Human Factors

Module 4: Case study

ICAO APAC AIG Workshop
15 August 2023 Singapore

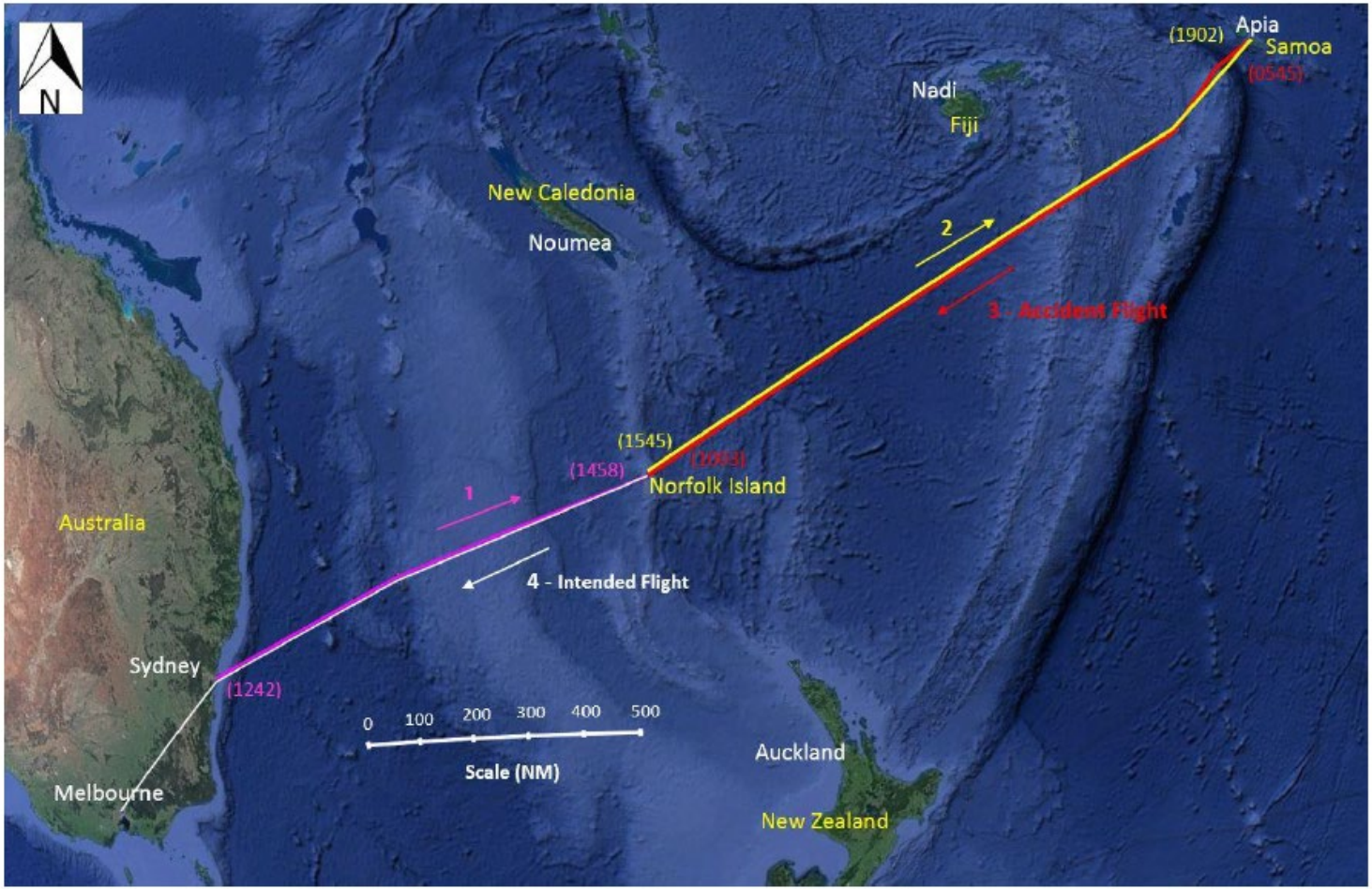
Presented by
Mike Walker

Module 4: Case study

- Background
- The occurrence (history of the flight)
- Other factual information
- Findings
- Lessons

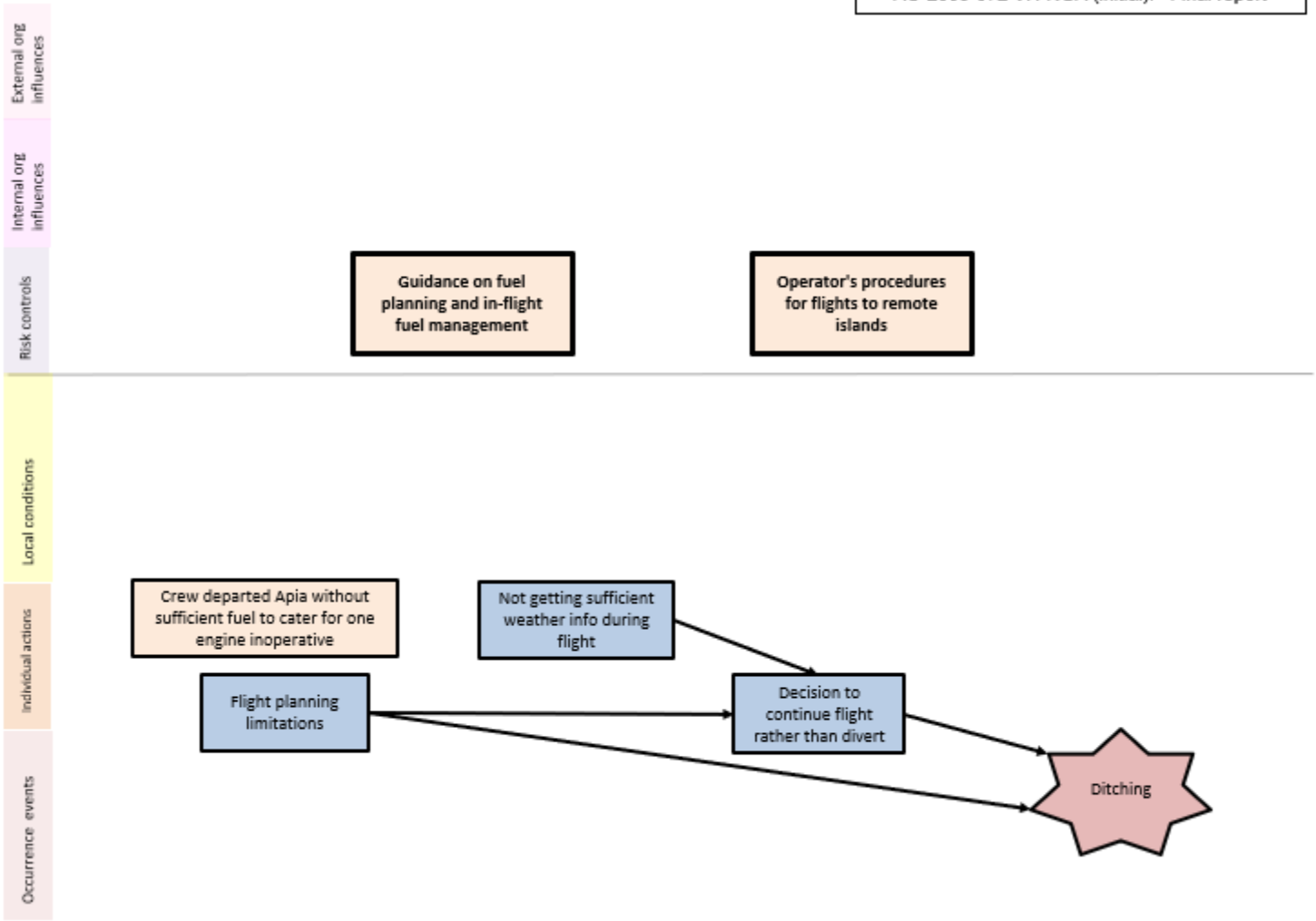
Background

- 18 November 2009
- Air ambulance flight
- Operated by Pel-Air for Careflight
- VH-NGA, IAI Westwind 1124A
- 6 on board (2 flight crew, doctor, nurse, patient, patient's husband)
- Apia (Samoa) to Norfolk Island, at night
- Forecast for Norfolk Island - fine
- Weather changed en route
- Conducted 4 approaches then ditched
- 2 serious injuries, 3 minor injuries, hull loss


N
(1902)
Apia
Samoa
(0545)
Nadi
Fiji
New Caledonia
Noumea
2
3 - Accident Flight
(1545)
(1458)
(0803)
Norfolk Island
1
Australia
4 - Intended Flight
Sydney
(1242)
0
100
200
300
400
500
Scale (NM)
Auckland
Melbourne
New Zealand

Initial investigation

- Accident – 18 November 2009
- ATSB preliminary report – January 2010
- Decision not to recover recorders – January 2010
- Final report – August 2012
- ‘Four Corners’ documentary – September 2012
- Senate inquiry report – May 2012
- Canadian TSB review of ATSB processes – Dec 2014


External org influences
Internal org influences
Risk controls
Guidance on fuel planning and in-flight fuel management
Operator's procedures for flights to remote islands
Local conditions
Individual actions
Crew departed Apia without sufficient fuel to cater for one engine inoperative
Not getting sufficient weather info during flight
Flight planning limitations
Decision to continue flight rather than divert
Occurrence events
Ditching

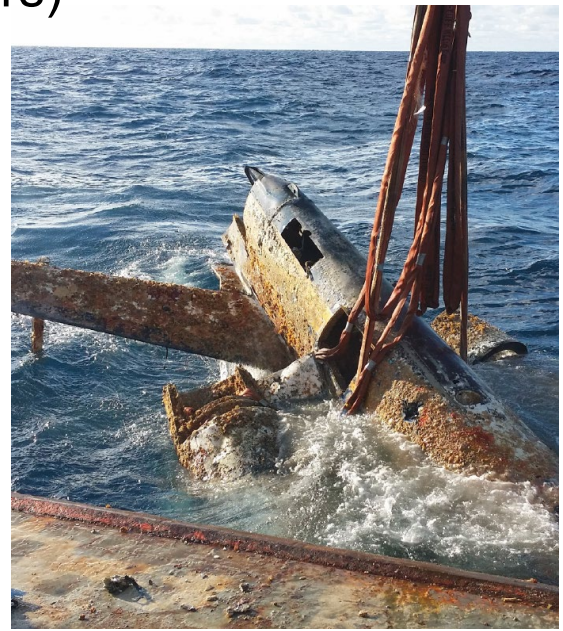
Reopened investigation

- Reopened investigation – Dec 2014
- Obtained significant amount of new evidence
- Retrieved recorders (Nov 2015)
- Treated it as a major investigation
- Completed investigation – Nov 2017
- 36 safety factors
  - 17 contributing factors (including 5 safety issues)
  - 19 other factors that increased risk (including 11 safety issues)

