Chapter 6

Primary Response

The previous chapter looked at the problems that any incident reporting system faces in eliciting submissions about adverse occurrences or the potential for future accidents. The following sections build on this by looking at techniques that can be used to address the problems of gathering further information about an occurrence once it has been notified. These data gathering techniques produce the evidence that supports subsequent analysis. As a result they have an important impact on the outcome of any investigation. If necessary data is not secured then analysts may be forced to rely upon supposition and introspection. Similarly, if investigators obtain biased or partial information then the conclusions of an enquiry may not accurately reflect the underlying causes of an incident. Further problems arise because different approaches to data gathering obtain very different results. Later sections will examine the ways in which one-to-one interviews can provide very different accounts than peer group meetings. These potential problems are exacerbated by the difficulties of supporting an iterative approach to incident investigation. Often the subsequent analysis of an occurrence will help to identify the need for further information about the causes or mitigating factors that influenced an adverse occurrence. However, data may be lost, opinions and recollections may change over time, outside influences may affect the participation of key individuals. As a result, the answers that are obtained during subsequent investigations may not actually reflect the potential answers that might have been gathered during the initial stages of an enquiry.

Figure 6.1 again illustrates how these different generic phases contribute to the operation of an incident reporting system. This chapter, therefore, concentrates on phase B data gathering. This abstract model is intended to describe common features of many different reporting systems. The following quotation provides greater detail about the sorts of activities, listed as points 3 to 5, that contribute to data gathering in a medical incident report system. It also illustrates the way in which these activities depend upon the elicitation of reports, see points 1 and 2, and support the subsequent analysis of adverse occurrences, mentioned in points 5 and 6:

> "*Summary of investigation process*: All investigations consist of a series of steps that should be followed, as a matter of routine, when an incident is investigated:
>
> 1. Ascertain that a serious clinical incident has occurred and ensure it is reported formally. Alternatively identify an incident as being fruitful in terms of organisational learning;
> 2. Trigger the investigation procedure. Notify senior members of staff who have been trained to carry out investigations
> 3. Establish the circumstances as they initially appear and complete an initial summary, decide which part of the process of care requires investigation, prepare an outline chronology of events, and identify any obvious care management problems;
> 4. Structured interview of staff: Establish chronology of events; Revisit sequence of events and ask questions about each care management problem identified at the initial stage. Use framework to ask supplementary questions about reasons for each care management problem;

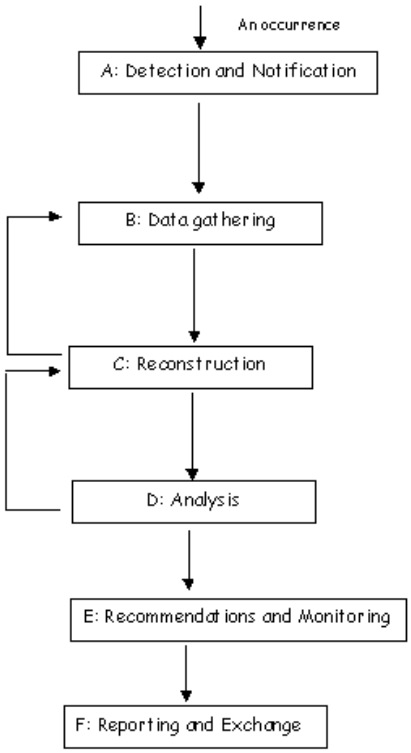


Figure 6.1: Generic Phases in Incident Reporting Systems

5. If new care management problems have emerged during interviews add them to initial list. Interview again if necessary
6. Collate interviews and assemble composite analysis under each care management problem identified. Identify both specific and, where appropriate, general contributory factors;
7. Compile report of events, listing causes of care management problems and recommendations to prevent recurrence
8. Submit report to senior clinicians and management according to local arrangements
9. Implement actions arising from report and monitor progress." [849]

It is important to emphasise, however, that individual reporting systems may different significantly from the blue-print provided by this list of activities. In particular, the opportunities for gathering further information are constrained by the procedures and practices that govern the management of any reporting system. The following paragraphs summarise the financial, social and technical issues that constrain data gathering exercises.

It may not be possible to identify the individuals who were involved in an incident. As a result, any subsequent data gathering must be based around teams or groups of individuals who might be involved in similar occurrences. Instead of interviewing the controller who was involved in a particular air separation violation, investigators must find other individuals who are willing to talk about the circumstances of previous incidents.

In a confidential system, it is likely that investigators will be able to identify the individuals or groups who reported an occurrence. However, this information may only be available during the initial stages of an enquiry. For instance, the UK CIRAS rail incident reporting system protects the identity of individuals by destroying all identifying information once an initial interview procedure has been completed. During those stages in which it is possible to identify the individuals who

contributed a report, it is important not to compromise the confidentiality of the system. For example, requests to interview an operator can raise suspicions about the purpose of any enquiry. As a result, many confidential systems make contact with contributors outside of normal working hours. It should also be noted that such procedures place important restrictions on the gathering of confirmatory evidence. For example, it is difficult to interview the colleagues of a contributor without telling them the purpose of the meeting;

The architecture of an incident reporting system can also limit the opportunity for data gathering activities. For instance, the simple monitoring architecture described in Chapter 3.7 does not assume that there will be any further investigation of a particular occurrence. A report is received, an initial assessment is made about its relevance and then feedback about the incident is published. Such an approach is both simple to manage and cheap to operate. It can also reduce concerns about anonymity because no investigation is initiated. However, there are also important concerns about the reliability and completeness of the information that is contributed about each incident. The Swiss Internet-based CIRS system is an example of this architecture [757]. CIRS gathers information about occurrences in anaesthesia. It addresses many of the concerns, mentioned above, by exploiting a complex and detailed form that is intended to elicit as much information as possible when an occurrence is notified to the system. This approach relies upon the intellectual capabilities as well as the enthusiasm and commitment of potential contributors.

Chapter 1.3 introduced Leape's analysis of the comparative costs of incident reporting in different industries [480]. The Aviation Safety Reporting System spends about $ 3 million annually to analyse approximately 30,000 reports. This equates to about $100 (£66) per case. If this figure were applied to the 850,000 adverse events that are estimated to occur annually in the UK National Health Service, the cost of investigation would be £50 million per year. This would impose a considerable burden upon the service. Such burdens can most easily be considered in terms of the opportunity cost; do the benefits of this expenditure outweight the benefits of alternative investments that might have been made with this money?

Data gathering can also be limited by the availability of skilled personnel. As we shall see, interviewing personnel in the aftermath of an incident can be a non-trivial exercise. It is difficult to probe behind the filters of guilt or resentment that may colour an individual's response in the aftermath of an adverse occurrence. Similarly, the extraction of necessary technical information from automated logging equipment typically requires considerable expertise. The burdens imposed by these requirements are exacerbated when investigators must be drawn from a more limited pool of potential personnel. For instance, if a reporting system relies upon independent external organisations to conduct any initial data gathering then that agency may not have the necessary capacity to cope with any expansion in the scope of a system or with any changes in the level of participation.

As mentioned above, a high degree of technical skill can be required to extract and safeguard information from automated logging equipment. It should also be noted that technical limitations, including the granularity of information that can be recorded, also affect the results of any data gathering exercise. The recovery of technical data can also be compromised by management failures in the aftermath of an incident. For example, the flight data recorders (or 'black boxes') that are used to record flight parameters have relied upon loops of tape. In several incidents, these recorders have not been switched off after landing so that they have continued to record 'null' data over critical information about the course of an incident.

The remainder of this chapter looks at techniques that support data gathering in the aftermath of an incident within the limitations identified above. The analysis initially looks at the immediate response to an incident, including the requirement to safeguard the system. Later sections look at how investigators identify and acquire the information that supports the subsequent reconstruction and analysis of safety-related incidents.

As we have seen, there are many different ways in which an occurrence can be reported. For example, the staff who are involved in an incident might directly inform their managers that an adverse occurrence has taken place. Alternatively, an automated monitoring system might generate an alarm which, in turn, can initiate further data gathering. Information about an incident can also be provided by members of the public who may also have witnessed a potential failure. It is important that the managers of an incident reporting system should consider, and ideally support,

these different possibilities if potential sources of notification are not to be ignored. In the following discussion, we will use the term 'primary recipient' to indicate the supervisors, managers or other nominated personnel who first receive an incident report. For instance, the UK Medical Devices Agency (MDA) requires that "local liaison officers" are appointed to perform this role [536]. In European Air Traffic Control, the primary recipient is typically the line manager or the supervisor of the officer who submits the report [423]. However, the primary recipient need not be employed by the same organisation as the contributor. In particular, they can be employed by an independent reporting agency, by the regulator or by some trade organisation. For instance, CIRAS staff are the first to receive notification of an incident from personnel who are employed by many different rail operating companies [198]. The term 'primary recipient', therefore, simply provides a place holder for the wide range of mechanisms that implement the duties which are described in this section.

Members of staff must understand the procedures that are associated with the immediate notification of an incident. For example, they must know how to pass information from the general public, from automated detection equipment or from their own experiences to the primary recipient. Such notifications are critical for occurrence registration. They warn primary recipients that report forms are being generated and that further data gathering may be required. Any delays in making this notification can jeopardise the acquisition of necessary information in the aftermath of an incident. There are also safety consequences if other systems are vulnerable to similar failures before any immediate remedial actions can be taken. Primary recipients must, in turn, warn others within their organisation. For example, they may be expected to inform higher levels of safety management. Many executives are embarrassed to learn of serious incidents from media enquiries rather than from the effective communication of safety concerns within their own organisation. In open reporting systems, it can also be good practice for primary recipients to brief other workers that an incident has taken place. Such actions are extremely important to preserve confidence in the reporting system; teams can see that some action is being taken. They can also elicit peer support for individual operators in the aftermath of an incident. Finally, it is often important to warn other organisations with a 'stake' in any incident investigation. For instance, air traffic control reporting procedures often contain a list of contacts and telephone numbers that should be called in response to particular occurrences. For example, if an incident involves a military flight then information should be passed to the force's duty liaison officer. If an incident has implications for other sectors operated by other national organisations then they also might be alerted to a potential investigation.

It is possible to envisage a number of circumstances in which personnel might not want to submit occurrence reports to the groups and individuals who are normally nominated as 'primary recipients'. 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. However, previous comments about anonymity and the problems of under-reporting indicate that such channels may not be used very frequently unless the supervisor or manager's behaviour has become irredeemable. The difficulties faced by junior personnel in questioning and reporting the 'errors' of their seniors can be illustrated by incidents drawn from the aviation industry. Crew Resource Management (CRM) training has been introduced to explicitly help staff overcome their inhibitions in intervening to question the actions of their seniors. The following incident illustrates how this training can fail to have a sufficient impact on operator behaviour:

> "*(Editorial comment) Recognition of the potentially hazardous effects (of the flight deck gradient) is often included as an aspect of CRM training, but the problem can be extremely complex, particularly if combined with an apparent short-term incapacitation. In such circumstances, it is often difficult for the junior crew member to intercede.*
>
> It was the Captain's leg. He is an experienced pilot, capable and well liked and in no way overbearing. On short finals to Runway 30 at ####, after a good, stabilised visual circuit and approach, the aircraft begins to descend below the Visual Approach Slope Indicator (VASI) indications, giving finally four reds. As the runway has a displaced threshold and the obstacle was now behind us I make no comment, as I presume the descent (below the correct glide-path) is intentional to facilitate an early touch-down point. The Captain now sees the VASI indications, says so, and applies power. I call

> 'Rad Alt 50', '30' and '20' but we don't land. I inform the Captain we are floating and to put the aircraft on the ground. He seems surprised by my call, but removed power and lands. However, we are between a third and a half of the way down the runway. The Captain appears transfixed by the runway and hasn't engaged reversers as per SOP. I call for reversers and query the autobrake setting of level three out of five available levels. He makes no response although he is not obviously unwell. I state that I am increasing autobrake to level four. He doesn't acknowledge. As speed reduces he finally deploys the reversers, but as our Normal Operations Standard Operating Procedures, only at idle thrust. We stop with approximately 200 feet runway remaining. On taxi back he states he had difficulty reading the VASI and no other discussion occurs. With hindsight I allowed my attitude of respect and friendliness toward the Captain to influence my actions. I was insufficiently assertive once the incident was in progress and prior to the incident I presumed rather than checked the reasons for his flight profile." [173]

This incident report illustrates how individuals still fail to question the actions of their colleagues even when they believe that their safety and the safety of their passengers might be threatened. This failure is all the more remarkable given that CRM training deliberately includes help in recognising when to question such behaviours. Given such reluctance it should not be surprising that very few contributors will use alternative procedures to implicate the normal 'primary recipients' of incident reports. The previous quotation is, however, more complex than this analysis suggests. It illustrates the way in which individuals may contribute information about an incident even though they failed to question their colleagues actions during the occurrence itself. It can, therefore, be argued that it illustrates the importance of providing alternative reporting mechanisms. If these procedures are used then it provides mixed news about the wider safety of any system. On the one hand, it may indicate a strong safety culture in which individuals are happy to question the actions of their colleagues. On the other hand, these reports are disappointing if subsequent analysis indicates potential problems with the behaviour of 'primary recipients' who play an important role in the success of any incident reporting system.

