and for how long was it? When did they last operate this shift pattern in this control position? Were you training (or being trained?).
Station configuration:	What was the station configuration/manning like at the time of the occurrence? What was the ATC display configuration? Were you working with headsets/telephones/microphone and speaker? Were there any technical failures?

Air Traffic Characteristics:	What was the traffic volume like in your estimation? What was your workload like immediately before the occurrence? Were there any significant meteorological conditions?
Detection and mitigation factors:	What made you aware of the occurrence (e.g. automated warning, visual observation of radar)? Were there any circumstances that helped to mitigate any potential impact of the occurrence?
Other factors:	Are there any personal (off the job) circumstances that might affect the performance of you or others during the occurrence?
Free-text description of the occurrence:	Describe the occurrence and your performance/role during it. Also consider any ways in which you think that the occurrence might have been avoided.

Table 4: Guidance Information for Initial Occurrence Reporting Forms

Supervisory staff may also decide to conduct initial interviews. The following comments also apply to investigators who choose to conduct interviews during any subsequent data gathering. There are a number of alternative interview techniques that can be used:

1. Individual interviews (one to one). This has the benefit of being relatively informal. Questions can be asked to clarify any of the information that was uncertain from the form. It can also be used to elicit information that might be missing in the original submission. The problems are that the interview can be seen as combative and antagonistic if the interviewee lacks the support of their colleagues and workplace representatives. It is usually better to conduct interviews with two investigators present in the room and to allow the personnel involved to bring in a colleague or other representative.

2. Interview panels (many to one). This approach can avoid the inter-personal problems of a one-to-one interview. Several people, including friends and colleagues of the person being interviewed, can meet to discuss the occurrence. However, if such a meeting is not chaired correctly then it can appear to be an inquisition rather than a meeting to elicit necessary safety information.

3. Team-based interviews (one to many). In this approach, one interviewer meets with members of the shift during which an incident occurred. This reduces the inter-personal problems that can arise from a one-on-one interview. It may also help to uncover information from others who were present but not directly involved in an incident. The disadvantages include the practical problems of gathering everyone together but also the problems of accounting for group dynamics – the interview may be dominated by forceful personalities within the group. They may also compensate for the failures of one of their friends or exacerbate the weaknesses of those who are less popular.

4. Group discussions (many to many). This approach enables teams of investigators and works to get to together to discuss an occurrence. This has the benefit that neither group need be seen to be “in control”. Conversely, of course, it can lead to a general meeting that produces few tangible results and which reduces to a very general discussion.

Irrespective of which approach is adopted, there are a number of key principles that should guide any interview process. Firstly, the interview should have a purpose. It may be a waste of everyone’s time if an interview simply repeats the questions on the reporting form. Secondly, the results of any interview should be recorded in either written or electronic form so that both the interviewer and the interviewee can subsequently review the products of the meeting. Thirdly, these results should be reviewed. There is little point in conducting such an exercise if it is not to be used as part of a subsequent enquiry. Finally, the findings from any interview should be documented in a formal way and (ideally) communicated to the interviewee. Otherwise, such meetings can increase stress on an individual and ultimately lead to rumour and discontent within a working group.

The supervisor may also be asked to complete a similar questionnaire to record additional contextual information. For instance, they can provide information about their view of the loading prior to the occurrence. These supervisor forms can also request information about whether or not the reporter asked for help at any stage during an occurrence. Another good practice is to develop a small number of additional forms that can be used to elicit specific information about particular issues within the ATM provider. These forms may accompany the introduction of new technology or be used to make sure that particular details about frequent occurrences are picked up on. Examples of occurrences that might be addressed by special forms are occurrences involving TCAS or STCA warnings plus navigational horizontal and vertical deviations

The supervisor should also take initial steps to notify regional and national safety teams, at Safety Manager level, that an occurrence has occurred and that report forms are being generated. This is critical for occurrence registration and also to alert regional and national investigators that they will be required to analyse the data that has been obtained in the aftermath of an occurrence.

In preparing this guidance material, several ATM providers have stressed the importance of providing receipts as occurrence reporting forms are passed within an organisation. This enables the individuals who have submitted a report to determine how they input is being dealt with. These receipts can also help to ensure that an occurrence is acted upon in a prompt and timely manner.

Generic Phase B: Data Gathering

A number of different data sources should be inspected after any occurrence. There include logs from automated systems such as radar and flight plan information. Communications logs and transcripts should also be gathered. These include recordings from telephones, radios and any other communications mechanisms that operate within and between centres as well as between controllers and flight crews. Personal journals and note should also be collected. These include supervisor's logs as well as individual records that may be maintained by controllers, for example about the shift patterns that were being operated at the time of an occurrence. Finally, all relevant flight strips and other physical artefact should be gathered. The exact nature of these will depend upon the automated support that is provided for the controller's everyday tasks. The procedures that can be used to ensure that all relevant data has been protected will vary between ATM providers. Initially, we assume that the local supervisor or manager is responsible. After notification, the Safety Management Group assumes responsibility. They, in turn, will delegate specific collection tasks to investigators. The key point here is not the exact procedures that are used. It is, however, that each ATM service provider should have established data acquisition procedures that are documented and well known. The responsibility for these tasks should be clear and support tools, such as checklists, can support each stage of data gathering. The following sections provide more detailed guidelines that are intended to help ATM providers ensure that this data is gathered in consistent and coherent manner.

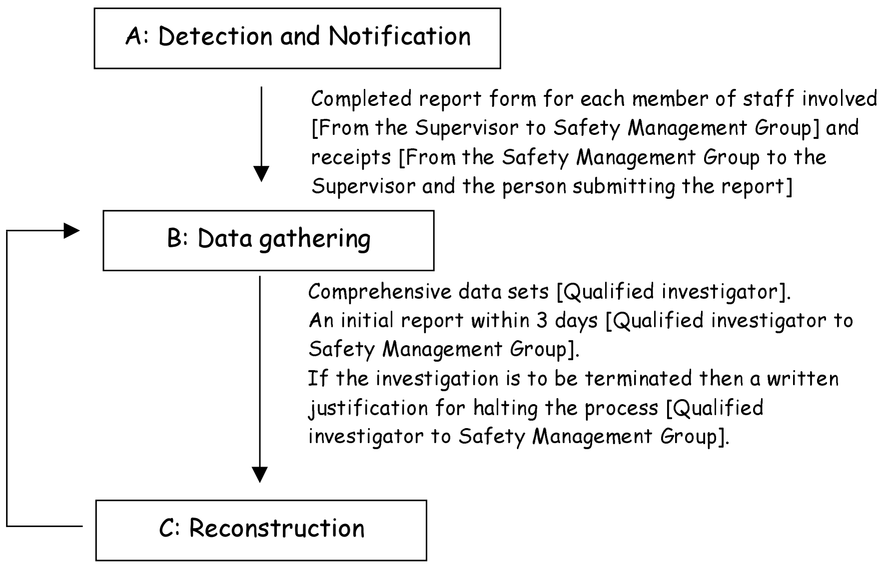

Figure 3: Inputs and Outputs from Generic Phase B (Data Gathering) of Occurrence Investigation

Guideline 5: National guidelines specify the data that is to be gathered.
Rationale: following an occurrence, necessary data may be lost if procedures are not followed.

The following minimum set of information should be available to any subsequent investigation. For each aircraft it should be possible to identify its type and whether any damage was sustained. It should be possible to determine the type of flight, for instance whether it was commercial air transport or general aviation. It should be possible to identify the phase of ATM operations during which the occurrence took place. Evidence should be provided about the flight rules that were in operation (IFR or VFR). The class of air traffic services air spaces should be identified as well as any other air space areas that were relevant to the occurrence, e.g. restricted, prohibited or danger areas.

In addition to information about each aircraft, it should also be possible to identify the type of the report e.g., air proximity warning, ACAS report etc. Information should be recorded about any people/vehicles/animals that were involved in the occurrence. Details should be provided about the ATS units that were involved in an occurrence. It is also important to record information about their operating circumstances. Later sections will provide more details about what should be considered here. The date and time of the occurrence should be recorded.

Guideline 6: Published checklists should be used to specify what data should be gathered following an occurrence.
Rationale: In the aftermath of an occurrence it can be difficult to identify what information is relevant

As mentioned previously, it is important that standard procedures are established for data gathering after an incident. These can effectively be published as checklists. These should be distributed prior to an occurrence so that it then becomes a straightforward task to contact, for instance, the meteorological office to gather information about the conditions before, during and after an occurrence.

It is important to identify the purpose of each item of information listed on a data-gathering checklist. There is a danger that they may formalise unnecessary tasks or that tasks may be needlessly duplicated. It is also important to specify a deadline by which each checklist should be completed after an occurrence. This is necessary to ensure that data is not lost.

It is important to emphasise that this information may also be collected for occurrences that are initially identified as having relatively low consequences. As mentioned in previous paragraphs, these occurrences can provide critical information about events that in other contexts might have had far more profound outcomes. They can also help to support more general forms of quality improvement, through better training or through the usual maintenance and acquisition procedures for ATM systems.

Guideline 7: The local safety department is responsible for data collection.
Rationale: Although the actual tasks of data collection can be delegated, it should be clear who is ultimately responsible for the data gathering tasks.

There should be a clear chain of responsibility for the co-ordination of these data-gathering tasks. Agreed guidelines ensure consistency and prevent individual judgements from causing necessary information to be lost. An important consideration here is what to do if a supervisor or manager is involved in an occurrence. In such circumstances, there should be procedures that enable the individual to delegate their data gathering responsibilities to another responsible employee. This should normally only be permitted with the express permission of the organisation's safety management or through the submission of a written form that indicates the transfer of responsibility to an identified individual.

It is important to re-iterate the opening comments of this document; by local safety department we mean the individuals or groups who are responsible for managing safety within the ATM service provider. This guideline is not intended to recommend any particular managerial organisation or structure.

Guideline 8: Approved investigators should issue a preliminary report and conduct any follow-up data gathering.
Rationale: considerable technical expertise is required to ensure that all aspects of an occurrence are thoroughly considered. It is also important to ensure that attitudinal biases do not affect the data gathering exercise.

Investigators are required to use the data that they gather to draft a preliminary occurrence report. This should be completed within three days of an occurrence and is passed to the safety a management group. They may then decide to conduct further enquiries. The precise nature of these subsequent investigations depends upon the occurrence that is being investigated. For example, more detailed system logs will be required if equipment failure is being considered. These information sources would be redundant if an occurrence investigation focussed upon an individual instance of human error. This illustrates how additional expert support may be required to perform these more detailed activities. Further data gathering will also be required because individual ATM teams will necessarily have a limited view of an occurrence. For instance, they may only have partial information explaining the behaviour of flight crew as an occurrence develops.

It is also important to note that the safety management group may decide that the preliminary report should immediately be passed to other centres or regions that might also experience similar occurrences. This is particularly important in the case of equipment failures that might be replicated in other systems. They may also be pro-active in both soliciting evidence from airline personnel and, conversely, in passing directly to them any preliminary report that has direct implications for airline operations. If an airline contributes in this way then they ought to be provided with updates about the progress of the investigation to ensure external confidence in the reporting system.

Generic Phase C: Reconstruction

The previous phases of occurrence investigation provide the factual data about an occurrence. The safety management group within the ATM service provider uses this to draft the preliminary report. This report is then used to determine whether, or not, investigators should conduct a more detailed investigation. All of this information from the notification report by the supervisor and the subsequent investigation should be complied into a coherent account of the events leading to an occurrence. This process of reconstruction takes place before any detailed analysis of the causal factors can begin.

