ICAO

Doc 10205

Manual on Hazards at Aircraft Accident Sites

First Edition, 2024

Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION

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AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue;* the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

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No.	Date	Entered by

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No.	Date	Entered by
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FOREWORD

During the Accident Investigation and Prevention (AIG) Divisional Meeting in September 1999, it was agreed that ICAO play a role in establishing and regularly maintaining an inventory of hazards specific to aircraft accident sites and provide the related guidance material to States and, more specifically, accident investigators, to avoid future hazards. Based on the meeting's discussion, ICAO established the Hazards at Accident Sites Study Group (HASSG). While the study group published the circular *Hazards at Aircraft Accident Sites* (Cir 315), in 2008, ICAO acknowledged the evolutionary nature of these guidelines and the need to update them periodically.

Accident site hazards and occupational safety management requirements have expanded significantly since Cir 315 was first issued. At the first meeting of the Accident Investigation Panel (AIGP/1) held in Montréal in April 2015, it was agreed to revise the circular to include safety actions associated with undeployed ballistic parachute recovery systems (BPRS) and investigations in hostile environments.

This manual replaces Cir 315 and includes the safety actions stated above.

This manual is intended to assist organizations and individuals to consider and apply effective occupational safety management practices to their activities as well as to the teams that they work with or are responsible for. The manual discusses the variable nature and scale of occupational hazards present in aircraft accident investigations and attempts to explain and manage the risks associated with their exposure at accident sites.

Throughout this manual, the use of the term "accident" should be understood to include "incident".

The *Manual of Aircraft Accident and Incident Investigation* (Doc 9756), Part I – *Organization and Planning* and Part III – *Investigation* provide additional information and guidance material on related subjects.

ICAO is grateful for the assistance provided by the Accident Investigation Panel (AIGP) in the preparation of this manual.

To keep this guidance material relevant and accurate, suggestions for improving content or presentation are welcome. Recommendations will be examined, and, if found suitable, included in the next edition.

Comments concerning this manual should be addressed to:

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GLOSSARY

The definitions below are given to ensure that the reader understands the intended meaning of the terms in the context of this manual.

Accident investigation authority (AIA). The authority designated by a State as responsible for aircraft accident and incident investigations within the context of Annex 13 – *Aircraft Accident and Incident Investigation*.

Accident investigator. A person engaged in the investigation of aircraft accidents and incidents within the context of Annex 13.

Asphyxia*.* Suffocation as a result of physical blockage of the airway or inhalation of toxic gases.

Ballistic Parachute Recovery Systems (BPRS). A rocket deployed parachute that enables an aircraft and its occupants to descend to the ground, following an in-flight emergency, at a survivable rate of descent. It consists of a rocket, parachute, cables connecting the parachute to the aircraft structure, and an actuation mechanism.

Dynamic risk assessment*.* Factors associated with the specific accident – accident location, specific details of damage sustained, occupants, cargo, fuel load, time of day, etc., that are used to generate an indication of the risk existing at a specific point in time.

Generic risk assessment*.* Background information available to all to assist with considering what hazards are likely to be present – aircraft type, age, modification standard, operating category, typical damage, pre-identified hazards, sampling, and analysis data. Enables organizations to plan and prepare, train and establish levels of support equipment.

Hazard*.* A condition or object with the potential to cause or contribute to an aircraft incident or accident.

Investigation*.* A process conducted within the context of Annex 13 for the purpose of accident prevention which includes the gathering and analysis of information, the drawing of conclusions, including the determination of causes and/or contributing factors and, when appropriate, the making of safety recommendations.

Investigator-in-charge (IIC). A person charged, on the basis of his or her qualifications, with the responsibility for the organization, conduct and control of an investigation.

Pathogen*.* An agent that can cause disease, such as a bacterium or a virus.

Pyrotechnics*.* An aircraft component whose function includes the intentional detonation of an explosive charge. Typical pyrotechnic devices on aircraft include one-time valves, such as those found in fire extinguishing systems, and separation hardware such as bolts.

Response personnel*.* Trained individuals responding to a distress by performing search and rescue functions, providing initial medical assistance, medical evacuation and recovery to a place of safety, through the use of public and private resources.

Toxic*.* Relating to or containing a poison or toxin.

Vaccination*.* The administration of a vaccine to help the body's immune system develop protection from a disease.

Victim. *An occupant of the aircraft, or any person outside the aircraft, who is unintentionally directly involved in the aircraft accident. Victims may include the crew, revenue passengers, non-revenue passengers and third parties.*

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ABBREVIATIONS AND ACRONYMS

AIA	Accident investigation authority
BPRS	Ballistic Parachute Recovery Systems
DU	Depleted uranium
ECAC	European Civil Aviation Conference
IIC	Investigator-in-charge
PPE	Personal protective equipment

Chapter 1

MANAGING OCCUPATIONAL SAFETY IN AIRCRAFT ACCIDENT INVESTIGATION

1.1 GENERAL

1.1.1 In the aviation industry, occupational health and safety systems have been developed to ensure that the highest standard of occupational safety is achieved for those involved in the manufacturing, operation, servicing and maintenance of aircraft. These safety systems utilize well established processes to identify hazards, assess associated risks and introduce effective measures to eliminate or mitigate these risks.

1.1.2 Applying occupational safety management practices in the conduct of aircraft accident investigation operations is complex. Unlike the personnel involved in the more predictable domains of the aviation industry, investigators are required to respond to accident situations that are variable in nature, scale and environment and may involve unfamiliar equipment. These factors make the identification of hazards and their associated risks a more difficult exercise. Furthermore, given the infrequent nature of accidents, there are limited opportunities for the scientific analysis of aircraft debris that is essential for accurate assessment of occupational health risks. Investigation teams must also work under the occupational health and national laws of their home State and/or of the State in which they work.

1.2 RISK MANAGEMENT AT ACCIDENT SITES

1.2.1 No activity can be absolutely free of risk, but an activity can be controlled to ensure that risk is reduced to an acceptable level. If risk remains unacceptably high, the activity should be delayed or modified and a new risk assessment should be conducted. Often, a balance should be struck between the requirements of the task and making its performance safe for investigators and search and rescue personnel. This balance may be difficult to achieve but the priority should always be safety at the accident site. If safe operations cannot be achieved, for example where operations are required in hostile environments, then the investigation agency should consider alternatives to deploying investigators to said site. When selecting a team, one should consider the team members' qualifications, medical status (vaccinations, medical conditions, allergies) and fitness for site conditions.

Note.— Often, experts from other organizations and agencies may require access to the accident site for specific evaluations. These individuals must be accompanied by a qualified investigator to ensure the safety of the visitor and the preservation of the accident site. Likewise, government officials, news media and family members are to be closely controlled, preferably from inside a vehicle, so as not to interfere with the investigation and to protect them from the various hazards of the site. These tours may be provided after all medical treatment is provided and fatalities are removed from the accident site.

1.2.2 Aircraft accidents, due to their highly variable nature and scale, pose a wide range of hazards and often present high levels of risks to those with specific responsive roles. Aircraft accident investigators face these safety challenges during their travel to and from accident locations, throughout their work at accident sites and, on occasion, during their work at investigation facilities (see Figure 1-1). To provide suitable protection for accident investigators, a recognized risk management process as illustrated in Figure 1-2 should be applied:

Figure 1-1. Identifying hazards at the site

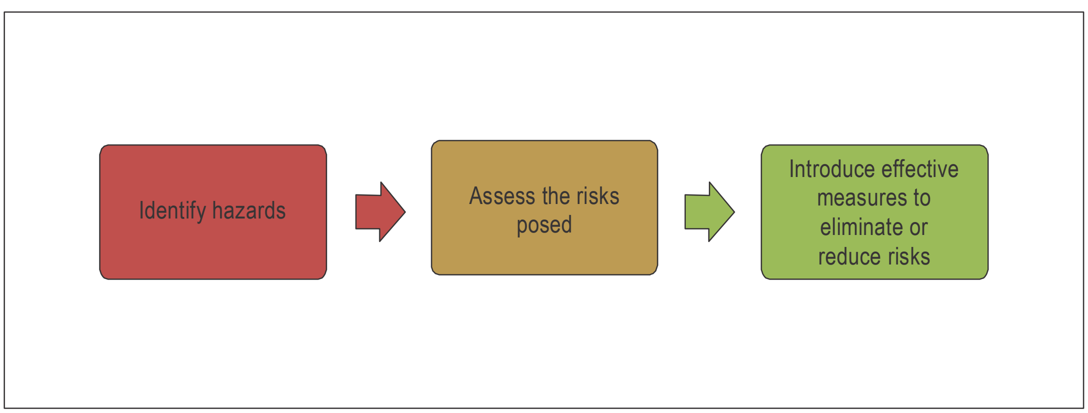

Figure 1-2. Risk management process

1.2.3 Given the unpredictable character of aircraft accidents, the task of applying such an effective risk management process can be both demanding and complex.