6.1 Safeguarding the System

Figure 6.2 illustrates part of the checklist that is to be used whenever US Army commanders receive notification of an accident or incident [807]. This check-list is intended to support their actions in the crucial first hours after an adverse occurrence has been reported. This initial response is critical because the primary recipient must act both to safeguard their system and to protect any necessary data about the course of an incident. As can be seen, the first items on the checklist are to secure the site of any incident and to obtain witness statements. Further items cover survey procedures and the notification of relevant authorities that an incident or accident has occurred.

The primary recipient's first responsibility is to safeguard any systems that are involved in an incident. Chapter 3.7 has described how the operators who are involved in an incident are often removed from further operation. This provides them with an opportunity to gather their thoughts, to document the events leading to the incident and to complete an initial report form. It also removes the additional fear of committing further 'errors' in the aftermath of an incident. Regulators often view such compound failures as indicative of a failure by the primary recipients to take adequate measures to safeguard the system.

6.1.1 First, Do No Harm

It is critical that any remedial actions should not exacerbate the consequences of any initial failure. This is, however, a non-trivial requirement. Feelings of guilt or loyalty can encourage individuals to take ill-advised risks in the aftermath of an adverse occurrence. Inadequate training, incomplete information about the nature of an incident or the potential impact of their actions can all predispose 'primary recipients' to act without adequate forethought. The following quotation illustrates many of these issues. It is important to note that the investigators were anxious both to praise the initiative

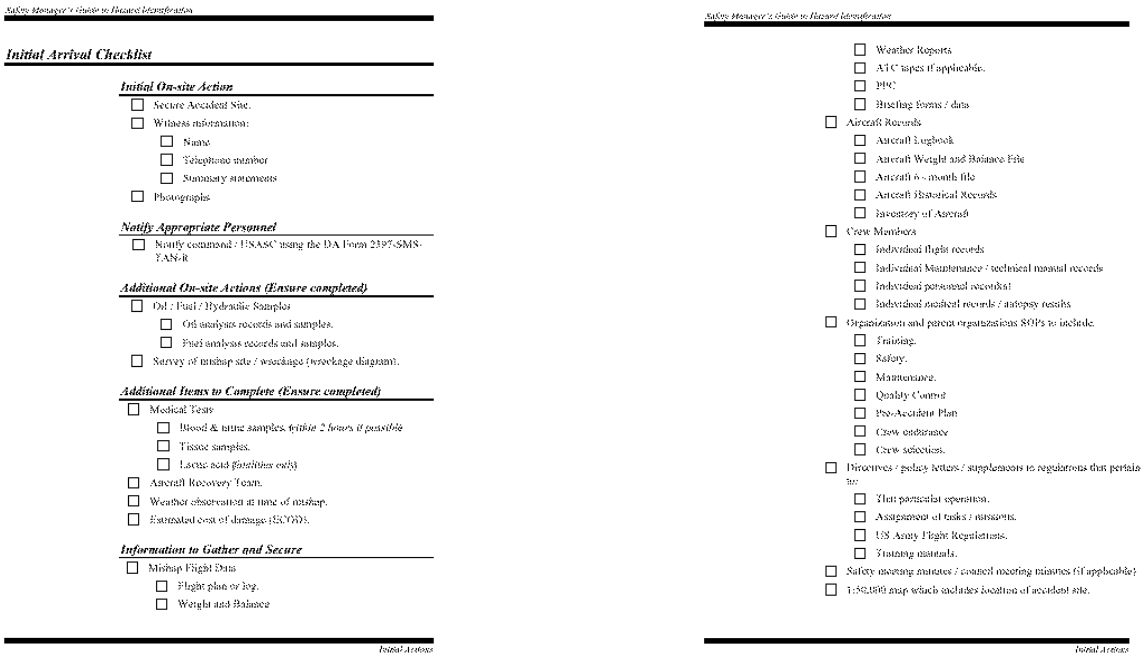


Figure 6.2: US Army Preliminary Incident/Accident Checklist

and endeavour of the crew but also to point out the potential consequences of an ill-considered response to an adverse occurrence:

> The 2nd Mates muster station was on the first bridge deck, the helicopter landing area, and his fire duty to take charge of a fire team. However, after the evacuation of the engine room, the 2 nd Mate took it upon himself to go alone and search for the 3 rd Engineer. He mistakenly understood that the 3 rd Engineer was still making his way out of the shaft tunnel. Although he advised the bridge by radio of his intended actions, he had no breathing apparatus and nobody was standing by to assist him. He went alone down the vertical after tunnel escape, along about 20 m of the shaft tunnel and into the engine room. He did not know if the atmosphere in the shaft tunnel was safe and, more particularly, whether the atmosphere in the engine room could support life. Fires deplete oxygen and, although the fire would have drawn air through the shaft tunnel, the combustion of fuel and the breakdown of insulation produces poisonous gases. The Inspector acknowledges that the 2 nd Mates actions were well-intentioned but he could easily have fallen, become disorientated or overcome by smoke, thereby hazarding the lives of any search party and compromising the fire fighting effort...
>
> *Conclusions.* In general the response to the fire by the ships crew and the expeditioners on board was measured, effective, demonstrated initiative and reflects great credit to all on board. Entry into any area adjacent to a fire, however, alone and without breathing apparatus or backup, is extremely hazardous and could compromise an entire fire-fighting effort. [48]

'Primary recipients' must address a number of complex problems in order to safeguard complex application processes. These problems are determined both by the nature of the failure and by the support that is afforded by remaining protection systems. For example, automatic deluge systems can quickly establish control over a reported fire. Similarly, critical tasks can be delegated to other members of a crew if an incident indicates excessive workload for key individuals. A drug mis-administration error may require both immediate and long term intervention to stabilise the patient's condition. It is important to remember, however, that any subsequent intervention must

not exacerbate an adverse occurrence. A number of factors help to determine whether such reactions are likely to safeguard the continued operation of a complex system:

- *poor training.* Many industries have drafted guidelines that are intended to ensure that personnel are trained in emergency response techniques. Many of these guidelines focus on the need to ensure that skills are reinforced through simulated exercises. There are many potential problems, however. It can be difficult to organise simulations that involve representative of the different groups that must coordinate their activities in the aftermath of an incident [746]. There are considerable barriers to such joint simulations. These include organisational and financial constraints. They also include the underlying problems of ensuring a common 'mental model' both of the nature of any potential incident and the best means of addressing it [218]. There is also a danger that simulations may not reflect the challenges posed in the aftermath of an actual incident [875]. One means of ensuring that simulations do reflect potential failures is to ensure that they are based upon accurate observations of the previous failures that have been submitted to incident reporting systems.

- *situation awareness.* Chapter 2.3 described the general problems that arise when individuals and teams must continually predict and respond to changes in application processes. Interruptions, high-workload and a myriad of other 'performance shaping factors' jeopardise accurate assessments of the current and future states of complex systems. This creates particular problems if individuals must respond to incidents that resulted from a loss of situation awareness. If the primary recipient has been called from other duties then they must quickly assess the state of the system. However, any information that they gain from the operators will reflect their initial loss of situation awareness. It is likely to be incomplete and possibly inconsistent. This can have an adverse effect on any subsequent intervention by the primary recipient.

- *time pressure.* Time pressures compound the problems of accurately assessing the state of a system prior to any response to a reported occurrence. As with many aspects of incident reporting, the precise nature of these pressures will vary from domain to domain [437]. In air traffic management, air proximity warnings must be resolved almost immediately if collisions are to be prevented. In other domains, such as batch chemical processing, operators may have minutes and even hours to rectify an adverse occurrence. There are two different dangers associated with time pressures in the immediate response to an incident and both are closely related to the more general problems of situation awareness, mentioned above. Firstly, if a process changes gradually over time then it may be difficult for people to notice slowly developing trends that emerge over many hours [438]. Secondly, in processes that require rapid intervention there is a danger that personnel will intervene before they understand the true nature of the problem at hand. Several regulatory agencies have responded to these different pressures by requiring that operator wait for some specified period of time, or that they ensure agreement with their colleagues, before actively intervening in the aftermath of an incident. Duncan describes how such measures have created delays that, in turn, have threatened the safety of a number of nuclear systems [220].

- *lack of information.* In order to act effectively to safeguard any system, it is important that the primary recipient of any incident report can rapidly access relevant information. This includes details about the state of the system prior to the incident and information about any interaction with an application as the incident develops. It also includes accounts of any initial actions that staff may have taken to mitigate the immediate effects of an adverse occurrence. This is particularly important in the medical domain when the patient's reaction to these interventions provides important guidance for further remedial actions. In consequence, both the medical and aviation industries specify protocols and procedures that govern the passing of information following particular incidents. When these protocols are broken then these is a considerable danger that the primary recipients will fail to recognise the nature of the incidents that they must address [10]. However, it is important not simply to consider ways in which this information can be made accessible to primary recipients. It is also critical that they are trained to avoid problems of interpretation and analysis, such as the confirmation bias that can

impair an individual's ability to consider alternative hypotheses. Later sections in the Chapter will consider the sister problems of recognition and judgement bias that can also impair the primary recipient's ability to use information in the aftermath of an incident.

- *lack of system support.* The primary recipient's ability to safeguard their system is, at least partially, determined by the level of available system support. An incident can often compromise their ability to intervene effectively. In many situations this forced them to resort to ad hoc measures or deliberate fall-back mechanisms to retrieve the situation, in other incidents they are not so fortunate:

  > "During the flight, the en route air traffic controller inadvertently cleared the aircraft to descend to an altitude that was below the minimum vectoring altitude (MVA) for the area. The MVA is the lowest altitude that meets obstruction clearance requirements in the specified airspace, and is the lowest altitude that Transport Canada has approved for vectoring of aircraft by air traffic control (ATC). The crew of ABL814 accepted the clearance and descended. By the time the controller recognised the problem, the aircraft had descended below radio coverage and could not be contacted directly using NAV CANADA's ground-based communications network". [622].

  This incident illustrates how those who are involved in an incident can use alternate safety systems to mitigate the consequences of an initial failure. However, the same system limitations affect the primary recipients who must also use the available infrastructure to safeguard their system.

- *need to preserve levels of service.* The primary recipient's ability to intervene to safeguard their system can also be constrained by external pressures to maintain particular levels of service. This raises particular problems, as we shall see in later sections, when primary recipients must both protect evidence of a failure and yet also enable the system to continue to operate. This is illustrates by the UK MDA's regulations for incident reporting:

  > "Defective items should not be repaired (either in-house or by a third party), returned to the manufacturer/supplier or discarded before an investigation has been carried out. The manufacturer or supplier should be informed promptly, and allowed to inspect the items if accompanied by an appropriate person... If devices are required to be kept in use, where possible remove defective parts so that the equipment may be repaired for re-use. Any parts so removed must be quarantined and securely stored pending investigation. MDA's advice should be sought and, in all cases, the defective parts should be clearly identified and kept secure. If it is not possible to remove defective parts or withdraw the machine from use, staff should be made aware of the need for increased vigilance and extra caution during use (see Evidence below). [536]

  At first site, it might seem that remedial actions must take priority over such 'quality of service' issues. However, the denial of Air Traffic Management services is likely to create further incidents and accidents. In other situations, poor situation awareness, the lack of necessary information and inadequate system support can place key individuals in an invidious position. For example, Offshore Installation Managers initially decided not to shut-down production on connected installations following the initial reports of fire on the Piper Alpha [194]. This had significant consequences because these inter-connections enabled gas to continue to escape from ruptured pipes on the Piper Alpha. If they had shut down production it would have caused an "almost immediate reduction in the flow of oil that was fuelling the fire in the centre of the platform".Their decision was justified because they had reason to believe that the Piper's on-board systems could cope with the emergency.It took a number of communications with company representatives and their fellow installation managers before the decision was taken to shut-down production. Their response was delayed not simply by a desire to continue

production during what they believed to be a controllable incident, it was also exacerbated by the failure of communications systems. This incident illustrates how several of the factors in this list can combine to delay or frustrate an effective response to adverse occurrences. Emergency planning and disaster management programmes, mentioned above, are specifically designed to help staff cope with the 'wicked' problems posed by such compound failures.