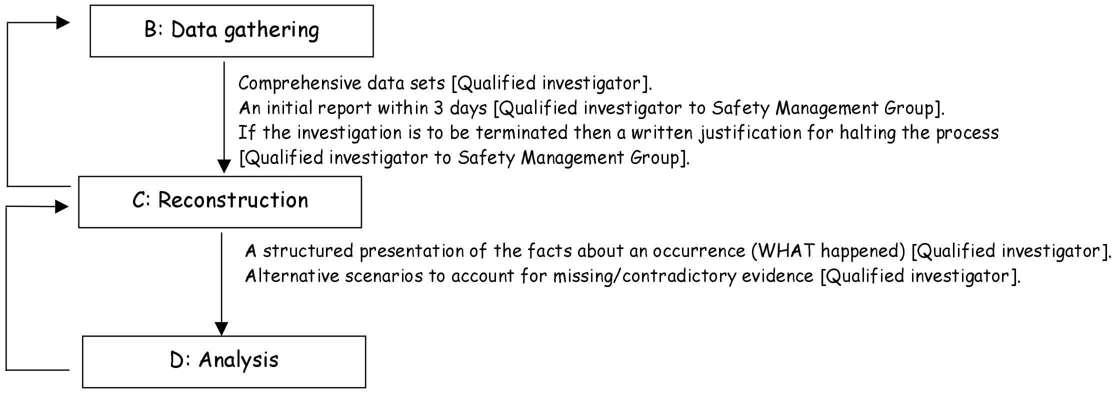

Figure 4: Inputs and Outputs from Generic Phase C (Reconstruction) of Occurrence Investigation

Guideline 9: Notifiers and contributors should be involved in occurrence reconstruction.
Rationale: This helps to validate the products of previous phases; it helps to identify omissions in the notification report and can encourage further participation.

There are a number of reasons why the individuals who report an occurrence also ought to be involved in the reconstruction of that occurrence. The first reason is that the reconstruction process can prompt controllers to remember significant events or occurrences that might unintentionally have been omitted in the aftermath of an occurrence. They can also alter or revise their recollection of events when faced with information from other information sources, in particular evidence from automated systems and communications transcripts.

There are other reasons why the people who notify an occurrence also ought to be involved in its reconstruction. In particular, several ATM providers report that it has important psychological and motivational benefits for the individuals who are concerned in an occurrence. Their involvement during occurrence reconstruction can help them to move away from any sense that they are the focus of an investigation. It can also help them to feel that they are making a direct contribution towards an improved understanding of the causal factors that lead to an occurrence. Involvement in reconstruction can, therefore, form part of critical incident stress management techniques. A number of ATM providers also offer counselling to help controllers overcome the sense of guilt and blame that they feel in the aftermath of an occurrence. Controllers are asked to nominate colleagues who will fulfil this support role in the aftermath of an occurrence. These individuals should then participate in a recognised counselling scheme. After receiving this training, they can help controllers to overcome some of the negative feelings that can affect their longer-term ability to successfully perform traffic management duties. The costs of investing in this form of mutual workplace support are argued to be relatively small in comparison with the costs of training replacement controllers.

Guideline 10: recognised reconstruction and simulation tools should be exploited whenever possible.
Rationale: The complexity of occurrences demands that some form of annotated time-lines or other graphical notation be used to support reconstruction.

