Hazards at aviation accident sites

Presented by
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ATSB

- **Disclaimer**
- This training material provides an overview of its subject matter only and is intended to be general guidance. It is not a substitute for independent professional advice specific to the needs of your organisation and should not be relied on to reflect the law applicable to your circumstances. Every effort has been made to ensure the information contained is accurate, but no legal responsibility is accepted for any errors or omissions.
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Content warning:

- General low-impact content (videos, images, and discussion) about fatal accident sites is throughout this presentation
- Wreckage is shown – may be confronting
- No human or animal remains are shown
- Discussion about protection from pathogens that can be present as part of human remains on accident sites
- Feel free to step away or take a break

What we cover

1. Introduction
2. Site safety management process
3. Working in and around wreckage
4. Hazard management
5. Site hazards
    - Personal, environmental, biological, and physical

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Why Site Safety?

- Safety of yourself and others
- Legislation requires a safe workplace
- We all deserve to come home from work uninjured

Things...

- no longer look the same
- no longer function the same
- previously safe things are no longer safe
- things become “infected”
- But there is still a job to do

Accident site workplaces

Source: ATSB

Accident site workplaces

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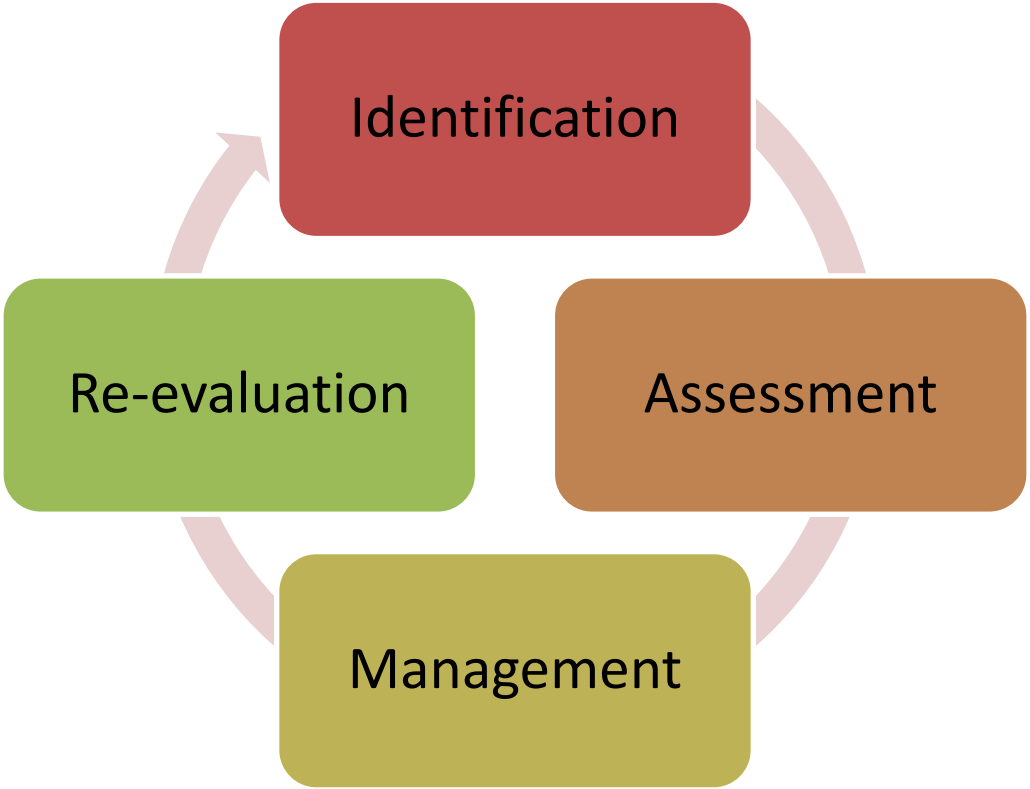
Discussion

What factors would you consider when deciding whether to attend this accident site?

Elements of an accident deployment

- Readiness
- Pre-deployment
- Travel
- Communications
- Team access
- Other access
- Working the site
- Ongoing site management
- Evidence recovery and transport
- Clean-up and handover
- Departure
- Off-site examination
- Post-deployment

Hazard management process



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Working in and around wreckage

Source: ATSB

Tripping Hazards

- Slips, trips and falls are one of the most likely accidents to occur onsite, and can also be among the most harmful, especially with sharp wreckage and bio-hazards present

Working in and around wreckage

Working in and around wreckage

Working in and around wreckage

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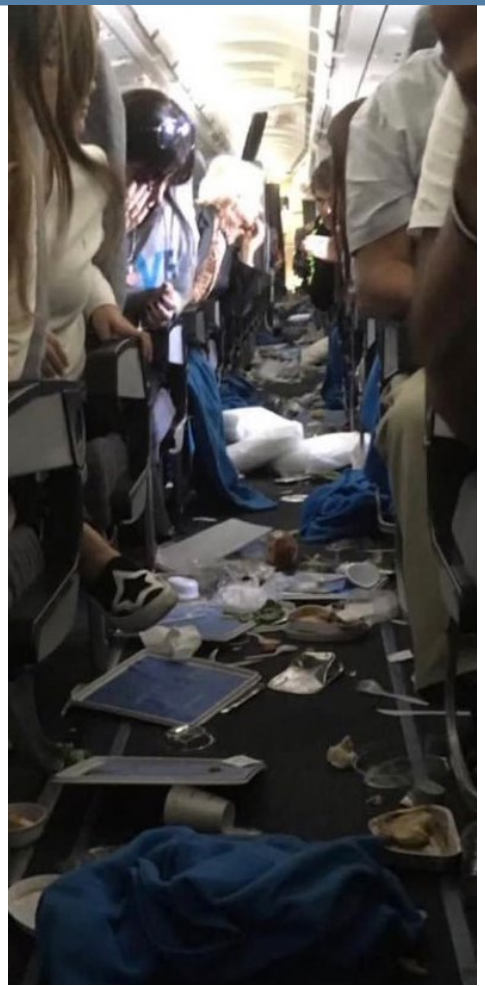
Working in and around wreckage



Working in and around wreckage

Working in and around wreckage

Working in and around wreckage

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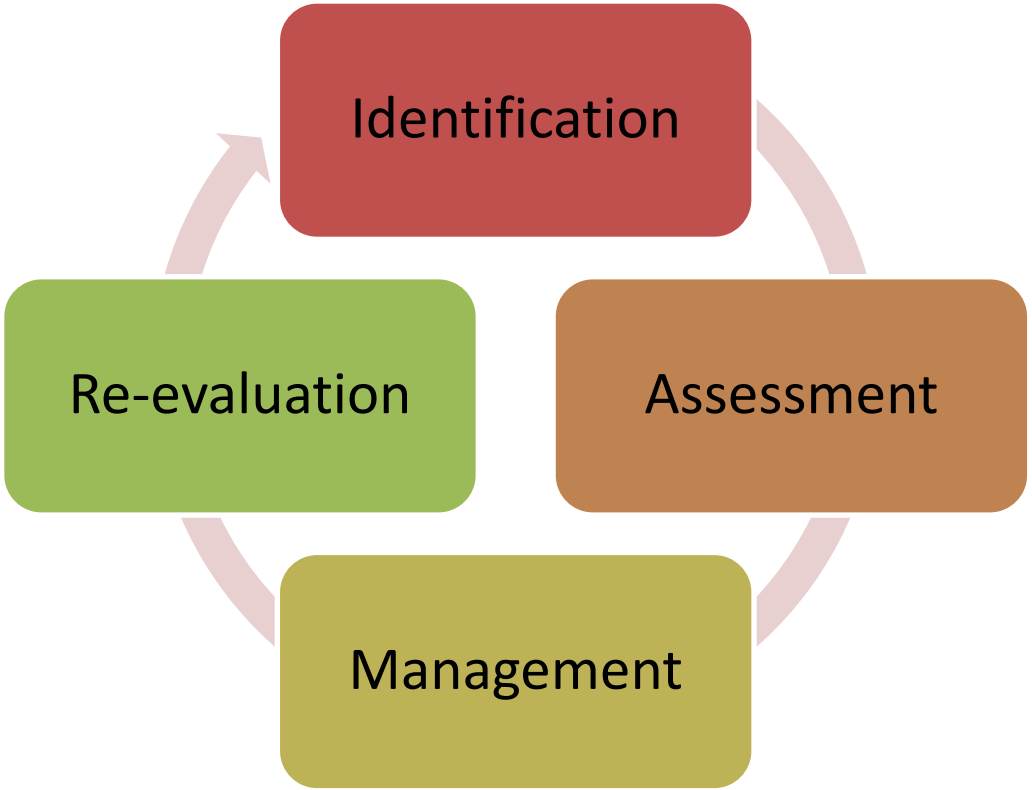
Hazard management process



Overall approach

- Be thorough
- Err on the safe side
- Work as a team
  - Collaborate on identification, assessment, management, and re-evaluation
  - Brief before, during and after
  - Check in on each other frequently

Pre-deployment brief

- Get information about site access, logistics, hazards, security
- What are the risks you are going to face?
- What don't you know, and how can you find out?