6.1.2 Incident and Emergency Management

The previous list mentioned that many organisations compile detailed plans for incident management. These are then rehearsed during simulated rehearsals. The amount of guidance that is provided for the compilation of these plans varies from industry to industry. The level of guidance also varies between particular types of incidents within the same industry! For example, these are very few national standards that guide the immediate response to iatrogenic injuries. In contrast, the UK MDA [536] and the US Food and Drug Administration (FDA) [270] issue detailed guidance on the primary recipients duties in response to reports of equipment failures. The degree to which emergency procedures are integrated into wider safety management practices also varies considerably. For instance, the following guidelines present the International Maritime Organisation's requirements for the integration of contingency planning into shipboard safety management systems:

> "The Guidelines provide a framework for preparing an emergency response plan to deal with emergency situations. The International Safety Management code requires contingency planning as part of the ship's Safety Management System (SMS). The Guidelines set out a modular designed structure for contingency planning which provides a quickly visible and logically sequenced source of information and priorities which can reduce error and oversight during emergency situations. The system should be applied to each individual ship, taking into account ship type, construction, cargo, equipment, staffing and route. A typical system would include six modules:
>
> Module I: Introduction - providing guidance and an overview;
>
> Module II: Provisions - should contain information and explanations for the development of the system based on the suggestions for improvement gained from the individual company and shipboard personnel;
>
> Module III: Planning, - preparedness and training should provide for emergency training and education of shipboard personnel to develop general awareness and understanding of actions to be taken in the event of an emergency;
>
> Module IV: Response actions - should provide for emergency training and education of shipboard personnel to develop general awareness and understanding of actions to be taken in the event of an emergency, including potential emergency situations;
>
> Module V: Reporting procedures - the System must specify procedures for making the initial report to the parties concerned since any ship involved in an emergency situation, or in a marine pollution incident, will have to communicate with the appropriate ship interest contacts and coastal State or port contacts;
>
> Module VI: Annex(es) - other requirements." [391]

Such general requirements can be supplemented by special provisions that guide intervention in the aftermath of particular types of incident. In other words, the development of an incident response plan must be guided by risk assessment techniques. Clearly, more detailed provising ought to be made for higher risk incidents. For example, the IMO issues special regulations to govern emergency procedures for ships carrying irradiated nuclear fuel (INF) [388]. Ships transporting these materials must develop shipboard emergency plans that include the procedure to be followed in reporting an incident involving INF materials. They must also have prepared a list of the authorities to be contacted in the event of an incident. They must have compiled a checklist of action to be taken immediately to "prevent, reduce or control the release of INF Code materials". Finally, contingency plans must describe procedures and points of contact for co-ordinating with local and national authorities. Such general requirements can also be supplemented with more detailed guidelines about the sorts of incidents that should be explicitly considered within a contingency plan. Problems

arise, however, from the difficulty of predicting the precise types of incidents that will be arise. Later sections will go on to argue that it is often difficult for primary recipients and their colleagues to accurately assess the potential risk of an incident in its immediate aftermath. For now it is sufficient to realise that the level of detail required in a contingency plan, in part, reflects the degree of risk associated with the consequences both of the potential incidents and of a failure to adequately deal with those incidents.

The previous paragraphs have described how the primary recipient must safeguard the system following an incident report. The problems of gathering information and of assessing the severity of an incident combine to make it likely that such responses will be error prone and may even exacerbate an adverse occurrence. As a result, many organisations codify procedures for the initial response to an incident in the form of emergency management systems. There are, however, a number of additional factors that complicate attempts to safeguard application processes in the aftermath of an incident. For example, some regulatory bodies use the immediate response to an incident as one means of measuring its criticality. This raises a number of complications, for example when the response to an incident is based upon a precautionary approach in which the primary recipient ensures the safety of the system by assuming the 'worst case' scenario. This has led the US Federal Railroad Administration to explicitly state the extent to which precautionary treatment can be taken into account when assessing the severity of an adverse occurrence:

> "Treatment provided in response to an event such as a dog bite may be precautionary. For example, a rabies shot following a dog bite is precautionary treatment, so the injury would be reportable. The single stated exclusion to reporting injuries which require precautionary treatment is a tetanus shot, since the decision to give this shot is generally based on the date of the last injection rather than the severity of the injury. Under certain circumstances some treatments occurring prior to a diagnosis may not, by themselves, make a case reportable. For example, it is often a standard procedure of emergency rescue teams to administer preventive treatment such as oxygen or apply an intravenous saline solution while a patient is being transported to a medical facility for further evaluation. Such preventive treatment does not make the injury reportable." [235]

It is important to emphasise that the primary recipient's actions in safeguarding the system are unlikely to provide adequate long-term fixes. Testing is required in order both to ensure that any remedial action actually does protect against the recurrence of an incident and that any recommended fixes do not introduce unwanted side-effects that may themselves threaten safe and successful operation. Typically, any longer term changes to the design or operation of a system must be documented and justified through changes in any supporting safety case that is approved by a regulator [434]. Further actions are also required if investigators are to determine whether particular fixes are adequate for similar systems in other plants or operating conditions. Further information about the causes of an incident often creates the need to implement additional remedial actions. In particular, the primary recipients view of a single incident must be placed in the context of any previous incidents with similar causes or consequences. These concerns make it likely that any initial actions in safeguarding the system are unlikely to provide long-term solutions:

> "The discovery that a remedial action is necessary may be a direct result of one or more medical device adverse event reporting (MDR) reportable events occurring, or may be discovered through the performance of internal analyses using appropriate statistical or other acceptable methodologies. Action taken to fix a single device involved in an MDR reportable event is not remedial action." [260]

In an ideal world, there would be a point in time when the primary recipient is confident that they have ensured the continued safety of their system. This would enable them to start acquiring additional logs and eye-witness statements about an adverse occurrence. In practice, however, data gathering activities are likely to be punctuated by the knock-on effects of their immediate actions in the aftermath of an incident. For example, high workload incidents often force managers to reallocate tasks to other members of staff. This creates the potential for further incidents until 'normal' working patterns are resumed. However, there is still the potential for further incidents

to occur before long-term changes can be implemented. Similarly, back-up systems are typically less reliable than the primary systems that they replace [763]. In consequence, primary recipients can find themselves under a considerable amount of stress as they struggle to coordinate the initial response to an adverse occurrence.

6.2 Acquiring Evidence

The primary recipient of an incident report is, typically, responsible for ensuring that any relevant evidence is secured in the aftermath of an incident. This raises the problem of defining what is, and what is not, relevant to the course of any future investigation. The United States Federal Rules of Justice (Article II, Judicial Notice) define relevant evidence to mean "evidence having any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence". In other words, evidence helps in the determination of fact.

6.2.1 Automated Logs and Physical Evidence

The importance of any fact cannot easily be predicted in the immediate aftermath of an incident. For example, flight data recorders are routinely inspected in the aftermath of an incident. ICAO requirements specify that effective use shall be made of flight recorders in the investigation of an incident (Annex 13, Section 5.8 [386]). However, this does not necessarily mean that this source of data will actually be useful in any subsequent investigation:

> "The flight recorders fitted to both aircraft were not removed for analysis. Adequate data for the investigation was available from the recordings of Air Traffic Control Radio Telephony frequencies and secondary radar returns." [14]

The difficulties in predicting precisely what evidence will be relevant to any investigation has led a number of organisations to publish check-lists that specify the sources of data that must be secured in the aftermath of an adverse occurrence. These documents must embody international agreements, such as ICAO Annex 13 mentioned above. They must also meet national and institutional guidelines that are intended to specify minimum standards across comparable organisations. However, it is important that such checklists also explicitly identify any local systems that might provide useful information about an incident. For example, the following sources of information must be gathered if an incident is reported to EUROCONTROL's Upper Air Control Centre in Maastricht: Recordings of system data (including PCPAMPLAY, PAMFLG, PAMTRK, PAMPOS); Voice Recordings; Statement by staff involved; DCFEP Recordings; Daily Log entries; Position Log, Break Lists and Shift Rosters; Personal Databank Information - ATC Related; Eurocontrol Operations Manual Part 1 and 2; Systems Manual Maastricht UAC; Internal Notes, Briefing Sheets and Attachments to Briefing Sheets; Supporting Technical Information; Letters of Agreement; National Documentation; ICAO Documentation [68]. As can be seen, the safety manager who compiled this took considerable care to enumerate the local systems that must be inspected to provide the data that is required by the ICAO and recommended by EUROCONTROL's Safety Regulation group.

Such lists can be deceptive. They hide the practical difficulties that primary recipients have to address in order to gather necessary data .

> "The first reported tampering with an event recorder was noted in the investigation of a 1982 side collision of two freight trains near Possum Grape, Arkansas. A deadheading conductor stated the speed-recording device was working properly prior to the accident; but several hours after the accident, a railroad official found the case broken open and the tape missing, even though the locomotive cab had not been damaged." [215]

Much has been done to improve the crash-worthiness of these recording devices and their logs. However, there may still be considerable personal danger involved in taking the necessary actions to safeguard automated logs.

> "In the 1994 investigation of rear-end collision of between a moving freight train with a standing freight train at Cajon, California, the Safety Board again found that 3 of the 4 solid state multi-event recorders had been destroyed by fire
> indexData recorders!limitations. Only the carriers quick action to remove the data pack, as the fire approached the locomotive, salvaged the fourth event recorder, which provided important data for the investigation. In June 1997 two freight trains collided and derailed in Devine, Texas. All of the event-recorder data were lost because impact forces or fire, or both destroyed the recorders. The Safety Board issued Safety Recommendation R-98-030 to the Federal Railroad Administration, asking them to develop and implement event recorder crashworthiness standards for all new or rebuilt locomotives by January 1, 2000." [215]

As we have seen, the necessity of safeguarding a system can also delay an efficient response. There can also be bureaucratic and technical barriers to data collection. It is important that these are minimised within any emergency response plan. If such issues are not addressed then these is a danger that necessary data can be destroyed, repaired or deleted. For example, many cockpit voice recorders (CVR) rely upon solid state storage devices that have enough capacity to hold approximately thirty minutes of conversation. Previous recordings are continually erased in order to make space for current data. As a result, if the recording is not halted in the aftermath of an incident then the CVR will be over-written. The report into the Puerto Plata air accident illustrates how a failure to safeguard critical data can occur even in the aftermath of major incidents. The need to motivate train staff to ensure the protection of necessary evidence is correspondingly greater for less critical incidents:

> "The CVR, which was of thirty minute recording duration, had been allowed to continue to operate after the aircraft had landed. This, together with the diversion flight from Puerto Plata, ensured that the audio recorded during the accident flight had been over-written. It thus proved to be of no use to the investigation. " [16].

This is one of a large number of similar incidents in which CVR data has been lost [19] . This incident is instructive for other reasons. In particular, it suggests that any attempts to introduce cockpit video monitoring, as described in Chapter 4.3, must also consider effective procedures for protecting such recordings once they have been made. Partly as a result of these concerns, the ICAO have initiated a campaign to increase the duration of CVR devices from thirty minutes to two hours [385]. Further problems complicate the primary recipient's task of collecting evidence about the causes and consequences of adverse occurrences. In particular, the increasing development of heterogeneous and distributed systems makes it highly likely that any data acquisition will depend upon the cooperation of several different organisations. In the immediate aftermath of an incident, the primary recipient may be able to do little more than alert their colleagues that some of their logs and transcripts must be saved. However, as time goes on they or other appointed investigators will have to collate the information from these disparate sources. For example, the European Turbulent Wake Incident Reporting System initially received forms from pilots that detailed the type of aircraft involved, its position, flight phase and control settings [548]. The pilot also assessed the effect of the vortex on the aircraft. They could submit a shortened version of the form if they could back up their submission with Flight Recorder information. After receiving notification of an incident, the primary recipients would obtain information about leading and following aircraft form the Air Traffic Service providers. This together with terminal radar data was used to verify the position and separation of the aircraft involved. Meteorological data was also collated in response to an incident report using the METAR reports that are made every half hour at all terminals during operating hours. The METARs immediately preceding and succeeding the incident provide information about wind, temperature, cloud cover, humidity and visibility. This brief description reveals that for every potential windshear incident the primary recipient would have to collate information from the pilot, from their data recorders, from en-route and terminal air traffic control systems and from meteorological records.

This section has reviewed some of the problems that arise when the primary recipient of an incident report, such as the "local liaison officer" for the MDA [536] or Air Traffic Management

supervisor [423], must safeguard necessary evidence. These problems include the need to meet national and international requirements for the collection of data in the aftermath of particular incidents. In order to do this they must ensure that automated logs are not deleted or corrupted. They must also ensure the cooperation of their colleagues in other agencies who often control other sources of corroborative information. Previous paragraphs have, however, focussed on the collection of data from automated sources. There are many other potential sources of evidence that must be protected in the aftermath of an incident. These can have create some particular problems for the primary recipients. For example, in order to meet ICAO requirements they must ensure that accident and incident investigators have "unhampered access to the wreckage and unrestricted control over it to ensure that a detailed examination can be made without delay by authorised personnel participating in an investigation" [386]. Pragmatically this can force the primary recipients of an incident report to instigate police and crowd control measures to preserve the physical evidence associated with severe near-miss incidents. In the medical domain, the collection of physical evidence raises even more complex issues. For instance, contaminated equipment must be labelled and kept in some form of quarantine. If this is not possible, then the state of the device at the time of the incident must be recorded by any and all means available for that it can be reconstructed during an investigation [536]. The following excerpt illustrates these concerns and recommends means of ensuring that physical evidence is protected in the aftermath of an incident:

> *Contaminated items.* "Where decontamination/cleaning would destroy vital evidence, the item should be placed in protective containment, labeled and placed in quarantine. MDA and the manufacturer/supplier should be contacted for advice prior to any further action being taken. IT IS ILLEGAL TO SEND CONTAMINATED ITEMS THROUGH THE POST
>
> *Evidence.* All material evidence should be labeled and kept secure. This includes the products themselves and, where appropriate, packaging material or other means of batch identification. The evidence should not be interfered with in any way except for safety reasons or to prevent its loss. If necessary, a record should be made of all readings, settings and positions of switches, valves, dials, gauges and indicators, together with any photographic evidence and eye-witness reports. If it is believed that an urgent examination of the defective item (or related items) is needed, then consideration should be given to sending the item(s) to MDA's Adverse Incident Centre, or inviting MDA's device specialists to inspect them on site." [536]

This quotation illustrates the emphasis that many regulators place upon documented procedures for the handling of physical evidence and automated logs. This information is critical to the success or failure of any subsequent attempts to reconstruct an incident or analyse its causes. MDA requirements also include detailed instructions that restrict the primary recipients interaction with product manufacturers. They are entitled to provide them with samples of unused stock from a large batch of similar products. However, they must ensure that manufacturer are not be allowed to "exchange, interfere with, or remove any part of the product" implication in an incident if it could prejudice subsequent investigations [536]. Such concerns are not simply based upon a natural desire to support the causal analysis of any incident. Legal consideration affect the ways in which evidence is handled in the aftermath of an adverse occurrence. ICAO requirements explicitly consider some of the problems that this creates. For example, possible 'conflicts' between investigating and judicial authorities regarding the custody of flight recorders and their recordings "may be resolved by an official of the judicial authority carrying recordings to the place of readout, thus maintaining custody" [386]. Previous sections have mentioned that investigatory bodies, such as the UK Air Accidents Investigation Branch (AAIB), determine the circumstances and causes of accidents and incidents rather than apportion blame or liability. However, their findings are often used in subsequent litigation. Similarly in no-blame incident reporting systems, such as the ASRS , there is still the possibility that an incident report may trigger a criminal prosection that will depend upon the primary recipient's ability to safeguard necessary evidence. As a result, it is important that the techniques that are used in gathering and protecting evidence should be beyond reproach.