The reconstruction of an occurrence is a transition phase between the immediate reporting of an occurrence and the subsequent analysis that identifies the causal factors, which lead to an occurrence. The output of this reconstruction phase should be a version of events that agrees with recorded information sources and which unifies the views of the various members of a team who were involved in the events immediately before and after an occurrence. One of the simplest means of drawing up this reconstruction is by time labelled paragraphs:

```
20:20:30    ACFT #1 CLRED FROM ILL TO MSP TO MAINTAIN 5000 FT
            THROUGH FLT SVC.
20:25:00    ACFT #1 CHKED ON FREQ DEPARTING THE ARPT.
20:32:00    CTRLS TELLS ACFT #1 TO RPT REACHING 5000 FT
20:32:00+   ACFT #1 NEVER RPTED 5000 FT OR TURNED ON HIS XPONDER.
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This is currently the most widespread means of reconstructing the events that take place during an occurrence. There are, however, a number of alternative approaches that have been adopted in other industries. For example, timelines have been used during the reconstruction of maritime occurrences. These simply map time-labelled paragraphs onto a linear chart so that an analyst gets a better overview of the flow of events leading to an occurrence. The previous approaches can be used to document the events that lead to relatively simple ATM occurrences. However, they suffer from a significant number of limitations that restricts their use for the reconstruction of more complex occurrences. In particular, they strip out spatial information about the relative positions of aircraft during some occurrences. They also provide little impression of the information that was available to either aircrew or ATC officers as an occurrence develops. A number of techniques can be used to avoid this limitation – for example by using two and pseudo-three dimensional representations of flight paths annotated with the timing of events as the aircraft move along those paths. Figure 5 represents the output from a system that takes the output from a number of flight data recorders and automatically produces these interactive reconstructions.

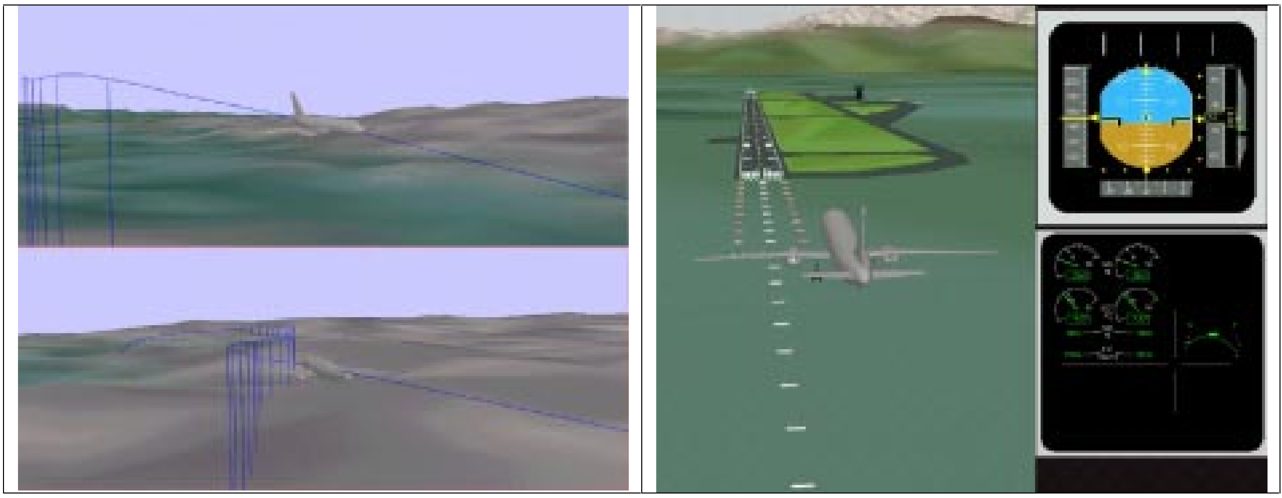

Figure 5: Transport Canada/Software Kinetics Tools for Occurrence Reconstruction [4]

Systems such as those illustrated in Figure 5 are only just beginning to be used routinely within ATM occurrence reconstruction. They are not a routine part of most mandatory systems. However, they offer a number of potential benefits and investigators should be given the opportunity to request such tools if required. These benefits include the ability to replay incident reconstructions to the many different individuals who may have witnessed an occurrence. They also include the training benefits identified by the FAA's Situation Assessment through the Reconstruction of Incidents (SATORI) initiative (Rodgers and Duke, 1993). This system enables time-synchronised replay of all information available to a controller; including meteorological data and recorded voice communications. These replays are used to recreate operational occurrences for review by quality assurance teams and by other controllers. They are also used in training and certification activities. The output from some of these reconstruction systems can be automatically saved and used during simulation exercises in which previous occurrences are used to direct the future training of controllers.

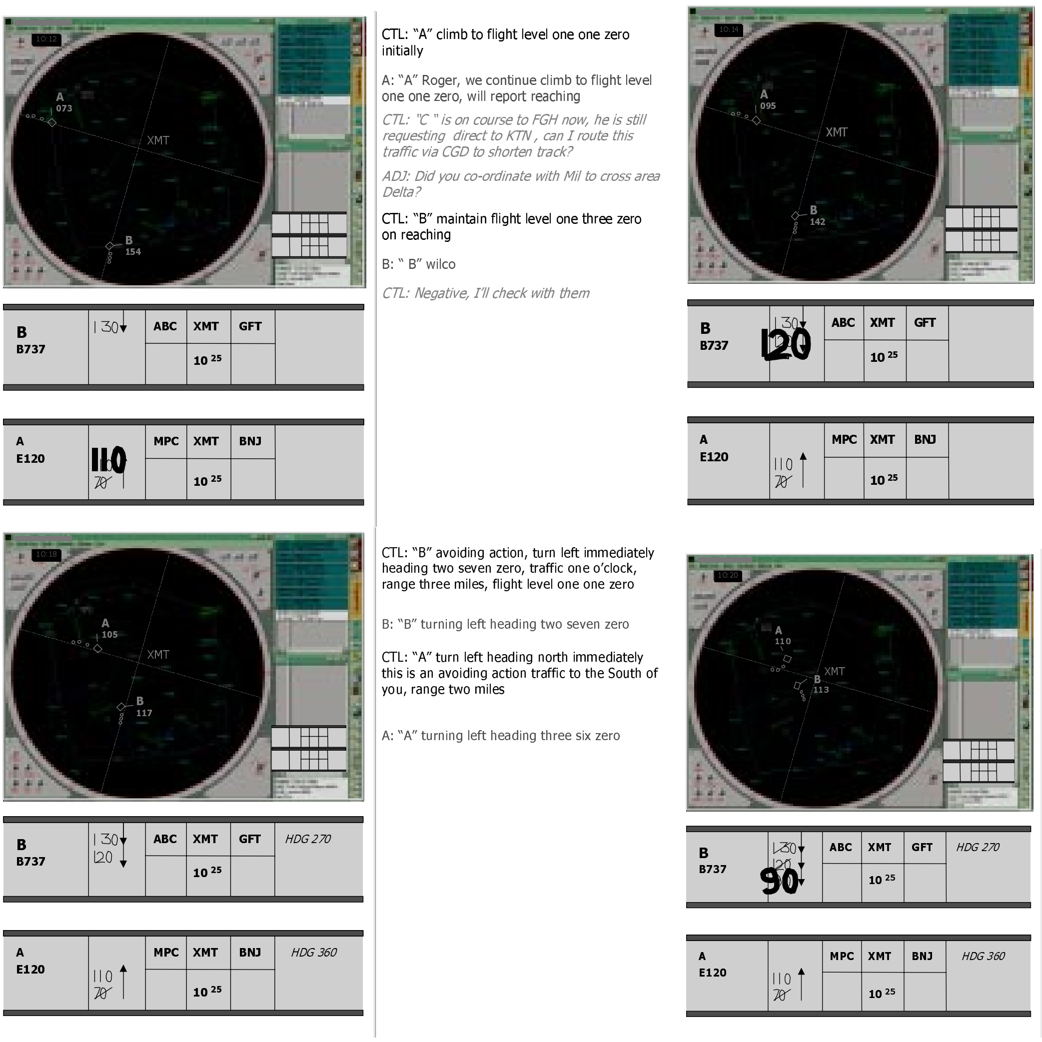

Figure 6: Designs for EUROCONTROL Reconstruction Tool

Figure 6 illustrates the reconstruction of an incident using a new tool that is currently being designed within EUROCONTROL. Rather than focussing on the three dimensional reconstruction of flight-paths, as shown in Figure 5, this approach focuses more directly on reconstructing the controllers' view of an incident. As can be seen, transcripts are played back along side the control station view. Flight strip annotations are also included. The strength of this approach is that it simply pieces together the evidence that has been collected in early stages of the occurrence investigation. However, further analysis is required if others are to understand how each of the events, shown in Figure 6, interacted to contribute towards the final failure.

Guideline 11:A formal approach to occurrence reconstruction and analysis should be adopted by using a proven method (e.g., STEP-Sequentially Timed Event Plotting).

Rationale: It is important to document any reconstruction and analysis using a method that is well understood and produces repeatable results.

Investigators often have individual ways of conducting an investigation based on their expertise, past experience and local operating environment. However without necessary guidance, many investigators develop their own methodologies and techniques. This can lead to inconsistencies that may bias the results of an investigation. It can also make it difficult to reproduce the results of any enquiry performed by different investigators or by even by the same investigator. We cannot control the quality of accident reports relying on personal conclusions without consistent investigation methods and sound, objective quality assurance criteria. We cannot link work products with previously predicted safety performance promised in safety approval documents or regulations or derived from safety analyses.

Any analytical technique that is to support investigators must help them to distinguish between the causes of an occurrence. Following the ICAO definition, causes can be broadly interpreted to include actions, omissions, events, conditions, or a combination thereof, that lead to an accident or incident. An occurrence is usually the result of a sequence of events. All causes together form the necessary and sufficient adverse event or condition flow for a particular occurrence. However, the findings of any analysis may focus on some of these necessary conditions that may, in the future, combine with other occurrences to cause similar but not identical incidents. Any analytical technique must enable investigators to identify the ATM system contribution to these causal events. It is possible to distinguish between a number of different ways in which the ATM system can contribute to an occurrence. For example, ESARR2 recognises the following distinctions:

1. *Direct involvement.* At least one ATM event was judged to be directly in the causal chain of events leading to an accident or incident. Without that ATM event (or if it occurred in a different order), the occurrence would not have happened. A direct contribution that starts an adverse event flow is called a root cause. Without such an ATM event, the accident or incident would not have happened.

2. *Indirect involvement*. No ATM event was judged to be directly in the causal chain of events leading to an accident or incident. However, at least one ATM event contributed to the level of risk or played a role in the emergence of the occurrence. Without such an ATM event, the accident or incident could still have happened.

3. *No involvement.* No ATM event was in the causal chain leading to an occurrence, nor did any ATM event play a role in the emergence of an occurrence. This covers situations where the ground elements of the ATM system had nothing to do with the safety occurrence.

It is also possible to identify further classes of factors that aggravated and mitigated the consequences of an occurrence. This analysis phase should identify whether any of the following factors contributed to the occurrence:

1. ATM service personnel. The analysis should determine whether physical/physiological and psychosocial factors were involved in the events leading to an occurrence. It should also consider the human-system interface, the controllers working environment and the operational task demands. This analysis requires the ability to analyse the effects both of normal working practices but also any unusual or transient factors that may have adversely affected operator performance. Did the personnel follow the procedures?

2. ATM services personnel operating procedures and instructions. The analysis should determine whether any operational ATC procedures contributed to an occurrence or conversely whether they helped to mitigate the consequences of an occurrence. Equally importantly for some occurrences, the analysis should consider whether engineering and maintenance procedures contributed to adverse events. Were the procedures applicable in the context of the occurrence?

3. Interface between ATM service units. The analysis should consider whether communications failed either technically or in a social sense between the different individuals who should co-ordinate during ATM procedures. The analysis should also consider whether any individual or institutional factors contributed to the failure, e.g., had the personnel received CRM training?

4. ATM service infrastructure/facilities and technical systems. The analysis should consider whether hardware or software problems contributed to an occurrence. Very often these issues do not relate simply to component failure but to design and integration problems. For example, changes in the presentation and format of data can prevent controllers from performing necessary tasks using particular software interfaces. The analysis should also consider particular characteristics of aerodrome layout and its associated infrastructure.

5. Airspace structure. The analysis should take into account route structure and capacity as well as the sectorisation of ATS airspaces. For instance, many ATM providers report that occurrences often occur during the

transition from periods of heavy loading to more quiescent intervals. Such informal observations should be backed-up by analyses that consider whether or not such changes were a factor in particular occurrences.

6. Company structure and management policy. The analysis should consider the contribution of operational line management. They should also consider any successes or failures in safety management systems. The analysis should include institutional arrangements both before, during and immediate after an occurrence. This may also lead analysts to consider the impact of management and personnel policy on the events leading to an occurrence.

7. The analysis should also consider whether any regulatory activities, regulation and approval processes failed to prevent an occurrence and whether appropriate changes might be requested in the light of an occurrence.

The previous list provides generic distinctions between causal factors. Any particular occurrence investigation should, of course, take place at a far more detailed level and should look at the particular local circumstances that influenced the course of an incident. It should also be stressed that any causal analysis should identify not only the exact way in which an occurrence occurred but should also consider any alternative ways in which the barriers that protect a system might also have failed.

The Sequentially-Timed Events Plotting (STEP) Technique

The method uses universal event building blocks to describe the causal chain leading to an occurrence. The building blocks represent each event in the format of "actors + actions". Each building block refers to events that are defined to take place as particular points in time. It is also possible to use these blocks in a more negative sense to denote the omission of a necessary event at a particular point in time. The source of evidence for the occurrence of an event is also denoted. Ideally, it would be possible to associate a unique actor with each event. In practice, however, a number of different actors may be involved in a single event. For instance, there may not be sufficient evidence in the early stages of a minor investigation to distinguish between which member of a flight crew performed particular actions or made certain decisions. Hence the term actor may actually refer to groups of individuals rather than any single person. Similarly, a number of discrete actions may together form a single event. For example, at the simplest level the assignment of a new flight level is an event that is composed from planning and executive actions.