Pre-deployment brief

- How will you get there?
- How will you find it?
- How will you get food and water?
- What clothing is appropriate?
- Who else will be wanting/needing access?

Pre-deployment brief

- **TEAM**
- What people will you need? How many?
- Training and recency
- **INDIVIDUAL**
- Physical condition
  - office vs field
  - physical conditioning
  - recent/ongoing injuries
- Vaccinations
- Medications and medical devices
- Mental condition
- Other medical issues
- Home situation

Pre-deployment brief

- How much equipment?
- How will you get the equipment to site?
- How far is it?

Pre-deployment brief

- How far are you from help?
- How long will it take to get to hospital?
- Remote area first aid?
- Food/water?
- Shelter?
- Contingencies?

Pre-deployment: communications

- What are your options for communications?
- What are your backups?
  - Mobile phones
  - Satellite phones
  - CB radio
  - Airband transceivers
  - SARTIME?

Pre-deployment: securing the site

- Why secure a site?
- What level of security is needed?
- Is it already a secure area?
- How accessible is the site?
- How big is the perimeter?
- Where and how will you mark the perimeter?
- Unguarded, security guards, military…?

Security hazards

- Interference with investigations
- Stealing / scavenging / souvenir hunters
- Political situation
- Illicit activities eg. drug growing in area

Arrival on site

- First time on an accident site can be a daunting experience
- Regardless of previous site experience, take it slow and work as a team
- Avoid rushing to enter site
- Pay attention to your senses
- Be careful and meticulous
- Do site assessment first
- Secure the boundaries/exclusion zone
- Start out wide and work your way inwards
- Can you do something else until the site is safer? (eg. interview witnesses while waiting for chemical fumes to fade)

Risk Assessment Matrix

S – Severe risk – detailed action plan required
H - High risk – needs senior management attention
M – Medium risk – specify management responsibility
L – Low risk – manage by routine procedures
VL- Very low risk – further risk reduction generally not required

ANY Severe or **High** risks must be reported to ATSB Management and require detailed treatment plans

		Consequence →				
	People (general health, mental)	Injuries or ailments not requiring medical treatment.	Minor injury or First Aid Treatment Case.	Serious injury causing hospitalisation or multiple medical treatment cases.	Life threatening injury or multiple serious injuries causing hospitalisation.	Death or multiple life threatening injuries.
	Site Hazards (pressure vessels, flammables, chemicals, fibres, radioactive, sharps, structures, dangerous goods)	Fully contained and isolated but still may cause some injury	Contained but may cause minor injury or First Aid Treatment if not controlled	Semi-contained causing serious injury, hospitalisation or multiple medical treatment cases	Uncontained exposure causing life threatening injury or multiple serious injuries causing hospitalisation	Totally uncontained exposure causing death or multiple life threatening injuries to multiple parties
	Biological (human tissue or blood, specimens, viruses or bacteria)	No reasonably expected biological presence with little or no infection risk	Potential of exposure to biological material requiring First Aid Treatment	Identified exposure incident leading to serious injury causing hospitalisation or multiple medical treatment cases	Identified exposure incident leading to life threatening injury or multiple serious injuries causing hospitalisation	Identified exposure incident leading to death or multiple life threatening injuries.
	Environment (animals, plants, temperature, site condition, weather, location)	Exposure causing injuries or ailments not requiring medical treatment	Exposure causing minor injury or First Aid Treatment Case	Exposure causing serious injury causing hospitalisation or multiple medical treatment cases	Exposure causing life threatening injury or multiple serious injuries causing hospitalisation	Exposure causing death or multiple life threatening injuries.
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
	Historical:	**1**	**2**	**3**	**4**	**5**
Likelihood ↑	Is expected to occur in most circumstances	**5**	**Almost Certain**	**L**	**M**	**H**	**S**	**S**
	Will probably occur	**4**	**Likely**	**L**	**L**	**M**	**H**	**S**
	Might occur at some time	**3**	**Possible**	**L**	**L**	**M**	**M**	**H**
	Could occur but doubtful	**2**	**Unlikely**	**VL**	**L**	**L**	**M**	**H**
↓	May occur in exceptional circumstances	**1**	**Rare**	**VL**	**VL**	**L**	**L**	**H**

WHS On-Site Risk Assessment

[Investigation number-]

Ref	Hazard [List the activity, procedure, process or situation that could give rise to an incident]	Impact of a hazardous event happening			Proposed risk control measures	Have the risk control measures been implemented? [If "No", document why not]	Residual risk after implementation of the risk control measures			Is the residual risk as low as reasonably practicable (ALARP)?
		C	L	R			C	L	R	

C = consequence
L = likelihood
R = risk rating

Name	Signature	Date

On-site evaluation – not always as it seems (or told)

On-site evaluation – not always as it seems (or told)

Site management - zoning

Site management - smaller accidents

- Should you (as an investigator) take control of the site from police?
- When?
- Working with and around others (DVI, forensics, insurance adjuster…)
- Would the Investigator-in-charge be responsible for site safety?
- Site entry and exit control

Site management

- Witnesses
- Property owners
- Onlookers
- Media
- Family & friends of occupants

Site management

Site management – larger sites

- Accredited Representatives
- Emergency services
- Police
- Military
- Emergency volunteers
- Insurance assessor
- Airline/operator(s)
- Manufacturer(s)
- Contractors
- Government officials

Source: ATSB

Site management – larger sites

- Who ‘owns’ the site?
- How are you going to manage safety for everyone in or near the site?
- Who has been trained & vaccinated?
- Who has access and where?
- How do you control access?
- Food, water, toilets, power, emergencies?
- How will you deal with occupants/witnesses?

Source: USAF

Typical deployment

- Physical stress
- Intellectual stress
- Emotional stress

Inadequate liquids

Missed or unhealthy meals

Long hours

Poor work planning

Illness

Time pressures

Poor work practices

Long travel times

Human remains

Media attention

Public attention

Other agencies

Survivors

Poor sleep

Next of kin

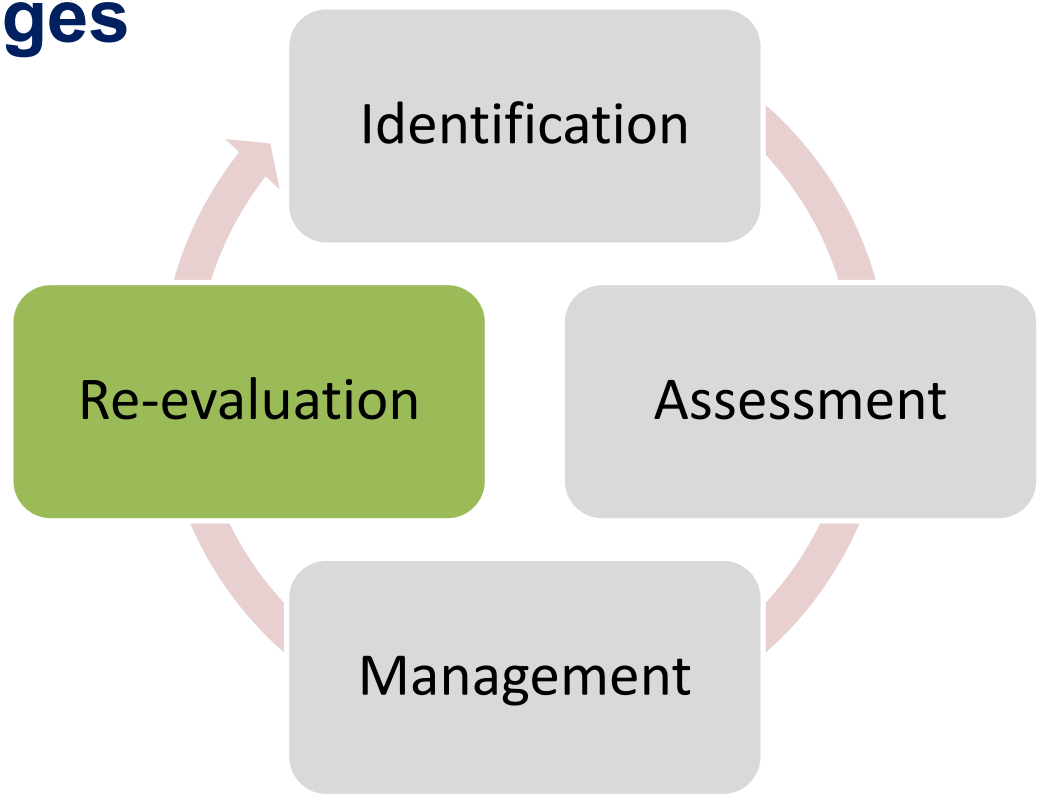
- Fatigue
- Bad decisions / complacency
- Decreased awareness, judgement and ability
- Increased safety risk