The primary recipient of an incident report must not simply collate and safeguard data for any subsequent investigation. They must also ensure that this data is protected from (ab)use by unauthorised individuals and organisations. The information that they acquire will be extremely sensitive for the people involved in the incident and for the organisations that they represent. This evidence can also have important implications both for regulatory authorities and, increasingly, for political administrations. Much of this sensitivity stems from public and media interest in incidents and accidents. As a result, many organisations argue that strong sanctions must be taken against individuals who 'leak' information before the publication of an official report. In addition to these more general concerns, there is a particular sensitivity about the release of data and voice recordings in the aftermath of aviation incidents. This stems from the ethical issues that are raised by attempts to broadcast the last actions of crews who are struggling to ensure the safety of their passengers [304]. Even in less serious incidents, there is a strong concern that the disclosure of evidence to the media or other partial sources could jeopardise confidentiality. Unless such disclosures are prevented then the natural fear of retribution will dissuade individuals from contributing to a system. As a result, international regulations have been drafted to explicitly restrict the disclosure of any information that is gathered by the primary recipient and other investigators in the aftermath of an adverse occurrence:

> " *5.12 Disclosure of Records* The state conducting the investigation of an accident or incident, wherever it occurred, shall not make the following records available for purposes other than accident or incident investigation unless the authority responsible for the administration of justice in the State determines that their disclosure outweighs the adverse domestic and international impact such action may have on that or any future investigation: all statements taken from persons by the investigation authorities in the course of their investigation; all communications between persons having been involved in the operation of the aircraft; medical or private information regarding persons involved in the accident or incident; cockpit voice recordings and transcripts from such recordings; and opinions expressed in the analysis of information including flight recorder information." [386]

Not only must primary recipients be aware of their duties of confidentiality, it can also be important for everyone involved in gathering evidence to understand how it may contribute to any subsequent legal proceedings. As mentioned previously, in the early stages of an investigation it may not be apparent whether an incident involves a criminal act. Even if the incident itself does not directly fall under the criminal law, evidence that is gathered in the aftermath of an adverse occurrence can be used by subsequent litigation. For example, individuals, trades unions and other commercial organisations may all seek redress if they feel that an incident has affected them in some material way. The statutes that govern the use of evidence vary from country to country. It is important that the personnel who are involved in incident investigations are familiar with at least the basic implications of these laws. For example, the following excerpt from the Law Commission for England and Wales provides an overview of criminal law in relation to the physical evidence and automated logs that can be gathered in the aftermath of an incident:

> "At present section 69 of the Police and Criminal Evidence Act 1984 requires a party to prove that the computer was working properly and was not being used improperly before computer evidence can be given. The Law Commission says this requirement is unnecessary and recommends its repeal... [The Law Commission's proposal on this point was implemented by section 60(1) Youth Justice and Criminal Evidence Act 1999 which provides that section 69 of the Police and Criminal Evidence Act shall cease to have effect.]
>
> The Commission recommends making automatically admissible those business documents which do not appear to be unreliable. At present all business documents are only admitted in evidence subject to the court's discretion. This discretion is exercised in different ways by different judges and magistrates, and parties cannot always predict whether the document will be admitted." [477]

The primary recipient of an incident report must first safeguard their system. They must then organise the acquisition of any evidence that might be relevant for the subsequent reconstruction and analysis of an adverse occurrence. This section has focussed on the acquisition of automatic logs and of physical evidence. The following section extends this analysis by looking in detail at the problems that arise when primary recipients must interview personnel in the aftermath of a safety-related incident .

6.2.2 Eye-Witness Statements

Witness statements are crucial to our understanding of the events that contribute to adverse occurrences. Without the evidence of those who were involved in an incident, it can be difficult or impossible to chart the ways in which multiple concurrent failures contribute to the eventual outcome. This data is particularly important for incidents that involve human factors issues. For example, the following excerpt from an incident report relies almost entirely upon the recollections of those involved. It is also instructive in that the analyst clearly does not take this evidence at face value:

> "At 0800, there were three persons on the bridge of Eternal Wind, the Mate, the 3rd Mate and the 4-8 AB[1]. The AB had been occupied writing up the deck log and plotting the position on the navigation chart, he had not been engaged in keeping a lookout after 0730 and, when interviewed, could not recall seeing any other vessels at all at that time. The Mate, who had been keeping his own lookout, at hand-over of the watch pointed out two vessels to the 3rd Mate, one northbound 13.5 miles to the west, the other four points on the starboard bow and southbound. Although Melina T would have been on the visible horizon of 8.5 miles at 0744 and had closed to a distance of four miles at 0800, the Mate had not seen the fishing vessel. The 3rd Mate, in taking over the watch, checked the horizon, using binoculars, and the radar, both on the 24 and 12 mile ranges, for other shipping. Visually he saw only the two ships handed over by the Mate, which he stated at interview were the only two targets indicated on the radar. He too did not see Melina T, which was at the same distance off as the southbound vessel and approximately midway between it and the ships head. Neither did he see the fishing vessel during the following 10 minutes, in which time it closed to a distance of 1.35 miles. It is evident that the lookout being kept aboard Eternal Wind was not effective. The 3rd Mate claimed that the reason for his not seeing Melina T was that he was blinded by the reflected glare of the sun. The strong glare was evident in a video film of the rescue, shot by one of the Eternal Wind crew-members, but despite this, the 3rd Mate was not wearing sunglasses." [521]

It can be difficult for the primary recipient of an incident report to determine the best time to interview the personnel who were involved in an adverse occurrence. If they meet with them in the immediate aftermath of an incident then feelings of shock and guilt can bias their responses. If they wait too long then memories of the incident may fade. There is also the danger that colleagues will gradually accept a shared view of events that may not initially have been held by all of the members in a group. Some organisations have established interview procedures to address these issues. For example, an initial debriefing session is held by the initial recipient. Subsequent interviews help to confirm the results of this preliminary meeting. They also help to elaborate any areas of remaining uncertainty. These subsequent interviews may be conducted by regional or national investigators or by the primary recipient depending on the seriousness of the occurrence [423].

There are many potential problems in conducting interviews. As we shall see, it is possible for the interviewer to bias responses by asking leading questions. For instance, asking 'why do you think the controller failed to spot this' presupposes that the controller actually did fail in the manner described. It is also possible to mis-interpret the responses that are provided to an interviewer. As a result, the US Occupational Health and Safety Administration (OSHA) has published a number of practical recommendations that are intended to guide interviews during incident investigation:

[1] This refers to an Able Seamen (AB) on the 4-8 watch

> "In general, experienced personnel should conduct interviews. If possible, the team assigned to this task should include an individual with a legal background. In conducting interviews, the team should: Appoint a speaker for the group. Get preliminary statements as soon as possible from all witnesses. Locate the position of each witness on a master chart (including the direction of view). Arrange for a convenient time and place to talk to each witness. Explain the purpose of the investigation (accident prevention) and put each witness at ease. Listen, let each witness speak freely, and be courteous and considerate. Take notes without distracting the witness. Use a tape recorder only with consent of the witness. Use sketches and diagrams to help the witness. Emphasize areas of direct observation. Label hearsay accordingly. Be sincere and do not argue with the witness. Record the exact words used by the witness to describe each observation. Do not 'put words into a witness' mouth'. Word each question carefully and be sure the witness understands. Identify the qualifications of each witness (name, address, occupation, years of experience, etc.) Supply each witness with a copy of his or her statements. Signed statements are desirable." [651]

Such pragmatic advice may seem like common sense. It is surprising, however, that many incident reporting systems rely upon ad hoc interview techniques. It is important to provide more coherent support when different interviewers are used to gather information about incidents that are reported to regional, national and international systems. There is a danger that inconsistencies in the elicitation of interview data can introduce systematic biases in the causal analysis of adverse occurrences.

Interview Structures

When providing advice or drafting procedures to support interviews about adverse occurrences, there are a number of issues to consider. These are illustrated by the US Department of Justice's guidelines of eliciting eye-witness statements:

> "When interviewing a witness, the preliminary investigating officer should:
>
> 1. Establish rapport with the witness.
> 2. Inquire about the witness condition.
> 3. Use open-ended questions (e.g., What can you tell me about the car?), augment with closed-ended questions (e.g., What colour was the car?). Avoid leading questions (e.g., Was the car red?).
> 4. Clarify the information received with the witness.
> 5. Document information obtained from the witness, including the witness identity, in a written report.
> 6. Encourage the witness to contact investigators with any further information.
> 7. Encourage the witness to avoid contact with the media or exposure to media accounts concerning the incident.
> 8. Instruct the witness to avoid discussing details of the incident with other potential witnesses." [583]

These guidelines are intended to support interviews during criminal investigations. There are, however, a number of constraints that complicate their application to incident reporting. For instance, economic considerations may prevent face-to-face meetings if colleagues are geographically dispersed or if their work involves significant amounts of travel, as in the case of pilots. Face to face interviews can also compromise the confidentiality of a system if the other members of a team become aware of such meetings. There are a range of further issues. For instance, it is important to determine whether or not a predefined set of questions will be used to structure the course of an interview. Similarly, it is important to decide whether or not to focus respondents answers by providing a predefined set of responses:

1. *Unstructured or flexible interviews.* These typically have a set of predefined topics but no prescribed questions. These topics might include the interviewees observations about the state of the system in the run-up to the incident. The interviewee might be prompted to provide their opinion about causal and mitigating factors. They could also be asked about the ways in which an incident was detected. These topics help to identify generic areas of concern that are common to many different incident investigations. For instance, the New Zealand Department of Labour urges health and safety representatives to ask a number of questions. "*Who?* Get the names of everyone involved, near, present or aware of possible contributing factors. *What?* Describe materials and equipment involved, check for defects, get an exact description of chemicals involved, etc. *Where?* Describe exact location, note all relevant facts, i.e. Lighting, weather, etc. *When?* Note exact time, date and other factors, i.e. shift change, work cycle, break period, etc. *How?* Describe usual sequence of events and actual sequence of events before, during and after the accident. *Why?* Find all possible direct and indirect causes AND How to keep it from happening again." [656] The general nature of these questions leaves the interviewer free to phrase them in a form that is appropriate to the particular incident under investigation. The interviewer is free to follow the interviewees' replies and to find out personal opinions in response to previous answers. There are a number of dangers with this approach. In particular, interviewers can be 'seduced' into pursuing the ideas and recollections of articulate interviewees. There is also a danger that the interviewee can lead the interviewer into prolonged discussions about topics that have little significance for the overall understanding of the incident under investigation. Unfortunately, it can be extremely difficult to determine whether this is a deliberate intention or an innocent preoccupation of the interviewee [687].

2. *Structured interviews.* These rely upon a tightly defined set of questions that are, typically, asked in a predefined order. There is little scope for exploring individual attitudes. This approach is often used in the immediate aftermath of an incident when a primary recipient simply needs to gain a coherent overview of the occurrence. A more prolonged investigation of individual attitudes can either be postponed until more is known about an incident or can be incorporated into stress counselling. Structured interviews can also be used to ensure that the minimum set of information is gathered about relatively minor incidents. This is important if organisations are to meet the documentation requirements that are often specified by regulators for adverse occurrences. There are a number of limitations with this approach. In particular, it can be difficult to ensure that the minimum set of questions actually capture all of the relevant information about an incident. There is also evidence that individual interviewers can also bias answers to pre-defined questions. Such concerns potentially jeopardise some of the supposed benefits of this structured approaches over unstructured interviews [362].

3. *Semi-structured interviews.* In semi-structured interviews, the interviewer may have a list of pre-defined questions that they can draw upon during the course of an interview. Some of these questions might be omitted if they are considered not to be relevant to a particular incident. Other questions can be introduced if particular issues are raised during the interview. OSHA recognises that this approach is often inevitable given the diversity of incidents that can occur:

> "Prior to the interviews, the team leaders and members shall develop key, critical and screening questions to ask all witnesses. Such questions may be written down and provided to all interviewers. While a specific list of questions is highly desirable, it may be more practical in some cases to have only a list of the topics to be covered. This list shall be developed before any interviews are conducted and shall include: 1 What is your name, address, telephone number, job, and employer? 2 How long have you done your present job? Have you ever seen any problem like this before? 3 Where were you at the time of the accident? What were you doing? Is that your normal job? Did you notice anything unusual? 4 How did you discover the accident? Were you close enough to physically sense (see, hear, feel, smell) anything?" [649].