1.3 GENERIC AND DYNAMIC RISK ASSESSMENT

1.3.1 It is recognized that in responsive operations such as accident investigation, a two-phased (generic and dynamic) approach to risk assessment provides the optimum means of managing operations safely. This approach entails looking firstly at activities in a predictive manner, sometimes referred to as a generic risk assessment. This is often carried out by individuals or teams who apply their knowledge and experience to consider the various activities at hand and the likely hazards and risks associated thereto. The generic risk assessment can be done in downtime, well before investigation deployments are undertaken, and should be reviewed on a regular basis to ensure that accurate information and recent experiences are used in assessments. Based on these considerations, risks can be reduced to an acceptable level by introducing measures such as planning, information systems, training, procedures, equipment, medical arrangements, and specialist contracts.

1.3.2 Due to the unpredictable nature of aircraft accidents, such generic assessments may not be suitable for all situations. A dynamic risk assessment should therefore be undertaken in the initial stages of accident site operations. In this situation, the team undertaking the task should identify the actual hazards and risks involved to confirm whether the generic risk assessment is suitable, or whether different and/or further measures are needed to mitigate the risks posed at the accident site. Hazard and risk identification should be done as a team activity to maximize the appropriate identification and assessment of risks and for improved team member awareness of the outcomes. The outcome of this assessment should be recorded and should identify the level of risk imposed by each hazard (for example, low, medium, high, or extreme risk) and the implications (for example, carry on as planned, proceed with mitigation measures in place, requires mitigation measures to be approved by a senior safety official) The *Manual of Aircraft Accident and Incident Investigation* (Doc 9756), Part I – *Organization and Planning*, Chapter 5, identifies several actions at the accident site that are important for both the safety of personnel and for the protection of evidence.

1.3.3 The generic or dynamic risk assessment approaches are commonly applied by emergency services personnel (see Figure 1-3). Information can be exchanged between responding organizations at the accident site (see Figure 1-4) to compile a separate but cooperative risk assessment suitable for the different tasks that each team will be completing.

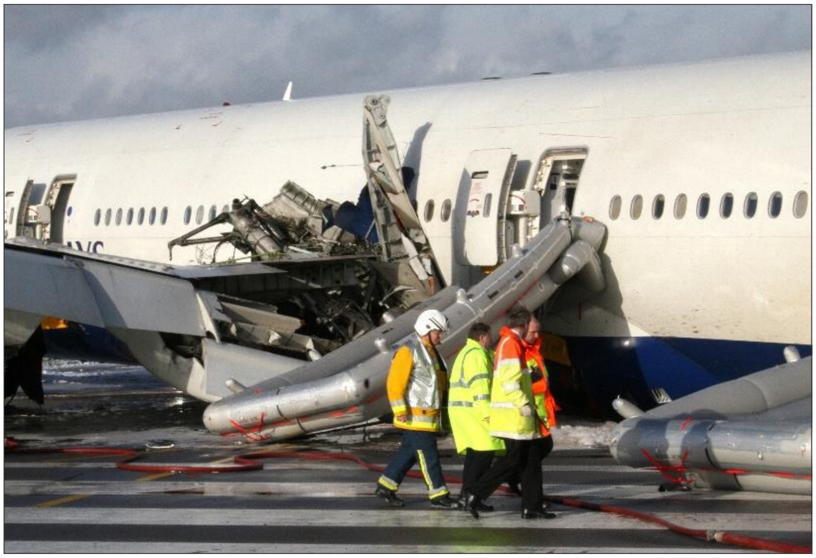

Figure 1-3. Dynamic risk assessment in progress

Figure 1-4. Information sharing at the accident site

1.3.4 A dynamic risk assessment should be reviewed as the accident site changes. This can be a partial or complete review, depending on the circumstance. Situations requiring a review of the risk assessment may include:

a) the initial assessment;

b) an evidence examination prior to, during and after body recovery;

c) the discovery of additional or changed hazards while working;

d) increasing fatigue;

e) changes to personnel, weather, site access, security situation, etc.;

f) evidence recovery;

g) wreckage recovery or lifting;

h) the transport and storage of off-site evidence examination and its disposal.

1.3.5 In aircraft accident investigation, a dynamic risk assessment will often identify the need for additional control measures on site, such as operational safety plans and procedures, safety teams or supervisors, controlling access and exposure, coordinating activities, measuring and analysing substances, containing or neutralizing hazards, and otherwise eliminating or reducing risks. For most small-scale general aviation accidents, the investigator-in-charge (IIC) or senior investigator at the accident site should hold the overall site safety responsibilities and duties. For larger aircraft accidents and complex accident sites, the appointment of a competent person to perform the role of site safety coordinator is recommended. This person should:

a) collate and analyse site safety information from working teams;

b) brief the investigation team on all known and potential hazards;

c) establish safety practices;

d) monitor the site situation and activity for new or changed hazards; and

e) monitor compliance with agreed safety practices.

Note.— Once the investigation is complete at the accident site, the remaining hazards must be properly collected and disposed of. As a humanitarian gesture, any personal effects from the passengers and crew must be returned to them or to their relatives in a timely manner.

Chapter 2

HAZARDS

2.1 GENERAL

2.1.1 A hazard is a condition or object that has the potential to cause or contribute to adverse consequences. For individuals responding to aircraft accidents, the range of hazards can be very wide. For investigators, many of the hazards faced are directly associated with the required tasks to perform at accident sites. However, investigators are also faced with hazards associated with other aspects of their work, including international and local travel, environmental conditions, security, wildlife and psychological pressures. Given the wide range of hazards associated with the role of the aircraft accident investigator, it is helpful to list hazards within distinct categories.

2.1.2 Hazards are categorized in this manual as follows:

— *Working environment*. Considerations of a hazardous working environment include location (remoteness, terrain type, topography and specific worksite hazards such as working at high elevations, in confined spaces or near train lines, local structures and damaged trees), fatigue (due to travel, working hours, work intensity and stress), security or political situation, climate, weather, hazardous plants and wildlife.

— *Physical*. Physical hazards include fire and flammable substances, stored energy (electrical, hydraulic, pneumatic, pressure vessels, tires, weapons, explosives, high energy systems, structural energy), aircraft structures and wreckage, aircraft systems and other sharp and heavy objects.

— *Biological.* Biological hazards can be blood-borne pathogens, insect-borne pathogens and pathogens from the environment.

— *Materials.* Hazardous materials may include metals and oxides, polymer composite materials, chemicals, gases and other substances, and radioactive materials.

— *Psychological.* Hazardous psychological conditions include stress, emotional stress and traumatic stress arising from investigation activities (at the accident site, interviewing and meeting with witnesses, relatives and others, or from courtroom appearances) and the chronic effects of severe, frequent, and/or continual exposure to those activities.

2.1.3 Multiple categories may apply to the same hazard. For example, composite materials pose a physical hazard (sharp shards and irritant fibres) but also a material hazard (inhalation of fibres). Similarly, lithium batteries pose several physical hazards (fire and explosive atmospheres in confined spaces) in addition to material hazards (toxic gases and corrosive residues following combustion).

2.1.4 The way hazards present themselves is important to consider when categorizing their risk. Some hazards produced by acute events may result in a risk of short duration and may be physically evident, such as fire, explosives, electrical discharges, lack of oxygen and chemicals. Other hazards may not be immediately observable but, through either single or multiple exposures, pose significant health risks over time. It is not unusual for hazards posing a more immediate threat to be prioritized ahead of those with delayed symptoms. However, hazards threatening delayed symptoms may eventually present a much greater degree of risk.