During deployment

- TEAM SUPPORT!
- Avoid rushing to leave site
- Watch work hours and fatigue
- Rest periods / rest days
- Limit exposure
- Say no if you have to
- Don’t push yourself

Source: ATSB

Re-evaluate at least twice a day or when something changes



ATSB site work policy

- Minimum of two people on site at a time
- IIC should not drive due distraction / preoccupation with investigation and other associated tasks
- Daily check-in with manager

Source: ATSB

Clean-up

- Specific entry/exit point with clean-up area
- Prepare clean-up area
  - Bio bag (tied open and upright)
  - Hand sanitising gel
  - Flat bucket or bag with 10% bleach and toilet brush
  - Alcohol wipes for equipment

Source: ATSB

Disposal and clean-up

- PPE disposal
- Equipment clean-up

Source: NSW Police

Evidence handling

- Removal
- Preparation
  - Cleaning
  - Packaging
  - Labelling
- Transport
- Storage
- Examination

Evidence retrieval and wreckage recovery

- Who is responsible?
- Use of specialised equipment

Evidence retrieval and wreckage recovery

- Water recovery

Evidence retrieval and wreckage recovery

- Helicopter transport

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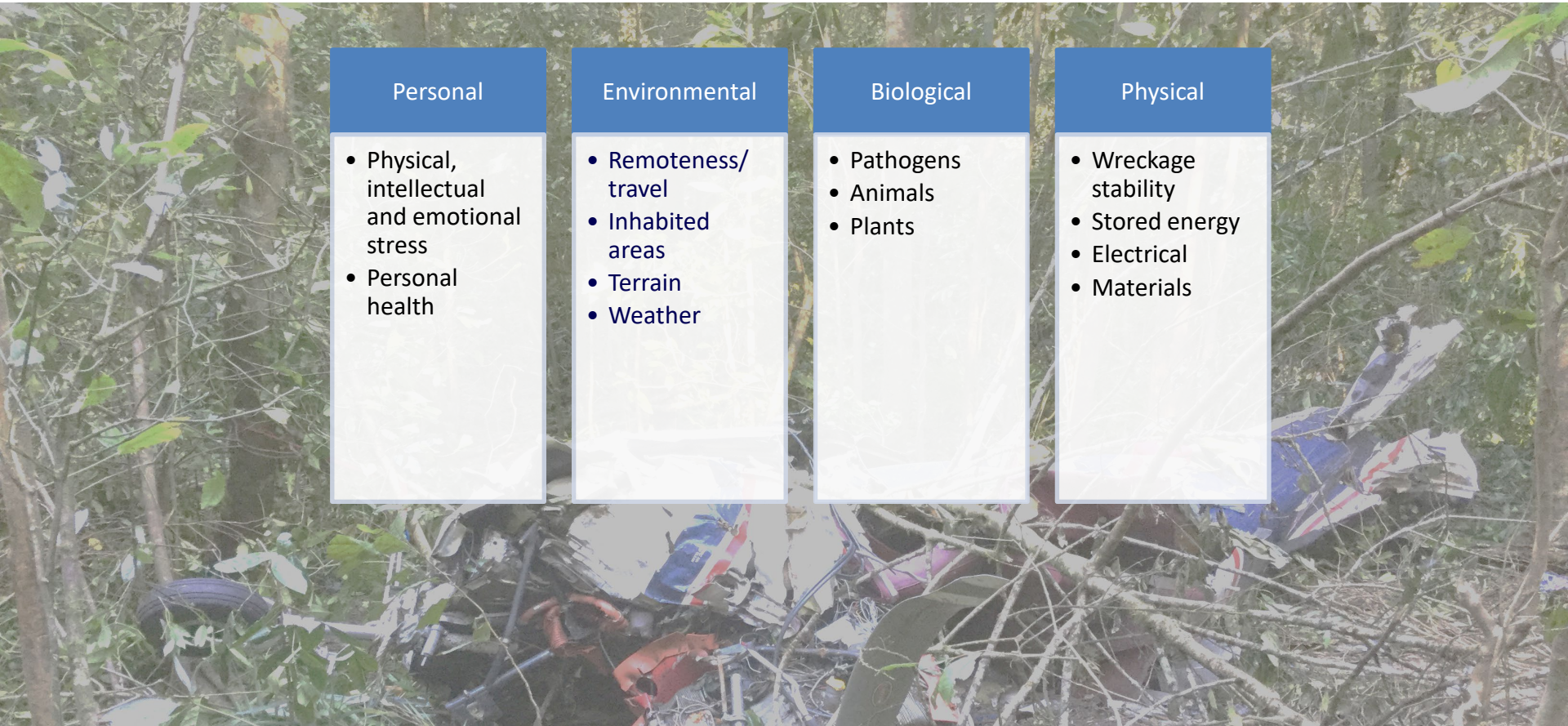
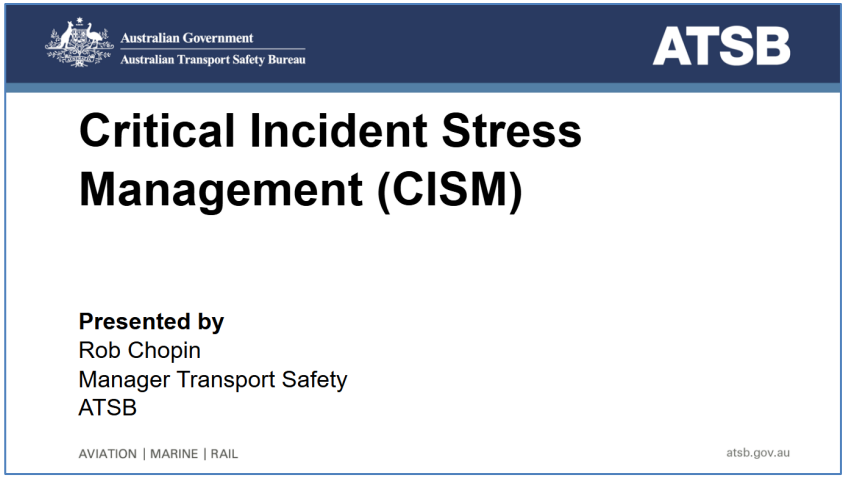
Hazards at accident sites



Personal	Environmental	Biological	Physical
• Physical, intellectual and emotional stress • Personal health	• Remoteness/ travel • Inhabited areas • Terrain • Weather	• Pathogens • Animals • Plants	• Wreckage stability • Stored energy • Electrical • Materials

Personal

- Critical incident stress (presented at APAC-AIG/12)