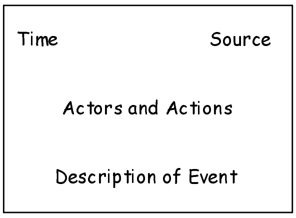

Figure 7: Event Building Block

The event blocks illustrated in Figure 7 can be placed on a timeline to show how an occurrence develops over time. This leads to the development of a matrix similar to that shown in Figure 8. The markers on the horizontal arrow at the top can be used to indicate the real-time interval during which particular events are known to occur. Below this timeline, a number of further rows are used to distinguish the events that are performed or omitted by the agents at certain times. Readers can look along the rows to identify the way in which the role played by each agent can change over time. By looking at different event blocks in the same vertical plane, they can also see how concurrent events can contribute to a failure.

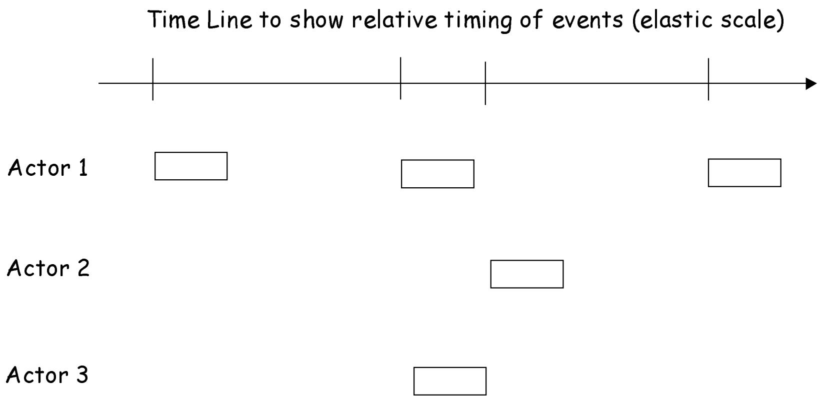

Figure 8: Actors, Events and the Timeline

Once the events associated with each actor have been placed on a timeline, it is then possible to denote causal relationships. Is can be achieved by drawing arrows that flow from the left to the right of the diagram. Each arrow links an event to its direct causes. Indirect causes that help to shape an occurrence are not shown in the following diagrams, although additional annotations may be used to denote these less direct causal relationships. The first diagram on the left of Figure 9 shows a direct one-to-one causal relationship in which event A leads to event B. The second diagram shows a converging causal relationship in which events A, B and C are all needed to contribute to event D. Conversely, the third figure denotes a diverging relationship in which the event A leads to B, C and D. Finally, there may be instances in which a causal relationship is suspected but not known. This is denoted by question mark in the diagram on the right of figure 9. Such uncertainties form a focus of further investigation and analysis.

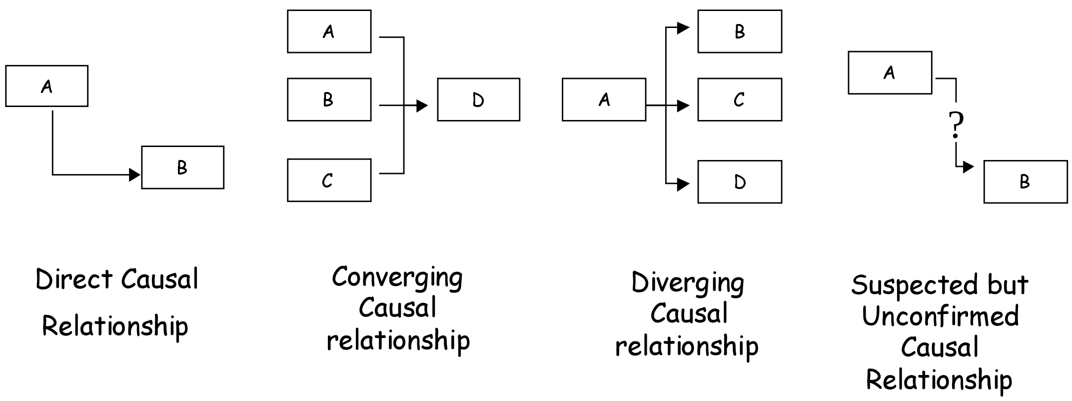

Figure 9: Graphical Representations of Causal Relationships

It is important to stress that Sequentially Timed Events Plotting (STEP) approach is one of a number of similar analytical approaches. For example, fault trees have also been used for similar purposes. Analysts can use this approach to denote a wider range of relationships than those shown in Figure 9. The disadvantage of this approach is that it can be more difficult for analysts to learn to apply the more complex structures that are available in this engineering notation [Johnson, 1999]. However, the key point is that investigators should be provided with some common means of representing the products of their causal analysis. This will improve both the consistency and transparency of investigations. It can also provide important tools to address the increasing complexity of occurrences that result from the closer integration of ATM systems.

Guideline 12: reconstruction should consider the worst, plausible scenarios.

Rationale: this process can help assess whether or not a recommendation has to be issued to avoid this worst case scenario. Barriers and defences may not be available next time, especially if the aircrew intervened to mitigate the occurrence.

During any reconstruction it is important not simply to consider what did happen during an occurrence but also what might have happened. A number of ATM providers have cited occurrences that emphasise the importance of this point. For example, if an accident was avoided because aircrew established visual contact then that occurrence should be treated as if an accident had occurred because ATC personnel cannot rely upon visual contact by aircrew to ensure adequate separation.

If external intervention, such as aircrew observation, did help to avert an occurrence then it may be necessary to produce several different reconstructions for a single occurrence. For instance, one might be used to indicate those events that are known to have occurred during an occurrence. Another construction might also be used to demonstrate a “worse case scenario” in which all mitigation and detection factors are removed. This will necessarily involve a certain amount of speculation but it is nevertheless important if we are to generalise the insights from a specific occurrence so that we can prepare for future adverse events.

The more general point here is that a worse case scenario should be considered during occurrence reconstruction. The cliché that “without any aircraft, there would be no ATM problems” has particular relevance here. If a failure occurs under light traffic conditions then the consequences might be relatively limited and hence any reconstruction would be straightforward. However, it should not be assumed that any future failure would also occur when ATM personnel have sufficient resources of time and attention to detect and respond to similar occurrences under heavier traffic conditions.

Generic Phase D: Analysis

Occurrence detection and data gathering help to drive event reconstruction. This provides investigators with an account of WHAT did or did not happen during an occurrence. The subsequent analysis phase helps to determine WHY those events occurred. There may be instances in which the causal analysis leads to new questions being asked about the reconstruction of events. This, in turn, may create the need for further data gathering. The exact nature of this iterative process will be determined by available resources and by the seriousness of the occurrence as dictated by international guidance, such as ESARR2, and by local priorities.

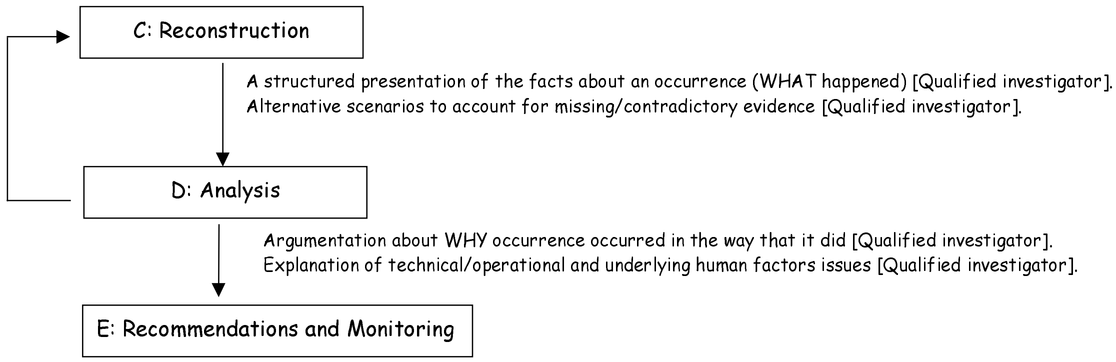

Figure 10: Inputs and Outputs from Generic Phase D (Analysis) of Occurrence Investigation

Guideline 13: The boundary of an investigation should be assessed and documented.
Rationale: This helps others to see that a systemic approach has been adopted.

A number of organisations have begun to advocate what has been called a "systemic" approach to the analysis of occurrences. The main idea is that particular failures may indicate deeper weaknesses. For instance, a large number of human errors may indicate underlying management problems in shift allocations or in team organisation, rather than a number of unrelated instances of individual failure. Similarly, a large number of continuing technical failures may indicate underlying acquisitions and maintenance problems rather than a more specific set of deficiencies in a particular item of equipment. The key issue here is whether or not the system as a whole performed as expected. If these expectations were correct and a system component failed then improvements can be isolated within that subsystem. However, if the expectations under which a system operates were incorrect then deeper questions should be asked about the potential for further occurrences from these wider systemic failures.

A systemic view also includes the idea that there are catalytic and latent causes of an occurrence. Latent causes are deficiencies in a system that need not lead directly to an occurrence. For example, the lack of a reliable backup system is a latent failure. It need have no direct impact upon the ability to provide ATM services until the primary system fails. This failure is the trigger or catalytic event that exposes these latent deficiencies in the system. This systemic view also takes into account the role of barriers or defences in an occurrence. This is illustrated in Figure 11. Here the immediate causes of an occurrence manage to find holes in the defences that protect a system. For instance, if equipment failure occurs then the ATC operator may provide a primary barrier against such a failure by detecting it and responding appropriately. Every so often, these barriers will fail. For instance, fatigue or high workload may prevent a controller from detecting the failure. Other defences should then protect the system. For instance, the aircrew might detect the problem. Accidents and occurrences occur when failures combine with weaknesses in the defences that protect the system.

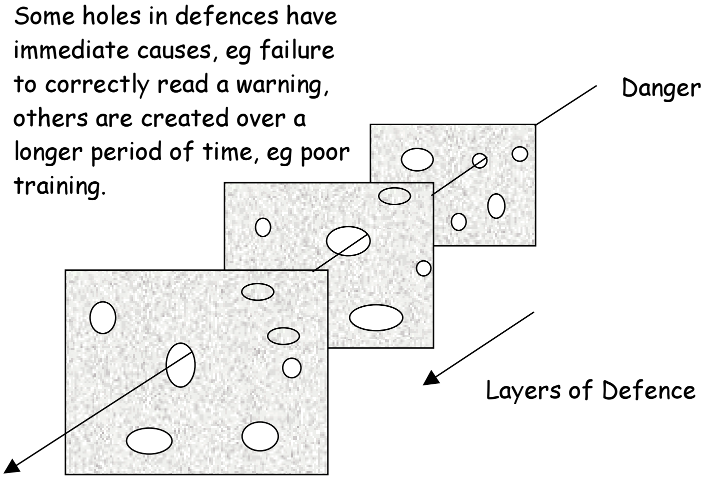

Figure 11: Swiss-Cheese Model of Defences and Occurrences

A systemic view of occurrence analysis provides answers to the framing problem that is a major issue for safety management. It can often be difficult to identify the scope or extent of an occurrence investigation. When does an occurrence really begin? For instance, if an ATC office misreads data from their workstation then this might be seen as a human error. The same occurrence might also be blamed on poor design from the component supplier. They, in turn, might argue that the problems stemmed from problems during requirement elicitation and tendering. This analysis illustrates that many occurrences have deep organisational causes. Organisational failures occur when no one person's error was a sufficient cause for an accident. Their origins can, typically, be traced far back into many parts of the organisation. Reason [1997] describes three stages in the development of such accidents: the organisational factors stage, the local workplace factors stage and the unsafe acts stage. Organisational factors include strategic decisions, managing and auditing. Local workplace factors include insufficient training, poor communications, and unworkable procedures. As can be seen, the investigation process should look at the immediate symptoms of a failure to uncover these deeper causes. This involves reconstructing the way in which barriers were avoided or overcome by unsafe acts, organisational problems and workplace factors.

Some ATM providers have used this style of analysis to define the scope of their investigation. Final reports should include sections on unsafe acts, local workplace factors and organisational failures. However, most organisations still rely upon more ad hoc approaches where individual investigators can determine whether or not an investigation should consider managerial and organisational failure. This approach is perfectly acceptable with **two** additional requirements. The first is that the investigator should explicitly state why organisational and local workplace factors were not considered relevant. The second is that another member of the safety management group should authorise this decision to limit the scope of the analysis. As mentioned before, it is important that the notion of collective responsibility is maintained within a Safety Management Group and that no single investigator should be allowed to take full responsibility for the course of an investigation without the support of their Safety Manager.

Guideline 14: Specialist human factors support should be recruited.
Rationale: It is increasingly important to recognise that specialist help should be recruited if we are to improve our understanding of increasingly complex occurrences involving the interaction between human operators and technical systems.