In order to maintain consistency, several incident reporting systems distinguish between 'mandatory' questions that are designed to satisfy regulatory requirements for the documentation of an incident. Other questions are explicitly labelled as optional.

4. *Prompted interviews.* These are a particular form of semi-structured interview. They consist of a list of questions that are deliberately designed to provoke more detailed responses from the interviewee. For example, the interviewer may begin by asking; what exactly did you see? After an initial response they can then elicit further information by asking; can you tell me a little more about that? Alternatively, the user can be prompted to provide further explanation by asking; what do you mean by...? As with flexible interview techniques, there is a danger that the interviewee can deliberately lead the interviewer away from significant areas of investigation. There is also a danger that they will focus on hear-say rather than direct observations of an incident.

5. *Closed response interviews.* The previous types of interview technique have looked at the ways in which the interviewer asks questions of an interviewee. Other forms of interview focus on the ways in which an interviewee can answer those questions. For example, interviewers can ask interviewees to select their answer to a question from a number of cards that are laid out in front of them. Alternatively, preferences can be expressed by sorting the cards into a particular order. A more constrained version of this technique, relies upon asking the interviewee questions that can only elicit either yes or no as an answer. These approaches have the advantage that they place the interviewer in control of the course of the interview. However, they clearly restrict the interviewee's opportunity to express their opinions. Although these techniques have been exploited by market research organisations and in requirements engineering, they have not been widely used to support incident reporting.

Wellbank [859] observes that the more structured an interview, the greater the interviewer's control. As a result, greater skill and expertise is required if flexible or semi-structured techniques are to be used. Preece et al [687] comment that structured interviews also provide considerable benefits if interviewers must elicit information from domain specialists. There is a danger with more open-ended questions that the interviewer may not be able to interpret the technical information that this being provided in response to a particular question. This analysis has important implications for particular domains. For example, in air traffic control there is often the requirement that any interview procedures be conducted by controllers with at least ten years of experience in a particular centre [423]. However, in medicine it is certain that no individual will possess the complete range of technical skills that are necessary to understand the many different factors that contribute to particular incident. Even in the case of air traffic control, skilled controllers are unlikely to have the technical expertise to understand the complex hardware and software interactions that can contribute to systems failures.

It is important not to underestimate the costs of interviewing contributors and witnesses in national and international systems. For instance, the UK CIRAS rail reporting system sends a investigator out to conduct a follow-up interview in response to every report form that is submitted. Similarly, NASA personnel go back to the contributors of many ASRS submissions. This approach requires considerable resources. There must be enough trained analysts to elicit the necessary information during follow-up visits. Alternatively, novel computational techniques might be recruited to improve the quality of information that is initially contributed in response to an incident. These techniques might, therefore, reduce the expense associated with site visits. Equally importantly, they might also avoid the biases that affect follow-up interviews. A number of social concerns must affect contributors during safety-related discussions with external interviewers. Eliciting more information in the immediate aftermath of an incident also helps to reduce any delay between the contribution of a report and a follow-up interview.

The problems of extracting information from domain experts has been addressed by work on knowledge elicitation in general and by computer-aided interviewing techniques in particular [726]. These interviewing techniques, typically, rely upon frames or scripts that are selected in response to information from the user. For example, the user of an air traffic management system might

first be prompted to provide information about the stage of flight in which an incident occurred. If it happened during landing then a script associated with that stage of flight would be selected. This might provide further prompts about the activities of arrivals and departures officers or about specific items of equipment, such as minimum safe altitude warning (MSAW) protection. These detailed questions would not be appropriate for incidents during other stages of flight, such as those filed during en route operations.

The relatively simple script-based techniques, described above, offer a number of further benefits. In particular, the use of computer assisted interviewing can reduce the biases that stem from the different approaches that are used by many interviewers. Inter-analyst reliability is a continuing concern in many incident report systems [417]. The scripts embodied in computer assisted interviewing systems might also be tailored to elicit particular information about regulatory concerns. For instance, if previous accidents had indicated growing problems with workload distribution during certain team-based activities then scripts could be devised to specifically elicit information about these potential problems. Of course, this analysis must be balanced against the obvious limitations of computer-based interviewing techniques [726] . Further evidence is needed to determine whether the weaknesses of computers assisted interviewing in employment selection or the analysis of consumer behavior also apply to their application in incident reporting.

Interview Formats

The structure of the questions and responses that are expected from an interview represent one of several issues that must be addressed by primary recipients. They must also decide upon the format of any elicitation exercises. There are a number of alternative approaches ranging from one-to-one interviews through to team meetings and focus groups. As before, the following comments also apply to investigators who follow-up these initial enquiries:

1. *Individual interviews (one to one).* This has the potential benefit of being relatively informal. Questions can be asked to clarify any of the information that was uncertain from the forms mentioned in Chapter 4.3. They can also be used to elicit information that might be missing in the original submission. This approach also has the benefit of protecting confidentiality and, as a result, has been recommended by several regulatory agencies: "Witness interviews shall always be conducted in private unless the witness requests otherwise" [649]. 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.

There a number of techniques that primary recipients can exploit to address some of the problems that stem from team-based interviews. In particular, it is possible to use a number of map-based plans to illustrate the flow of conversation during a meeting. Figure 6.3 illustrates this approach. Firstly, an observer notes down the name and position of every person in the room. Secondly as each person contributes to the discussion, the observer draws a line between that person and their intended audience. At the end of each meeting these diagrams can be inspected to determine which of the participants contributed most to the meeting. If particular individuals are shown to have dominated proceedings then the interviewer must determine whether this reflects their involvement in the occurrence. If not then some of the findings from the meeting may have been biased by the views of this individual. If other people are shown not to have participated so actively in a discussion then follow-up interviews can be used to determine whether or not their views were adequately reflected during the course of the meeting. Such differences in participation can even out during the course of a meeting. It can often be helpful, therefore, to begin a new diagram each time the topic of conversation changes. This can reflect the way in which different individuals may have different degrees of participation in the lead-up to an incident and in any mitigating actions.

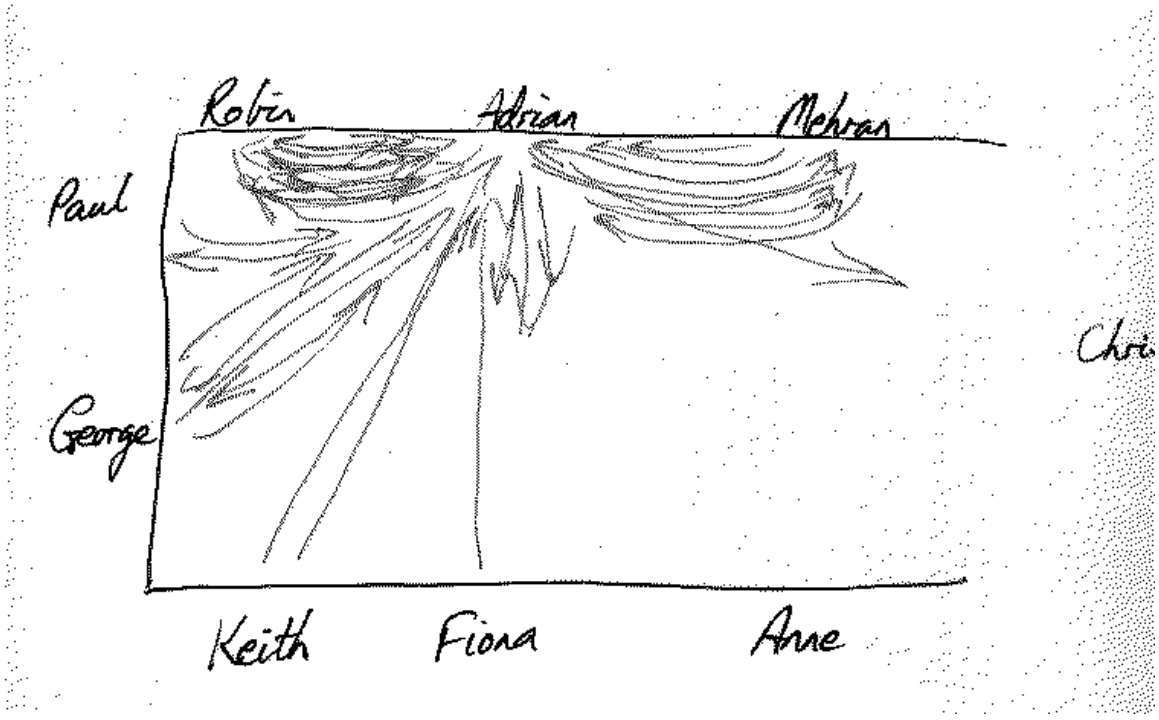


Figure 6.3: Interview Participation Diagram

This approach can also be used post hoc if the interviewees agree to have their contributions recorded. This raises a number of further issues. Audio tapes provide important reminders of passing comments that can easily be overlooked as interviewers struggle to control and direct a meeting. However, they lose the facial expressions, gestures and other forms of non-verbal communication that can be necessary in interpreting the force and meaning of an utterance [227]. Alternative, video recordings can provide much more of this contextual information. Unfortunately, our ability to analyse this data has not kept up with our ability to collect it. The rich information that can be obtained from such recordings makes it correspondingly more difficult to transcribe and analyse [725]. For both video and audio recordings, it is important to remember the OSHA directive that "interviews shall not be tape recorded as the only record of the interview" [649]. If such recording devices are used then the interviewer must also arrange for an alternative physical transcript in case the devices fail or the recordings are later corrupted.

There are a number of key principles that should guide any interview process. Firstly, the interview should have a purpose. As mentioned previously, interviews are costly in terms of the time needed to prepare for and attend such meetings. They also involve considerable resources if their results are to be accurately transcribed and analysed. 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.

Legal Issues Surrounding Eyewitness Statements

Previous sections have argued that even within no-blame systems, there are circumstances in which an initial investigation can uncover criminal actions. It is for this reason that OSHA recommend that each interview panel should include at least one member with at least some legal training [651]. The law governing witness statements varies from country to country, although there are a number of common features such as rules against hearsay. Hearsay, in a general sense, refers to the repetition of information received from others rather than from personal knowledge. Within the UK legal system there are a number of exceptions that make such information admissible in court. In particular, hearsay can be used for the purposes of identification. The Law Commission for England and Wales have recently sought to extend this exception:

> "...the identification exception extends only to identifications of people, and referred to cases such as Jones v Metcalfe (31) as revealing a deficiency in the law. Thus, where it is sought to establish the registration number of a car involved in an incident, and an eye-witness A, who saw the incident, related the number to B, who did not, it is inadmissible hearsay for B to tell the court what the number was for the purpose of proving which car was involved." [477]

It is a sobering thought that many accident and incident reports make extensive use of hearsay evidence that would not be admissible in a court of law. The following extracts illustrate the complexity of legal provisions regarding eyewitness evidence. It describes a number of exceptions that apply to the rule of previous consistent statements. This is significant because under this rule when a witness does give evidence it is not usually possible to put in evidence previous statements by that witness. As a result, evidence gathered at interview is 'superceded' by the witness' direct testimony. This raises particular problems for the subsequent handling of any incident enquiry if the the witness cannot significant information when it comes to trial. Previous statements cannot be used to reinforce the original terms of an identification or description.

> "(4) What we called in the consultation paper (5) the rule against previous consistent statements (and what others have called the rule against narrative) is the rule that such a statement cannot even be used to enhance the credibility of the witnesses oral evidence, by demonstrating the consistency of his or her story. This rule is subject to several exceptions.
>
> 10.88 A witness may be cross-examined on an oral or written statement made before the trial which is inconsistent with his or her oral testimony. The evidential use of the earlier statement is governed by the common law. If the witness accepts the earlier statement as being true, it is evidence of its facts; but where the witness denies the truth of the earlier statement it is not evidence, being nothing but hearsay, in which case the earlier statement reflects only on the witnesses credibility. If the witness does not admit making the earlier statement then the making of the statement may be proved.
>
> 10.63 A witness may refresh his or her memory from a statement in a document made contemporaneously with the events it concerns and while the facts were fresh in his or her memory. If the statement was recorded by someone else, the witness may nevertheless

> make use of it if the witness verified or adopted the statement. The document does not become an exhibit merely because a witness refreshes his or her memory from it."

The previous analysis focuses on criminal law within England and Wales. The intention is not to identify generic issues that affect all legal jurisdictions. In contrast, these provisions have been used to illustrate the importance of ensuring that primary recipients understand at least the basic legal framework that supports any subsequent litigation. If they do not have an appreciation of these constraints then any subsequent interpretation of the evidence may be open to legal challenge. These considerations affect confidential, proportionate-blame systems as much as they affect open reporting systems. For instance, interviewees often ask investigators about the legal implications of answering particular questions. It is important that the answers to such questions are both honest and truthful. It is also important to stress that no-blame systems continue to operate within the rules established by national legal systems.

Interpreting Eyewitness Statements

Previous sections have described several interview structures ranging from flexible question and answer sessions through to more restrictive closed response approaches. We have also introduced different interview formats including one-to-one reviews and many-to-many group meetings. Previous sections have also briefly described some of the legal issues, such as hearsay and the rule against previous consistent statements, that must be considered when gathering evidence about adverse occurrences. In contrast, this section looks more closely at the reliability of witness statements and the factors that can influence individual recollections of incidents and accidents.