2.2 WORKING ENVIRONMENT HAZARDS

2.2.1 General

The consideration of hazards associated with investigation activities at accident sites is often limited to the hazards posed by the aircraft and its contents. While these are important, there are many others hazards of similar or greater importance present, in particular those generated by the investigators' working environment. As identified below, some of these hazards are significant, while others are likely to have a strong influence on associated hazards. Weather conditions, for example, will often be hazardous due to extreme heat and intense cold. Even seemingly minor hazards such as a small change in temperature, rain, wind or snowfall, can make conditions more difficult and/or increase the physiological risks to health investigators. These conditions may hinder the on-site management of non-investigation personnel, such as police, emergency services, local contractors assisting investigation work, insurance companies, and other visitors. A central screening and logging of check-in and check-out position should be made, with a schedule for periodic reports to ensure workers are accounted for. This is especially important on larger sites, at remote locations or during adverse weather conditions.

2.2.2 Location

The accident location often presents a range of hazards and difficulties for investigators due to the site's geographic and topographic situation. Shelter, food, water, professional medical aid and a means of communication with others may be limited or unavailable. In the case of in-flight break-up and mid-air collisions, wreckage could be strewn across wide areas. Each type of location may present hazards that are general in nature, but specific to that location. Location is likely to present a combination of hazards and to be linked to other categories of hazards such as climate and weather

2.2.3 Travel

On deployment, investigators may be required to travel by air, road, on water, or by a combination of these modes. Investigators may wish to determine what mode of transport is considered suitable and safe in the State of occurrence prior to departure, considering the regions traversed and any foreseeable hazards therein. Investigation teams may prefer to use local drivers where road transport risks are considered high and may also wish to limit driving duties for those members of the teams who are fatigued or who have a high workload (for example, the IIC). Some accident investigation authorities (AIA) provide driving skills training to mitigate the risks of driving in difficult terrain. There may be a need to use specialized transport vehicles or helicopters to reach some accident sites. Investigators may also need to traverse long distances over difficult terrain on foot while carrying bulky or heavy equipment, and then return with evidence for further investigation. A longer travel duration may necessitate shorter workdays.

2.2.4 Worksite hazards

On land, the accident may be in an urban, rural or remote location, on or off airport terrain, at high altitude, on hillsides or in low lying areas. Wreckage may come to rest in trees, around or on high buildings, across roads, railways, and other infrastructure, with electrical, gas and other services presenting serious risks to investigation teams. Noise and air quality should be considered. Investigators may need to work at high elevations, in confined spaces or there may be other activities being carried out in the area (such as at an active airport or near construction works), with associated hazards. The terrain may be easy to traverse, or it could be steep, uneven, slippery, muddy, boggy, sandy, rocky, filled with dense vegetation, or mixed. There could be a risk of landslides in steep terrain. Accidents may also result in aircraft wreckage coming to rest in the sea or inland waterways, in shallow or deep water that is subject to tides and/or strong currents.

2.2.5 Fatigue

Fatigue is often an understated hazard for investigators. There will often be extended journeys, causing jet lag or similar effects due to trans-meridian travel, long working hours and demanding working conditions, all of which can affect performance due to fatigue. Team members should be aware of and prepared for these significant issues. Investigators should understand the potential physical and psychological demands of their work. When confronted by particularly demanding working conditions, they should rest when able to, limit work time (per day and long term), monitor themselves and others for signs of fatigue, and seek advice from management or professional advisors at the earliest signs of fatigue. Investigators should also be aware of their limitations and plan their activities to limit the effects of fatigue. For example, driving duties could be shared among the members of the investigation team to limit fatigue, which can be a major factor in road transport accidents. Health and fitness can also be significant to the individual’s ability to withstand the effects of fatigue. Many investigation agencies encourage staff to maintain an appropriate level of health and physical fitness to safely undertake the investigation task. There are also advantages for investigators to undergo periodic medical and physical assessments to help them understand their fitness to work in the range of environments they could encounter. At the start of the investigation process, management must ensure that investigators are in a suitably rested state to travel or commence investigation activities. Fatigue could be present before the investigative task commences due to high workload or personal circumstances. Likewise, levels of fatigue should be considered at the end of the field stage of an investigation. Following what is typically a few days of demanding activity, investigators should be suitably rested before return travel commences and may need recuperation time away from work in the weeks immediately following deployment.

2.2.6 Security

Criminal and terrorist threats are a feature of the social situation in many regions, even in seemingly safe cities. The potential for the loss of a civil aircraft in areas of conflict should also be considered. Advice and support from diplomatic and other sources should be considered as part of predeployment procedures to ensure that security measures are appropriate. Professional security at the accident site may need to be contracted for the duration of the site access by investigation teams. In some cases, State military or law enforcement resources can be engaged. Accident sites can attract onlookers, media, family and friends of victims, and people wishing to interfere with investigations or steal and scavenge items. Even in remote areas, it is often beneficial to clearly mark the boundary of the site using police ribbon or similar, put up warning signs, and mark multiple zones (outer, middle, inner) depending on the level of security needed, the size of the site, the extent of hazards, etc. Illicit activities may be secretly carried out in the area, which poses a security issue for government officials attending the accident. Other political and social advice should be sought to ensure that the local population is not offended by actions of the investigation team.

2.2.7 Climate and weather

Even in moderate climates, weather conditions are likely to pose safety considerations for investigators. Planning and being prepared for specific weather, and changes in weather conditions, is particularly important. If an individual is too hot, too cold, wet, sunburned or dehydrated, it will affect their performance and pose health risks. Extreme climates will certainly present hazards for investigators, especially when they are coupled with challenging environments (for example, high temperature and humidity) and the requirement to wear restrictive or non-ventilated personal protective equipment (PPE). Local weather phenomena such as high winds, rapid or unforeseen changes, rain, hail, snow, sleet, fog, dust, or storms may also affect the effectiveness of investigative activities. Wind affects the direction of fumes and airborne particulates and can destabilize damaged trees and wreckage. Daylight hours may be a concern, especially in polar areas.

2.2.8 Wildlife and hazardous plants

Hazards posed by wildlife and insects have the potential to cause immediate and long-term health conditions, some of which can also be life-threatening. Investigation teams must consider the threat from wildlife as part of predeployment assessments, particularly when travel to remote areas is required. As well as more obvious hazards from wild animals, snakes, spiders and scorpions, there is also a less obvious hazard posed by insects, such as mosquitos (for example, malaria), ticks and other parasites (for example, bilharzia), with exposure often going unnoticed until sometime after return from deployment. Aggressive livestock and domestic animals may be present. Some plants may pose physical hazards (such as thorns or falling branches) or may cause very painful stings when touched (the most concerning being plants of the Dendrocnide or “stinging tree” genus across Northeast India, Southeast Asia, Australia and the Pacific Islands). Investigators must prepare themselves by seeking advice in advance of their deployment on the hazards posed by wildlife and local plants. They must also take appropriate measures to prevent exposure.

2.3 PHYSICAL HAZARDS

2.3.1 Fire and flammable substances

Fuel is likely to be one of the most common hazards encountered at an accident site. Fuel poses problems primarily due to its flammability, but it is also hazardous as a toxic substance. In many events, despite there being a significant and perhaps protracted fire, not all flammable fluids may have been consumed by the fire. This often leaves sufficient flammable fluids to pose further fire risks for extended periods. In addition, aviation fuels (and other similar substances spilled at the site) can present a toxic hazard through contact or through the inhalation of fumes. These types of fluids are often also corrosive and can pose significant skin contact hazards if exposure goes unnoticed or is ignored, for example, where boots and socks become contaminated with fuel. Furthermore, flammable substances may be present in cargo and in ground vehicles and buildings. Ignition sources such as sparking from aircraft batteries or from the use of cutting equipment, must be kept away from flammable materials. Where available, the advice of an experienced fire officer attending the site should be sought in guarding against fire hazards and in securing fuel tanks and containers of other flammable liquids, such as hydraulic fluids.

2.3.2 Stored energy components

Many systems and components on aircraft (and in equipment on the ground) have the potential to pose injury to investigators through the release of stored energy. Electrical equipment (for example, accumulators) can contain capacitors, batteries and emergency power supplies that present hazards, even when aircraft are undamaged, through their electrical potential and/or their chemical content. Following aircraft impact and fire in accidents, these hazards can be less obvious, yet more significant. Electrical current can flow through any conductive material, including aircraft structures. In recent years, the potential for even minor damage from lithium batteries has generated increasing concern. They may cause the energetic failure of devices, resulting in fire that can be extremely difficult to extinguish, pose an explosion risk and give off very toxic and flammable fumes. Wheels, tires and sprung propeller systems are further examples of components that may have stored energy at high pressures. Deployable emergency locator transmitters may have strong springs (or pyrotechnics as discussed below). Large aircraft may be fitted with devices that generate oxygen (a fire risk) and can get very hot. Significant spring energy may be stored in bent structures such as wing spars and can be released when moved or cut. These items may pose an increased risk of failure when they have sustained damage from fire and/or impact. Many manufacturers publish aircraft rescue and firefighting guidelines which include the location of stored energy and other hazardous materials, which are appropriate for review during the generic risk assessment. In the case of a major accident, consult the manufacturer for specific information relevant to the specific aircraft involved during the dynamic risk assessment.