Human factors issues are increasingly being recognised as critical to an understanding of ATM occurrences. There is a tendency, however, for individuals to consider themselves to be human factors 'experts' with little or no formal training in ergonomics or psychology. This creates considerable problems because the interpretation and analysis of human error remains a skilled, technical discipline. It can be difficult to distinguish slips from lapses. In other words, it can be difficult to distinguish errors in intention from incorrect execution. Similarly, it can be difficult to determine whether a problem may have arisen from a genuine error or from a deliberate violation of operation procedures. Even if these distinctions are apparent during the analysis of an occurrence, further work may be required to identify the underlying causes of an error. For example, there is a range of well-documented techniques for determining whether high workload or poor situation awareness contributed to an occurrence. Unless one of these recognised techniques is used then it can be difficult for investigators to defend their subjective judgements about the probable causes of human error during examination by a regulator.

EUROCONTROL have developed a range of tools to support the human factors analysis of an occurrence, using the HEIDI taxonomy and the HERA tool. However, even when these techniques are available, there will still be circumstances when specialist human factors support should be recruited during the analysis of an occurrence.

Guideline 15: Risk Assessments should be based on EUROCONTROL guidance material (ESARR 2).
Rationale: This is critical if occurrence reporting is to support risk assessment during any subsequent redesign or maintenance of the systems involved in an occurrence.

There are two ways in which risk assessment may be integrated into occurrence reporting systems. Firstly, local investigators can perform a preliminary risk assessment during the analysis phase. This helps to determine the allocation of resources that will be provided to any investigation. Clearly an infrequent, low criticality occurrence may not merit the resources of a high-criticality event. Secondly, a national review of occurrences may take place during subsequent stages of occurrence investigation. This is intended to ensure that consistent criteria are applied to the analysis of any risk posed by an occurrence. Different ATM providers may operate their own local classification schemes. For example, it can be decided to increase the criticality of occurrences that pose a particular local hazard given the configuration of a particular sector. Ultimately, however, this process of national or regional moderation should be conducted to ensure that the levels of risk that are assigned to an occurrence can eventually be linked to internationally agreed definitions; see for example the more detailed guidelines in ESARR2 and ESARR4.

Risk assessment helps to prioritise the allocation of finite development resources. More resources should be allocated to those failures that pose the highest risk. This idea has become enshrined within risk assessment techniques, such as Failure Modes, Effects and Criticality Analysis (FMECA). It has also been extended to support the “as low as reasonably practicable” (ALARP) principle illustrated in Figure 12.

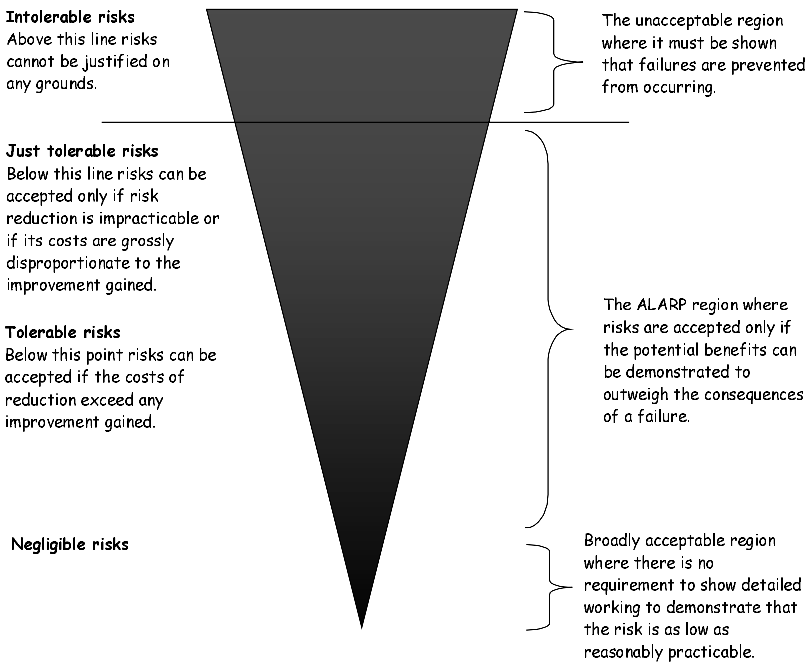

Figure 12: The ALARP Principle for Risk Analysis and Design

At the top of the diagram, risks are so high that they cannot be tolerated. At the bottom of the diagram, risks are so small that they need not be considered in great detail. In the middle of the diagram is a region in which the risks of failure should be reduced as low as can be justified by available development resources. Incident and occurrence reporting systems play a key role in this approach to systems development because risk is defined to be the product of two factors: risk = severity x frequency. Incident reporting systems provide first-hand experience of the severity of particular failures. The process of reconstruction and simulation can also be used in the aftermath of an occurrence to identify worst-case scenarios. It is, therefore, important that any incident reporting system be closely tied to the use of risk assessment in ATM safety cases. Not only will future safety cases have to be informed by the incidents that are investigated but so too will any existing safety cases that make inappropriate assumptions about the nature of potential incidents. It is, therefore, recommended that a formal criticality and frequency assessment be performed for any of the occurrences that are investigated by regional and national investigators. Table 5 provides qualitative guidance on frequency assessments that may be associated with types of incidents. In contrast, tables 6 and 7, therefore, present the definitions of accident and occurrence severity that have been recommended by EUROCONTROL's Severity Classification Scheme.

Frequency	**Definition**
Extremely rare	Has never occurred yet throughout the total lifetime of the system.
Rare	Only very few similar incidents on record when considering a large traffic volume or no records on a small traffic volume.
Occasional	Several similar incidents on record. Has occurred more than once at the same location.
Frequent	A significant number of similar occurrences already on record. A significant number of similar occurrences have taken place at the same location.
Very Frequent	A very high number of similar occurrences already on record. A very high number of similar occurrences have taken place at the same location.

Table 5: Occurrence Frequency Assessment

Severity	**Definition**
Accident	A person is fatally or seriously injured. The aircraft sustains damage or structural failure. The aircraft is missing or completely inaccessible. Collisions between aircraft. Controlled flight into terrain, loss of control in flight due to meteorological conditions and VORTEX.
Serious Incident	Circumstances in which an accident nearly occurred. Critical near collisions between aircraft or between aircraft and obstacles. Near controlled flight into terrain, near loss of control in flight due to meteorological conditions and VORTEX.
Major Incident	Incident associated with an aircraft in which safety may have been compromised. Safety margins were not respected.
Significant incident	An accident, a serious or major incident could have occurred if the risk had not been managed within safety margins or if another aircraft had been in the vicinity.
No safety effect	An incident which has no safety significance.
Not determined	Insufficient information was available to determine the risk or conflicting evidence.

Table 6: Accident/Incident Severity Assessments

Severity	**Definition**
Total inability to provide safe ATM service	An occurrence associated with the total inability to provide any degree of ATM service in compliance with applicable safety regulatory requirements, where: There is a sudden and non-managed total loss of ATM service or situation awareness; There is a totally corrupted ATM service or corrupted information provided to ATS personnel.
Serious inability to	An occurrence associated with almost a total and sudden inability to provide any degree of

provide safe ATM service	ATM Services in compliance with applicable safety regulatory requirements. It involves circumstances indicating that the ability to provide ATM services is severely compromised and has the potential to impact many aircraft safe operations over a significant period of time.
Partial inability to provide safe ATM service	An occurrence associated with the sudden and partial inability to provide ATM services in compliance with applicable safety regulatory requirements.
Ability to provide safe but degraded ATM service	An occurrence involving circumstances indicating that a total, serious or partial inability to provide safe and non-degraded ATM Services could have occurred, if the risk had not been managed/controlled by the ATS personnel within safety regulatory requirements, even if this implied limitations in the provision of ATM services.
No effect on ATM service	Occurrences which have no effect on the ability to provide safe and non-degraded ATM services.
Not determined	Insufficient information was available to determine the risk involved or inconclusive or conflicting evidence precluded such determination.

Table 7: Accident/Incident Severity Assessments for Air Traffic Service Provision

It is important to stress that the distinctions that are shown in Tables 5, 6 and 7 are only intended to provide high level guidance. Quantitative measures may be introduced to provide more detailed guidance at a local level. For example, individual ATM service providers may choose to regard two incidents per year as a frequent number of incidents. Other ATM service providers with different traffic patterns and infrastructure capabilities may decide that this rate should be associated with the “very frequent” category. The key issue, however, is that the risk assessment process should guide investment in safety improvements and that the frequency of higher criticality events should be shown to decline over time. As mentioned in previous paragraphs, the criticality of an incident is the product of its relative frequency and its severity. Taking the previous tables, it is then possible to allocate a severity index to the incident under investigation. The severity classification is based on that in Tables 6 and 7 but accidents are omitted because they will be handled by national regulatory mechanisms.

Severity	A	Serious	A1	A2	A3	A4	A5
	B	Major	B1	B2	B3	B4	B5
	C	Significant	C1	C2	C3	C4	C5
	D	Not determined	D1	D2	D3	D4	D5
	E	No safety effect.	E1	E2	E3	E4	E5
			1	2	3	4	5
			Very Frequent	Frequent	Occasional	Rare	Extremely rare
			Frequency				

Table 8: Critical Assessment Table

It should be possible to trace the justifications for a particular severity assessment and that this assessment should be linked to the EUROCONTROL guidelines. For ATM service providers, this linking of occurrence reporting and of risk assessment will help to ensure that safety cases have a firm foundation in operational experience.

Guideline 16: When assessing the risk of future incidents, attention should be paid to the record of previous occurrences.
Rationale: This is an important means of feeding information about previous occurrences forward into the subsequent development of ATM services.

In assessing the future likelihood of an occurrence, it is important not simply to take into account the incident that is currently under investigation but also any previous occurrences that have similar causes or outcomes. This might appear to be an obvious point. However, there are a number of important practical implications that should be considered. Firstly, in any occurrence reporting system, there will be a problem of under-reporting for certain classes of incident. A number of ATM providers have launched special initiatives to encourage the reporting of particular classes of incidents, for example by issuing personnel with newsletters or mail shots. This has led to a short-term increase in the number of those incidents that are notified to the service provider. Such a short-term increase indicates that some of these incidents are not normally reported.

A second issue in the use of information about previous incidents is that it can be difficult to recognise common causes or outcomes for all but the simplest of occurrences. This problem partly relates to the numbers of reports that are submitted to some systems. For instance, one service provider that has a wide national definition of occurrences, ranging from minor equipment failures to more serious incidents, now receives over 1,500 reports per annum. This problem of identifying trends amongst incident data also stems from the geographical distribution of occurrence reporting systems. As a result, several service providers have recruited database support to help trained staff to search for information about previous incidents when assessing the likelihood of previous failures.