There have been numerous experimental studies of eye-witness recollection [7, 224, 861]. A typical method involves showing a witness a simulated 'crime'. They are then asked if the 'criminal' is in a line-up potential suspects. If they are in the line-up then they are asked to identify them. Witnesses show a bias towards answering yes to the first of these questions irrespective of whether the criminal is actually in the line-up [224]. As Wickens notes; this would not be so worrying if individual eye-witness recall of brief incidents were not so poor [864]. He argues that studies into eye-witness responses reveal numerous biases that can affect both recognition and judgement. For example, individuals who express the greatest confidence in positive identifications are typically the least sensitive observers. Informing participants that a suspect may not be in a line-up can significantly reduce potential false-positives [224, 760]. They also argue that dressing individuals as similarly as possible will not only reduce the likelihood of biasing witnesses towards certain individuals but will also reduce the 'false alarm' rate. There are other factors that can bias individual eye-witness statements. For instance, Steblay identifies what has become known as the 'weapon focus' [759]. This biases the eye-witness to focus their attention on any weapon that is used in a crime rather than the perpetrator or the victim.

The basic psychological research into the eye-witness recollection of crimes has some relevance to accident and incident reporting. For example, it is possible to find evidence of the confidence bias in incident reports. Individuals who express the greatest confidence in their interpretation of an event may not be the most sensitive observers. This extension of the existing psychological literature is, partly, supported by judicial findings that must weigh the evidence provided by eye witness statements. For example, the following except shows how doubt can be cast on the evidence provided by witnesses who express undue confidence in their analysis. It is drawn from an OSHA case following an explosion in a detonator factory. The initial blast led to a secondary explosion involving a trailer that was parked nearby. The original judgement cleared the company of two violations of the US Occupational Safety and Health Act of 1970. The following quotation comes from a judicial review of the first decision and, therefore, reviews the quality of evidence provided by various witnesses:

> "I do not find the testimony of Prows and Del Regno summarily referred to by the majority to be compelling. First, neither Prows nor Del Regno testified that the cited trailer under the conditions existing at the time of citation was a service magazine. They offered only general opinion testimony to the effect that a trailer loaded with explosives

> and not moved for 'several days' or until 'ultimately loaded' would be a 'service magazine'. While neither Prows nor Del Regno gave further substantiation or qualification to the term 'several days,' I note that Prows made the contradictory statement that even 'one day would be too long'. Finally, Prows did not make a specific objection that the trailer was indeed in violation of the quantity-distance requirements during his prior inspection. Rather, Prows only observed that 'a loaded trailer would exceed' the limits. Given the lack of evidence regarding the amount of explosives on the trailer, the length of time the trailer remained at the dock is not relevant, even under the majority's test. In sum, there is no evidence that the trailer remained at the dock without fuses being loaded onto it and without proceeding to shipment. Therefore, I conclude that the trailer was spotted at the building for loading and shipping purposes rather than for the intermediate storage of explosives." [644]

This quotation is interesting because it provides indirect evidence to support the previous psychological studies into eye witness evidence. These studies identified a form of bias that occurs when over-confident witnesses are likely to miss significant information. The previous citation, arguably, shows that judges develop considerable expertise in spotting the flaws in evidence which is provided by such witnesses. However, such an interpretation goes well beyond the more focussed laboratory studies that characterise previous research in this area. More work is clearly need to determine whether or not these biases affect witness reports in the aftermath of incidents. Similarly, further research is needed to determine whether or not individual judges become skilled in filtering for these biases. For example, there is some evidence to suggest that the power of these effects varies even within the legal profession. Brigham and Wolfskiel surveyed 89 public defenders, 69 state prosecutors and 77 private defence attorneys in Florida [95]. 75% of prosecutors believed that witnesses who are more confident are more likely to be accurate. However, only 40% of defence attorneys agreed with this statement. It is readily apparent, however, that considerable weight is often placed upon the evidence of witnesses who recognise the limits of their statements. This is particularly apparent when reviewing the treatment of expert testimonies before the Occupational Safety and Health Review Commission that resolves disputes arising out of enforcement actions brought by the US Secretary of Labor:

> "We would comment that this was a difficult case, which we have decided solely on the preponderance of the evidence test. Weighing and reconciling conflicting opinion testimony from expert witnesses is never a simple task. Here, we were impressed by the candor of Professor Hochman, who did not attempt to convince us that the wires could not possibly have been broken before the accident. Instead, he explained that, because of the court's injunction, he was not able to perform the necessary examination in order to make that determination. He explained how, without such an examination, one kind of break may be mistaken for another. His testimony leads us to find that the other witnesses' opinions were formed without adequate empirical data to draw definitive conclusions." [647]

As mentioned, there has been relatively little work into the biases that affect eye-witness statements in the aftermath of incidents and accidents. Most previous research has focussed on individual and group recollections of criminal acts. These studies have been used to inform police procedures during the gathering of evidence for subsequent prosecutions. They have not been used primarily to inform safety improvements. As a result it is difficult to know whether or not observed behaviours can be used to help interpret witness statements in these two different domains. For example, it is possible to find parallels with the 'weapon focus' mentioned above. Eye-witness' who observe major equipment failures often focus on the behaviour of that equipment in subsequent accounts of an incident. As a result, they often omit important information about the behaviour of other systems or operators who indirectly influenced the eventual failure of that equipment. This analysis also has strong links to psychological research into 'post-event' reconstruction. This examines the ways in which individual memories change over time [500]. For example, an individual may be asked to observe a scene. They are then provided with information that is either consistent or inconsistent

with the image that they have observed. Later when asked to recall aspects of that scene, the responses of individuals who received inconsistent information can be shown to be less reliable than those that had the reinforcement of consistent information. In psychological terms these studies are important because they long-term memory might be shaped by subsequent events. The legal implications of post-event reconstruction are clear [860]. For example, eye-witness evidence in the detonator explosions investigated by OSHA, cited previously, indicates the diversity of opinions that can exist over relatively straightforward estimates of physical distance even when supported by photographic evidence:

> "At the time of the explosion on the production line, a semi-trailer truck was parked at the loading dock adjoining the work bay. Referring to a photograph in evidence, Harrold Owen, Respondent's president, testified that the distance between the end of the loading dock and the work bay was 48 feet. Other witnesses estimated the distance as 10 feet and 20 feet." [644]

These effects need not, however, simply be seen as the effects of post-event reconstruction. They can be interpreted as the result of social influences rather than more direct cognitive effects. For example, the relative distances cited in the previous excerpt were used in a more complex argument about the safe positioning of the trailor. The witnesses were not, therefore, simply recalling a physical distance. They were providing evidence that, in turn, supported or weakened particular lines of legal argument. Hence their recollections might have been influenced by their knowledge of the context in which their evidence was being elicited.

There remains considerable disagreement about the impact of repressed memory syndrome on eye witness testimony. As with previous studies, most of the work in this area has not focussed on eye-witness statements in the aftermath of incidents and accidents [862]. It has, in recent years, focussed on recollections of childhood abuse. Critics of this work have shown that "children who witness traumatic events seem to have trouble forgetting it rather than showing signs of repression" [860]. However, Lindsay and Read have also shown that false autobiographical memories can be created by suggestion and by repeated imagination [495]. They can also be correlated with a belief in the concepts of repression and recovery of repressed memories and by hypnosis or hypnotic-like interventions.

Cultural Issues

The previous paragraphs have briefly reviewed the many complex factors that must be considered when interpreting eyewitness statements. For example, we have cited studies in which individual recollections of an incident can be affected by prompts and questions that they receive during post-event reconstruction. These factors have received considerable attention as a result of the increasing number of unsafe convictions in which DNA tests have been used to exonerate individuals who have been convicted on the strength of eyewitness statements [181]. As a result, national guidelines have been developed to minimise such influences during subsequent interviews [862]. For instance, the following excerpt provides the US Department of Justice's guidance on the interpretation of eye witness testimony:

> "*Principle:* Point-by-point consideration of a statement may enable judgement on which components of the statement are most accurate. This is necessary because each piece of information recalled by the witness may be remembered independently of other elements. *Policy:* The investigator shall review the individual elements of the witness statement to determine the accuracy of each point. *Procedure:* After conducting the interview, the investigator should:
>
> 1. Consider each individual component of the witness statement separately.
> 2. Review each element of the witness statement in the context of the entire statement. Look for inconsistencies within the statement.
> 3. Review each element of the statement in the context of evidence known to the investigator from other sources (e.g., other witnesses statements, physical evidence)." [583]

There are further issues that arise in using witness statements from individuals who have been trained within particular organisational cultures. Again, many of these concerns stem from the use of evidence in police investigations. However, the underlying issues also affect the use of witness statements in more general investigations. For instance, police officers have often been criticised as witnesses in criminal cases because they may hold certain beliefs and biases that affect their perception, recognition and recall of events in a way that might not affect other members of the public. These biases can stem from the recruitment and selection process, from training, from working culture or from experience. For example, training manuals have in the past directed officers to look for particular characteristics of groups. The clothes that they wear, the way in which they stand and walk, their use of language all provide indications of a potential criminal intent. This reinforces stereotypical categories that can support everyday police tasks. These categories can also reinforce inappropriate cultural stereotypes that lead individual officers to ill-considered assumptions about the perpetrators and course of a crime. In the UK, these concerns crystalised in the Macpherson's Inquiry into the death of Stephen Lawrence [511]. Stephen Lawrence was murdered by a group of five or six white youths while he waited for a bus on 22nd April 1993 . Initially it was thought that he had been involved in a fight rather than an unprovoked racist attack. The subsequent investigation failed to result in the conviction of anyone involved in the incident. Prolonged police investigations, in two distinct phases, produced only one witness. The Police Complaints Authority engaged the Kent Police to investigate complaints by Stephen Lawrence's parents that the first Metropolitan Police Service (MPS) investigation had been bungled. The resulting report roundly criticised many aspects of the MPS investigation. Public concern over the findings of this document and the justified indignation of Stephen Lawrence's parents led the Home Secretary to instigate a more general inquiry. The resulting Macpherson report proposed the following definition for 'institutional racism':

> "*Institutional Racism* consists of the collective failure of an organisation to provide an appropriate and professional service to people because of their colour, culture or ethnic origin. It can be seen or detected in processes, attitudes and behaviour which amount to discrimination through unwitting prejudice, ignorance, thoughtlessness, and racist stereotyping which disadvantage minority ethnic people." [511]

It is readily apparent that the Macpherson report deals with the failure of a criminal investigation rather than a 'near-miss' incident. However, the findings of this inquiry are extremely important for any reporting system that collects and analyses accounts of complex human behaviour. Organisational factors not only effect the sorts of occurrences that are contributed, through its reporting culture, they also affect the organisations interpretation and response to those occurrences. The problem of institutional racism, or other forms of discrimination, are clearly not restricted to the UK police service. The Macpherson report goes on to describe in precise detail how the problem of institutional racism affected many different stages of the investigation into Stephen's death. For instance, the initial investigations failed to consider the evidence of the main witness that Stephen Lawrence had been the victim of an unprovoked attack. This inquiry is unusual in that it provides arguably the only analysis of the corrosive effect that organisational 'bias' has upon a professional organisation. The concern is that if these factors affected the Metropolitan Police's investigation of a murder then the biases may be even more pronounced in the elicitation and analysis of evidence in less serious incidents by less well-trained personnel [381]:

1. "Inspector Groves' insensitive and racist stereotypical behaviour at the scene. He assumed that there had been a fight. He wholly failed to assess Duwayne Brooks as a primary victim. He failed thus to take advantage of the help which Mr Brooks could have given. His conduct in going to the Welcome Inn and failing to direct proper searches was conditioned by his wrong and insensitive appreciation and conclusions.

2. Family Liaison. Inspector Little's conduct at the hospital, and the whole history of later liaison was marred by the patronising and thoughtless approach of the officers involved. The treatment of Mr and Mrs Lawrence was collective, in the sense that officers from the team and those controlling or supervising them together failed to ensure that Mr and Mrs Lawrence were dealt

with and looked after according to their needs. The officers detailed to be family liaison officers, Detective Sergeant Bevan and Detective Constable Holden, had (as Mrs Lawrence accepted) good intentions, yet they offended Mr and Mrs Lawrence by questioning those present in their house as to their identity, and by failing to realise how their approach to Mr and Mrs Lawrence might be both upsetting and thoughtless.

3. This sad failure was never appreciated and corrected by senior officers, in particular Mr Weeden, who in his turn tended to blame Mr and Mrs Lawrence and their solicitor for the failure of family liaison. The failure was compounded by Mr Barker in his Review.

4. Mr Brooks was by some officers side-lined and ignored, because of racist stereotyping particularly at the scene and the hospital. He was never properly treated as a victim (Chapter 5).

5. At least five officers, DS Davidson, DC Budgen, DC Chase, DS Bevan and DC Holden simply refused to accept that this was purely a racist murder. This (as we point out in the text) must have skewed their approach to their work (Chapter 19).

6. DS Flook allowed untrue statements about Mr and Mrs Lawrence and Mr Khan to appear in his statement to Kent. Such hostility resulted from unquestioning acceptance and repetition of negative views as to demands for information which Mr and Mrs Lawrence were fully entitled to make. DS Flook's attitude influenced the work which he did (Chapter 16).