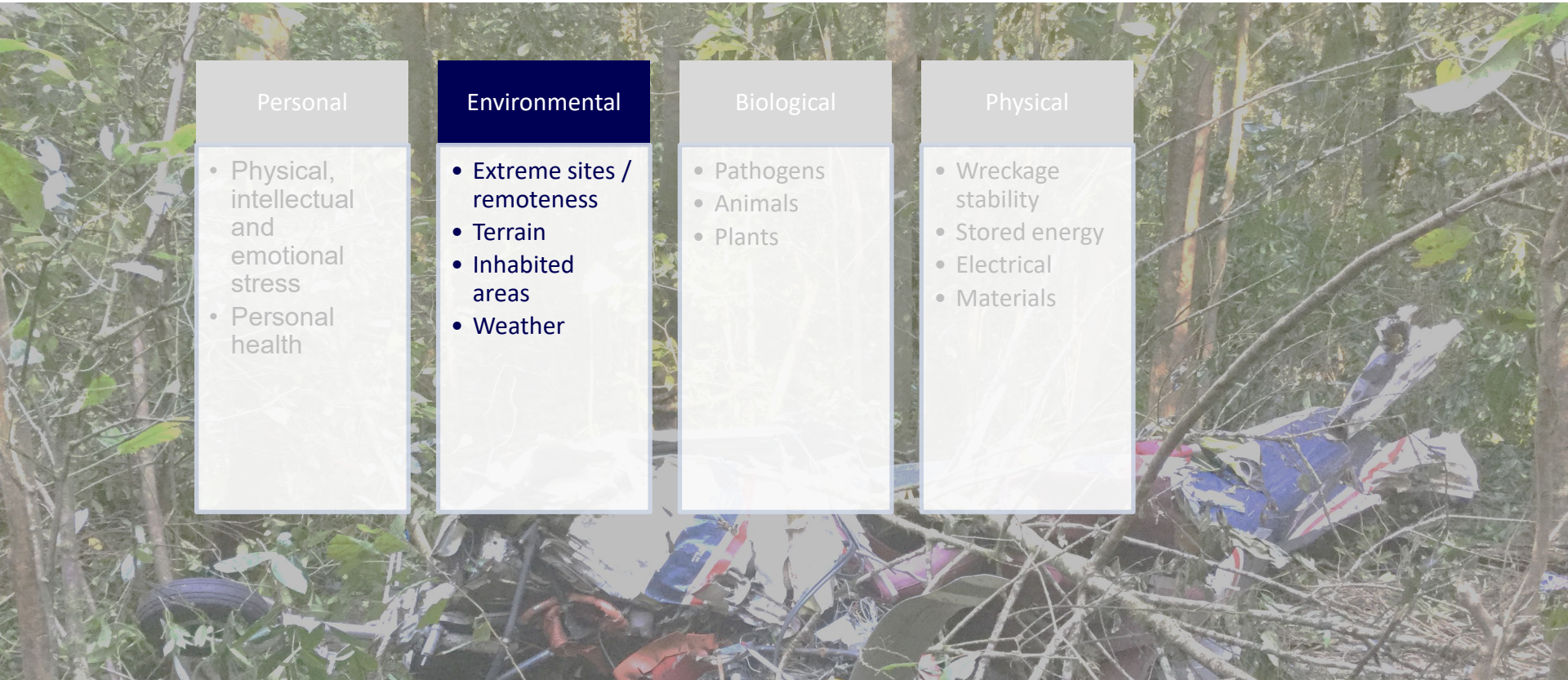


Personal health care

- Stay healthy
- Normal meal times
- Eat healthy foods
- Bring plenty of water and healthy snacks
- Electrolytes
- Avoid alcohol, sugar and fats

Source: iStock

Hazards at accident sites



Personal	Environmental	Biological	Physical
• Physical, intellectual and emotional stress • Personal health	• Extreme sites / remoteness • Terrain • Inhabited areas • Weather	• Pathogens • Animals • Plants	• Wreckage stability • Stored energy • Electrical • Materials

Helicopter operations

- travel to and from site
- winching
- wreckage removal
- aerial photography
- boarding safety
- Helicopter Underwater Escape Training (HUET)

Remote sites

- How far are you from help?
- How long will it take to get to hospital?
- Remote area first aid?
- Food/water?
- Shelter?
- Contingencies?

Terrain

- Steep
- Slippery
- Uneven
- Rocky
- Muddy
- Soft (loose sand, wet silt)
- Dense bush
- Wet
- Unstable footing (rocks, vegetation, rail ballast)
- Mixed

Terrain

Terrain

Weather

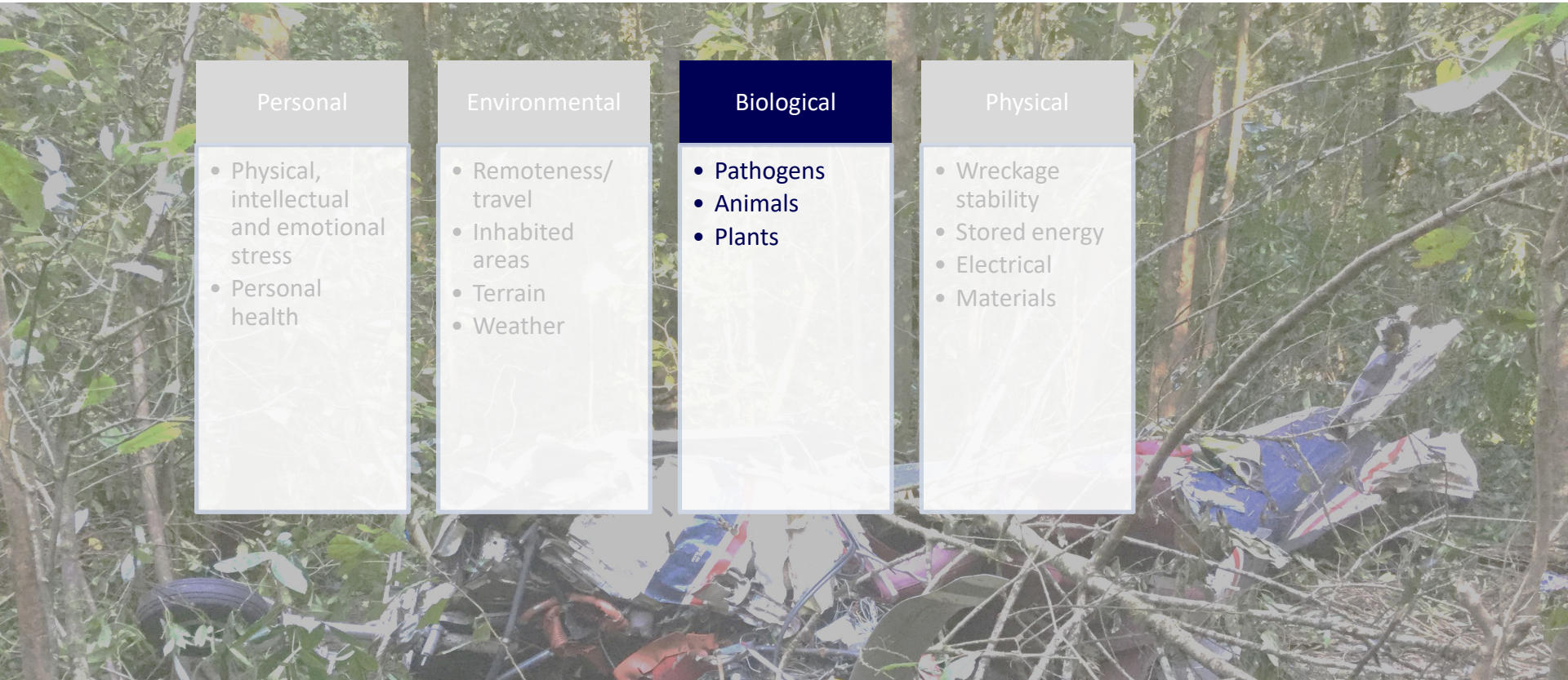
- Temperature
- Humidity
- Wind
- Dust
- Rain / hail / snow
- Fog
- Daylight hours
- UV
- Tides
- Altitude sickness
- Sudden changes

Extreme heat

Extreme heat

Extreme cold

Hazards at accident sites



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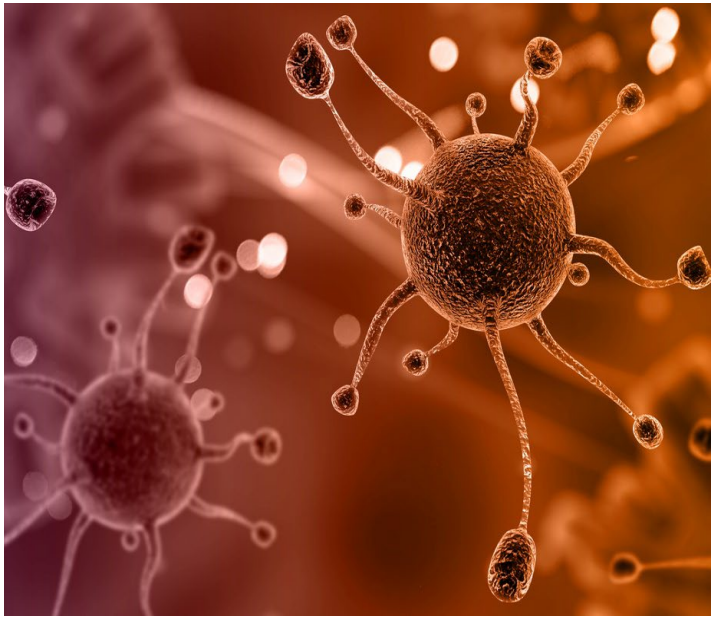
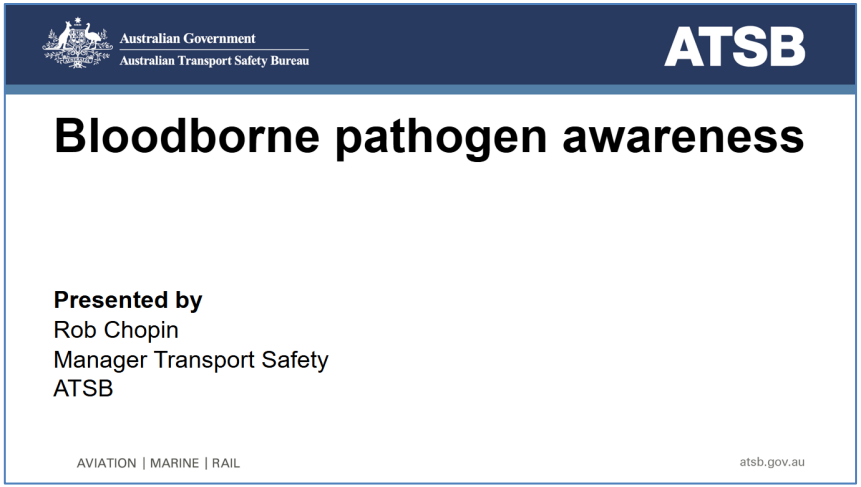
Biological Hazards