The use of information technology raises further problems in this area. For instance, it can be difficult to develop an appropriate tool that will allow personnel to issue natural language queries when looking for similar occurrences. Often database systems expect that incidents will be encoded to support a restrictive set of pre-prepared searches. Current research in the US and in Europe has begun to exploit search engines that were initially developed for the Internet as a fast and effective means of retrieving information about previous occurrences [Johnson, 2000].

Historic data about previous occurrences represents an extremely valuable source of information for the subsequent design of ATM services. Data about previous incidents can be used to inform systems acquisition. It can also be used to identify areas in which training should be updated. The key point is that the information collected by these systems should be used as widely as possible to inform ATM service provision.

Generic Phase E: Recommendations and Monitoring

The main product from any particular occurrence investigation should be the recommendations that are made in the final report. It is, however, possible to identify a number of further products that can be obtained from occurrence reporting systems. For example, an analysis of several previous occurrences can be used to inform future safety recommendations. These investigations can also be used to compile the annual statistical data about ATM occurrences that are requested by regulatory documents such as EUROCONTROL's ESARR2. These include the total number of occurrences in a state, classified according to severity level, phase of flight, flight rules etc. These classifications depend upon the ATM providers ability to extract statistical information based on the data requirements and analysis techniques that have been advocated in the generic phases in this document. There is also a need for guidance on how to evaluate whether a safety recommendation should be made. It may not always be necessarily to revise operating practices in response to every incident. Too many ill-advised revisions in the response to individual occurrences can have a chaotic impact and can jeopardise the future success of a reporting system. Clearly, such a decision depends upon the individual judgement of an investigator with regard to the particular events during each occurrence. However, these judgements should be validated; ideally through documented consultations with other investigators. The drafting of such recommendations also depends upon an assessment of their potential efficiency; of any undesired side effects, of interactions with previous recommendations on the subject etc. The following guidelines support these activities.

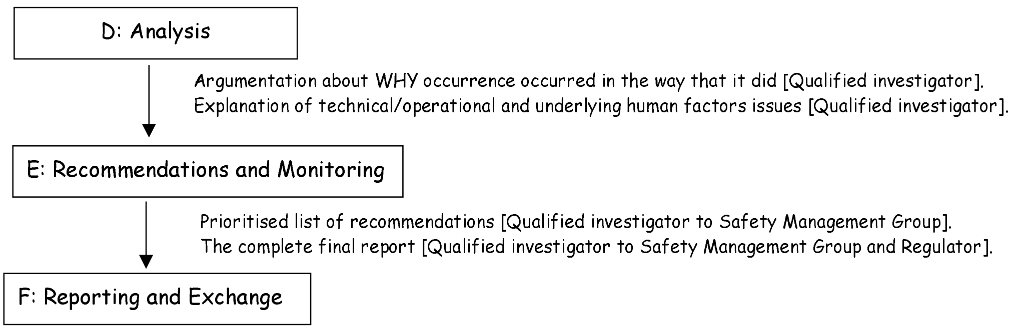

Figure 13: Inputs and Outputs from Phase E (Recommendations and Monitoring) of Occurrence Investigation

Guideline 17: Feedback should be provided to personnel.
Rationale: Personnel should trust the system and be confident in its value.

Occurrence reporting systems also provide a valuable source of information that can be communicated back to personnel within the ATM provider. The importance of this feedback should not be under-emphasised. It is increasingly being recognised that human factors represent a primary causal factor in many occurrences. As a result, ATC personnel can be provided with constant reminders about the importance of particular procedures and working practices through the occurrences and near occurrences that are investigated by occurrence reporting systems. Although this document has focussed on mandatory occurrence reporting, the same feedback mechanisms that are used in voluntary schemes can also be employed here. The FAA/NASA's Aviation Safety Reporting System publications provide valuable examples for this form of feedback. For example, the following excerpt provides information about the potential causes behind a number of occurrences involving altitude deviations:

> "Throughout 21 years of operation by the Aviation Safety Reporting System (ASRS), approximately 35 percent of all occurrences reported to the ASRS have been altitude deviations. Previous ASRS reviews of altitude errors have identified multiple contributing factors for these events. A 1982 ASRS study, Probability Distributions of Altitude Deviations, found that altitude deviations reported to ASRS were exponentially distributed with a mean of 1,080 feet, and that deviations from ATC-assigned altitudes were equally likely to occur above or below the assigned altitude.1 Another ASRS review of altitude deviation problems, One Zero Ways to Bust an Altitude,2 looked at the percentage of altitude deviations by altitude pairing, (i.e., confusing one altitude for another) and found that 35% of all paired deviations occur at 10,000 and 11,000.

More recently, ASRS analysts have noted that approximately 15 to 20 percent of the altitude deviations reported to ASRS involve crossing restriction errors on Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs). SIDs and STARs are published instrument routings whose primary purpose is to simplify ATC's clearance delivery procedures.

Altitude crossing restrictions associated with SIDs and STARs may be published on navigation charts or assigned by ATC. Crossing restrictions exist for two primary purposes: 1) to provide vertical separation from traffic on different routings that cross the same fix, and 2) to contain traffic vertically within a given ATC controller's sector in cases where other sectors within the same facility, or sectors in another facility, are layered above and below. ATC-assigned crossing restrictions (as opposed to published crossing altitudes) may be temporary requirements imposed to meet changing operational conditions, including facilitating traffic hand-offs to another sector. Pilot compliance with SID and STAR altitude assignments is important, for if a controller permits traffic penetration of another sector either laterally or vertically without prior coordination and approval from the controller in that sector, an operational deviation results.

No previous ASRS review of SID and STAR-related altitude deviations has been conducted. Thus we undertook this review to determine the causes and contributors to altitude deviations that occur during SID and STAR procedures, and to compare the results of this analysis with selected findings of the 1982 ASRS study." ASRS Directline Issue Number 10 : December 1998
See: http://asrs.arc.nasa.gov./directline_issues/dl10_xing.htm

Many ATM service providers already provide newsletters and other publications to disseminate the lessons that are learnt from occurrence reporting systems. It is possible to identify and, therefore to advocate, two different approaches to these publications. The first follows the form of the ASRS' Callback bulletin. This is published once every month. These publications provide two or three pages of information about recent occurrences. Usually the text is prefixed by a brief narrative or analysis that is intended to draw lessons from these occurrences and potentially link adverse situations to the procedures and protocols that might have avoided them. The second class of publications follows the DirectLine model, illustrated above. This provides a much less frequent overview of key topics that have been identified over many months of reports. The distribution is more restricted and it is intended to inform managers and policy makers as much as it is intended to have a direct effect on operating practices.

Guideline 18: Safety recommendations should be implemented or the reasons why they are not implemented should be documented and approved. These actions should be monitored.
Rationale: there should be an established mechanism to verify that any accepted recommendations have been implemented

Final reports should contain recommendations that are intended to either reduce the likelihood of an occurrence or mitigate the impact of that occurrence should it occur. National or regional regulators make these recommendations to the ATM service provider's safety managers. These investigators are assumed to be trained personnel who are free to make independent decisions about potential recommendations. It, therefore, follows that safety managers may have good reasons not to accept all of their findings. The ALARP principle recognises that it may not be financially possible to avoid all risks. The final occurrence report should, therefore, include an appendix summary from the Safety Manager that reviews each of the recommendations and states whether or not it is accepted for implementation. The rationale for each decision should also be provided. This response then forms a blueprint for subsequent intervention to reduce the occurrence or mitigate the consequences of future occurrences.

In providing an argument for or against a recommendation, the Safety Manager should not only consider the particular occurrence that is being investigated. They should also consider whether there have been any previous occurrences that are similar to the one being investigated. This implies that they should monitor occurrences throughout their operations but also, when possible, those in other ATM service providers. They should also consider the "plausible" worst case scenarios that form part of the analysis that has been conducted by the regional or national investigators. Decisions to accept recommendations may be guided not only by what DID happen but also by what MIGHT have happened.

Recommendations may not only focus on remedial or mitigating actions. They may also focus on improved techniques for monitoring and recording the occurrence of future similar occurrences. This is particularly important if managers believe there is a problem with under-reporting. Such recommendations, if accepted, can lead managers to conduct specific reporting initiatives through the publications that are used to disseminate these findings back to ATM staff.

It is also very important that the data gathered from occurrence reporting should also be used during target setting. In particular, the output of these systems can provide quantitative evidence to back-up the use of risk assessments during future development. This helps to ensure a direct link between the safety 'feedback' about previous incidents and the safety 'feed-forward' of information into development.

Guideline 19: periodic reviews and monitoring help to assess the success or failure of remedial actions or whether actions that were not accepted ought to now be performed.
Rationale: it is important to validate accepted recommendations.

It is not sufficient for safety managers to accept or reject the investigator's recommendations. They should also monitor the success or failure of the actions that are approved following a final report. It can be very difficult to predict the many different ways in which future occurrences might differ from previous occurrences. As a result, periodic reviews should be conducted to detect patterns of similar occurrences that might emerge in spite of additional safeguards. In particular, many previous occurrence reporting systems have resorted to the use of low cost remedies, such as reminder notices and warnings. Whilst these techniques can have a short-term effect on staff performance, they do not provide a long-term solution to occurrences involving human error. The initial costs of implementing more fundamental changes can be offset by the repeated costs of continued occurrences when recommendations are only partially implemented.