Flight recorders

- L3 Communications FA2100 solid-state CVR (2 hours)
- Fairchild F1000 solid-state FDR (6 parameters)
- Underwater (49 m) for 6 years
- All data recovered

Figure B3: FDR at the ATSB laboratories in Canberra (16 November 2015)

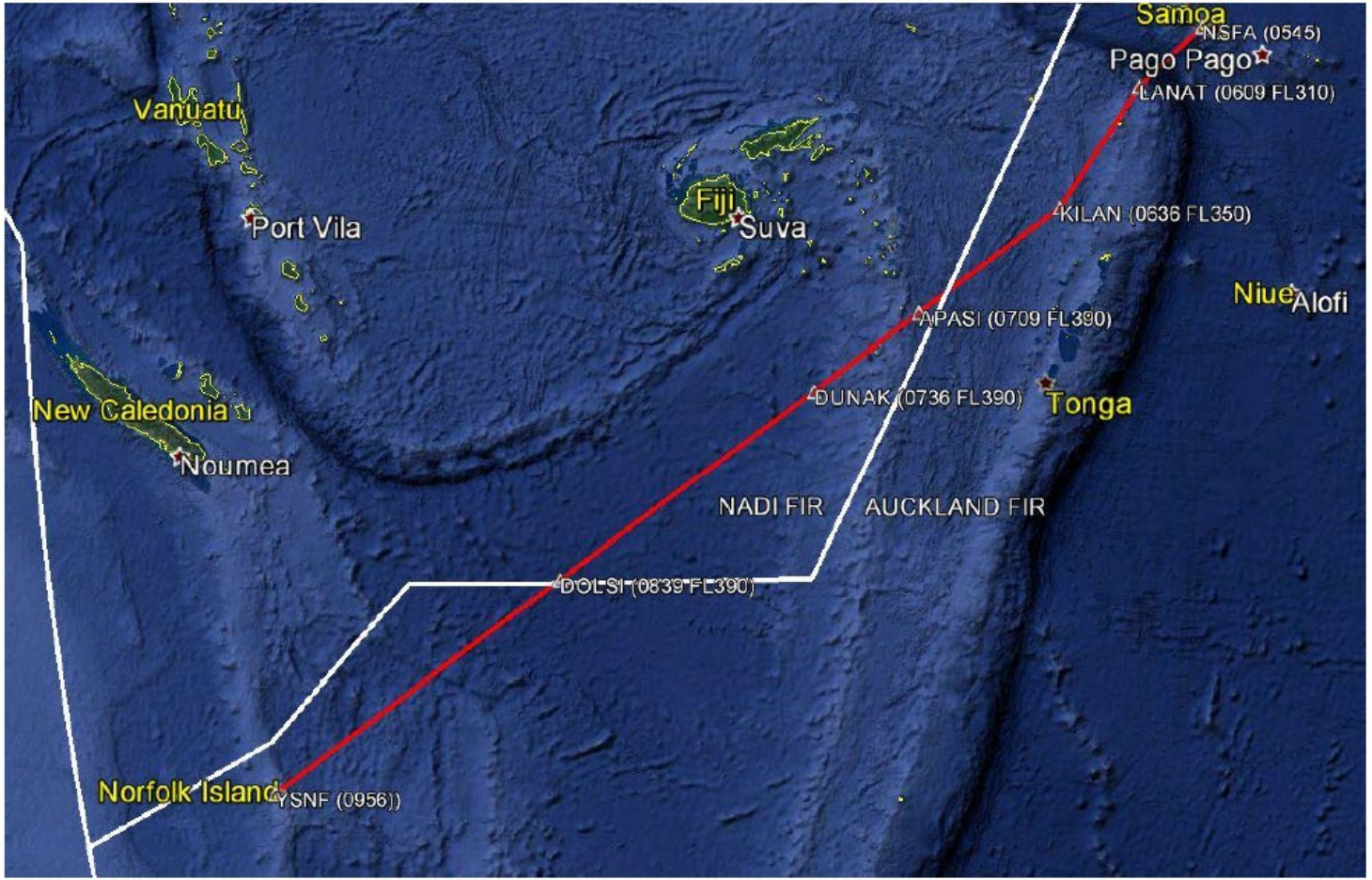


Module 4: Case study

- Background
- The occurrence (history of the flight)
- Other factual information
- Findings
- Lessons

Before flight

- Outbound flight landed in Apia at 1902 UTC
- Captain commenced flight planning at 0330
  - problems with internet access
  - phoned flight service to submit flight plan (3.5 hours)
  - obtained Norfolk Island forecast (scattered cloud 2,000 ft)
- Captain organised refuelling at airport, filled to full main tanks (7,200 lb fuel); maximum fuel with tip tanks was 8,700 lb
- Patient placed on stretcher / oxygen before take-off
- Departed Apia at 0545 (1845 local, 1645 AEST)
- First officer was pilot flying


Samoa
NSFA (0545)
Pago Pago
LANAT (0609 FL310)
Vanuatu
Port Vila
Fiji
Suva
KILAN (0636 FL350)
Niue
Alofi
APASI (0709 FL390)
DUNAK (0736 FL390)
Tonga
New Caledonia
Noumea
NADI FIR
AUCKLAND FIR
DOLSI (0839 FL390)
Norfolk Island
YSNF (0956)

En route

- Climbed to flight level 310, 350, then 390
- 0756 – captain requested weather from Nadi flight service
  - 0630 METAR (few cloud 6,000 ft) then 0800 SPECI (overcast 1,100 ft)
- 0904 – captain requested weather from Auckland flight service
  - 0902 SPECI (scattered cloud 500 ft, broken cloud 1,100 ft)
- 0907 – approach brief (planned for runway 29 VOR approach)
- 0928 – crew advised weather below landing minima
- 0940 – top of descent

Approaches

- VOR non-precision approaches
- Wind did not favour runway 29 or 11 (minima 100 ft lower for 11)
- Approach 1 runway 29 (first officer)
- Approach 2 to runway 29 (captain)
- Approach 3 to runway 11 (captain), abbreviated

- Approach 1 (29)
- Approach 2 (29)
- Approach 3 (11)
- Approach 4 and ditch

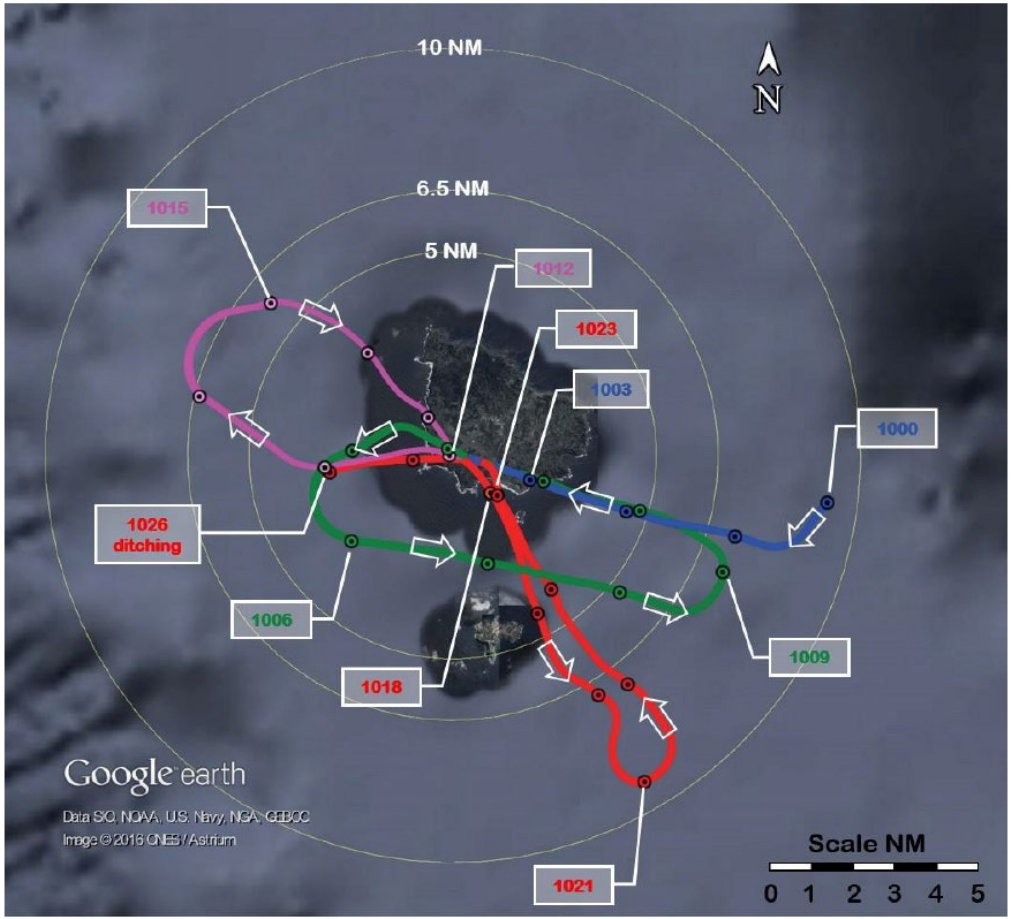


Figure 6: Final approach tracks flown to runway 29 (approaches 1 (blue), 2 (green) and 4 (red)), overlaid on chart extract of procedure used by the crew on the night of the accident