7. The use of inappropriate and offensive language. Racism awareness training was almost non-existent at every level." [511]

Previous paragraphs have used the Stephen Lawrence inquiry to illustrate the ways in which cultural norms can bias the direction of police investigations. Whist the problems of institutional racism have not been identified to the same degree in other safety-critical professions, including medicine and aviation, it is possible to find other forms of organisational bias [411]. For example, many professional groups can influence the reporting behaviour of its members by exerting a strong normalising influence [344]. The esoteric nature of the knowledge and skills that are required by professions, typically, implies that their members are self-regulating. This affords a degree of protection from the general public. In exchange the members of the profession accept the 'social control' of their peers. This normalising influence is not common to all professions. For example, the role of the external regulator in aviation makes it more difficult to preserve the internal regulation of an 'old boy network'. However, there are other forms of profession bias. In particular, the 'self-concept' has been used to describe the self evaluations that people make with reference to other groups of their peers. There are striking parallels between this analysis of the cultural barriers to professional change within the medical and aviation communities and the problems faced by the Metropolitan Police in the aftermath of the Macpherson report:

> "Since work is the central aspect of being for many, the internalised values of professional culture are likely to be important components of the self-concept. The positive aspects of professional culture, including prestige, contribute to a positive self-concept in the work domain and to self-esteem. Unfortunately, the negative aspects of the culture including the sense of invulnerability, also become integral parts of the self-concept. One of the more provocative findings regarding the self-concept is that individuals seek to maintain their established self-concepts, even when they are recognised as negative. The resistance of self-concepts to discomfirming evidence can explain why attitudes about personal limitations seem to fall on death ears and why change proceeds at a slow pace" [344]

This section has introduced a number of factors that complicate the elicitation and the interpretation of evidence from eye-witnesses. Some of these problems stem from basic properties of human cognition. For instance, it seems likely that individual memories of complex events can be affected by the witness' subsequent re-appraisals of the events they have observed. Other problems relate

more narrowly to the biases that affect those individuals who collect eye-witness statements. It is relatively easy to guide evidence by posing leading questions or by suggesting particular lines of argument. Later sections have gone beyond the effects of individual bias to look at the cultural norms that prevent, or conversely promote, the effective use of eye-witness statements.

6.3 Drafting A Preliminary Report

A number of national and international bodies require that incident information is disseminated to other organisations that might be involved in similar adverse occurrences. For instance, the ICAO specify that if incident reports help a State to identify safety matters that are considered to be "of interest" to other States then that State should forward the information to them "as soon as possible". They are require that member States "promote the establishment of safety information sharing networks" that facilitate the free exchange of information on actual and potential safety deficiencies [386]. As a result, they require that member states should draft a preliminary report within thirty days of a severe incident and "as soon as reasonably practicable' for minor occurrences. For more severe incidents, the report must be sent to the State of registry of an aircraft or the State in which the incident occurred. It should also be sent to the State of the operator, the State of design and the State of manufacture. A copy of this prelimiary report must also be sent to states that provided relevant information, significant facilities, or experts. A copy must also be sent to the ICAO. For less sever incidents, the distribution requirements for a preliminary report are more limited:

> "The State conducting the investigation should upon request provide other States with pertinent information additional to that made in the Accident/Incident Data report.

Aviation is not the only domain in preliminary initial reports are used to warn other organisations about adverse occurrences. For example, the FDA require what is known as a 5-day report after the notification of a medical incident to a device manufacturer [260]. The International Atomic Energy Authority (IAEA) require a "short preliminary report" within one month of a nuclear incident being reported in a national incident reporting system coordinator [384]. Although there are significant differences in the regulatory requirements for these initial reports, there are also a number of common features. For example, the primary recipient of an incident report is often left to draft the preliminary report into less severe incidents. They must collate the available evidence in the manner described in previous sections. The primary recipient then use this evidence to perform an initial severity assessment. They typically, conduct an informal causal analysis of the events that contributed to the failure. The preliminary report is then passed to regional or national safety managers who can supplement the report if necessary. For more severe incidents, the task of drafting a preliminary report is typically to professional incident investigators.

6.3.1 Organisational and Managerial Barriers

Irrespective of who produced the initial report, safety managers must decide who should receive copies of this document. A number of factors influence their decision. Most importantly, managers must determine whether there is a significant risk of a similar incident recurring at other sites both inside and outside their organisation. If the preliminary report suggests that such a risk exists then information must be passed on. There are clear ethical and legal implications about any failure to pass on reports of previous failures if a similar incident does occur in the future. The decision to pass on a preliminary report can also be influenced by explicit requests to receive information on particular topics. For example, the European Turbulent Wake incident reporting system registered an interest in hearing about any of these incidents that involved commercial aircraft [548]. At a local level, managers may decide to pass on preliminary reports if they identify an incident as part of a regional trend. This depends upon a careful monitoring of incidents over time and, in the eraly stages of an investigation it may be impossible to accurately determine whether a particular occurrence does or does not form part of a wider pattern.

It may at first sight appear that preliminary reports should, by default, be broadcast as widely as possible. For instance, the International Atomic Energy Authority reporting system encourages national coordinators to provide information about all incidents that might be of international interest. In all cases, preliminary reports are followed-up by the publication of a final report:

> "Each participating member country designates a national Incident Reporting System (IRS) co-ordinator. An event report is submitted to IRS when the event is considered by the national co-ordinator to be of international interest. IRS when the event is considered by the national co-ordinator to be of international interest. Only events of safety significance are reported. When information is considered time sensitive, a short preliminary report is distributed within one month of the event." [384]

However, the decision to publish all preliminary information is not as simple as it might seem. Confidence in reporting systems can be jeopardised if a large number of preliminary reports are subsequently revised in the light of more detailed investigations. Warnings about potential incidents can threaten long-term safety if organisations forget to revise their initial corrective actions in the light of any subsequent findings. There is a danger that a large number of 'spurious' reports can mask preliminary information about more critical incidents. As a result, some incident reporting systems actively prioritise or filter the dissemination of these initial reports [807]. Only the most critical documents are released until more evidence is obtained about the causes and consequences of an adverse occurrence. Other systems adopt a multi-tier approach in which a succession of regional, national and international committees determine whether information about an incident should be passed onto the next level of investigation. This approach characterises some aspects of the European Space Agencies Alert system:

> "The providers and users of the information channelled through the European Space Agency (ESA) Alert System are the participating organisations. They play a key role in actively notifying failures and problems, which they do by initiating a PAI (preliminary alert information); they also participate in the investigation of a PAI. If the PAI is officially adopted it achieves the status of an ESA Alert. Participating organisations also act upon the information promulgated through an ESA Alert and provide feedback on the effectiveness of the suggested corrective actions. Each participating organisation nominates an Alert Coordinator who manages communications with ESA. Due to the sensitive nature of the information contained in an ESA Alert, ESA requires that all PAIs be subject to a rigorous scrutiny and a well defined authority is maintained for the release of an ESA Alert. The parties involved in these processes are: the ESA Alert Committee; the ESA Alert Focal Point; technical specialists. The ESA Alert Committee, chaired by the Head of the Product Assurance & Safety Department, ESTEC (Research and Development Arm of ESA), has overall responsibility to decide whether or not an identified failure or problem should be published as an ESA Alert. The ESA Alert Focal Point, is a centralised function within the ESA Product Assurance and Safety Department which administrates the ESA Alert system and maintains its effective functioning." [232]

There are further managerial and organisational factors that complicate the dissemination of initial information about incidents and accidents. There is a natural reluctance to publicise a potential failure in safety mechanisms prior to more detailed investigations. For example, the UK Major Hazard Incidents Data Service (MHIDAS)deliberately delays the publication of some incident reports in order to ensure that the information which it provides is as complete and as accurate as possible:

> "The database is updated every quarter, but incidents are not generally entered onto the database until a year after they have occurred so that as much information as possible can be collected for each incident from a number of different types of journals. Because of their nature, information published in reports soon after an incident occurred may be incomplete and for major incidents some early reports may contradict each other as the exact number of fatalities or injuries may not immediately be apparent. It is thus

> important that information on an incident is collected from as many information sources as possible." [325]

This quotation illustrates two different approaches to the publication of incident information. On the one hand, there is a requirement to provide as much accurate information about adverse occurrences as possible. This helps to ensure that lessons from past failures are not propagated into the future design and operation of safety-critical systems. On the other hand, there is a more immediate requirement to warn other operators about the potential for previous failures to recur. Clearly, there must be some alternate means of ensuring that adverse occurrences cannot be repeated in the twelve months before they appear in the MHIDAS database. This implies not only that preliminary reports must be published but also that thy must contain subsequent information for other organisations to be able to act on the warning. This is illustrated by the FDA's criticisms of Atomic Energy of Canada Limited's (AECL) response to exposure incidents involving the THERAC-25 linear accelerator. The following paragraph forms part of the FDA's response to a letter that was sent by AECL to each Therac user recommending a temporary 'fix' to the machine that would allow them to continue to be used:

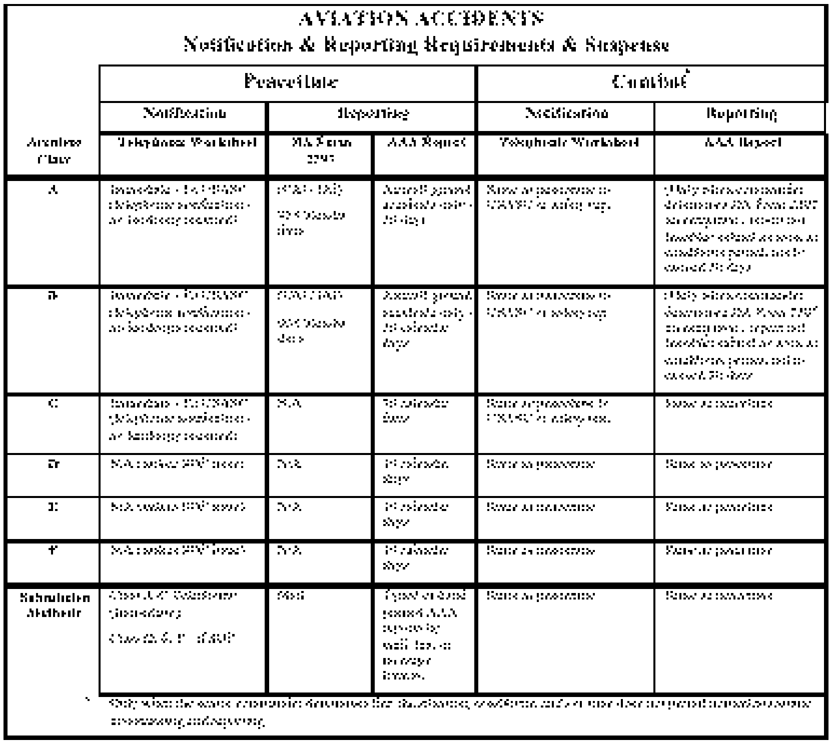
> "We have reviewed [AECL's] April 15 (1986) letter to purchasers and have concluded that it does not satisfy the requirements for notification to purchasers of a defect in an electronic product. Specifically, it does not describe the defect nor the hazards associated with it. The letter does not provide any reason for disabling the cursor key and the tone is not commensurate with the urgency for doing so. In fact, the letter implies the inconvenience to the operator outweighs the need to disable the key. we request that you immediately re-notify purchasers." (FDA to AECL, Director of Compliance, centre for Devices and Radiological Health, cited in [486]).

This quotation illustrates how regulators will intervene if they believe that preliminary reports do not provide sufficient information about the potential risks of future failures. Such responses are usually symptomatic of a deeper breakdown in the relationship between the manufacturer or supplier and the organisations who must intervene to ensure the safety of the market place.

6.3.2 Technological Support

AECL's letter was sent almost twelve months after the initial incidents took place but less than one month after a lawsuit was issued by the first patient. These is evidence that this delay in issuing a preliminary report stems from the lack of any mechanism within AECL to follow-up on suspected accident or incident reports [486].Many organisations, therefore, explicitly publish deadlines for their initial response to an adverse occurrence [807]. Previous paragraphs have mentioned the FDA's 5 day rule and the ICAO's 30 day deadline for preliminary reports into the most serious incidents. Other organisations are forced to specify deadlines that vary according to the operational demands upon its staff. Figure 6.4 provides an extreme example of this. It illustrates the US Army's time-scales for the submission of preliminary, interim and final reports [807]. Unit commanders and safety officers can provide prelimiary reports over the telephone. The AGAR form, typically, provides an abridged form of interim information about accidents and incidents. The DA 285 form provides greater detail and in many cases represents a final accident report. IAI refers to an Installation Accident/incident Investigation, CAI refers to a Centralised Accident Investigation. As can be seen, these time-scales depend not simply upon the severity of the incident but also upon whether or not the unit reporting the incident is involved in a combat operation. For example, the abridged AGAR form can be used used under combat for category A and B accidents that would normally require the more exhaustive DA 285.