It is recommended that review meetings be conducted on a 3, 6 or 12 monthly basis to review recent occurrence reports. This meeting should not only review the causes of the occurrences, as documented in the final reports. They should also address a number of more general issues relating to the effective management of the occurrence reporting programme:

1. Are ATM personnel actively participating in both confidential and anonymous systems? In particular, are there any regional or operational variations in the frequency of occurrence reports in relation to overall traffic patterns?

2. Do investigators have sufficient training and resources to conduct their investigations effectively? In particular, is it possible to identify weaknesses or biases in the analysis and recommendations that have been produced following certain occurrences?

3. Are remedial actions having the anticipated effect in reducing the occurrence of occurrences or in mitigating their impact? For example, are changes in training techniques having the anticipated impact upon the operational performance of ATM personnel?

4. Are there any underlying changes in the technological infrastructure or in the operating environment that might make certain types of occurrence more likely and, if so, should special reporting initiatives be conducted, for example by issuing special forms that request information about these particular occurrences?

As before, this is a preliminary list. Local and regional circumstances should help to determine the agenda of these meetings that are primarily intended to ensure effective management of the reporting system.

Guideline 20: studying changes in the severity weightings over time using ESARR2 metrics can assess the success of the scheme.
Rationale: the benefits of maintaining the system should be demonstrated to be worthwhile

The previous pages of this document have identified a number of practices and procedures that are intended to support occurrence investigation and reporting. Each of these techniques incurs additional expense to ATM service providers. It is, therefore, important that managers be provided with some means of assessing whether their expenditure is yielding benefits.

The validation of an occurrence investigation system is a very difficult problem. The annual frequency of high severity occurrences is very low amongst European ATM providers, often only one or two per year. Unusual, pathological events can lead to single occurrences that, in turn, can have a considerable impact upon any trend data. As a result, several ATM providers monitor the success of an occurrence reporting system not by examining the frequency of high severity occurrences but by looking at the frequency of medium to low severity occurrences. There are, however, a number of further methodological problems in measuring the success of an occurrence reporting system. A fall in the number of reports falls may either indicate an overall improvement in safety or it may indicate less participation in the system. Some reporting systems, therefore, aim to maintain the same number of submissions whilst ensuring that the severity of the occurrences that are reported goes down. All of this depends upon a consistent and coherent severity classification system, such as the HEIDI taxonomy.

Generic Phase F: Reporting and Exchange

Previous phases have described how occurrences are detected and reported by ATM personnel, by aircrews, by automated systems and by the general public. They have also described how report forms are passed on to investigators who generate an initial report and then conduct more detailed data gathering, reconstruction and analysis. These analytical activities lead to the generation of recommendations that should then be monitored to determine whether or not they have been successful. The final phase focuses on occurrence reporting and the exchange of information both within and between ATM service providers.

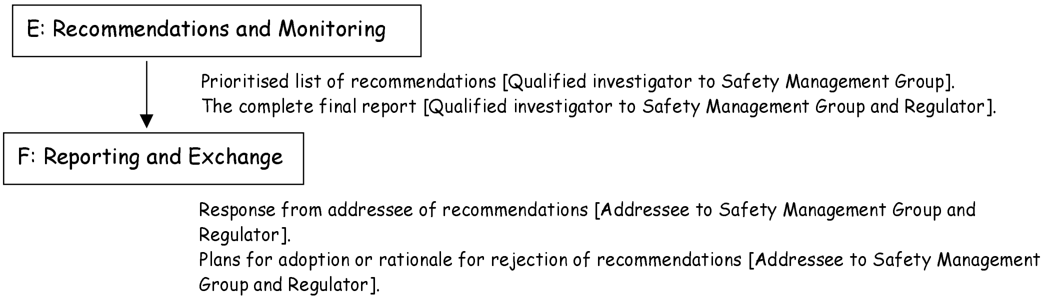

Figure 14: Input and Output from Generic Phase F (Reporting and Exchange)

Guideline 21: The final report should be issued in an approved format
Rationale: This ensures consistency and aids comparisons between occurrence reports.

The drafting of the final report should follow a set format. This helps to ensure that all of the data that might be relevant to an occurrence is recorded in an accessible form that can be retrieved at a later date. This is critically important if analysts are to trace trends in occurrences that emerge over several months or even years. A typical format provide:

1. A brief summary of the occurrence that provides all of the minimum data requirements that were identified in data gathering.
2. A chronology of events derived from reconstruction together with a brief description of any alternate chronologies that might have been considered during the investigation. WHAT happened during the occurrence.
3. An analysis of these events that describes the judgements that were made about the causes of an occurrence WHY it happened in the way that it did.
4. The recommendations from the occurrence investigation. If no recommendations were made then this decision should be justified. If several recommendations are made then they should be prioritised and this ordering should also be justified.
5. Finally appendices may contain additional expert statements or evidence that was gathered during the analysis and which is considered relevant to a subsequent interpretation of the occurrence. Immediate feedback may also be included from the notifier and the supervisor if they provided a response to the initial analysis mentioned in guideline 12.

The following checklist provides a framework to ensure that any report considers the minimum of relevant information to support its findings:

Evidence and Factual Data:

1. Does the final report contain a summary of the information obtained about the occurrence both from interviews and automated logs?
2. Does the final report provide sufficient information for readers to assess the reliability of that data, especially if there was inconsistent or missing evidence?
3. Does the factual data adequately explain any unusual circumstances, of workload or system failure, that might affect the readers interpretation of the evidence?

Analysis of the Data:

1. Does the report determine whether or not the ATM service provider could have anticipated the occurrence?
2. Does the report determine whether ATM personnel had the means to avoid and mitigate the occurrence?
3. Does the analysis explain any particular human factors issues that exacerbated the occurrence or greatly contributed to its likelihood?
4. Where there any precursors of that incident which were not given required attention?

Conclusions:

1. Does the report state whether it was feasible to avoid the occurrence and, if not, does it state the steps that could be taken to improve the management of future occurrences?
2. Does the report specify time limits and validation constraints on the implementation of future improvements?
3. Does the report specify whether any steps ought to be taken to ensure that any future occurrences of similar occurrences are detected, notified and responded to?

There are a number of simple techniques that can be used to check the argument that is presented in an incident report. For example, one approach is to sketch the relationship between any conclusions and the evidence that supports them. This is illustrated in Figure 15.

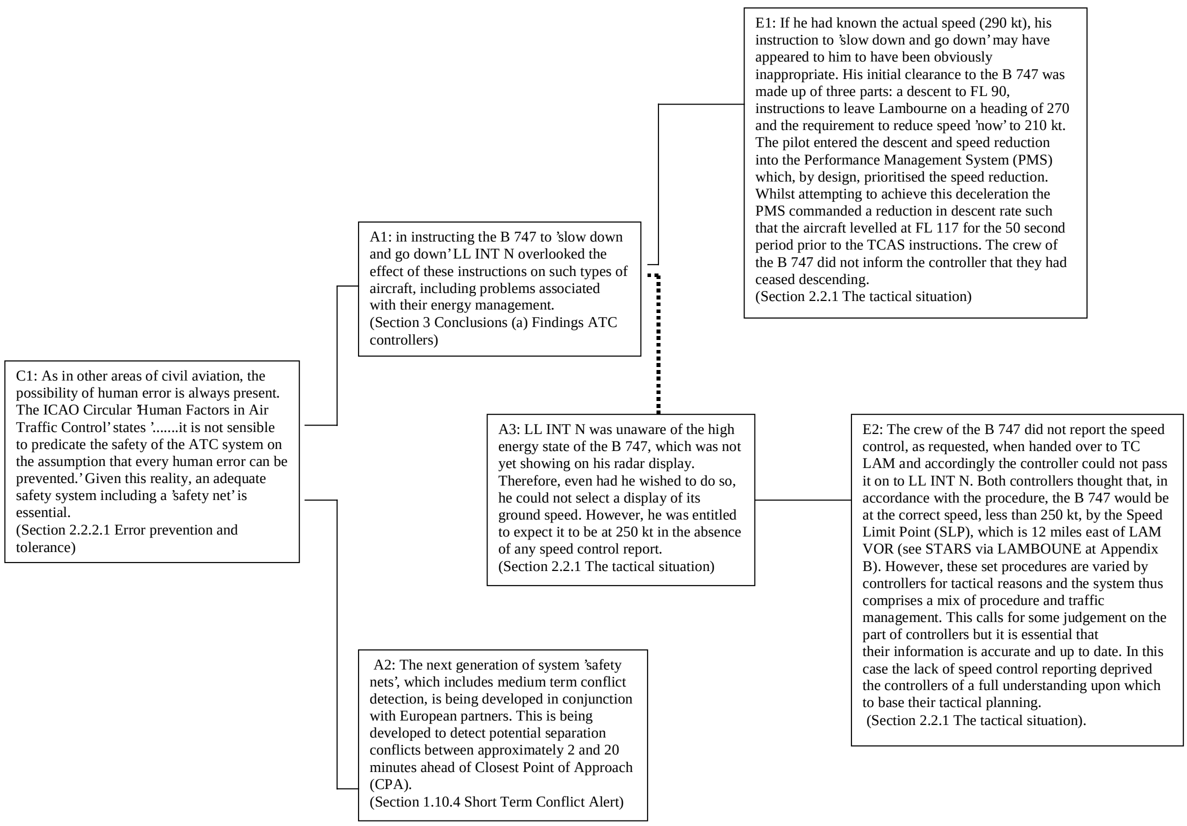

Figure 15: Conclusion, Analysis, and Evidence (CAE) Diagrams for an ATM Occurrence

This figure is based on an AIRPROX incident reported by the UK Air Accident Investigation Branch, however the approach may also be used to check the argument in lower severity occurrences [AAIB, 98]. The conclusion on the far left of the diagram was that a 'safety net' approach is necessary because it is impossible to eliminate all forms of potential human failures. Two lines of analysis that are connected to it support this conclusion. The first line of analysis, A1, refers to an apparent error that was made by ATC personnel in issuing the instruction to `slow down and go around' to the crew of a Boeing 747. The second line of analysis, A2, argues that medium term conflict detection may provide means of avoiding such incidents in the future. Figure 15 goes on to analyse the argument in the occurrence report in greater detail. In particular, the evidence that supports A1 is based around the observation that B747's performance management system (PMS) intervened to reduce the rate of descent when the crew attempted to execute the ATC officer's instruction. As a result the B747 did not successfully implement a previous instruction to descend below the altitude being assigned to a Gulfstream IV. This evidence, E1, supports the previous analysis, A1. The ATC error is confirmed by the way in which the PMS intervened. This supporting relationship is denoted by a solid line between the analysis and the evidence, i.e., between A1 and E1. This should be compared to the comments about European safety net initiatives, denoted by A2, that have no supporting evidence. The occurrence report does not elaborate further on any lessons that this particular incident might have provided for medium term conflict avoidance.

Figure 15 also shows a further line of analysis that contradicts previous arguments about a relatively straightforward controller error. The controller was unaware of the impact of their command to 'slow down and go around' because they had underestimated the present speed of the B747. They made a reasonable assumption about the probable speed of the aircraft. The B747 crew had been requested to provide this information to TC LAM but had failed to provide it. TC LAM, in turn, could not hand this information over to LL INT N. A broken line between A1 and A3 denotes this opposing argument.

The key point here is to illustrate the degree of complexity that can arise when investigating and reporting occurrences. Considerable care must be taken in framing and checking arguments about human and technical failure. The procedure for constructing these Conclusion, Analysis, Evidence (CAE) diagrams is given below, more information is available in [Johnson, 2000a]. They provide a useful tool for checking that any conclusions or findings in a report are well supported by the available evidence:

a) List all of the conclusions that are identified in the report. Next to each conclusion, indicate the page or section numbers where they are proposed. This will help to ensure that all conclusions are gathered together within the same section of the report.

b) List each line of analysis that supports or weakens the conclusions identified in stage 1. This is, typically, a non-trivial exercise. Few occurrence reports explicitly record the lines of analysis that support their findings. The reader is expected to piece together the implicit inferences that support specific conclusions. Again, a note is made of every page number on which the line of analysis is presented.

c) List the evidence that either weakens or strengthens each line of analysis. This is relatively straightforward because stage 2 helps to identify the evidence that is needed to support a particular line of argument. Page numbers are recorded for each item of evidence.

d) Construct a graph based on the products of the first three stages. A separate CAE diagram is produced for each of the conclusions identified in stage 1. These are drawn as the roots for each of the graphs. The arguments for and against a conclusion are connected to the root. Solid lines connect arguments that support a conclusion. Arguments that weaken a conclusion are connected by dotted lines. Finally, each item of evidence is linked to the relevant arguments. As before, evidence in support of an argument is shown by a solid line whilst negative or contradictory evidence is shown by a dotted line.