2.3.3 Pressurized gases and fluids

Pressurized containers may also present hazards with hydraulic accumulators, oleo struts, fire extinguishers, oxygen and other gas cylinders, etc. It is not unusual to find a variety of pressurized gases carried on aircraft in containers of varying designs (see Figure 2-1). The rapid discharge of these gases can pose a risk of physical injury or of asphyxiation, if released in enclosed spaces. Some gases may be toxic (fire extinguishants, for example) and others, such as oxygen, may increase the risk of fire or explosion when released. Fluids are also frequently present in hydraulics or braking systems and at pressures at or in excess of 5 000 psi (340 bar). Commonly used mineral oils present health risks if oil mists are inhaled, or when injection injuries are sustained following high pressure fluid release.

Figure 2-1. A selection of pressurized containers recovered from aircraft accidents

2.3.4 Weapons, pyrotechnics, and explosive charges

Commercial and private aircraft, and helicopters, may carry explosive charges to operate escape slides, fire extinguishers, winch cable cutters, flotation gear, deployable emergency locator transmitters, etc. While activating the charges may pose only a small direct risk to personnel, the unexpected initiation of the systems they operate may present a more significant risk. The activation of these charges could also ignite previously spilled flammable liquids. Pyrotechnics, such as flares and signal rockets, are carried by a variety of aircraft and may therefore be discovered among the wreckage, particularly where ground impact has been severe. Weapons and ammunition may be carried as cargo or by passengers or crew as cabin or checked baggage and should be carefully treated. During the early stages of an investigation, investigators should seek information about the carriage of any pyrotechnics, weapons, ammunition, or similar items carried as Dangerous Goods or otherwise. In addition, the potential for undeclared Dangerous Goods should also be considered.

2.3.5 High energy emergency support systems

2.3.5.1 Military and ex-military aircraft can carry ejection seats and canopy release/destruction systems that pose high levels of risk to investigators and responders following accidents. In recent years, aircraft have been fitted with other high energy systems that pose safety risks from their operating components. Inflatable seat restraints (airbags) are increasingly being installed on commercial and general aviation aircraft. While these airbags deploy at a much lower speed than road vehicles, they can still pose a risk of injury to response and investigation personnel, particularly where the presence of the system is unexpected. Ballistic parachute recovery systems (BPRS) are available for installation on a wide range of light aircraft, microlights and gliders, either as part of the initial Type Certification, or as optional equipment installed via a Supplemental Type Certificate. The presence of BPRS in accident-damaged aircraft can pose hazards for personnel tasked with responding to aircraft accidents and to members of the public. There is often little visible indication of the fitment of these systems.

2.3.5.2 Ballistic parachute recovery systems consist of a rocket, parachute, cables connecting the parachute to the aircraft structure, and an actuation mechanism (see Figure 2-2). System design may vary significantly, with rocket and parachute packs capable of being fitted in a variety of locations. Actuation mechanisms may also vary, with operating handles capable of being fitted in different positions and at times having duplicate operating handles. Actuating mechanisms are generally mechanical cable-operated but may also be electrical in operation. Such variability in design presents additional safety challenges for personnel responding to, or assisting with response to, aircraft accidents. Guidance and information are often available from manufacturers through their emergency contact phone numbers and websites. Some aviation authorities may also provide information in a similar manner.

Figure 2-2. Rocket-deployed emergency parachute system

2.3.5.3 Hazards posed by BPRS post-accident include:

— *Rockets.* Injuries through being struck by an inadvertently deployed rocket during rescue and recovery of aircraft occupants, or during investigation and wreckage recovery.

— *Fire risk.* Due to an initiated rocket being contained within the cockpit or close to flammable substances. This could happen during the accident, or in subsequent rescue/accident investigation activities.

— *Cables.* Injury or entanglement by the parachute to aircraft connecting cables following an inadvertent deployment. This has a significant potential when occupants are being rescued or when investigators are working in the cockpit area.

— *Inflated parachutes.* Whether the BPRS has been operated on purpose or inadvertently, once on the ground the aircraft or parts of the aircraft can be dragged by an inflated parachute, particularly during windy conditions. Inflated parachutes should be deflated as soon as possible to prevent the wreckage from moving with the wind.

— *Delayed operations.* Fire and heat damage during an accident can "cook" the rocket propellant, which can then initiate combustion some hours after the accident has occurred.

2.3.5.4 Placards are required on the aircraft to warn personnel of the hazards associated with BPRS (see Figure 2-3). To avoid danger to investigators and responders, an unfired rocket must be deactivated before the aircraft wreckage is disturbed during investigations and rescue activities. To this effect, an agreement should be established with a national agency or organization providing specialized services on BPRS.

Figure 2-3. Warning placard

2.3.5.5 Appropriate BPRS safety measures include:

a) good levels of awareness among investigators;

b) circulating the manufacturers' information on BPRS;

c) establishing response arrangements for dealing with live BPRS post-accident;

d) including national lists of BPRS-equipped aircraft (where possible); and

e) including contact details for manufacturers' safety personnel.

2.3.6 Wreckage and unstable structures

Often, the hazards posed by damaged aircraft structures will be obvious and readily identified. Damage posed by fire and impact can leave structures weak and badly damaged without this being immediately obvious. Modern materials, including composite materials, for example, may appear to be in good condition but could have lost all structural integrity and will support little or no weight as a result. Investigators should also be mindful of any damage to buildings and other structures during accidents. Structure failure or exposure to electrical and other hazards may pose significant risks. Inside a large burned aircraft, structural integrity and visibility may be issues. Sharp and heavy objects, including damaged metals, glass, hard plastics, and composite materials (fibreglass, boron and Kevlar composites and carbon fibres, which are a significant puncture risk), are hazards on many accident sites and can be dangerous to personnel walking around the site and moving wreckage. Power tools, hoists and other equipment used to access or move wreckage should only be used by individuals with the appropriate experience or training.

2.4 BIOLOGICAL HAZARDS

2.4.1 Overview

Accident investigators may be exposed to many biological hazards throughout their investigation activities. Such hazards may exist in the form of:

a) blood-borne pathogens (viruses), through exposure to blood and body fluids from injuries sustained by aircraft occupants and others during accidents;

b) vector-borne pathogens, where investigators are exposed to insects and wildlife carrying diseases in the course of their work;

c) pathogens in the environment, to which investigators can be exposed as a result of their activities on the accident site.

In the planning for action in the field, it is important to include the mapping of hospitals and/or other health facilities that could be used in the event of an emergency during work on site, including their opening hours, level of care available, contact information and means of access from the accident site.

2.4.2 Blood-borne pathogens (BBP).

2.4.2.1 The risks of contracting diseases through exposure to blood-borne pathogens is widely recognized. Awareness training and other safety measures, such as good hygiene, covering cuts and grazes, limiting the number of personnel exposed and wearing PPE, have been incorporated into internationally-recognized occupational safety management practices.

2.4.2.2 Pathogens such as the human immunodeficiency virus (HIV), Hepatitis B and C, and tetanus are of a significant concern for personnel working in any industry where exposure to body fluids is likely. Precautions should be taken to prevent viruses from entering the blood stream through cuts, abrasions or skin conditions, or through the membranes of the eyes, nose and mouth. Although many pathogens will become non-viable relatively quickly as blood and body fluids dry, there are some (Hepatitis B, for example) that remain viable, and a significant risk, for some time. Duration of pathogenic viability varies greatly (from a few minutes to years) depending on pathogen type and the environment. Most common pathogens such as Hepatitis B and C reduce in viability after a few weeks at room temperature, while HIV typically degrades much faster.