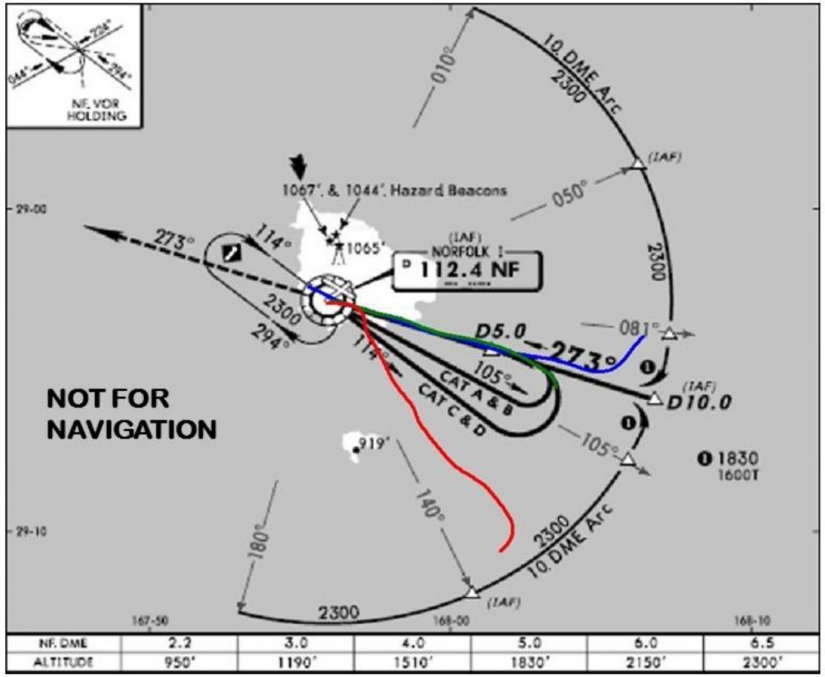
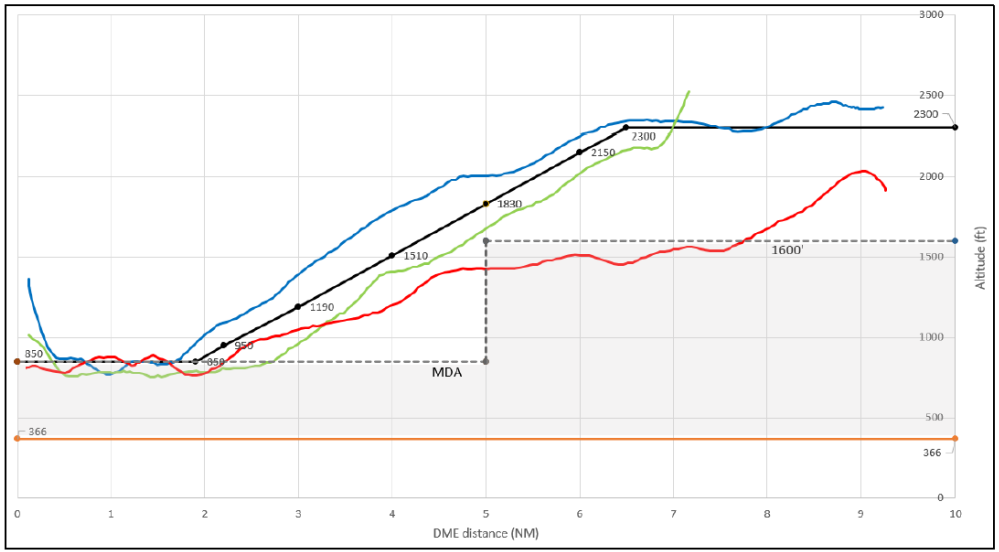


Figure 7: Vertical profile of final approaches flown to runway 29 (approaches 1 (blue), 2 (green) and 4 (red))



Ditching

- Extended discussion about ditching after approach 3
- FO told occupants to prepare for ditching, life raft placed in aisle
- Conducted approach 4 then ditched
- FO advised on radio they were ditching, did not advise where
- Dark night conditions
- Captain aimed for 100 kt
  - Vref was 120 kt; crew did not refer to ditching checklist
- Ditched 6.4 km from airport, 4.6 km from nearest land
- Speed 92 kt, vertical speed 600 ft/min

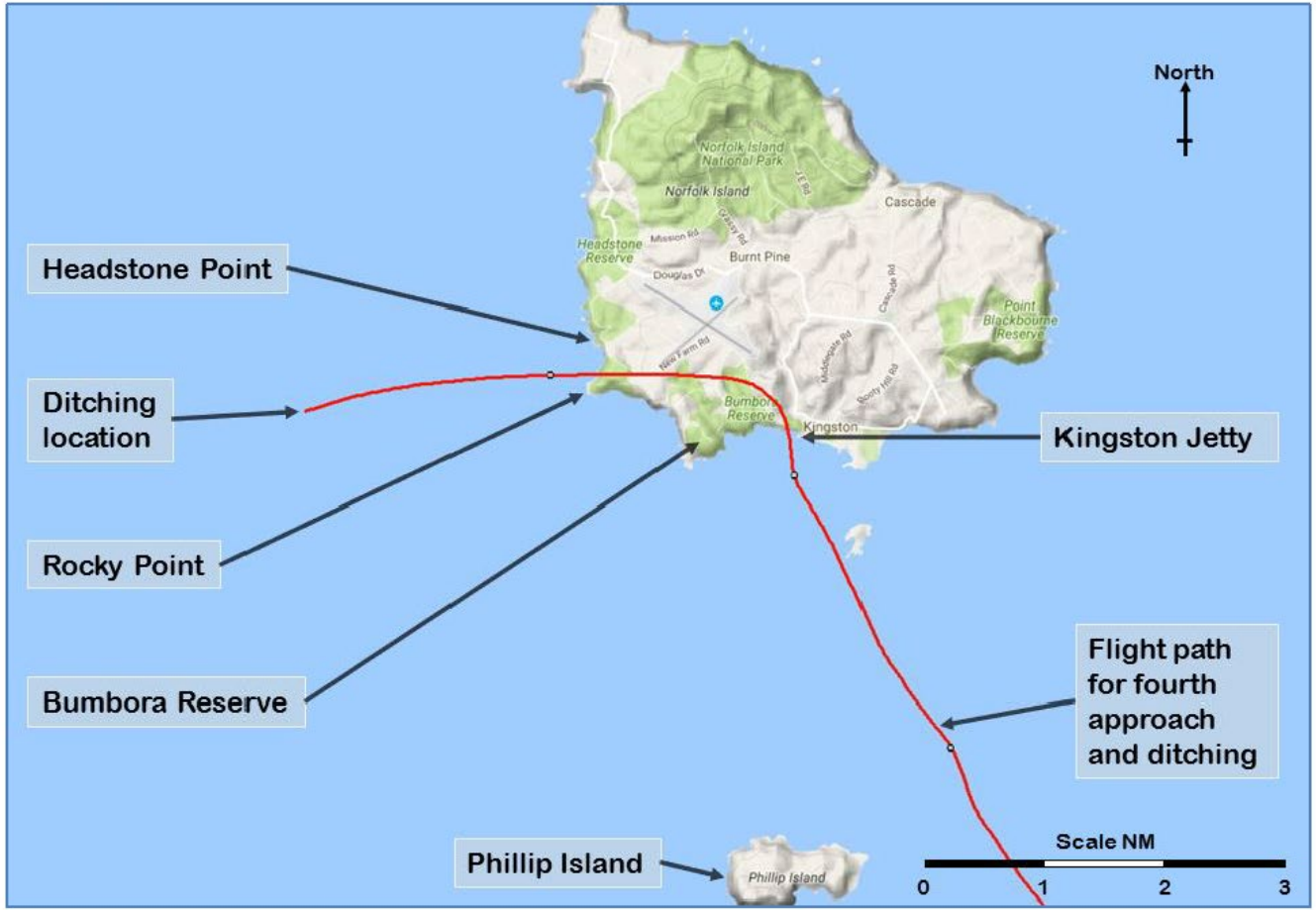
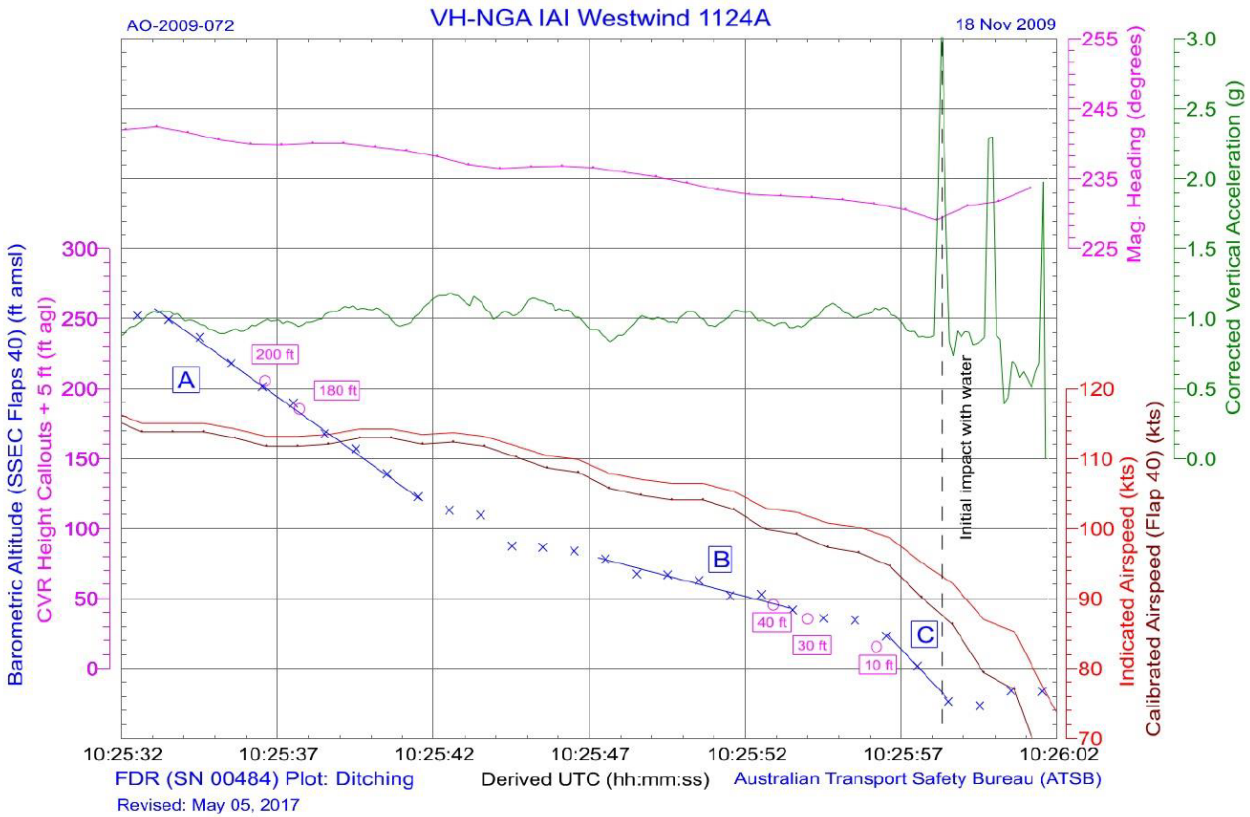
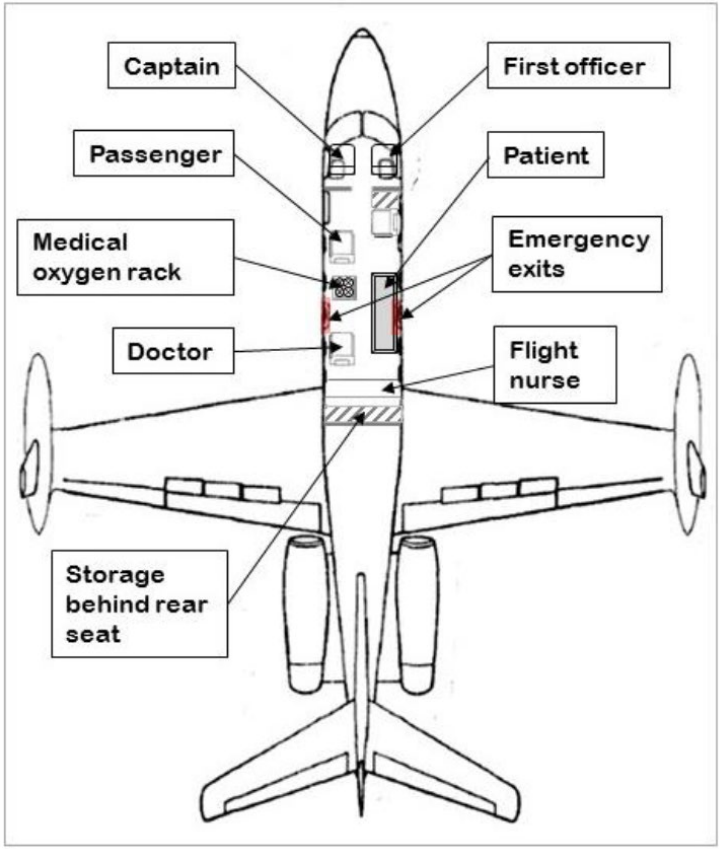