The key benefits of the CAE approach are that they illustrate those conclusions that are best supported by arguments and evidence. If a conclusion has only weak support then there may only be one or two lines of analysis that connect it to the evidence and reconstruction. If it is well founded then there will be multiple, independent sources of evidence, for example from eyewitness testimony and from automated logs. Similarly, the use of dotted lines to indicate contradictory evidence can help to visualise counter-arguments that may be used by regulators or by others during any subsequent review of the report.

The submission of a final report is not the end of the occurrence investigation process. As mentioned above, it is critical that feedback be provided to personnel so that they can read about the impact of previous failures and of the improvements that have been made following from those occurrences. It is also important that ATM service providers also consider the long-term storage and retrieval of the occurrence reports that they generate. At present there are few national guidelines and no national standards that address the sorts of databases that might be used to help organisations search for similar causes or consequences amongst occurrence reports. Standard relational databases can be used. These include a large number of widely available commercial products. There are a number of disadvantages to these systems. In particular, it can be difficult to train investigators to accurately form the complex queries that can be necessary to identify whether or not similar occurrences have already been reported. A number of organisations are, therefore, recruiting natural language search tools based on those that are available for commercial web sites. These systems have not been widely exploited yet but they offer a number of additional benefits. For instance, it is possible to build up profiles to identify whether there are any individual biases in the ways in which investigators classify the causal factors behind particular occurrences. It is also possible to gather information about the querying behaviour of users to determine whether or not they consider the range of causal factors that might lead to particular occurrences.

Guideline 22: Occurrence reports should be accessible to all staff. In particular, the notifier should receive a copy of the draft final report
Rationale: This increases sense of involvement and encourages final additional feedback

The analysis of any occurrence requires a certain amount of subjective interpretation based upon the events that were identified by the previous analysis. This interpretation rests on the analytical skills of the national and regional teams that support the controllers' immediate supervisor in the immediate aftermath of an occurrence. It is entirely possible that this analysis may fail to consider relevant information. It may also trigger further relevant recollections from both the person notifying the occurrence and from their colleagues. It is, therefore, appropriate to provide the notifier and their supervisor with a draft copy of the causal analysis and severity assessment.

There are a number of recommended techniques for exploiting the feedback that can be provided in response to a preliminary causal analysis. In some reporting systems, the comments of the notifier and their supervisor are used in an informal way to inform the subsequent redrafting of an occurrence report. The investigator then has considerable freedom over the extent to which they incorporate any changes into a final draft. Alternatively, other ATM providers may insert these additional comments as a very brief appendix to the final report that is submitted to the regulator and other external agencies.

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Recommended Reading

EUROCONTROL documents:

EUROCONTROL, Safety Regulatory Requirement: Reporting and Assessment of Safety Occurrences in ATM, Ref. ESARR 2, Brussels, Belgium, 1999. Available on:
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EUROCONTROL, Short Report on Human Performance Models and Taxonomies of Human Error in Air Traffic Management, Brussels, Belgium, 2000.

EUROCONTROL, The HEIDI Taxonomy, Brussels, Belgium, 2000.

EUROCONTROL ATS Occurrence Reporting Form. APDSG, Brussels, Belgium, 2000.

ICAO Documents:

ICAO Annex 13 to the Convention on International Civil Aviation

ICAO Manual of aircraft accident investigation. Ref: ICAO Doc 6920

ICAO Accident prevention Manual. Ref: ICAO Doc 9422

ICAO Air Traffic Services Planning Manual. Ref: ICAO Doc 9426.
Guidance on the reporting and analysis of ATS incidents, plus the ATS reporting form for pilots to report.

ICAO Accident Investigation and Prevention (AIG) Recommendations for SARPS (Aircraft Accident and Incident Investigation) Annex 13 to the Convention on International Civil Aviation, Ref. AN-WP/7472 (ANC Task No. AIG-9801), 1998.

EU Directives:

Draft proposal for a Council directive re-establishing a co-ordinated system of national mandatory occurrence reporting schemes in civil aviation. Council directive 94/56/EC of 21 November 1994.

CEC Directive L319

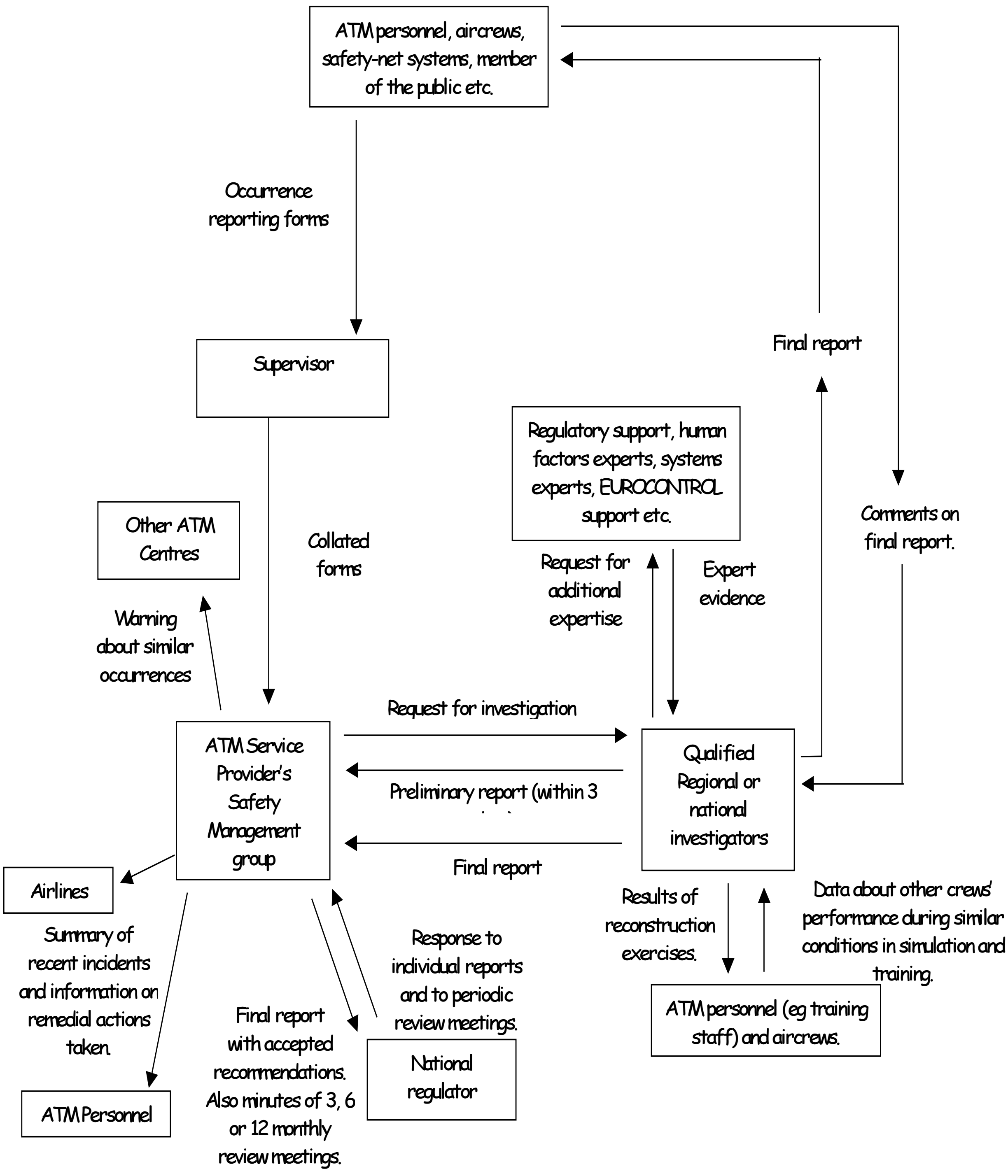
JAA Documents:

Advisory Material, Draft NPA 20-6 on occurrence reporting, Ref: ACJ 20.XX, 2000.

ECAC documents:

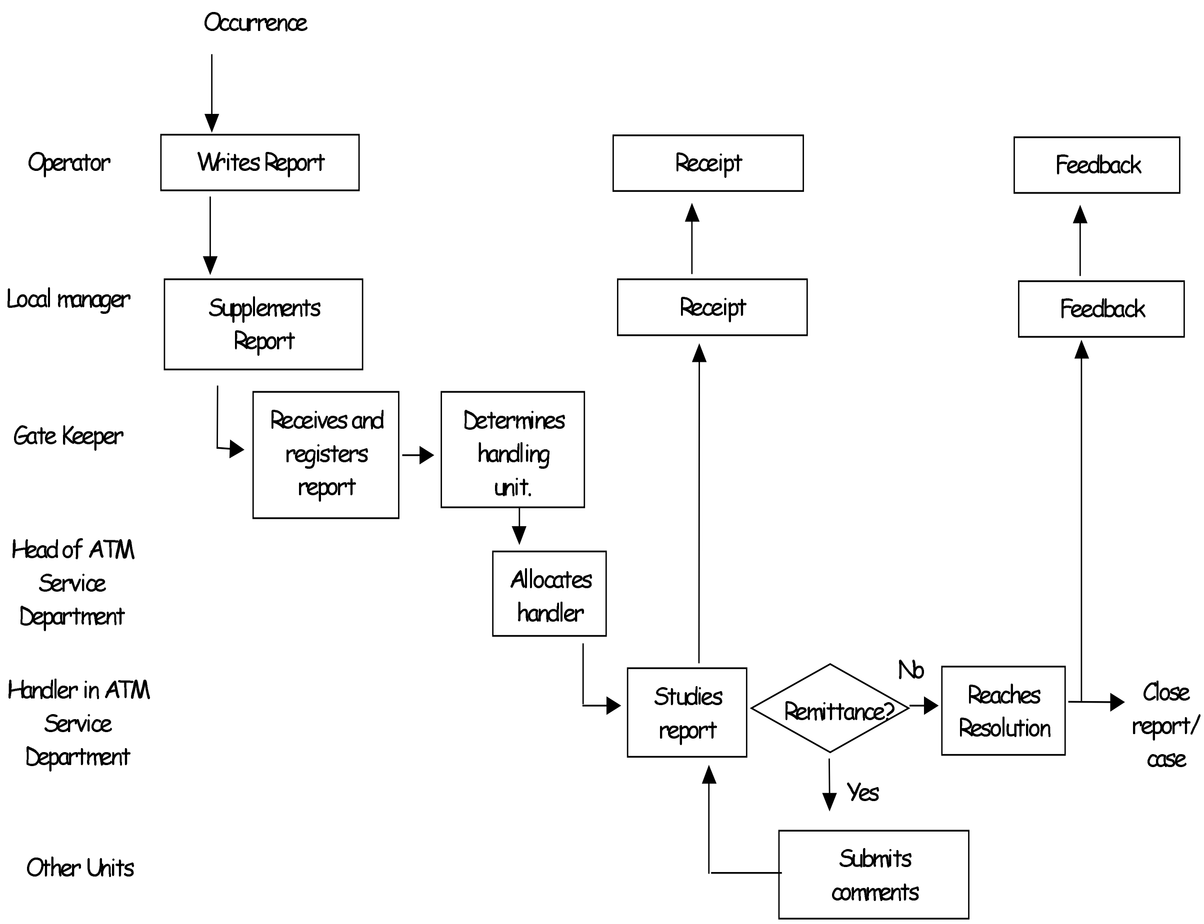
European Civil Aviation Conference, Experts on Accident Investigation Summary of Decisions. Ref: ACC/16(Inf.)-SD, Lisbon, Portugal, 1999.

Appendix A – Overview of Occurrence Reporting Process



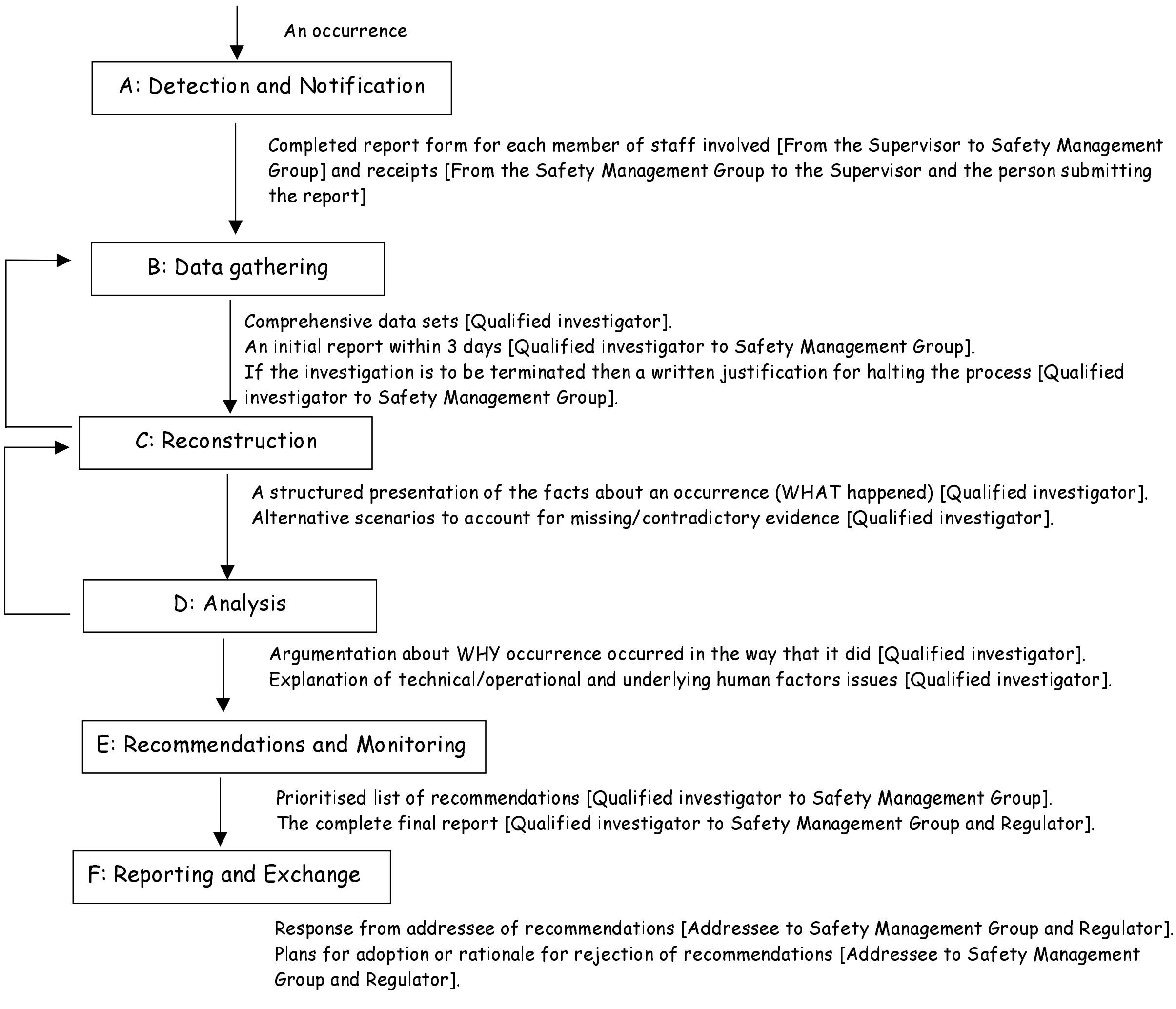
This diagram provides an overview of the stages involved in one approach to occurrence reporting and investigation. It is closely modelled in existing practice within several ATM service providers. However, there are a number of different means of implementing the various activities shown in this diagram. For instance, this approach suggests that all reports may be investigated. In contrast, appendix B provides an overview of an existing ATM reporting system that relies upon the submission and filtering of occurrence reports by a gatekeeper before they are passed for further investigation.

Appendix B – Overview of Alternative Occurrence Reporting Process



This diagram illustrates how some ATM service providers have integrated their occurrence reporting system into more general quality improvement systems. Here the definition of occurrences includes all forms of human, operational and technical failures even including incidents such as a failure of a light bulb. All reports are handled centrally by a number of specially trained gatekeepers who are responsible for filtering the reports and then passing them on to the relevant departments for action.

Appendix C – Inputs/Output of the Reporting Process



Appendix C – EUROCONTROL Sample Reporting Form

National Reference Number:

ATS OCCURRENCE REPORTING FORM

for ATS personnel to report an occurrence caused by an aircraft or a vehicle, by your own or another ATS Unit, an alleged violation of ATS provisions or clearances, equipment/ATC Procedures shortcomings, etc.

Fill in as many Boxes **(1** *to* **19)** *as possible and relevant, mark ☐ as appropriate; Refer to Guidelines*

1. Date/Time of occurrence (in UTC):

Y Y	M M	D D	h h	m m

2. Day or Night ☐ Day ☐ Night

3. Geographical location of occurrence:

4. Aircraft involved:

Operator	Call sign and/ or registration	Type	ADEP	ADES	FL, altitude or height: actual	FL, altitude or height: cleared	SSR Code	Mode C	Relevant route segment	Flt. Rules
								☐ YES ☐ NO		☐ IFR ☐ VFR ☐ Spec.
								☐ YES ☐ NO		☐ IFR ☐ VFR ☐ Spec.

5. RTF frequency/communication equipment and surveillance equipment used:

6. Class of ATS airspace: ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G

7. Type of Air Traffic Service:

8. Estimated vertical distance (ft/metres):

Estimated horizontal distance (NM/km/minutes):

9. Automated Warning Systems: ☐ Ground-based ☐ Airborne

10. Traffic information given Yes ☐ No ☐

11. Have you reviewed relevant RTF and/or surveillance recordings? Yes ☐ No ☐

12. Was Weather considered relevant? *(if YES, include details in Box 13)* Yes ☐ No ☐

13. Description of occurrence with diagram, if necessary; Causes and factors believed relevant to the occurrence; Suggested changes and improvements, if appropriate:

Use additional forms as necessary

14. Assessment of workload: ☐ (very) ☐ heavy ☐ medium ☐ light

15. Time since last break:

16. Start time of shift in UTC: local time:

17. Name of your ATS Unit and Sector:

18. On duty as:

19. Your Name, Signature and local Date:

FOR OFFICE USE ONLY

Appendix C – EUROCONTROL Guidelines for Completion of ATS Occurrence Reporting Form

Use this Form to report an occurrence involving an aircraft or vehicle, your own or another ATS Unit, an alleged violation of ATS provisions or clearances, equipment and ATC Procedures shortcomings.

Fill in this form as soon as practicable after the occurrence

Fill in as many Boxes (1 to 19) as possible. Fill in relevant information. If NOT RELEVANT, use N/R; or if NOT KNOWN, use N/K.

Box 1: Year (YY), Month (MM), Date (DD), hour (hh), minute (mm) of occurrence

Box 2: Night: as defined nationally, or by ICAO

Box 3: State location using latitude/longitude, a place name, aerodrome, bearing/distance from a NAVAID or significant point, etc.

Box 4: Use this Box only if aircraft affected or involved. Provides for details regarding up to two aircraft involved. Use Box 13 for additional aircraft.
Type: use ICAO aircraft designators; **ADEP/ADES**: use ICAO location indicators or plain language; **FL, altitude or height**: specify Flight Level (FL), altitude (A), height (H) in feet. If metric, add m. Insert altimeter setting if applicable; **Mode C**: if level information from the aircraft is available from other sources (e.g. Mode S, ADS, etc.) specify in Box 13; **Relevant route segment**: e.g. SID/STAR/ATS route (specify) / aerodrome traffic circuit (specify, e.g. downwind) / landing / taking-off) / taxiing / initial climb / etc.; mark flight rules.

Box 5: To assist in retention of relevant RTF and surveillance recordings

Box 6: Mark the Class of ATS Airspace (A, B, C, D, E, F, G) within which the occurrence took place

Box 7: Indicate the type of service provided, e.g. Area/Approach/Aerodrome - Control/Advisory/ Information - Procedural/Radar - etc. Use a combination of these for full description of service provided

Box 8: Use this Box only if aircraft affected or involved, or if near-Controlled Flight Into Terrain (CFIT) event, to indicate distance aircraft/aircraft or aircraft/terrain

Box 9: Specify if automated warning system(s) was/were involved (e.g. conflict alert, ACAS). If applicable, specify type and contents of warning and/or alert

Box 10: Mark **YES** or **NO** if relevant

Box 11: Self-explanatory

Box 12: Mark **YES** or **NO**, if weather was considered relevant to the occurrence, include details in Box 13

Box 13: Use free text to describe the occurrence, include diagram if necessary; Causes and factors believed to be relevant to the occurrence; Suggest changes and improvements, if appropriate; *You may wish to indicate that the Report reflects your subjective recollection of the facts*; Include relevant weather information. If necessary, use Box 13 of additional Forms, indicate sequential number of pages and total number of pages.

Box 14: Give your assessment of workload, taking into account complexity and other factors

Box 15: Indicate the time period since your last rest break

Box 16: Self-explanatory

Box 17: Self-explanatory

Box 18: Specify your duty position and/or responsibility at the time of the occurrence

Box 19: Self-explanatory