2.4.2.3 There are many situations where investigators may come into contact with items contaminated with blood and other body fluids. This could be around the accident site, on the ground, on wreckage, or on debris associated with the accident. Contamination is not always immediately visible. Contamination may cover a wide area after an in-flight break-up, mid-air collision, or other collision at high speed or above the ground. Evidence at the scene, such as aircraft cockpits, instruments, controls and furnishings, may be contaminated. Evidence capable of being readily removed from the scene, including maps, clothing, personal effects, electronic devices, recorders and documentation, may also be contaminated. Investigators should always remain aware of the potential for contamination and of the need to take suitable measures to protect themselves and others who may be involved in the investigation process. In recent years, the risk of flight data analysis personnel being exposed to hazards has increased due to the widespread use of electronic devices by aircrew.

2.4.2.4 As part of routine occupational safety management arrangements and the investigation planning process, precautionary measures should be taken to protect investigation personnel against blood-borne pathogens. It is recommended that all investigation personnel who may come into contact with contaminated items complete biohazard awareness training on a regular basis and be immunized against pathogens such as Hepatitis B and A and tetanus.

2.4.2.5 It is further recommended that accident investigation authorities introduce procedures to ensure the safety of personnel, which should include, among others:

a) a system for providing awareness training and vaccinations, with suitable means of maintaining records;

b) procedures for identifying and marking biohazard areas, and for introducing appropriate safety measures;

c) procedures for the selection, use, maintenance and disposal of personal protective equipment;

d) work practices that will minimize or prevent exposure to blood-borne pathogens;

e) procedures for the decontamination of equipment and evidence;

f) procedures for preventing others from being exposed to contamination when sending items to third party investigation facilities; and

g) procedures for when exposure to blood-borne pathogens has occurred or is suspected.

2.4.2.6 Procedures for arriving at the accident site should include an initial survey for hazards, including BBP in the form of visible blood and other body fluids. Areas contaminated by BBP should be identified and cordoned, with only one entry or exit point permitted. Only those persons meeting the minimum training, vaccination, or PPE requirements should be allowed access. Items or components removed from the accident site for examination should be packaged appropriately (preferably double-bagged) and labelled as a biohazard to ensure the safety of personnel away from the accident site.

2.4.2.7 General guidelines on the selection and use of PPE are contained in Chapter 4.

2.4.2.8 When planning tasks, investigators should assess the risks of being exposed to BBP and should introduce safety measures suitable for the level of risk presented to them. For example, the most common and most grossly contaminated areas include cabin and cockpit interior materials, seat belts and harnesses, cushions, furnishings and instruments. It is also recommended to restrict practices such as eating, smoking, applying skin products or lip balm and adjusting contact lens, within the cordon.

2.4.2.9 Good work practices reduce the potential for exposure to BBP hazards. The practices include the suitable disposal of contaminated clothing or PPE (in accordance with State requirements), washing hands and exposed skin with suitable cleaning substances, and cleaning or disinfecting non-disposable items. Alcohol gels and wipes are effective against most pathogens, but not all. Bleach and other decontaminant solutions should be prepared and refreshed as directed in data sheets. Caution should be taken when using bleach solutions due to their potentially corrosive effect on glass components within equipment such as cameras, phones and electronic devices. A combination of chlorhexidine and alcohol solution can also be considered where bleaches cannot be used, such as on the skin or where corrosion is a concern. To reduce the need for cleaning or disinfecting items, investigators should limit the number of pieces of equipment that they use at the site when undertaking hazardous tasks. It may help to have one colleague operate cameras and other equipment while another is working on badly contaminated items.

2.4.2.10 Where it is suspected that exposure to BBP has occurred (for example, blood has entered a cut), medical advice should be sought as soon as possible. While post exposure treatments continue to be developed and can reduce the effects of blood-borne pathogens, treatment programmes should be started as soon after exposure as possible.

2.4.3 Vector-borne pathogens

Vectors are insects and other organisms that transmit pathogens from one person (or animal) to another. These can cause serious diseases in humans. These diseases are most commonly found in tropical or sub-tropical regions where access to safe drinking water and sanitation systems is problematic. Vector diseases account for about 17 per cent of the global burden of all infectious diseases, with the most common disease being malaria. However, there are many others, such as Dengue fever, which has seen a 30-fold increase in incidence over the last 50 years. Others, such as Lyme disease (ticks), Yellow Fever (Aedes mosquito) and Schistosomiasis (flatworms), generate varying levels of concern at times and are not always restricted to tropical regions. The World Health Organization provides a range of information on vector borne pathogens at https://www.who.int. Investigators should be aware of the hazards that are likely to pose risks to their teams prior to and during deployment.

2.4.4 Pathogens in the environment

Investigators are often required to work in locations that present difficulties due to poor hygiene conditions and where there is frequent contact with animal or human waste. If investigators do not take appropriate measures to maintain good levels of hygiene and protection, there is a significant risk of contracting pathogens or bacteria that can result in varying levels of ill health. Common pathogens can include Hepatitis A, E Coli, Salmonella, Cholera, and typhoid. Care should be taken when eating and drinking in remote or unfamiliar locations. Even minor health conditions occurring during deployments can reduce the effectiveness of individuals and can become serious if medical treatment is not available. Vaccination programmes are recommended for investigators, particularly where travel to foreign States is undertaken. There is a wide range of advice available for maintaining good hygiene controls through national and international health organizations.

2.5 MATERIAL HAZARDS

2.5.1 Overview

2.5.1.1 Materials encountered at the accident site and during further investigation activities can pose health hazards to investigators and response personnel. Many States are required by national legislation to control the hazards posed by exposure to hazardous substances with defined exposure limits (usually based on a typical eight-hour working day). This requires identifying materials that are considered hazardous, assessing the risks resulting from exposure and introducing measures to reduce or eliminate the risks. This is not an easy task, as the list of potentially hazardous materials is long and the risk of exposure is very variable and dependent upon the accident profile.

2.5.1.2 Groups of materials that have been considered as hazardous to date include:

a) metals and oxides;

b) polymer composite materials;

c) chemicals, gases and other substances, and;

d) radioactive materials.

2.5.1.3 Of these groups, polymer composites have attracted much recent interest. This is pertinent, given that manufacturers are finding a widening application and use for these materials in aircraft.

2.5.1.4 The support of the manufacturer and the operator is vital, as each has relevant information about potential dangers arising from the materials used in the manufacture of the aircraft and the cargo transported.

2.5.2 Metals and oxides

2.5.2.1 Many metals and their respective oxides are hazardous to health when taken into the body. However, it should be remembered that all dusts and particles are considered hazardous when encountered in sufficient concentrations. For some metals, it requires only small quantities of material to reach bodily organs to present significant risks to health. Metals may also adversely react with other materials and chemicals present at the accident site to generate a complex risk for safety personnel to control.

2.5.2.2 Traditionally, aircraft structures consisted of aluminium alloyed with small amounts of other metals, including magnesium, zinc and copper. However, advanced materials are now being developed or are in use that use a much wider range of materials, including toxic metals such as beryllium. The properties of many of these materials when damaged or subjected to high temperature are not yet well understood and could present increasing safety challenges.

2.5.2.3 The products of combustion of many materials are hazardous when inhaled, ingested or absorbed through the skin. Exposure to these should be controlled by identification, assessment and control. In practice, however, due to variable accident sites, (see Figure 2-4), it is almost impossible to separately identify and quantify the safe limits of exposure to substances during accident investigation activities, especially considering the variety of cargo that could be carried. Accidents that also involve infrastructure and buildings may introduce additional materials that make the identification and control of hazards more complex.

Figure 2-4. Fire damaged structures

2.5.2.4 In all situations, the priority safety approach is to prevent exposure to hazardous substances. This can often be achieved by restricting access to hazardous areas; neutralizing the substance; isolating or removing hazards; reducing the number of personnel in the hazard areas; changing work tasks; and by wearing PPE.

2.5.3 Polymer composite materials

2.5.3.1 The use of fibre-based (such as carbon, aramid and glass), polymer-bound, composite materials have grown at an exceptional rate since the introduction of these materials in the 1960s. The advantages of these materials (physical, thermal, chemical and mechanical properties) have encouraged their use in the manufacture of vehicles, aircraft, boats, ships, civil infrastructure, sporting goods and consumer products. In aircraft, the use of polymer composites has grown at a very fast rate, with some large commercial aircraft operating with more than 40 per cent of their structure composed of these modern materials.

2.5.3.2 However, polymer composites do have disadvantages; the primary issue being the performance of the materials in fires. Temperatures over 300ºC cause the bonding matrix to start breaking down, releasing heat, smoke, soot and toxic volatiles in particulate and gas form. This leaves the fibre reinforcement in a “soft” condition where free fibres and particulate are readily released by the damaged materials. While it is unlikely that investigators will be exposed to heat, smoke and volatile substances from burning polymer composites, they are often likely to risk exposure to the resulting particulate, fibre, soot and chemical residues. Identifying and assessing the hazards posed by these residues can be challenging as polymer composites are highly variable in their content, construction, and fire resistance.