North
Headstone Point
Ditching location
Rocky Point
Bumbora Reserve
Kingston Jetty
Flight path for fourth approach and ditching
Phillip Island
Scale NM
0
1
2
3
Norfolk Island National Park
Norfolk Island
Cascade
Burnt Pine
Kingston
Phillip Island

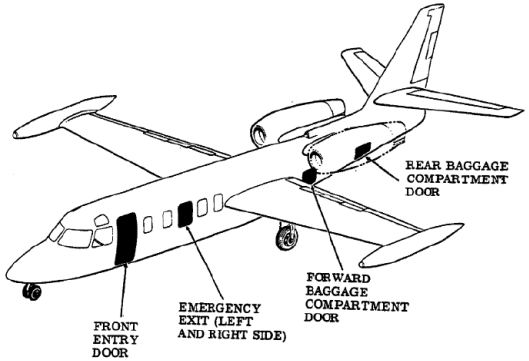
Figure B6: Data from the FDR showing the last recorded 30 seconds

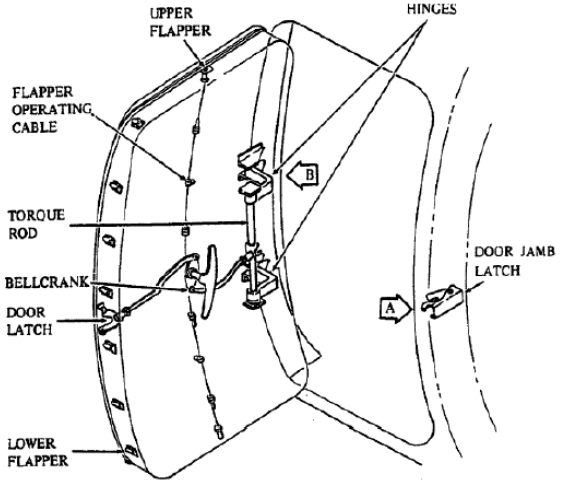


Evacuation

- Aircraft rapidly flooded
- All 6 occupants exited
- Only doctor, nurse, patient's husband wearing life jackets
- No time to find life raft
- Only 1 chamber of nurse's life jacket inflated
- In water for 85 minutes before rescue
- 2 serious injuries, 3 minor injuries, hull loss


Captain
First officer
Passenger
Patient
Medical oxygen rack
Emergency exits
Doctor
Flight nurse
Storage behind rear seat


REAR BAGGAGE COMPARTMENT DOOR
FORWARD BAGGAGE COMPARTMENT DOOR
EMERGENCY EXIT (LEFT AND RIGHT SIDE)
FRONT ENTRY DOOR


UPPER FLAPPER
HINGES
FLAPPER OPERATING CABLE
B
TORQUE ROD
DOOR JAMB LATCH
BELLCRANK
A
DOOR LATCH
LOWER FLAPPER

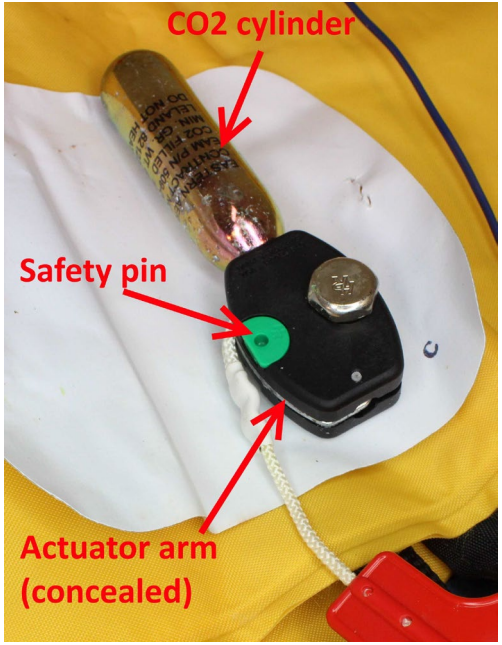
Module 4: Case study

- Background
- The occurrence (history of the flight)
- Other factual information
- Findings
- Lessons

V7 L10 301HD+2 CA-35 21DEC09
LBV H7 GR 0048.4MS 17C 10:25:10

V7 L10 012HD+2 CA-35 21DEC09
LBV H7 GR 0048.6MS 17C 10:23:55

Lifejackets recovered from Norfolk Island police station in 2015



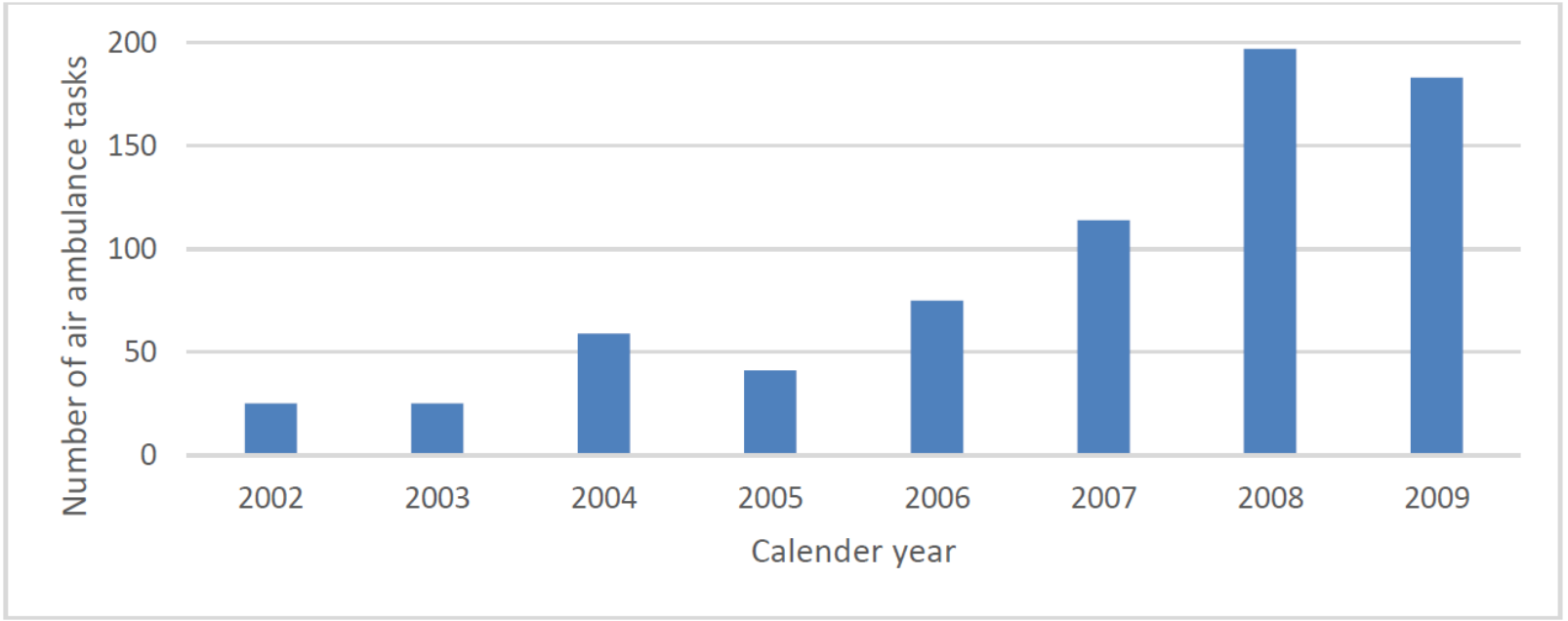
Personnel information

- Captain:
  - 4,378 hours (2,418 command), 889 hours Westwind (294 hours command)
  - captain for 12 months
  - met recency requirements
  - Norfolk Island 4 times (once from Apia in September 2009)
- First officer
  - 1,961 hours (951 command), 656 hours Westwind
  - met recency requirements
  - Norfolk Island 3 times

Operator information (Pel-Air Aviation)

Fleet	Description
Westwind operations	Up to 7 Westwind aircraft Main bases in Sydney and Darwin, small bases in Perth and Cairns Air ambulance and ad hoc charter operations, including most of the passenger charter operations the operator conducted for the Australian Defence Force (ADF) 16 flight crew
Military jet operations	4 Learjets and some Westwind aircraft (as required) Base in Nowra Primarily tactical mission simulation, with some passenger charter operations for the ADF 11 flight crew
Turboprop operations	5 Saab 340 and 6 Metro aircraft (4 Metro 23 and 2 Metro III) Bases in Adelaide, Sydney, Brisbane, Mackay, Townsville Regular freight operations and passenger charter operations (primarily fly-in fly-out support to mining operations) 32 flight crew

Figure 33: Number of air ambulance tasks conducted by the operator during 2002–2009



Sydney – Apr 2002

Darwin – Feb 2007
Perth – Jun 2008
Night freight – ceased Apr 2009
Cairns – May 2009