These deadlines can impose considerable burdens upon operational staff. As a result, organisations such as the US Army make extensive use of telephone notification procedures. Again, as can be seen from Figure 6.4 these are reserved for the preliminary reports associated with high-criticality incidents and accidents. The preliminary reports associated with less 'severe' incidents are submitted using the AGAR forms. Figure 6.5 shows the forms that operators must complete when they



AVIATION ACCIDENTS
Notification & Reporting Requirements & Suspense

Accident Class	Peacetime			Combat*	
	Notification	Reporting		Notification	Reporting
	Telephonic Worksheet	DA Form 2397	AAA Report	Telephonic Worksheet	AAA Report
A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C	[illegible]	N/A	[illegible]	[illegible]	[illegible]
D	[illegible]	N/A	[illegible]	Same as peacetime	Same as peacetime
E	[illegible]	N/A	[illegible]	Same as peacetime	Same as peacetime
F	[illegible]	N/A	[illegible]	Same as peacetime	Same as peacetime
[illegible]	[illegible]	[illegible]	[illegible]	Same as peacetime	Same as peacetime

* [illegible]

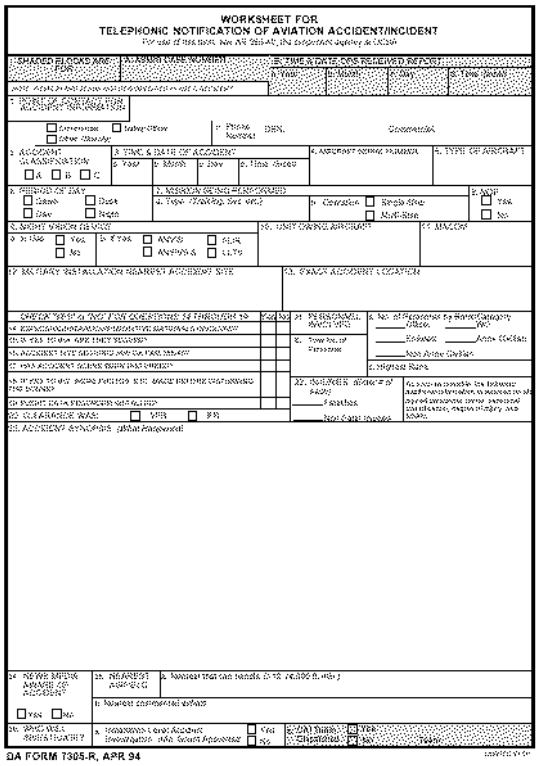
Figure 6.4: US Army Incident/Accident Reporting Procedures

receive a preliminary oral report of an incident. In passing it is worth noting that this form is quite different from some of those shown in Chapter 4.3. It is not intended to be completed by the staff who were involved in an incident nor is it expected that those staff would telephone-in an account of an incident. Instead this form represents a preliminary report because it is assumed that it will provide a record of the initial observations made by either a unit commander or by a trained safety officer. The degree of planning reflected in Figures 6.5 and 6.4 contrasts sharply with the FDA's criticisms of AECL. It also illustrates what is required if large, relatively complex organisations are to meet relatively tight deadlines for the investigation and analysis of adverse occurrences.

Information technology is increasingly being recruited to support more traditional communication media in order to meet the deadlines shown in Figure 6.4. For instance, Figure 6.6 illustrates the web-based interface to the US Army Aviation and Missile command preliminary incident reporting system [822]. As with the telephone form shown previously, this interface provides a rapid means for primary recipients to provide a safety management group with a preliminary report about an incident. The relatively open format, typified by the field labelled 'Description of incident', can be contrasted with the more tightly defined fields of the CIRS form illustrated in Chapter 4.3 [757]. This web-based system elicited reports directly from anaesthetists. The user of the CIRS system selects the types of incident from a predefined list of possible events. In contrast, the Army system covers may different engineering and military applications. As a result, the open field format provides greater scope for the initial analysis in the preliminary incident report.

6.3.3 Links to Subsequent Analysis

The previous sections have focussed on a number of organisational issues that complicate the dissemination of information contained in preliminary reports. It has been argued that concerns over the sensitive nature of information about system failure must usually be addressed by regulatory


WORKSHEET FOR
TELEPHONIC NOTIFICATION OF AVIATION ACCIDENT/INCIDENT

DA FORM 7305-R, APR 94

Figure 6.5: US Army Preliminary Incident/Accident Telephone Reports

intervention. Subsequent sections went on to briefly describe how fixed time-scales are usually imposed for the completion of preliminary and interim reports, such as the AGAR forms used by the US Army. Telephone procedures can be used to ensure that necessary information is passed from the primary receiver to central safety managers. Web-based systems are also playing an increasing role in the communication of initial information about adverse occurrences.

It is important to emphasise, however, that the drafting of a preliminary report only represents an initial step in the response to a safety-critical incident. This point is illustrated by the FDR's reporting system for the manufacturers of medical devices.

> "There are five types of Medical Device Reporting (MDR) reports that FDA requires the manufacturer to submit. Each type of report is to be submitted within the mandatory time frame by completing the appropriate form. MDR reports for manufacturers include a:
>
> 1. 30-day report,
> 2. 5-day report,
> 3. baseline report,
> 4. supplemental report, and
> 5. annual certification." [260]

The 30-day, 5-day and baseline reports represent refinements on the general concept of a preliminary report that has been presented in this chapter. If a manufacturer receives information about an MDR reportable event, they must submit a 5-day form within five work days after: (1) becoming aware that a reportable event necessitates remedial action to prevent an unreasonable risk of substantial harm to public health; or (2) becoming aware of an MDR reportable event from which FDA has made a written request for the submission of a 5-day report involving a particular type of medical device

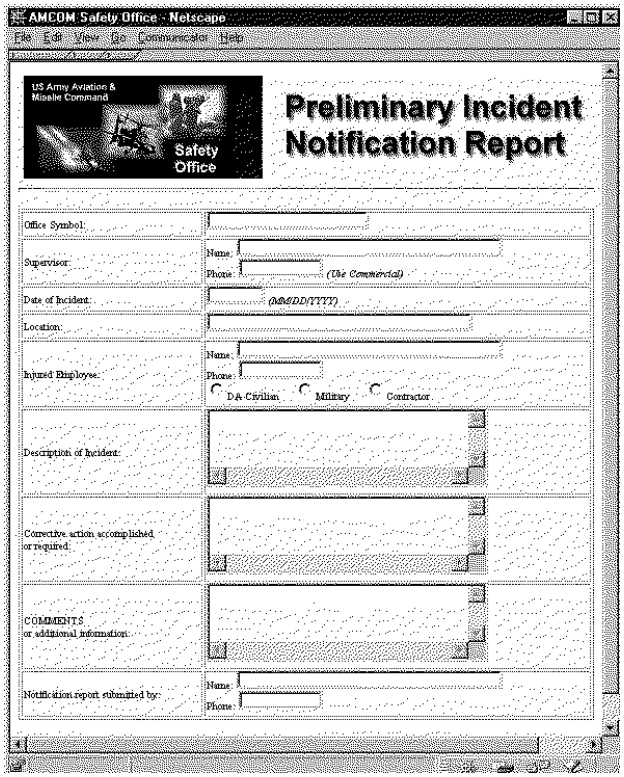


Figure 6.6: US Army Aviation and Missile Command Preliminary Incident Form

or type of event. The thirty day report must be submitted by any manufacturer within 30 calendar days after becoming aware of a reportable death, serious injury, or malfunction. Baseline reports illustrate a further development of the preliminary report; they must be submitted in response to the first MDR reportable incident involving a particular device. This report provides basic device identification information including: brand name, device family designation, model number, catalogue number and any other device identification number. This information helps ensure clear, unambiguous device identification.

The last two classes of document required by the FDA's MDR scheme illustrate the way in which preliminary reports form part of a more complex process in which regulators may intervene to monitor any subsequent analysis, to oversee the implementation of any further remedical actions and to assess the overall effectiveness of those actions. Manufacturers must submit a supplemental report if they obtain additional information denoted as unknown or not available at the time of the preliminary 30 and 5-day reports. A supplemental report is also required when new facts prompt the manufacturer to alter any information submitted in the original MDR report. This must be submitted within one month of the receipt of the information.

Follow-up reports document important stages in the investigative process after the primary recipient has filed an initial notification with the MDR system. Typically, medical device manufacturers must seek this additional information by follow-up interviews with the end-users of their devices. This raises the question of how many attempts must manufacturers make to obtain additional contextual information about particular incidents. The FDA requires that a 'good faith effort' be made to obtain information. At least one request for information should be made in writing. In a sense, therefore, the preliminary 5 and 30-day reports help to identify the more detailed information needs that must be addressed during a subsequent investigation.

Annual reports provide a further monitoring tool for the FDA and the operators of the MDR system. Section 510(d) of the Federal Food, Drug, and Cosmetic Act (the act) [21 U.S.C. 360I(d)]

provides that each manufacturer, importer, and distributor shall certify that they filed a certain number of medical device reports (MDR's) in the previous twelve months or that they did not file any MDR's. The legal requirement helps to ensure that the FDA keeps an overview of the relative performance of particular commercial organisations from year to year. By requiring that named individuals sign these annual reports, there is an additional means of verifying the internal MDR audit mechanisms.

The MDR procedures illustrate how prelimiary reports, at 5 and 30 days, can be used to provide an initial notification of an adverse occurrence. Previous sections have argued that these initial reports often contain omissions and inaccuracies. The FDA have addressed these concerns by providing for supplementary reports that are intended to resolve any ambiguities or gaps that could not satisfactorily be explained within the relevant time limits. Each of these reports, in turn, must be accounted for in an annual report that provides an overview of the longer-term safety record of an organisation. Importantly, this mechanism also forces individuals to document the multiple 5 and 30 day reports that can arise when the same device generates numerous incidents. Base line reports provide the necessary identification information to ensure that reports of these failures are not disguised by arbitrary distinctions within a product line. The key point behind all of this is that preliminary reports only provide an initial glimpse of the information that must be collected for more serious incidents. There must be some mechanism for ensuring that these additional details are collected and recorded. There must also be some means of assessing the effectiveness of the entire reporting process, for instance through annual surveys of incidents and accidents.

6.4 Summary

This chapter focussed on the responsibilities of the 'primary recipient'. This term is used to describe the supervisors, managers or other nominated personnel who first receive an incident report. Initially, their first priority is to safeguard their system. This can involve removing operators from positions of control if their involvement in an incident makes them susceptible to further 'errors'. It may also force them to instigate back-up procedures or to restrict the level of service that is provided. It is critical, however, that any remedial actions should not exacerbate the consequences of any initial failure. A number of factors were identified that can combine to frustrate attempts to safeguard the system. These include poor training in emergency procedures and a lack of situation awareness that can prevent primary recipients from accurately predicting the consequences of any intervention. Their tasks can also be complicated by time pressures in the aftermath of an incident. Lack of information and a lack of necessary system support can deprive primary recipients of the necessary resources to effectively direct their interventions. The pressing need to preserve levels of service, for example in air traffic control, can also further complicate attempts to safeguard a system. Previous sections then went on to review a number of emergency management procedures that can be used to address many of these potential pitfalls. Documented procedures, reinforced through simulated emergency training, have proven to be effective in many different domains. There are, of course, concerns that such techniques may do little more than establish stereotypical responses that can even hinder an individual's ability to respond to pathological failures. One solution to this potential weakness is to ensure a close link between the scenarios that are used during simulated emergencies and the incident information that is gather by reporting systems in similar organisations.

Later sections went on to discuss the problems that primary recipients face in gathering automated data about adverse occurrences. It can be difficult to predict which logs will actually contribute most to any subsequent investigation. In consequence, many regulatory organisations specify a minimum list of information sources that must be secured after any incident. It is important, however, to realise that many automated systems cannot be relied upon to produce accurate information about a failure. For example, the loop recording facilities of cockpit voice recorders make it particularly important that primary recipients instigate measures to stop the recording process if they do not want important information to be over-written. Subsequent paragraphs reviewed the legal issues surrounding the disclosure of evidence in the aftermath of an incident. This area is of particular concern when the anonymity of potential contributors might be jeopardised by the

subsequent release of automated recordings.

Primary recipients are also often involved in collecting evidence from eye-witnesses. A number of techniques were therefore presented to help in this task. Different interview formats were considered. These included one to one interviews, many to one interview panels, one to many team-based interviews and many to many group discussions. Interview structures were also discussed. These included flexible interview techniques, more formal interview structures, semi-structured interviews, prompted interviews and closed response techniques. However, the information that is provided by these approaches can be subject to a number of biases that affect eye-witness testimonies. These biases stem from both cognitive factors, including post-event reconstruction, as well as the more obvious social pressures to conform to a 'group-view' of an adverse occurrence. Later sections also went on to consider ways in which more fundamental, institutional and organisational factors can influence the entire elicitation or interview process. This analysis drew heavily upon recent reports into the biases that affect the ways in which police agencies have taken and analysed eye-witness testimonies.

The closing sections of this chapter have reviewed the primary recipient's role in drafting a preliminary report. This document, typically, provides a summary of the initial data gathering tasks and may also describe the initial actions that were taken to safeguard the system. Our analysis has focussed on the way in which time limits are usually established for the presentation of these reports so that other organisations can be warned about potential failures. However, there is a natural reluctance to present what might be premature reports about commercially sensitive failures. As a result, regulatory intervention is typically required to ensure that other organisations are alerted of a potential hazard. Other industries rely upon a less rigorous approach in which the publication of safety information can be filtered or postponed until the results of a more complete investigation are compiled. The next chapter looks at the next stage in such a detailed investigation. In particular, it focuses on the reconstruction techniques that can be used to form a coherent account from the individual events that are identified in a preliminary report.