2.5.3.3 Another concern with polymer composites is whether the free fibres and other residues associated with these materials present a significant health risk either in their raw, pre-manufactured form, or in their post impact and fire condition.

2.5.3.4 There is significant evidence to demonstrate that exposure to particulates (fibres and dusts) will cause irritation to the skin and the eyes, nose, throat and lungs, which, although for a short duration, can be debilitating. Damaged composite panels can have extremely sharp edges and needle-like exposed strands of fibre (see Figure 2-5). There is also a potential for skin conditions, such as dermatitis, to be caused by exposure to the residues of burned polymer composites. In some cases when injury occurs, surgical removal is the only option. Carbon fibres are extremely sharp (a few micrometres in diameter) and can easily penetrate standard PPE. Temporary skin and eye irritation can be caused by exposure to sharp, fragmented fibres.

Figure 2-5. Sharp edges and fibre “needles”

2.5.3.5 Of greater concern, however, is the potential for damaged composites to pose long-term health effects. The health effects of respirable asbestos fibres on lungs are well documented. Research indicates that, when burned, carbon composite materials can decompose into respirable fibres that are physically and chemically similar to asbestos fibres, suggesting that they may present a similar safety concern. Respirable fibres may also adsorb toxic chemicals from the decomposing matrix material, which then enter the lungs and may cause acute or chronic effects. Research into the potential hazards posed by these materials has been conducted at various times following their early use, although much of this has considered raw, pre-manufactured materials rather than damaged manufactured products. However, there have been relatively few published studies analysing the possible exposure of investigation personnel during investigation activities. One such study conducted in the United Kingdom identified the most significant tasks for producing airborne dusts and fibres as being those involving the movement or transfer of large volumes of dry, fire damaged materials. The report concluded that simple safety arrangements (such as applying water orfixant and using PPE) provided adequate protection for investigators and response personnel. This response arrangement appears to be commonly used by accident investigation authorities. The results from further studies would be beneficial to accident investigators and AIAs are encouraged to commission similar studies during tasks involving damaged composites to widen understanding of the hazard and risk associated with these materials. It is highly recommended to limit exposure until the effects are better known.

2.5.3.6 Polymer composites are highly variable materials that are exposed to varying types and degrees of damage. There is agreement that further research in this field is necessary. As a result of the limited research available, AIAs can find different approaches to manage the exposure to and handling of damaged polymer composites. One view, however, is that the chemical hazard posed by the exposure to substances adsorbed onto fibres/particulates may generate more of a health risk than exposure to the fibres themselves.

2.5.3.7 As with other respiratory and skin contact hazards, measures to limit or prevent exposure will reduce the risks to investigators and other response personnel. Dusts and fibres can be prevented from becoming airborne by damping them down with a fine water spray (short-term measure) or by applying a fixant (long-term measure) to bond the surfaces together. Components or structures can be wrapped with materials such as industrial shrink wrap (see Figure 2-6) to contain dusts and fibres and access to high-risk areas could be limited to reduce the potential for disturbing particulate. Ultrafine particles are particulate matter of nanoscale size (including carbon-based and metallic particles, smoke, printer toner) and are believed to have several more aggressive health implications than those classes of larger particulates.

Figure 2-6. "Wrapping" rotor blades to reduce contact hazards

2.5.4 Chemicals, gases and other substances

2.5.4.1 Aircraft contain many materials in their construction and can carry a wide range of further materials as cargo. While these materials may be hazardous in their normal state, they may also become hazardous when subjected to the extremes of fire damage, or when combined with other materials. Given the scale of some accidents and the nature of the damage sustained, it is not surprising to find a wide variety of substances in the remains of fire damaged aircraft (see Figure 2-7). These can be present in many forms, such as fluids, particulates, aerosols, solids, and gases. Hazards may be simple in nature, consisting of a single substance that is corrosive (acidic or alkaline) or toxic, but they may also be complex, where several substances combine to form toxic chemicals. Such hazards may produce immediate symptoms of exposure, but in some cases, may not produce symptoms for many years (for example, asbestos used in firewalls and in older braking systems).

Figure 2-7. Fire damage can generate a wide variety of hazardous substances.

2.5.4.2 Investigators should always be aware of the potential hazards posed by chemicals and substances on or within the items that they handle, or in the environment that they generate as a result of their activities. As with other material hazards, the safe approach is to prevent exposure to hazards, thereby reducing the potential for ill health. Awareness of the potential for hazardous materials to be present is considered a primary safety measure. Early site assessment combined with identifying, neutralizing and removing materials causing concern comprises good occupational safety management practices.

2.5.5 Radioactive materials

2.5.5.1 It is not unusual to find materials containing radioactive nuclides, which generate ionizing radiation, within aircraft structures or systems. These materials will be present as low specific activity materials and in low volumes, although there is still a small potential for a higher activity or larger quantities of such materials to be present. Small amounts cannot be detected by the human senses. Radioactive material generally does not glow, is not at a different temperature to the surroundings and has no inherent taste or smell. Large doses of radiation can cause radiation sickness, while small amounts can increase the likelihood of developing cancer. There are three major types of radiation due to radioactive decay: alpha particles, beta particles, and gamma (high-energy photons such as gamma rays and X-rays). Neutrons can also be emitted by fissionable material when undergoing a fission process. Each type of radioactive material has different penetrating and damaging properties. For example, alpha particles are the least penetrating (can be blocked by paper or skin), however, they are very damaging to human tissue if ingested.

2.5.5.2 Depleted uranium (DU) was used in significant volumes as mass balance weights on wide-bodied civil aircraft, although very few aircraft currently operate using these materials. It is possible to find small volumes of DU as mass balance on some military transport aircraft. DU poses more of a toxicological hazard than a radiological hazard and would need to be inhaled or ingested (for example, as particulate following a fire) to pose a significant risk.

2.5.5.3 Thorium may be found in the engine casings of some military and vintage fixed-wing aircraft and in the gearbox casings of some more recent helicopters. Tritium was used within Beta lights to illuminate emergency exit signs. Americium can be found in some infra-red camera systems and in smoke detectors. Krypton is used in some oil indicating systems, and strontium within ice detection and crack indication systems. These materials are often subject to strict controls to limit exposure at the workplace. AIAs are therefore advised to seek the assistance of radiation protection specialists where the presence of these materials is suspected within aircraft wreckage.

2.5.6 Cargo aircraft

2.5.6.1 There are increased challenges faced where accidents involve cargo. A wide variety and high volume of freight is carried by air on both passenger and cargo aircraft, most of which is identified in some way, although much of this will only be a general description. Dangerous Goods are generally well identified and documented, and manifests may be obtained at an early stage to help determine the hazards present. While general cargo, by definition, is considered non-dangerous for transportation, many of these items or materials may be classed as hazardous for occupational safety exposure. In addition, when subject to impact and fire in accidents, or when mixed with other materials, non-dangerous goods may readily prove more hazardous than expected. The advice of a relevant expert should be obtained when assessing the risks posed by exposure to substances present in cargo aircraft accidents. This should be done during the early stages of an investigation by seeking information about the carriage of any Dangerous Goods. In addition, investigators should consider the potential for undeclared Dangerous Goods.

2.5.6.2 When conducting an early accident site assessment, it is important to obtain both Dangerous Goods manifests and copies of air waybills for analysis, along with a copy of the load plan to help identify what goods may present a hazard and where they may be positioned on the accident site.

2.5.7 Radium

2.5.7.1 Radium was used until around the 1960s in small amounts as paint to enable instrument indications to be seen in dark conditions. It can remain radioactive even when it no longer glows. While the quantity of radium on any site is likely to be very small, instruments using radium can still contaminate other objects nearby (such as storage containers and other items stored with them) to unsafe levels. In addition, it is conceivable that flakes of radium paint can be inhaled and lodged in the lungs where they can irradiate the lung tissue and eventually cause cancer.

2.5.7.2 The aircraft manufacturer should be consulted to provide information on hazardous materials used in the original construction. Monitoring instrumentation (for example, hazardous substance detection kits, gas monitors and Geiger counters) is available to help search, classify and measure material hazards. Professional guidance should be sought if the risk is deemed to be significant.