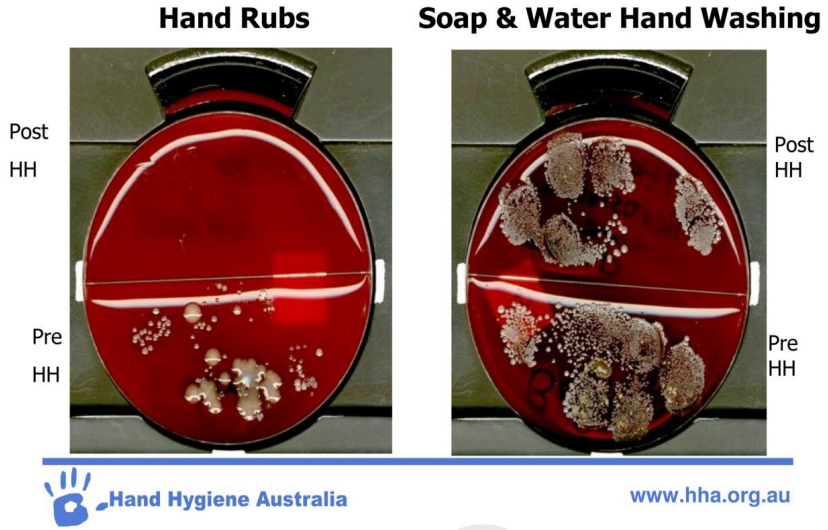
- Bloodborne pathogens (presented at APAC-AIG/12)





Sanitising

- Alcohol hand scrubs are 60-80% effective against most microbes and viruses (including hepatitis and HIV)
- Less effective against cryptosporidium, norovirus, rotavirus, clostridium difficile, poliovirus, and some others
- Physical removal (thorough washing) first helps deal with these
- Alcoholic chlorhexidine (70% ethyl or isopropyl alcohol and 0.5-2% chlorhexidine) is somewhat more effective (but some are allergic)
- Pre-washing with soap and water if possible
- Use correct technique: wash thoroughly and air dry



ATSB policy

- Avoid entering site until remains have been processed and removed (usually by Police)
- Avoid photos/videos showing human remains unless important to the investigation
- Stop work if remains are found during your work
- Do not get involved in recovery of remains

Effects of fire

Effects of fire

Animals (Australian context)

Spiders, snakes, leeches, ticks, mosquitoes, midges/sandflies, horseflies, houseflies, wasps, ants, scorpions, centipedes, goannas, crocodiles, wild pigs, dogs, livestock

Plants

- Wait-a-while
- Stinging nettle
- Lantana, blackberry, etc

Hazards at accident sites

Personal	Environmental	Biological	Physical
• Physical, intellectual and emotional stress • Personal health	• Remoteness/ travel • Inhabited areas • Terrain • Weather	• Pathogens • Animals • Plants	• Wreckage stability • Stored energy • Electrical • Materials

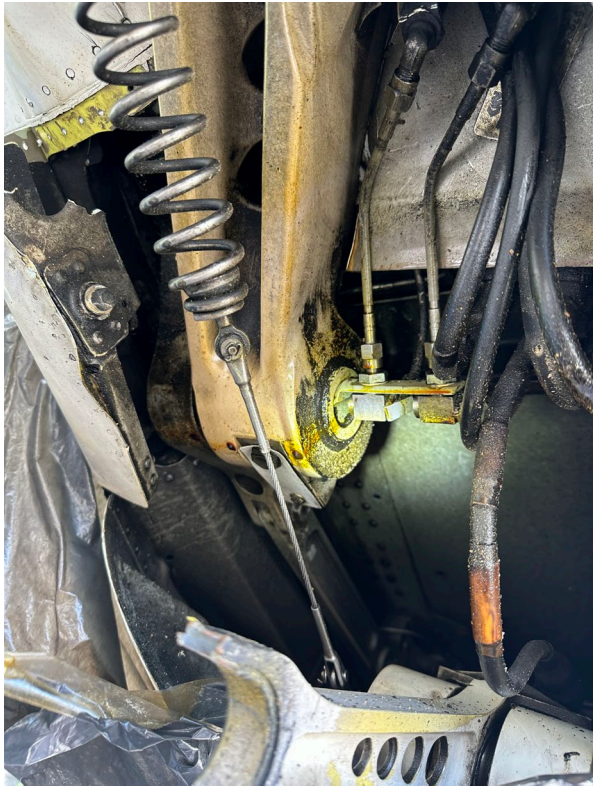
Damaged and unstable structures

Damaged and unstable structures

- Modern materials, including composite structures, may appear undamaged but can be dramatically weakened by impact or fire
- Structural strength may also be reduced by corrosion, especially materials containing magnesium

Damaged and unstable structures

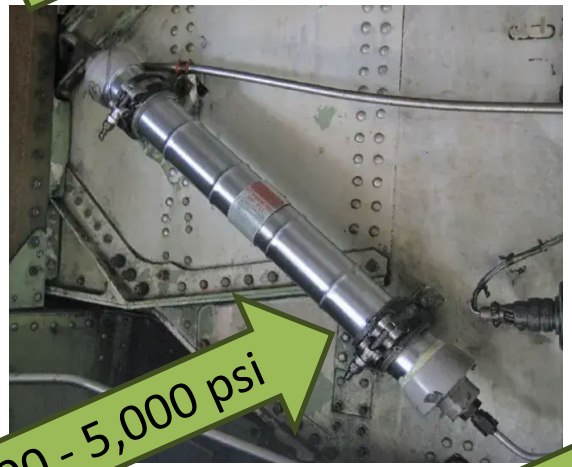
Damaged and unstable structures



Pressure vessels

- Gas bottles
  - Oxygen (next slide)
  - LPG/acetylene/etc
  - Fire bottles & extinguishers
  - Other gases
- Accumulators / reservoirs
- Flotation devices

- **Risks**
- Explosive release
- Toxicity
- Fire/explosion



Oxygen bottles

- Flight crew oxygen
- Cabin crew (portable) oxygen
- Passenger oxygen
- Medical oxygen (with aircraft)
- Therapeutic oxygen (with passenger/s)