Module 4: Case study

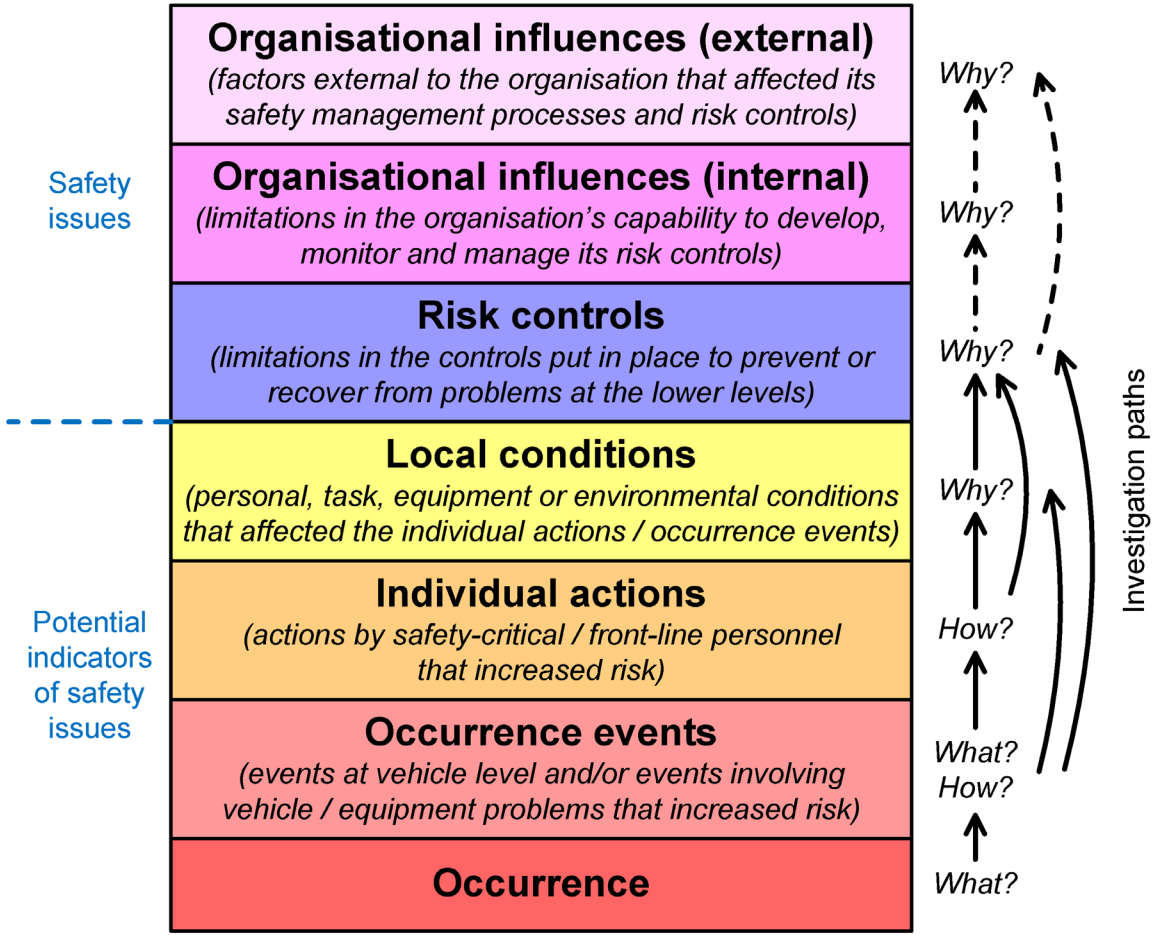
- Background
- The occurrence (history of the flight)
- Other factual information
- Findings
- Lessons

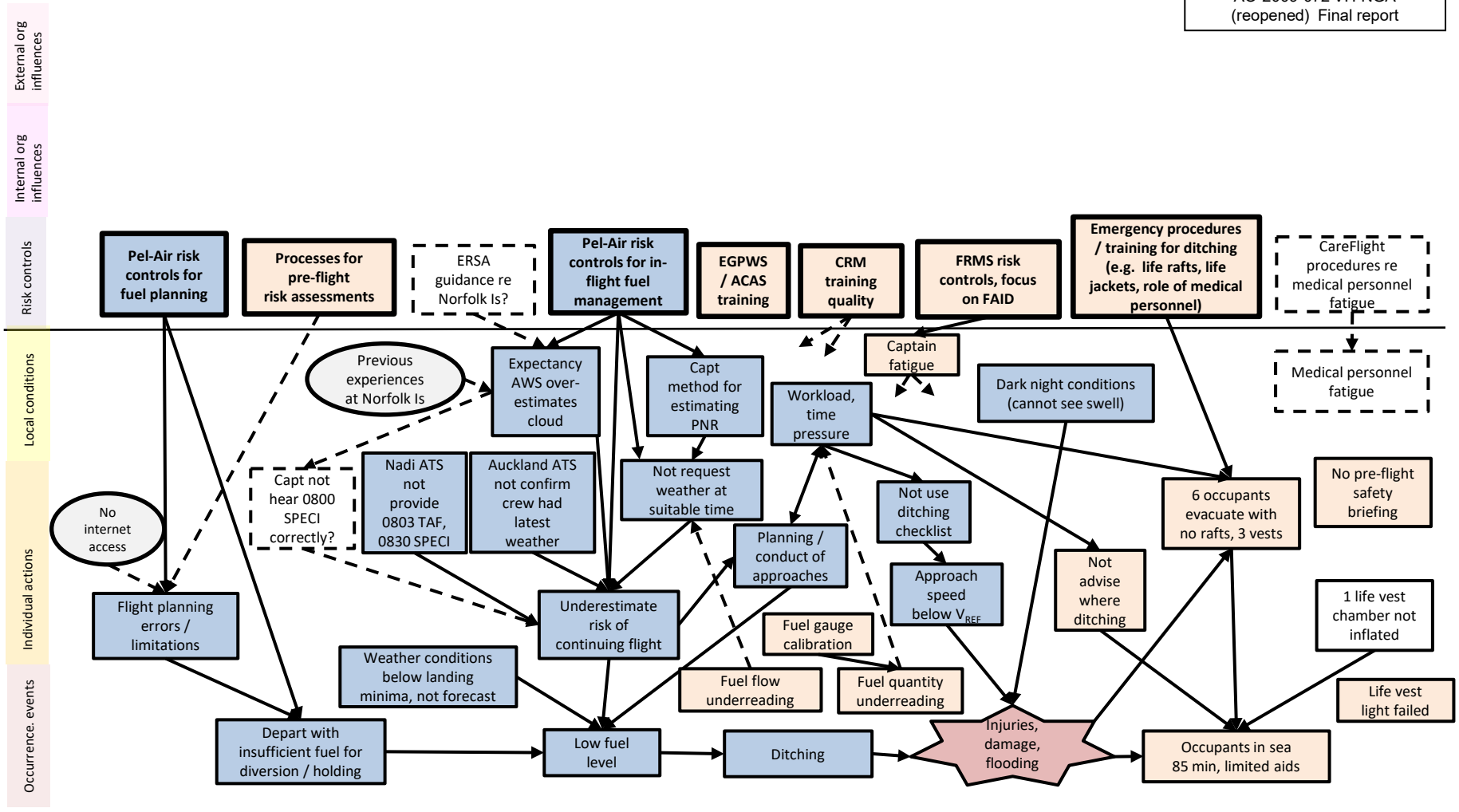
Questions

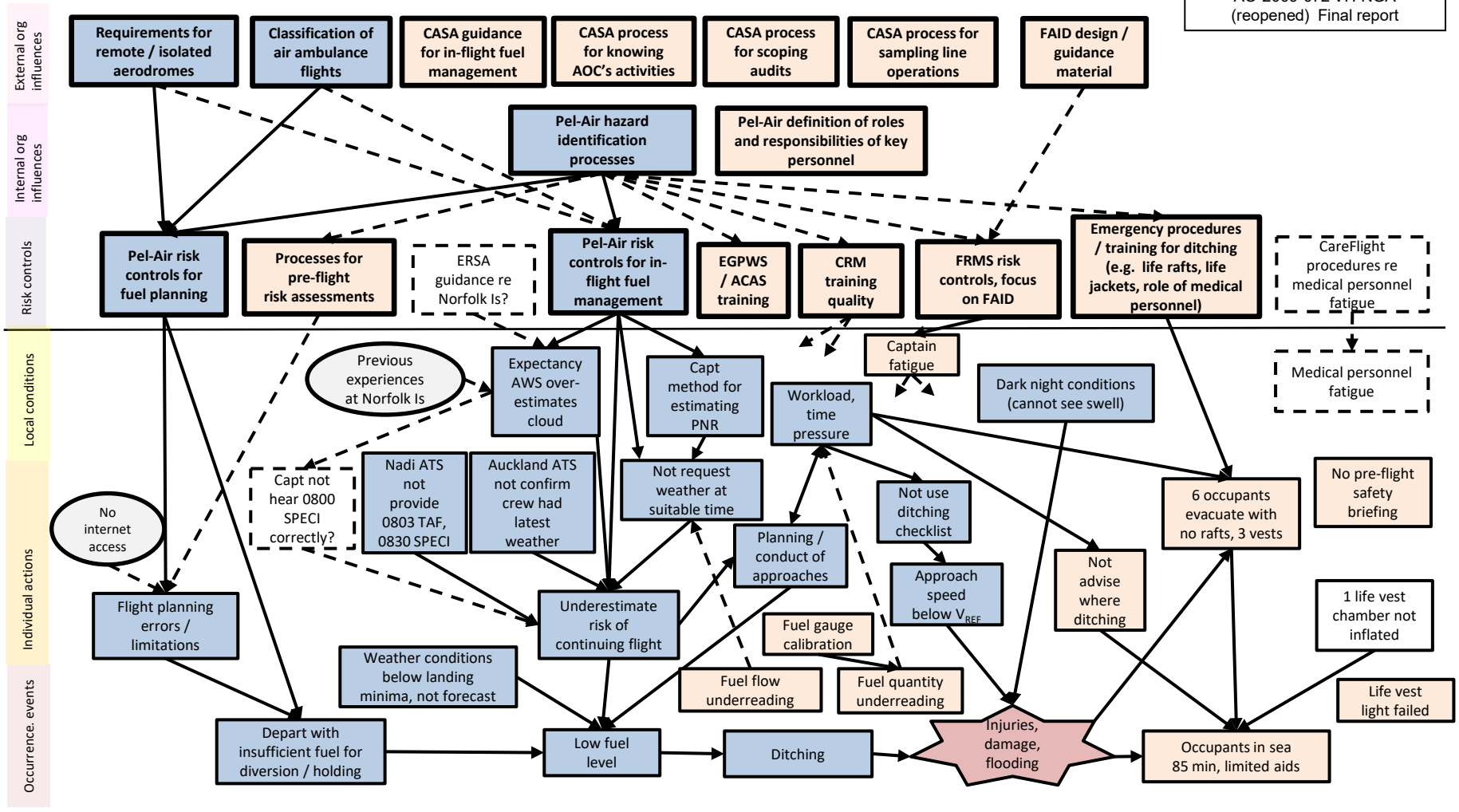
- What types of individual actions?
- What types of local conditions / risk controls to explain these actions?