2.6 PSYCHOLOGICAL HAZARDS

2.6.1 Aircraft accident investigation frequently requires personnel to work near disaster and trauma. This work involves dealing with:

a) accident victims and their families, witnesses, colleagues, and friends of the victims;

b) intense media and public attention;

c) a high-stress and fatiguing work environment;

d) human remains, personal items and other items on site;

e) having a personal association with the victims and their families; and

f) details of the accident sequence, including distressing video and audio, examination of injuries sustained and other survivability aspects.

2.6.2 The intensity, scale and (frequently) long duration of the investigation task can present significant potential for adverse psychological impact on investigation teams. Responders at disasters of other types in the past have reported symptoms recognized as traumatic stress, with sleep disturbance, intrusive thoughts and flashbacks being suffered. There is little published evidence to indicate that aircraft accident investigators have suffered to the same degree, although some AIAs have reported traumatic stress-related symptoms among staff. The differences in outcome may be due to the focused nature of work activities and effective peer support, awareness and management training, minimizing exposure whenever possible.

2.6.3 While the outcomes at present are positive, the challenges appear to be increasing for the investigation profession. Expectations among the public media and others are now much greater than they were and may be shared at high speed using social media. It is likely that pressures will increase for investigators along with other members of the support team, particularly in their involvement with relatives, legal representatives and in potential court sessions.

2.6.4 Understanding the psychological issues of highly stressful work activities continues to be a developing area for medical professions. There are varying opinions as to the degree of adverse psychological impact posed by responsive work activities (emergency services, search and rescue, accident investigation, etc.). Nevertheless, it is undeniable that some risk will be present and it is recommended that some proactive and reactive arrangements be incorporated into occupational safety management systems. It is important to prevent or limit involvement in potentially traumatic tasks whenever feasible. Peer support is particularly valuable, as colleagues are likely to recognize personality changes in fellow team members and are in a position to offer them support or assist with obtaining counselling. There is also a need for managers to understand the issue and receive training in recognizing the signs of stress/traumatic stress before symptoms are experienced. It is also recommended that the services of professional counsellors be made available for those who need to have access to their services.

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Chapter 3

GENERIC OPERATIONAL SAFETY PLANNING GUIDE

3.1 OVERVIEW

To assist in generating commonality across States, AIAs should introduce measures to manage the occupational safety risks for accident investigators. As a minimum, these measures should include:

a) systems within their organizations that will provide appropriate occupational safety management resources for investigators and supporting teams, with suitable means of maintaining records and identification of qualified personnel on site;

b) occupational safety training and vaccination programmes for investigators and supporting staff involved in accident investigation tasks;

c) risk management processes that enable the production of generic and dynamic risk assessments, and the application of generic and dynamic control measures, including accident site operational planning;

d) procedures for identifying and marking hazardous areas (especially biohazard areas), and for introducing appropriate safety measures;

e) a suitable range and quantity of PPE and supporting equipment and procedures for the selection, use, maintenance and disposal of PPE;

f) work practices to minimize or prevent exposure to hazards to investigators and others at or near an accident site or involved in transporting, examining, and disposing of evidence;

g) procedures to be followed when an occupational safety accident or incident has occurred or is suspected; and

h) assistance from specialist advisors, should risk management be beyond the skills and knowledge of investigators.

3.2 TRAINING

The provision of training to accident investigators on a range of occupational safety topics should be part of national requirements. Familiarity with blood-borne pathogens, for example, has become an accepted standard and is being used as an indication of competence for accident site access. Other topics, such as familiarity with general hazards awareness, is also being widely adopted as a minimal requirement. Occupational health and safety training is detailed in Chapter 5.

3.3 PLANS AND PROCEDURES

A system for managing occupational safety should be a legal requirement in States. Some States have produced comprehensive guidance documents that include plans and procedures. Such plans should identify, as a minimum, the duties and responsibilities of key personnel, the actions required at the various stages of response, and consider the variable nature of aircraft accident sites. Introducing a common format for planning or site assessment and control will benefit investigators and other organizations working at accident sites and within investigation facilities. These planning or assessment documents may be modified to suit the accident site, task, and local conditions. An example is illustrated in the Appendix to this chapter.

3.4 PERSONAL PROTECTIVE EQUIPMENT AND SUPPORT EQUIPMENT

Given the variable nature of aircraft accidents, and the locations and conditions in which investigators work, it is difficult to produce a definitive list of PPE for all tasks. While a generic list of PPE is provided in Chapter 4 for guidance, it is advisable to seek advice from PPE specialists to ensure that the most appropriate equipment is made available to meet task requirements. A wide range of support equipment may also be required to ensure that an operating base can be established in any location.

3.5 SPECIALIST ASSISTANCE

The nature and scale of some accidents can present risk management situations that exceed the knowledge or capabilities of the investigation team. It is prudent to recognize the limit of capabilities within teams and arrange access to specialist advice where this may be required (for example, where hazards from chemicals and/or radioactive substances are present).

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Appendix to Chapter 3

OPERATIONAL SAFETY PLAN/SITE ASSESSMENT

The operational safety plan/site assessment form should be used as a guide to:

a) identify the aircraft, location, accident wreckage/site information and hazard assessment information;

b) identify and list operational tasks;

c) record identified and anticipated hazards;

d) list control measures;

e) identify who will take action and implement control measures;

f) list and record the location of positively identified and suspected biohazards, hazardous materials, dangerous goods, other hazards and the control measures and mitigation options;

g) brief operational personnel on the hazards and control measures;

h) plan for emergency procedures and contacts in response to post-accident hazards;

i) identify an off-site administrative unit to provide briefings and handle public inquiries so as to minimize the number of non-operational personnel within the accident site;

j) brief personnel on the safety plan during pre-op briefing;

k) identify a central administrative point of contact for processing needs of investigators and collecting information on requests for assistance;

l) designate a specific time and place for a daily (or more frequently if required) meeting of all accident site personnel;

m) brief other personnel on site and after departure on hazards that may affect them;

n) have a post-op debrief to identify problems, evaluate any injuries and assess coordination with outside agencies;

o) establish a post-op panel to review and modify the operational safety plan when required, and;

p) retain a copy of this form with the investigation file.

TYPICAL OPERATIONAL SAFETY PLAN/SITE ASSESSMENT FORM

AIRCRAFT ACCIDENT HAZARDS ASSESSMENT (Table 1 of 2)

Aircraft type and registration: ____________________________ Location: ______________

Accident wreckage/site information: ____

Assessment date/time: ____

Operational tasks planned: ____

Name of person completing the assessment: ____

CATEGORY	*Hazard*	*Identified and condition*	*Location*	*Control measures*	*Risk acceptable?*
PHYSICAL Fire	— Fuel and fuel tanks — Flammable fluids — Leaking oxygen — Oxygen generators — Leaking/hot batteries — Smouldering material — Use of cutting or power tools — Pyrotechnics — Hot brakes and tyres				
High pressure systems	— Brakes and tyres — Hydraulic systems — Pneumatic systems — Shocks, struts — Fire extinguishers (fixed and portable)				
Explosives	— Hot brakes and tyres — Weapons, ammunition — Ejection seats — Escape systems — Pressurized bottles — Ballistic parachute recovery systems — Cartridge operated devices				
Electrical	— Batteries and electrical supply systems				
MATERIAL Radioactive	— Weapons and ammunition — Structural materials — System components				

CATEGORY	*Hazard*	*Identified and condition*	*Location*	*Control measures*	*Risk acceptable?*
	— Instruments in vintage aircraft — Anti-ice systems — Crack indicating systems				

AIRCRAFT ACCIDENT HAZARDS ASSESSMENT (Table 2 of 2)

Aircraft type and registration: ______________________________ Location: _______________

Accident wreckage/site information: ____

Assessment date/time: ____

Operational tasks planned: ____

Name of person completing the assessment: ____

CATEGORY	*Hazard*	*Identified and condition*	*Location*	*Control measures*	*Risk acceptable?*
BIOLOGICAL	— Blood-borne pathogens — Poisonous plants — Poisonous insects — Animals — Local health hazards				
MATERIAL Substances	— Combustion residue — Rocket/missile propellant — Hydrazine — Hazardous cargo — Battery electrolyte and gases — Smoke, vapour, gases				
Composite materials	— Dusts and fibres — Sharp edges — Shards, ”needles”				
PHYSICAL Aircraft recovery	— Lifting and transport tasks — Unstable structures and loads — Disassembly and cutting — Manual handling — Damaged, unstable ground installations and structures				
WORKING ENVIRONMENT	— Heat stress — Cold exposure — Terrain — Weather — Water hazards				
PSYCHOLOGICAL	— Traumatic stress — Security				