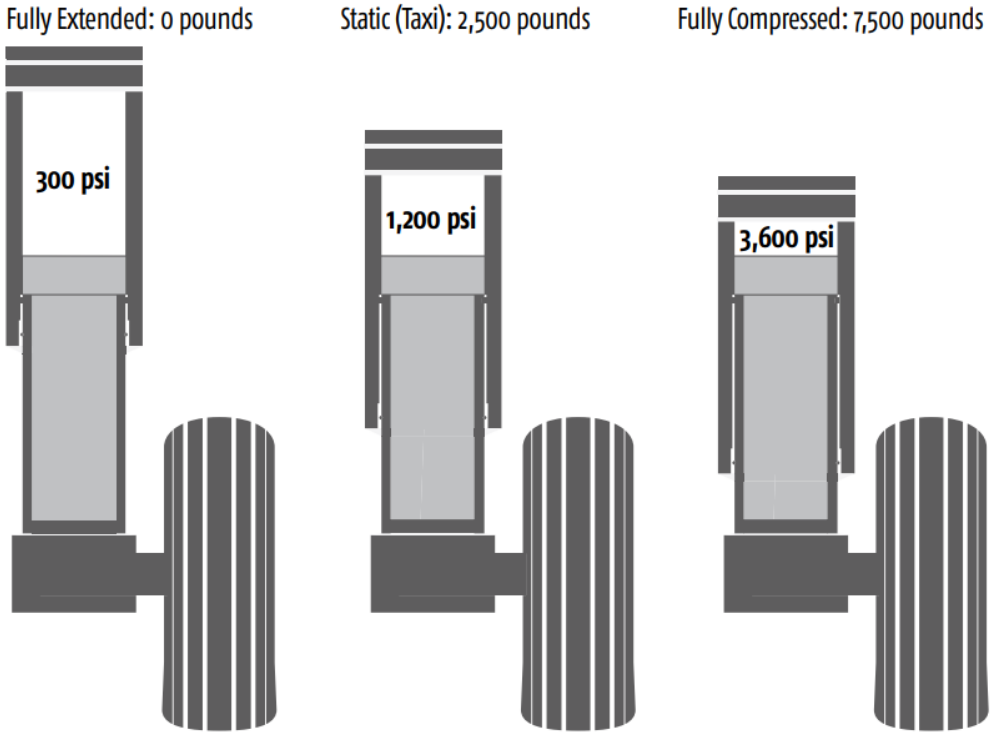

QANT
Spirit of Aus


S 33
S 32
S 32
S 34
S 36
BS 840
BS 820
BS 800
BS 780


LOCKED


LOCKED

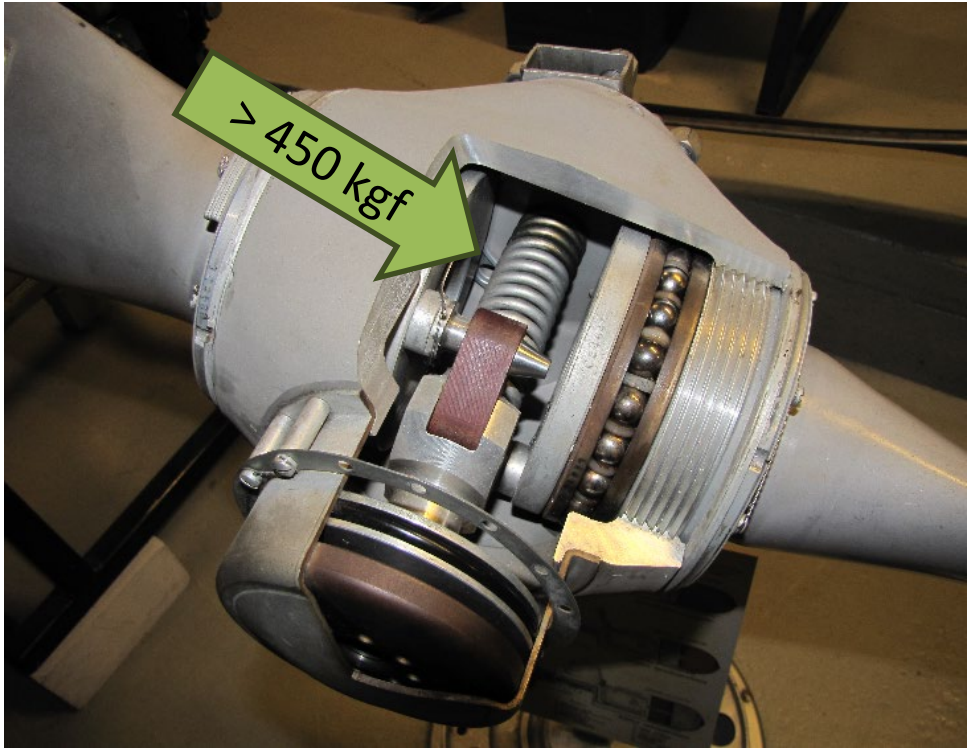
Oleos


Fully Extended: 0 pounds
300 psi
Static (Taxi): 2,500 pounds
1,200 psi
Fully Compressed: 7,500 pounds
3,600 psi

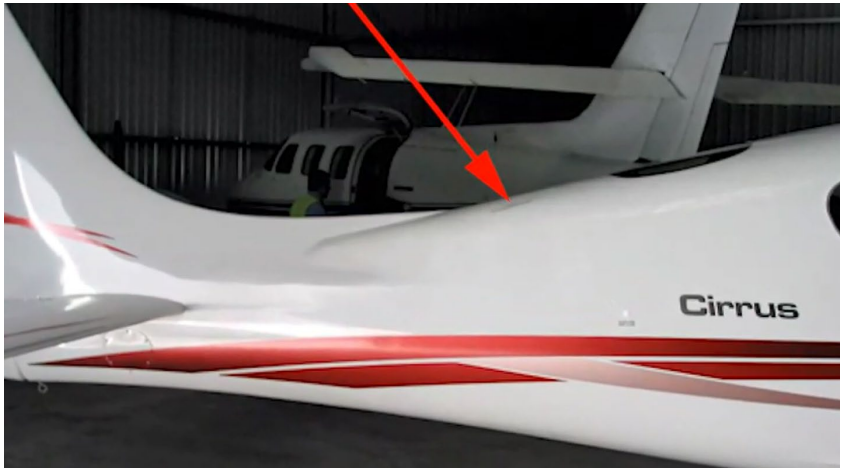

1,200 psi

Propeller hubs

- Hartzell Manual 118F states the compressed s pressure, in relaxed position, is around 1,000 lbf (454 kgf) when assembled. This will increase when the propeller moves out of feather and kit compresses



Pyrotechnics



- Escape slides
- Emergency floats
- Airbag restraint systems
- Deployable ELT (pyro or sprung)
- Rescue winch squibs
- Fire extinguisher bottles
- Rocket-deployed emergency parachute systems (BRS)

Recovery parachute rockets

Recovery parachute rockets

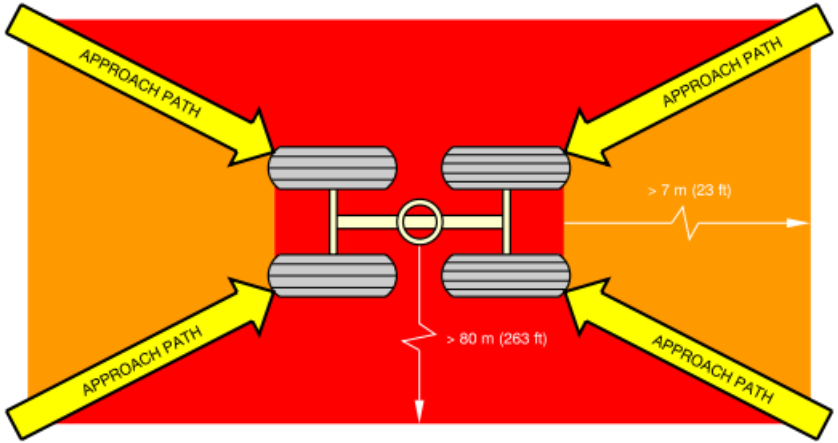

VH
IRRUS


SR22

Military aircraft

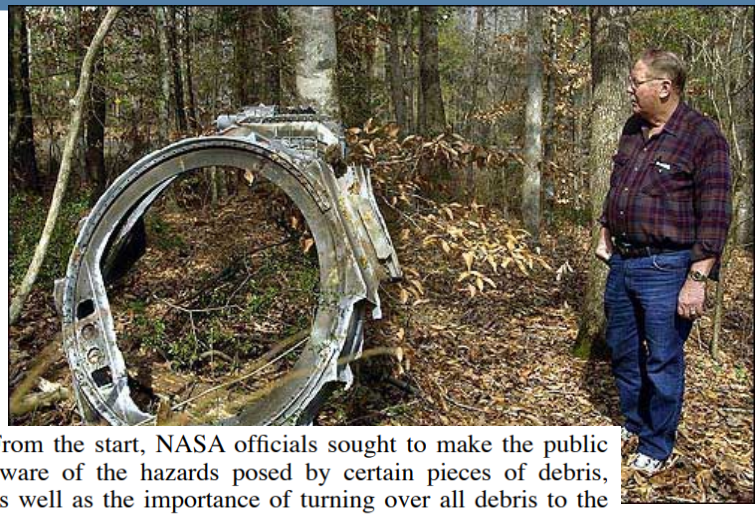
- Exotic materials
- Military stores, ammunition, pylons, squibs, countermeasures, sonobuoys and ejector systems

Tyre hazards



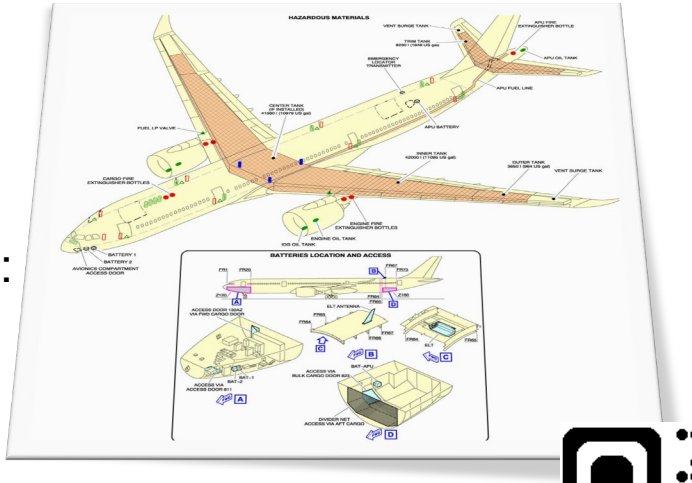
Tyre failure

Space vehicles



From the start, NASA officials sought to make the public aware of the hazards posed by certain pieces of debris, as well as the importance of turning over all debris to the authorities. *Columbia* carried highly toxic propellants that maneuvered the Orbiter in space and during early stages of re-entry. These propellants and other gases and liquids were stored in pressurized tanks and cylinders that posed a danger to people who might approach Orbiter debris. The propellants, monomethyl hydrazine and nitrogen tetroxide, as well as concentrated ammonia used in the Orbiter's cooling systems, can severely burn the lungs and exposed skin when encountered in vapor form. Other materials used in the Orbiter, such as beryllium, are also toxic. The Orbiter also contains various pyrotechnic devices that eject or release items such as the Ku-Band antenna, landing gear doors, and hatches in an emergency. These pyrotechnic devices and their triggers, which are designed to withstand high heat and therefore may have survived re-entry, posed a danger to people and livestock. They had to be removed by personnel trained in ordnance disposal.