(ATSB Final Report pp.7-9)

ATSB analysis model




External org influences
Internal org influences
Risk controls
Local conditions
Individual actions
Occurrence. events
Pel-Air risk controls for fuel planning
Processes for pre-flight risk assessments
ERSA guidance re Norfolk Is?
Pel-Air risk controls for in-flight fuel management
EGPWS / ACAS training
CRM training quality
FRMS risk controls, focus on FAID
Emergency procedures / training for ditching (e.g. life rafts, life jackets, role of medical personnel)
CareFlight procedures re medical personnel fatigue
Previous experiences at Norfolk Is
Expectancy AWS over-estimates cloud
Capt method for estimating PNR
Captain fatigue
Workload, time pressure
Dark night conditions (cannot see swell)
Medical personnel fatigue
Capt not hear 0800 SPECI correctly?
Nadi ATS not provide 0803 TAF, 0830 SPECI
Auckland ATS not confirm crew had latest weather
Not request weather at suitable time
Not use ditching checklist
6 occupants evacuate with no rafts, 3 vests
No pre-flight safety briefing
No internet access
Planning / conduct of approaches
Approach speed below V_{REF}
Not advise where ditching
1 life vest chamber not inflated
Flight planning errors / limitations
Underestimate risk of continuing flight
Fuel gauge calibration
Weather conditions below landing minima, not forecast
Fuel flow underreading
Fuel quantity underreading
Life vest light failed
Depart with insufficient fuel for diversion / holding
Low fuel level
Ditching
Injuries, damage, flooding
Occupants in sea 85 min, limited aids


External org influences
Internal org influences
Risk controls
Local conditions
Individual actions
Occurrence. events
Requirements for remote / isolated aerodromes
Classification of air ambulance flights
CASA guidance for in-flight fuel management
CASA process for knowing AOC's activities
CASA process for scoping audits
CASA process for sampling line operations
FAID design / guidance material
Pel-Air hazard identification processes
Pel-Air definition of roles and responsibilities of key personnel
Pel-Air risk controls for fuel planning
Processes for pre-flight risk assessments
ERSA guidance re Norfolk Is?
Pel-Air risk controls for in-flight fuel management
EGPWS / ACAS training
CRM training quality
FRMS risk controls, focus on FAID
Emergency procedures / training for ditching (e.g. life rafts, life jackets, role of medical personnel)
CareFlight procedures re medical personnel fatigue
Previous experiences at Norfolk Is
Expectancy AWS over-estimates cloud
Capt method for estimating PNR
Captain fatigue
Workload, time pressure
Dark night conditions (cannot see swell)
Medical personnel fatigue
Capt not hear 0800 SPECI correctly?
Nadi ATS not provide 0803 TAF, 0830 SPECI
Auckland ATS not confirm crew had latest weather
Not request weather at suitable time
Not use ditching checklist
6 occupants evacuate with no rafts, 3 vests
No pre-flight safety briefing
No internet access
Planning / conduct of approaches
Approach speed below V_{REF}
Not advise where ditching
1 life vest chamber not inflated
Flight planning errors / limitations
Underestimate risk of continuing flight
Fuel gauge calibration
Weather conditions below landing minima, not forecast
Fuel flow underreading
Fuel quantity underreading
Life vest light failed
Depart with insufficient fuel for diversion / holding
Low fuel level
Ditching
Injuries, damage, flooding
Occupants in sea 85 min, limited aids

	Contributing factors	Other factors that increased risk
Safety issues	• Flight planning requirements (remote is. / isolated aerodromes) • Classification of operations (air ambulance) • Hazard identification processes • Flight planning controls • In-flight fuel management controls	• Operator profile • Surveillance scoping • Surveillance product sampling • In-flight fuel management guidance • Definition of management roles • CRM training • Emergency procedure controls • Training on EGPWS / TCAS • Application of BMMF • Pre-flight risk assessments • FAID BMMF guidance
Potential indicators of safety issues	• Departed without maximum fuel • Flight planning errors • WX below landing min., not f'cast • Nadi not pass some sig. WX info • Auck. not confirm received sig. WX • Not request sufficient WX < PNR • Underestimate risk / expectancy • Not discuss options > PNR • Workload, time pressure, stress • Dark night conditions • Not use ditching checklist (airspeed) • High impact forces	• Fatigue (captain) • Fuel quantity gauges underreading • Fuel gauge calibration • Fuel flow gauges underreading • No pre-flight safety brief • Evacuated with no raft, 3 life jackets • Life jacket light < 85 minutes • Not advise ditching location

Fuel planning findings 1

- Contrary to the consistent practice of the operator's Westwind fleet, the long-distance flight to a remote island aerodrome departed without uploading the maximum possible amount of fuel prior to departure. Had the flight departed with the maximum amount of fuel, it is very likely the aircraft would have had sufficient fuel to divert from the top of descent or to hold at the remote island for a significant period of time.
- The captain's pre-flight planning did not include many of the elements needed to reduce the risk of a long-distance flight to a remote island or isolated aerodrome. Limitations included:
    - miscalculating the total fuel required for the flight under normal operations
    - not obtaining relevant forecasts of upper-level winds and, in the absence of such forecasts, underestimating the potential headwind component
    - not calculating the additional fuel required to allow for aircraft system failures
    - not obtaining a current aerodrome forecast and NOTAMs for potential alternate aerodromes
    - not calculating a point of no return (PNR).

Why not take full fuel?

- Original investigation did not know what was normal practice
- When ATSB spoke to other pilots, they advised:
  - they always took full fuel for such flights
  - never any pressure to not take full fuel
  - asked why did crew not take full fuel?
- Captain's explanations during investigations:
  - no requirement to take full fuel (or alternate fuel)
  - had calculated had sufficient fuel
  - fuel at 'remotish' locations can be expensive
  - aircraft not approved for RVSM, wanted to be able to climb quickly to get higher flight levels

Figure 35: Fuel on board and flight time for the operator's long-distance air ambulance flights to all destinations (2002–2009)

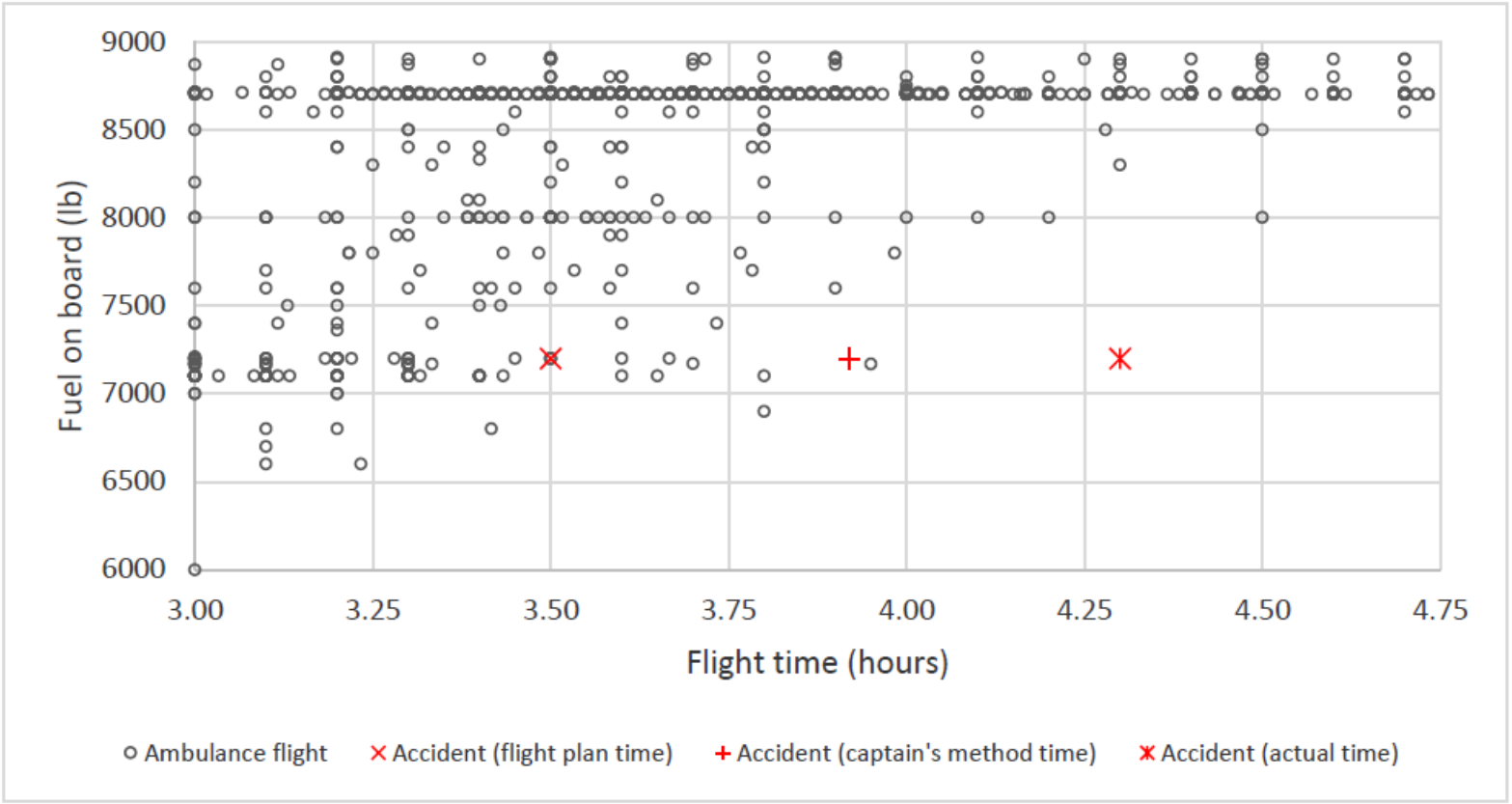
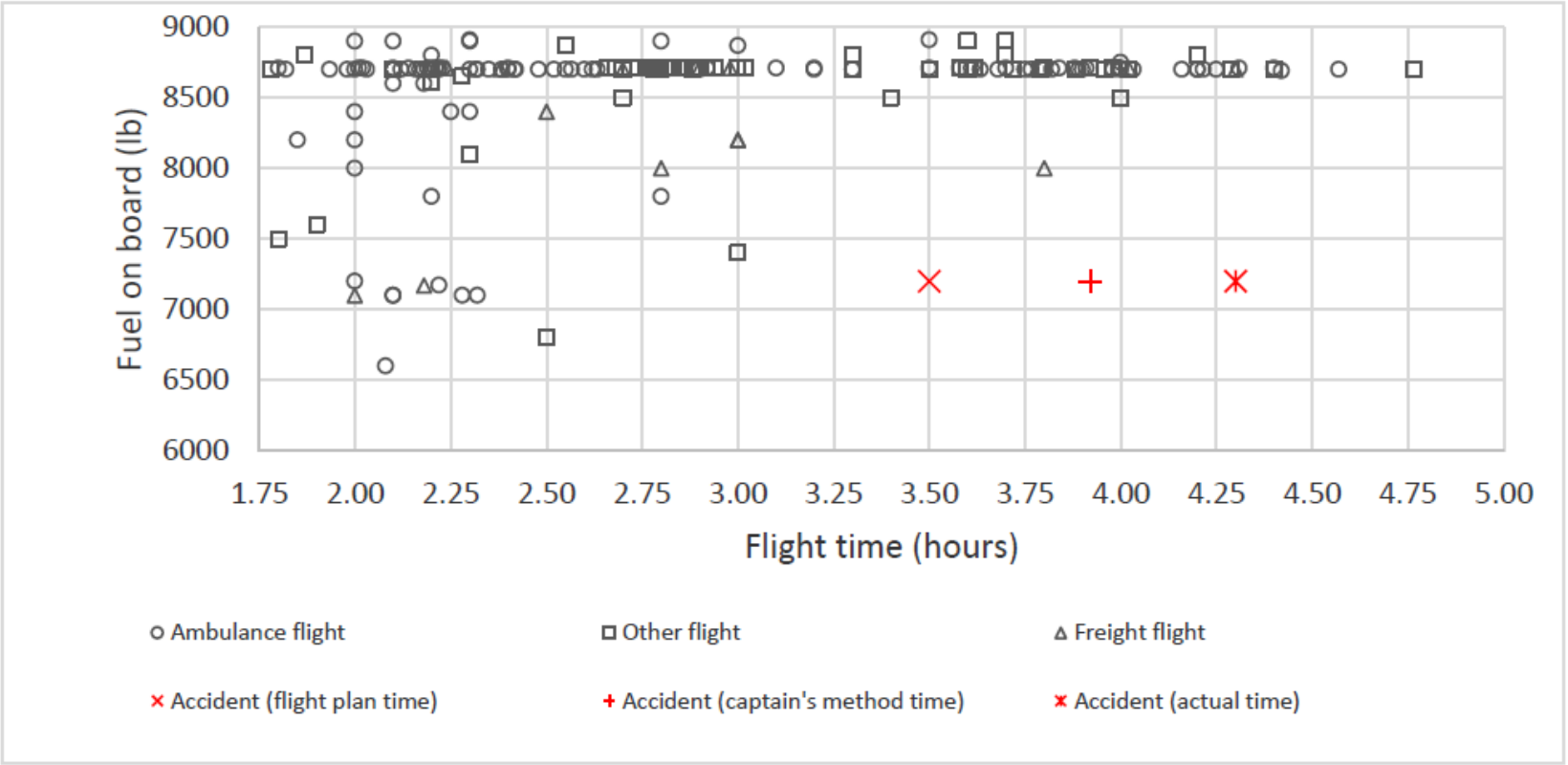