CATEGORY	*Hazard*	*Identified and condition*	*Location*	*Control measures*	*Risk acceptable?*
	— Sleep disturbance — Level, frequency, and duration of exposure				

OTHER SAFETY INFORMATION

ACCIDENT SITE EVACUATION ALARM METHOD: ______________________________________

ACCIDENT SITE EMERGENCY PROCEDURES: ____

EMERGENCY CONTACTS: ____

PRE-OP BRIEF: (Review with all participants) ____

____

POST-OP BRIEF: (Incidents, Problems, Observations) ____

____

____

____

PREPARED BY: ____ DATE: ______________________

LIST NAMES OF PARTICIPANTS BELOW:

RETAIN ON OPERATIONAL FILE

____

Chapter 4

PERSONAL PROTECTIVE EQUIPMENT

4.1 OVERVIEW

4.1.1 Aircraft accident investigation activities are often complex and subject to many factors such as accident site, weather, location and conflicting operational requirements. It is therefore of utmost importance that accident investigators select the most suitable kit of personal protective equipment (PPE) to keep them safe during their activities.

4.1.2 Wearing of PPE may pose its own range of safety hazards and may also limit investigation activities. It is strongly recommended that donning PPE is introduced as a measure only after all other safety protective measures have been considered or employed.

4.1.3 Investigators are often limited in what they can carry on their travels (especially when traversing long distances or over difficult terrain on foot) and may not be able to obtain replacement items once deployed. In addition, the factors affecting the investigation activities can often have an influence on the use of PPE and some PPE requires specific training to ensure that it is worn to recognized standards. There are benefits in having a common approach to the selection and use of PPE throughout the investigation activities. Thus, it is important that investigators and site-essential experts are properly trained in using the required PPE and that they are closely monitored to ensure their safety during the use and disposal of the PPE.

4.2 STANDARD PERSONAL PROTECTIVE EQUIPMENT

The following list of items has been compiled to assist AIAs in the selection of commonly used items of a PPE kit. Investigators should review their possible tasks and stocks of PPE to ensure that there is enough equipment available for their deployment. The list could include:

— *A half- or full-face respirator with cartridges*. Choose HEPA/P3 cartridges that provide protection against particulates (dusts/fibres), with an additional set that provides protection against organic vapour/gases, often referred to as ABEK cartridges. Chemical cartridges are significantly heavier than particulate cartridges. It is therefore important to know whether chemical hazards could be present, or whether particulate filters could be used. These respirators should be fit tested when used (this may be a legal requirement depending on the relevant State laws);

— *Disposable HEPA/P3 face masks*. It is recommended that these be used for short duration tasks. If longer tasks are required, it is likely that a half mask will be more comfortable and efficient to wear;

— *Disposable dust/fibre proof overalls*. Overalls can protect the user against composite fibres. Overalls that are specified for work with asbestos provide a good level of quality;

— *Disposable pathogen protective gloves that are manufactured using nitrile materials*. These will protect against blood and fluid contact hazards and will provide a barrier against contact with dusts, fibres, and other substances in aircraft debris. These should also provide short-term protection against contact with fuels and oils during aircraft accident investigation. These should also offer good dexterity to the wearer;

— *Heavy duty gloves*. It is common to find Kevlar knitted gloves with the palm and fingers/knuckles coated with nitrile or similar protective materials;

— *Protective footwear*. Good quality safety boots with steel or composite midsoles and impact resistant toecaps that can be worn when climbing or walking. These should be comfortable enough to be worn for long periods, suitable for walking over significant distances on rough terrain, have a high ankle and be waterproof;

— *Hard hat and a bump cap* (for example, a strengthened baseball cap). These also offer protection against the sun, particularly those that cover the back of the neck;

— *Eye protection*. Ski-type goggles are often required where there has been a severe fire. However, they often mist up when the user starts to get warm. Only use if required. Protective spectacles are recommended to protect against contact with sharp objects, such as branches;

— *Hearing protection*. The choice of earmuffs or ear plugs is subjective. While earmuffs are bulky, ear plugs present a hygiene risk when working in dirty, warm conditions;

— *High visibility vest.* It is recommended to choose a type that is acceptable for working at airports.

4.3 ADDITIONAL PERSONAL PROTECTIVE EQUIPMENT FOR INVESTIGATION WORK IN MARINE ENVIRONMENTS

This PPE is likely to be specified by the operators of the marine vessel:

a) life vest – auto or manual inflation where recommended;

b) appropriate (and preferably easily removed) footwear for deck operations;

c) suitable gloves; and

d) motion sickness medication.

4.4 OTHER RECOMMENDED ITEMS TO BE CONSIDERED

a) hand cleansing wipes;

b) antiseptic or disinfectant gel wipes suitable for the skin and for equipment;

c) sunscreens and broad hats;

d) lip balm;

e) disinfectant solutions or tablets and suitable containers, brushes etc;

f) duct tape;

g) biodisposal sacks;

h) first aid kit, suitable for the area of travel;

i) communication equipment suitable for the location;

j) emergency communication equipment such as beacons or strobes;

k) navigation equipment and maps for remote areas;

l) insect repellent/medication as recommended for the area;

m) container for drinking water;

n) foul weather clothing; and

o) tarpaulins or shelters and cooling containers, depending on the team's capability to transport the equipment (these can sometimes be bought locally or borrowed from local emergency services or volunteer organizations).

Chapter 5

HEALTH AND SAFETY TRAINING

5.1 GENERAL

5.1.1 Many States will have health and safety training, as well as competency standards that are determined by their own legislation. Regardless, every authority responsible for investigating aviation accidents and incidents should provide its investigators with periodic health and safety training. The aim of this chapter is to identify common training objectives and standards for aircraft accident investigators and support personnel that are recognized and accepted by States. This will ensure that the health and safety of investigation teams is appropriately supported, and that entry to the accident site and facilities is not restricted for occupational safety reasons.

5.1.2 The following is recommended as a basis for the minimum syllabus for training courses. States should review the syllabus to determine whether they wish to add further content to meet the needs of their operations. Additional guidance material is provided in the *Manual on Aircraft Accident and Incident Investigation Training* (Doc 10206).

5.2 TRAINING AIMS

Recommended training aims include:

a) detailing the potential variable nature and scale of occupational health hazards experienced at aircraft accident sites;

b) outlining any applicable State occupational health and safety legislation, as well as its applicability to accident investigation activities undertaken by the State's aircraft accident investigators;

c) providing an understanding of the occupational health risk management, risk assessment, and risk control processes associated with aircraft accident investigation operations;

d) providing an understanding of the hazards and available means of prevention of exposure to blood-borne pathogens;

e) providing an awareness of the selection and use of personal protective equipment to meet the risks posed in aircraft accident investigation tasks;

f) providing an awareness of the effects and symptoms of psychological hazards associated with aircraft accident response activities; and

g) demonstrating an application of the knowledge, techniques and skills necessary to maintain safety on an accident site.

5.3 TRAINING CONTENTS

Health and safety training should include, at the minimum:

a) health risk management;

b) categories of hazards at aircraft accident sites, including the categories listed in Chapter 3, 3.1.2;

c) accident site occupational safety management;

d) preservation of evidence, and;

e) selection and use of personal protective equipment (PPE).

5.4 TRAINER COMPETENCIES

In addition to any training competencies set by States, it is recommended that training courses include trainers who are knowledgeable and experienced in their subject as it applies to accident site operations. In the case of accident investigation, many of the lessons learned from industry, especially regarding medical waste treatment and dangerous goods transportation, are applicable to accident investigation and recovery procedures.

5.5 TRAINING VALIDITY

Validity periods for some aspects of training may be set by State legislation. In addition, research and guidance on hazards is frequently updated. Therefore, hazard awareness training should be refreshed every 24 to 36 months, with specific training elements (for example, blood-borne pathogens) being refreshed at frequencies set nationally.

5.6 DOCUMENTATION

Trained personnel should carry evidence of their completion of training courses, including validity periods, and, if desired, details of vaccination status. This may be presented at the accident site to confirm training competency. On-site credentials or access badges could also be provided to identify authorized members and to ensure accountability of those conducting the investigation.

— END —

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