Aircraft information



- Seek information and advice from:
  - Aircraft manufacturer
  - Operator
  - Aviation Rescue Fire Fighting Service
- https://www2023.icao.int/safety/lists/rffcrashcharts/allitems.aspx
- (or search “crash chart”)

Electrical hazards

Batteries

- Lithium
- Lead acid
- Ni-cad

- All contain hazardous materials
- Can be a source of ignition or arc-weld injury
- Disconnect on arrival if possible

Lithium-ion batteries

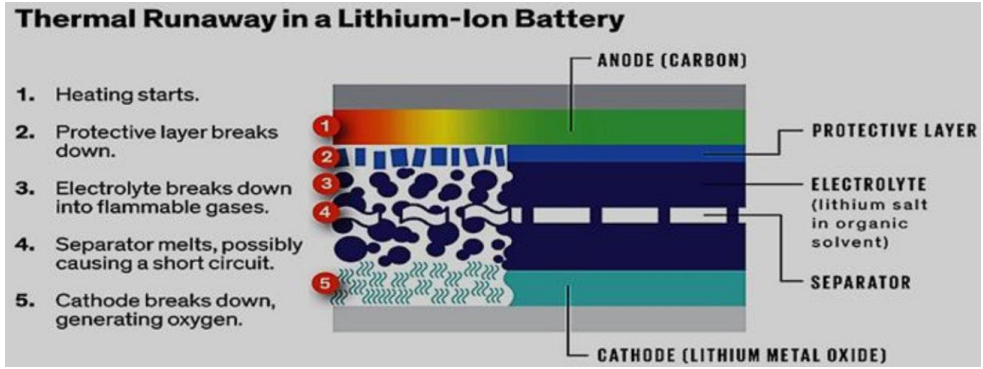
Lithium-ion batteries

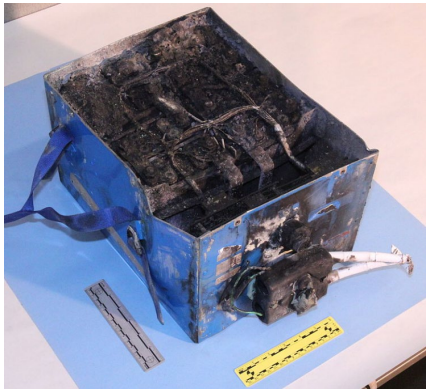
Fires are fully self-contained:

- Heat
- Fuel
- Oxygen

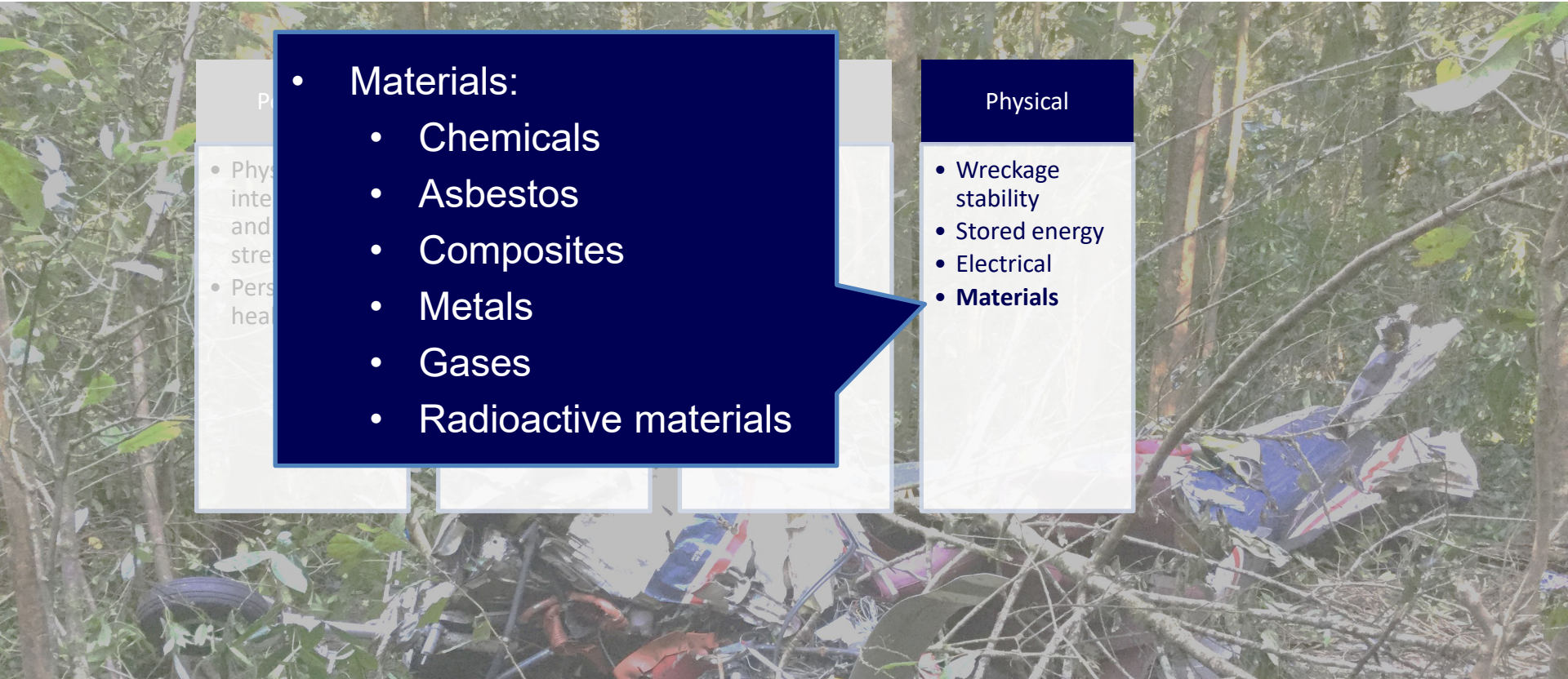
- Burns at up to 1,000˚ C

- Extinguish by removing heat with water, or isolate, until long after it stops smoking





Hazards at accident sites



Example manifest

- This freight train carried, among other things:
- Ammonia, oxygen, acetylene, various compressed non-volatile gases, refrigerant, ethanol, aerosols, lighters, corrosives, matches, flammable liquid, hydrogen peroxide, fireworks…
- Not all hazardous cargo is necessarily declared!

AMMONIA SOLUTION		21000 KG
ETHANOL (ETHYL ALCOHOL) or ETHANOL SOLUTION		1 KG
CORROSIVE LIQUID, BASIC, INORGANIC, N. O.S.	CORROSIVE	27 KG
CORROSIVE LIQUID, BASIC, INORGANIC, N. O.S.	CORROSIVE	8 KG
HYDROGEN PEROXIDE, AQUEOUS SOLUTION		2 KG
MAGNESIUM HYDRIDE		16 KG
AEROSOLS		296 KG
SODIUM HYDROXIDE SOLUTION		5 KG
CARBON DIOXIDE, REFRIGERATED LIQUID		16000 KG
REFRIGERANT GAS, N.O. MISC S.		44 KG
OXYGEN, COMPRESSED		885 KG
NITROGEN, COMPRESSED		100 KG
REFRIGERANT GAS R407C		11 KG
CARBON DIOXIDE		415 KG
ACETYLENE, DISSOLVED		1828 KG
COMPRESSED GAS, N.O. MISC S.		66 KG
HELIUM, COMPRESSED		1125 KG

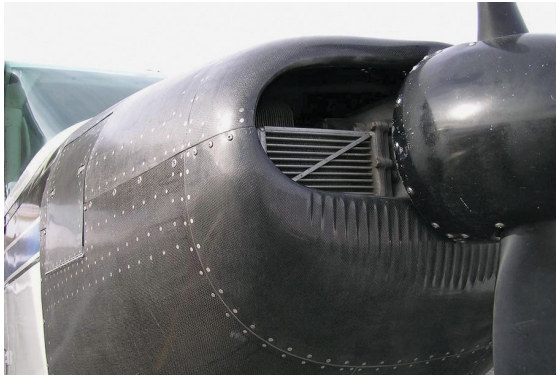
Materials – chemicals

- Fuels and other liquids
- Oils, hydraulics
- Gases
- Powders
- Fire fighting products
- Industrial/ agricultural products
- Any unidentified substance

- Flammability
- Toxic fumes
- Reactions between multiple chemicals
- Eye irritation
- Skin contact
- Slippery
- Structural integrity

Composites

- Fibre types:
  - Asbestos
  - Fibreglass
  - Kevlar
  - Boron
  - Carbon
- Where:
  - Small aircraft
  - Newer aircraft
  - Military aircraft
  - Repair tape
  - Modifications
  - Helmets (all kinds)
  - Cargo
  - Space junk!