Figure 36: Fuel on board and flight time of the operator's Westwind flights to remote aerodromes (2002–2009)



Fuel planning findings 2

- The operator's Westwind pilots generally used a conservative approach to fuel planning, and the operator placed no restrictions on the amount of fuel that pilots uploaded. However, the operator's risk controls did not provide assurance that there would be sufficient fuel on board flights to remote islands or isolated aerodromes. Limitations included:[342]
  - no explicit fuel planning requirements for remote islands or isolated aerodromes
  - no formal fuel planning guidance for some relevant situations, such as a loss of pressurisation or flight below reduced vertical separation minimum (RVSM) airspace
  - no formal training for planning flights to remote islands or for international operations
  - no guidance information about potential hazards at commonly-used aerodromes
  - no procedure for a captain's calculation of the total fuel required to be checked by another pilot
  - little if any assessment during proficiency checks of a pilot's ability to conduct flight/fuel planning. [Safety issue]

In-flight fuel management findings 1

- The flight crew did not request sufficient weather information at an appropriate time prior to reaching the point of no return (PNR) to support effective decision-making. In addition, the captain's method for estimating the PNR to an off-track alternate aerodrome during a flight would generally not produce a specific, accurate time that could be used as an effective basis for deciding when to gather relevant weather information.
- The captain underestimated the risk associated with continuing the flight to Norfolk Island. This underestimation was probably associated with several contextual factors, including the limited weather information he had been provided during the flight, the limited information he had requested during the flight, and a strong though mistaken expectancy that the automatic weather station at Norfolk Island generally overestimated the amount of cloud that was present.

In-flight fuel management findings 2

- The operator's risk controls did not provide assurance that the operator's Westwind pilots would conduct adequate in-flight fuel management and related activities during flights to remote islands or isolated aerodromes. Limitations included:[343]
  - no formal guidance material about how to calculate a point of no return (PNR) for an off-track alternate aerodrome
  - no formal guidance material regarding what types of weather information to obtain during a flight and when to obtain the information
  - no procedure for a captain's calculation of the PNR to be checked by another pilot
  - little if any assessment during proficiency checks of a pilot's ability to calculate a PNR and conduct in-flight fuel management on long distance flights
  - no fitment of a satellite phone in most of the operator's Westwind aircraft. [Safety issue]

Fatigue aspects - captain

- Landed Apia 1902 UTC (0602 AEST), off duty 1945 (0645)
- Commenced flight planning 0330 (1430)
- 7.75 hours off duty
- Originally reported slept most of rest period, definitely refreshed
- Later reported to CASA 4 hours sleep, disrupted
- ATSB obtained phone records in 2015
  - multiple non-work calls 0000-0110 (1100-1210)
- Overall, estimated 3.5-4.0 hours sleep, broken by calls

(ATSB Final Report pp.7-9)

Fatigue aspects - captain

- Relatively normal sleep until trip (8 hours per night)
- Times of day of key interest were flight / fuel planning and
- Commenced flight planning 0330 (1430) and when initial weather received and assessed
- 7.75 hours off duty
  - originally reported slept most of rest period, definitely refreshed
  - later reported to CASA 4 hours sleep, disrupted
  - ATSB obtained phone records in 2015
  - multiple non-work calls 0000-0110 (1100-1210)
- Overall, estimated 3.5-4.0 hours sleep, broken by calls

(ATSB Final Report pp.7-9)

Fatigue findings

- Due to limited sleep in the previous 24 hours, the captain was probably experiencing a level of fatigue that has been demonstrated to adversely influence performance.
- **The operator's application of its fatigue risk management system overemphasised the importance of scores obtained from a bio-mathematical model of fatigue (BMMF), and it did not have the appropriate expertise to understand the limitations and assumptions associated with the model. Overall, the operator did not have sufficient risk controls in addition to the BMMF to manage the duration and timing of duty, rest and standby periods. [Safety issue]**
- **Guidance material associated with the FAID bio-mathematical model of fatigue did not provide information about the limitations of the model when applied to roster patterns involving minimal duty time or work in the previous 7 days. [Safety issue]**

Did fatigue have an influence?

Determining whether the existence of a mild to moderate level of fatigue could have contributed to specific errors or actions is a difficult process.[338] Certainly plan continuation errors can be consistent with the effects of fatigue. However, there were contextual factors, particularly the captain's expectancies regarding the weather conditions, that can also explain such errors. In other words, although fatigue could have contributed to or increased the likelihood of some of the captain's errors before and during the flight, such errors can also occur without fatigue. Therefore, it is difficult to conclude that fatigue contributed to the captain's actions on this occasion.

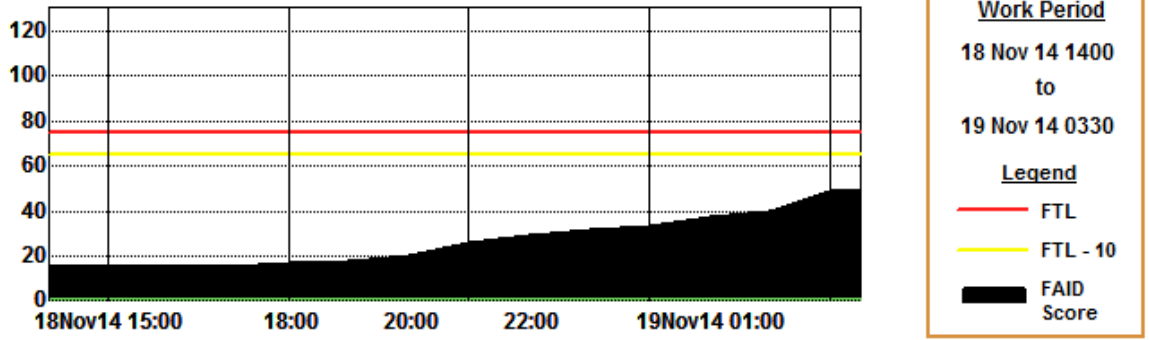
As already noted, the flight crew experienced significant workload, time pressure and stress during the latter stage of the flight, which influenced their ability to assess and discuss their situation, make effective decisions and conduct the approaches. It is also possible that fatigue adversely influenced the crew's performance during the latter stage of the flight. However, the assessment of the influence of fatigue during this period is complicated by the crew's elevated arousal level.

FAID SCORE TABLE

Summary

Details	
ID#	1
Work Schedule	1

Results	
Compliance %	100
Peak FAID Score	50



FAID Score Table

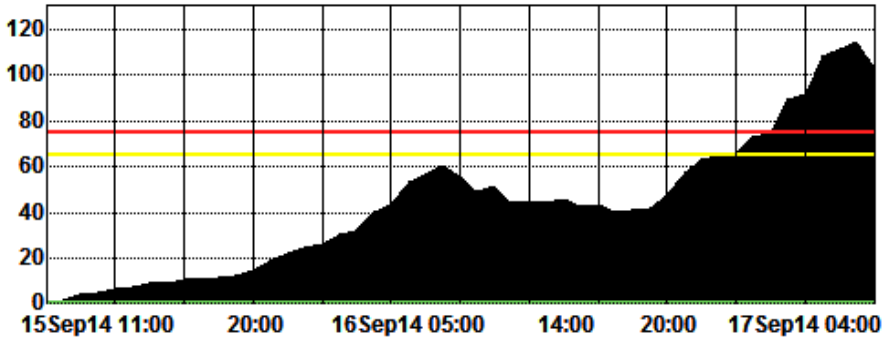
	ID#	Start	End	FAID Condition Green	FAID Condition Yellow	FAID Condition Red	Peak FAID Score	Non-Work	Task Risk	Work
1	1	10 Nov 14 1530	10 Nov 14 2030	5hr 0min			6	183.5	Moderate	5.0
2	1	17 Nov 14 2200	18 Nov 14 0630	8hr 30min			27	169.5	Moderate	8.5
3	1	18 Nov 14 1400	19 Nov 14 0330	13hr 30min			50	7.5	Moderate	13.5

FAID SCORE TABLE

Summary

Details	
ID#	2
Work Schedule	1

Results	
Compliance %	87.5
Peak FAID Score	115



Work Period

15 Sep 14 0800
to
17 Sep 14 0800

Legend

FTL
FTL - 10
FAID Score

FAID Score Table

	ID#	Start	End	FAID Condition Green	FAID Condition Yellow	FAID Condition Red	Peak FAID Score	Non-Work	Work
1	2	15 Sep 14 0800	17 Sep 14 0800	39hr 3min	2hr 58min	5hr 59min	115	368.0	48.0