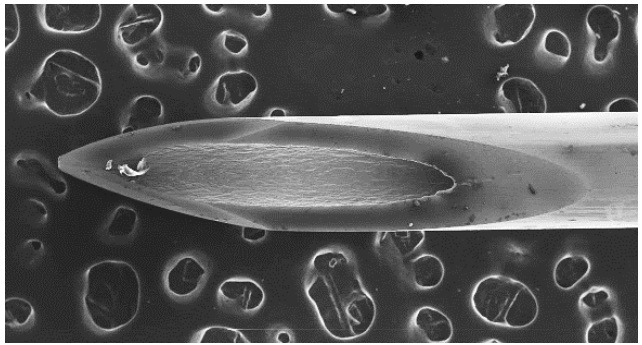
Composites: Carbon fibre

Carbon fibre in aircraft skin

Carbon fibre in spar

How sharp is carbon fibre?

- The smallest hypodermic needle that you can get is 34 gauge – smaller than all of these needles.
- It has an outer diameter of 0.18 mm.
- You could fit 50 – 200 carbon fibres inside it.



Respirable fibres

- Burned carbon fibre ash is physically and chemically a lot like asbestos
- You may not see effects for 20 years (mesothelioma)
- Burnt resins and other plastics are also hazardous

How to find composites?

Materials – metals

- Some metals react with chemicals, such as fire fighting agents
- Magnesium burns with intense heat
- Some are toxic when burnt or powdered (heavy impact)

Materials – toxic gases

- Set off when some plastics and adhesives are burnt
- Includes hazardous cargo (eg. crop sprayers)
- May be strongly acidic, or dangerous to ingest
- Halon gas (some fire extinguishers) is not very toxic itself but can generate very toxic decomposition products at high temperatures: about 40x more toxic than carbon monoxide
  - Hydrogen bromide: gaseous, heavier than air
  - Hydrogen fluoride: gas > 20°C, lighter than air
    liquid < 20°C (i.e. liquid/vapour can be persistent)

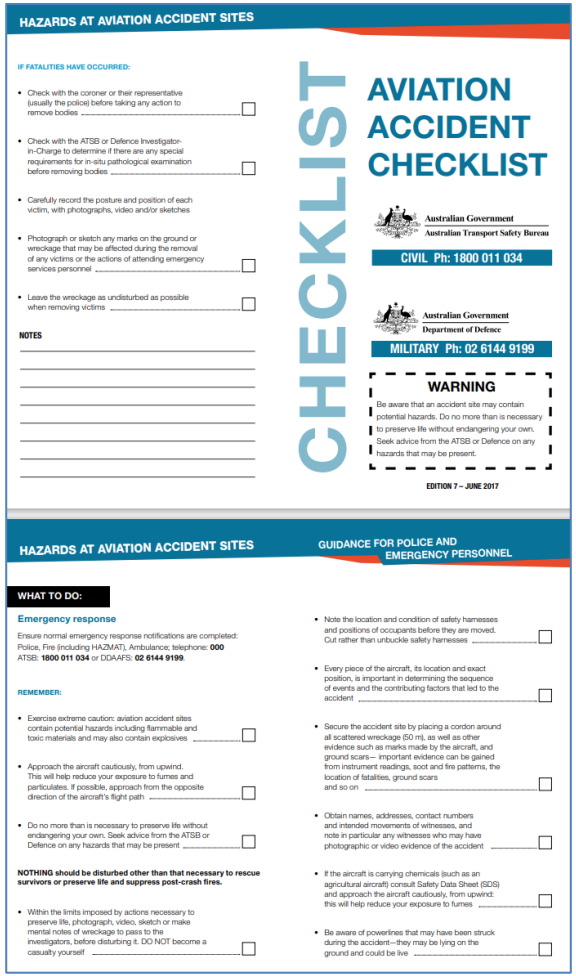
Radioactive materials

- Older instruments - radium
- Flight control mass-balance weights in some older big jets – depleted uranium
- Military aircraft
- Carried as cargo – should be marked/listed as DG
- Not all glowing materials are very nasty (eg tritium)

Radioactive materials

- small amounts can't be detected by human senses
- may not glow
- hazardous if handled, ingested or inhaled, especially after a fire
- containers may become radioactive
- delayed injury (eg. cancer)
- storage/examination considerations


HAZARDS AT AVIATION ACCIDENT SITES
GUIDANCE FOR POLICE AND EMERGENCY PERSONNEL
Edition 7 2017
Australian Government
Department of Defence
Australian Government
Australian Transport Safety Bureau



HAZARDS AT AVIATION ACCIDENT SITES

IF FATALITIES HAVE OCCURRED:

- Check with the coroner or their representative (usually the police) before taking any action to remove bodies ☐
- Check with the ATSB or Defence Investigator-in-Charge to determine if there are any special requirements for in-situ pathological examination before removing bodies ☐
- Carefully record the posture and position of each victim, with photographs, video and/or sketches
- Photograph or sketch any marks on the ground or wreckage that may be affected during the removal of any victims or the actions of attending emergency services personnel ☐
- Leave the wreckage as undisturbed as possible when removing victims ☐

NOTES

CHECKLIST

AVIATION ACCIDENT CHECKLIST

Australian Government
Australian Transport Safety Bureau

CIVIL Ph: 1800 011 034

Australian Government
Department of Defence

MILITARY Ph: 02 6144 9199

WARNING

Be aware that an accident site may contain potential hazards. Do no more than is necessary to preserve life without endangering your own. Seek advice from the ATSB or Defence on any hazards that may be present.

EDITION 7 – JUNE 2017

HAZARDS AT AVIATION ACCIDENT SITES

GUIDANCE FOR POLICE AND EMERGENCY PERSONNEL

WHAT TO DO:

Emergency response

Ensure normal emergency response notifications are completed: Police, Fire (including HAZMAT), Ambulance; telephone: **000**
ATSB: **1800 011 034** or DDAAFS: **02 6144 9199**.

REMEMBER:

- Exercise extreme caution: aviation accident sites contain potential hazards including flammable and toxic materials and may also contain explosives ☐
- Approach the aircraft cautiously, from upwind. This will help reduce your exposure to fumes and particulates. If possible, approach from the opposite direction of the aircraft's flight path ☐
- Do no more than is necessary to preserve life without endangering your own. Seek advice from the ATSB or Defence on any hazards that may be present ☐

NOTHING should be disturbed other than that necessary to rescue survivors or preserve life and suppress post-crash fires.

- Within the limits imposed by actions necessary to preserve life, photograph, video, sketch or make mental notes of wreckage to pass to the investigators, before disturbing it. DO NOT become a casualty yourself ☐
- Note the location and condition of safety harnesses and positions of occupants before they are moved. Cut rather than unbuckle safety harnesses ☐
- Every piece of the aircraft, its location and exact position, is important in determining the sequence of events and the contributing factors that led to the accident ☐
- Secure the accident site by placing a cordon around all scattered wreckage (50 m), as well as other evidence such as marks made by the aircraft, and ground scars— important evidence can be gained from instrument readings, soot and fire patterns, the location of fatalities, ground scars and so on ☐
- Obtain names, addresses, contact numbers and intended movements of witnesses, and note in particular any witnesses who may have photographic or video evidence of the accident ☐
- If the aircraft is carrying chemicals (such as an agricultural aircraft) consult Safety Data Sheet (SDS) and approach the aircraft cautiously, from upwind: this will help reduce your exposure to fumes ☐
- Be aware of powerlines that may have been struck during the accident—they may be lying on the ground and could be live ☐

Any questions?