Module 4: Case study

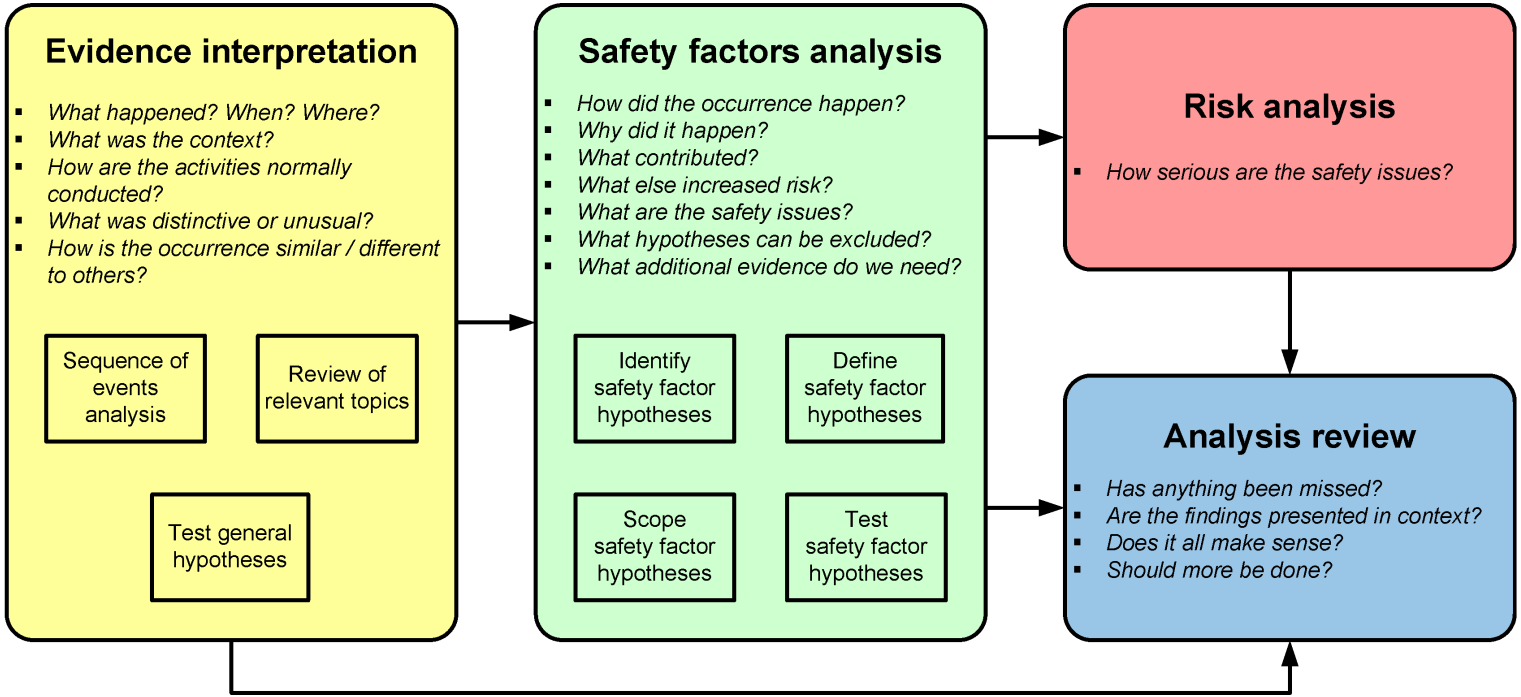
- Background
- The occurrence (history of the flight)
- Other factual information
- Findings
- Lessons

Lessons for investigators

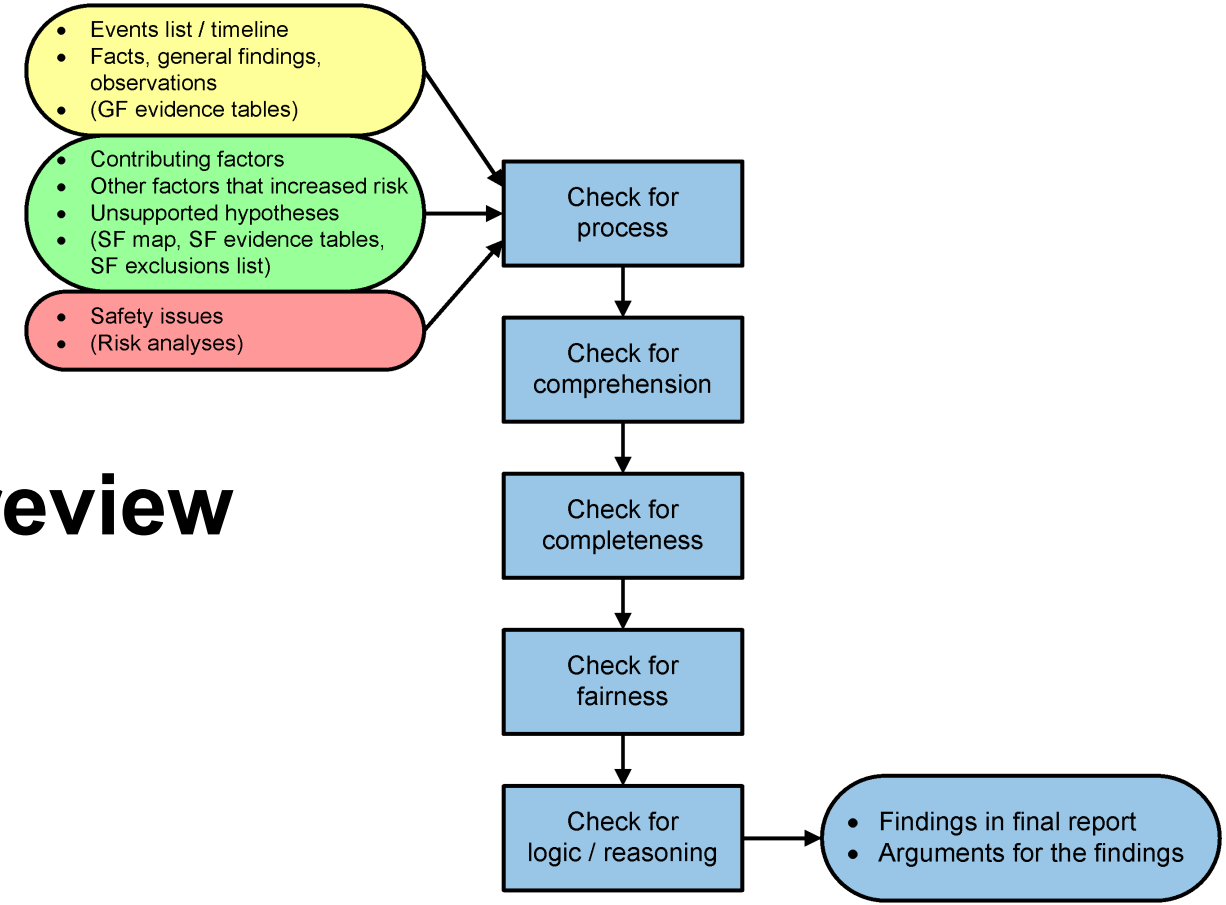
- Understand normal operations and their context when evaluating crew performance
- Use a structured process for reviewing progress during an investigation

(ATSB Final Report pp.7-9)

Analysis process



Analysis review



Check for fairness

- For findings about individual actions:
  - Do the findings appear to be allocating blame to an individual? Can the language be made less pejoratively and the finding have the same safety value?
  - Have we been fair to each of the individuals?
  - Have safety factors associated with individuals been placed in relevant context? That is, have we also included explanations for such actions?
- For findings about risk controls or organisational influences:
  - Do the findings appear to be allocating blame to the organisation? Can the language be made less pejoratively and the finding have the same safety value?
  - Have we been fair to each of the organisations?
  - Have safety factors associated with organisations been placed in relevant context?
  - Has the investigation considered practicability when making findings about organisations?

Australian Government
Australian Transport Safety Bureau
ATSB

Analysis checklists

26 March 2020

Lessons / reminders for flight crew

- Discuss and consider options to manage threats when there is time available to do so
- Use checklists in emergencies (wherever possible)

(ATSB Final Report pp.7-9)

Figure 37: Westwind 1124A ditching checklist

PREPARATION

1. Communications – MAYDAY
2. Transponder – CODE 7700
3. Passengers – BRIEFED AND PREPARED
4. Cabin baggage – SECURED
5. CABIN LIGHTS switch – BELTS/NO SMK
6. EMERG LT switch – ARM
7. Cabin altitude controller – SET FOR DESCENT
8. Fuel DUMP pushbuttons – PUSH ON (boosted dump required)

APPROACH

1. Cabin pressurization – MONITOR DEPRESSURIZATION
2. Landing gear lever – UP; WARNING HORN CB – PULL
3. FLAPS lever – 40°
4. AIRSPEED bug and AOA indicator – SET FOR V_{REF} (Figure 5-61)
5. Heading – PARALLEL TO MAIN SWELL

BEFORE TOUCHING WATER

1. Radbar altimeter – SET FOR 50 FEET
2. Attitude – NOSE UP; 10° deck angle when DH light comes on (GO AROUND mode)
3. Thrust levers – CUT-OFF
4. FUEL SHUTOFF switches – CLOSE
5. BATTERY MASTER SWITCH – OFF

AFTER DITCHING

1. Pilot DV window – OPEN to depressurize cabin (after removing loose articles from window and console areas)
2. Emergency escape windows and door – OPEN WHICHEVER IS ABOVE WATER LEVEL
3. Life rafts – TIE STATIC LINE TO ANCHORING POINT AND PREPARE FOR DEPLOYMENT
4. LAUNCH AND BOARD LIFE RAFTS

Lessons / reminders for operators

- Do not rely on ‘informal’ risk controls for managing performance of safety-critical tasks
- Ensure flight crew proficiency checks assess the performance of key tasks required of flight crew
- Check that emergency procedures will actually work
- Ensure have a detailed understanding of the assumptions and limitations associated with a BMMF
- Use proactive / predictive processes to identify hazards
- Understand and monitor data on ongoing operations

(ATSB Final Report pp.7-9)

Lessons / reminders for regulators

- Develop effective methods for obtaining, storing and integrating information about operators and their operations (in order to develop effective surveillance plans)
- Consider the nature of an operator's activities and their inherent threats / hazards when scoping an audit

(ATSB Final Report pp.7-9)

Module 4: Case study

- Background
- The occurrence (history of the flight)
- Other factual information
- Findings
- Lessons