Halifax 5 presentation

Rob Lee

Safety Information Systems: Lessons from Aviation

Rob Lee, PhD

*There is no such thing as an accident. What we call by that name is the effect of some cause which we do not see*

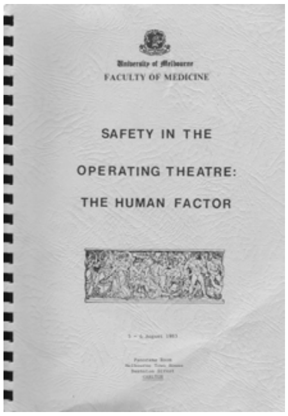
*- Voltaire*


Some history…

Safety in the Operating Theatre: The Human Factor

University of Melbourne, 1983

Course Director: David P. Crankshaw, Senior Lecturer in Anaesthetics, Dept of Surgery, Royal Melbourne Hospital




The 1983 Papers included

- An incident reporting facility – "If we cannot learn from history we are doomed to repeat it" Rubenstein

## HOW TO FIND OUT ABOUT WHAT IS GOING WRONG

**Safety and Quality in Healthcare**
**Monday 2 February 2004**

**WB Runciman**

**President, Australian Patient Safety Foundation**
**Member, Australian Council for Safety and Quality in Healthcare**
**Member, Australian Health Information Council**

## Advanced Incident Management System (AIMS)

**A computerised system for monitoring, analysing, reporting and managing problems ranging from near misses to sentinel events across the entire spectrum of health care**

In all industries involving complex systems made up of people and technology – 'sociotechnical' systems…

For almost every accident or incident, the subsequent investigation has shown that:

- The main contributing factors were present before it happened
- In some cases they were common knowledge, and many people were not surprised by what occurred
- In all cases, they could have, and should have, been identified and rectified before the accident or incident

- Often, critical information which could prevent an accident is known to one part of an organisation,
- But that information is not disseminated to other key parts of the organisation
- Because of the lack of an effective organisation-wide safety information system.

- To manage safely effectively, the management of an organisation must be fully aware of what is actually happening at all levels in the organisation
- In addition, staff at all levels need to be aware of what is going on in management with regard to safety
- All staff members, at all levels, in an organisation in some way contribute to its level of safety.

The human contribution to safety:

The negative dimension:

Considered systemically, the human factors contribution to accidents and incidents is close to 100%, for most well-defended sociotechnical systems

The human contribution to safety:

The positive dimension

It is also clear from operational experience and incident data that humans play the primary role in maintaining and enhancing the safety of the system

- which is hardly surprising, since people
  - design
  - build
  - operate
  - maintain
  - manage
  - regulate
  - finance

sociotechnical systems

- The physical hazards of aviation operations are well known
- But it is human factors which constitute the greatest area of risk
- Consequently, a comprehensive knowledge and understanding of human factors is essential when setting up a safety information system

Similarly,

- The physical hazards of the healthcare system are well known
- But it is human factors which constitute the greatest area of risk
- Consequently, a comprehensive knowledge and understanding of human factors is essential when setting up a safety information system

What is meant by the term 'human factors'?

The term 'human factors' refers to...

- the study of humans as components of complex systems made up of people and technology.
- these are often referred to as 'sociotechnical' systems.
- Healthcare is such a system

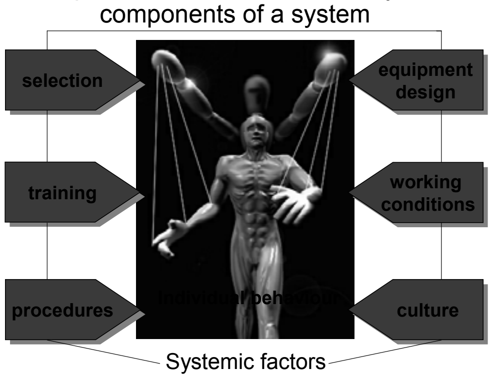
- human factors is concerned with understanding the performance capabilities and limitations of the individual human operator, as well as the collective role of all the people in the system which contribute to its output
  - which thus includes factors such as organisational, national, and professional cultures

- To use an ice hockey analogy, in the field of human factors, we are considering:
  - the capabilities and limitations of a single player (the individual)
  - and of the team as a whole (the system)

- a system can be defined as a collection of interconnected components consisting of people and technology, which interact to produce a given output (US SAE)
  - such as ‘safe, effective and efficient healthcare’
  - it can be made up of many sub systems
    - hospitals
    - equipment design and manufacture
    - training
    - maintenance

The systemic approach to safety

People are not autonomous, they are components of a system




- In all aspects of operations, including safety, we have learned in aviation that we must consider human performance, including human errors and violations, in the context of the total system of which the person,or people, are part

## Human factors in safety

- a change in emphasis from focusing primarily on the individual, to also include the system
- development of a practically useful theory of systems safety – James Reason
- the concept of the 'organisational accident'
- In civil aviation these changes have been reflected in ICAO Annex 13.
- The Australian Defence Force (ADF) has also applied these systems safety concepts in military aviation

## The Reason Model of Systems Safety

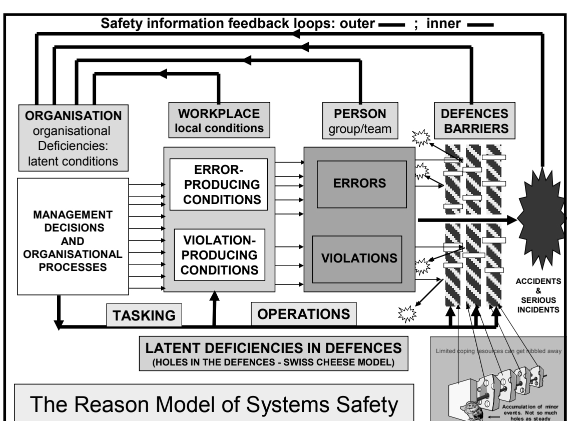
- Was originally developed in the 1980s by Professor James Reason, Department of Psychology, University of Manchester

- Since that time, James Reason and his colleagues have continued to develop the Reason Model, and its practical application, in various high technology industries, including healthcare
- It is fundamental to the nature and structure of safety information systems
- There are now a number of variations on the basic model

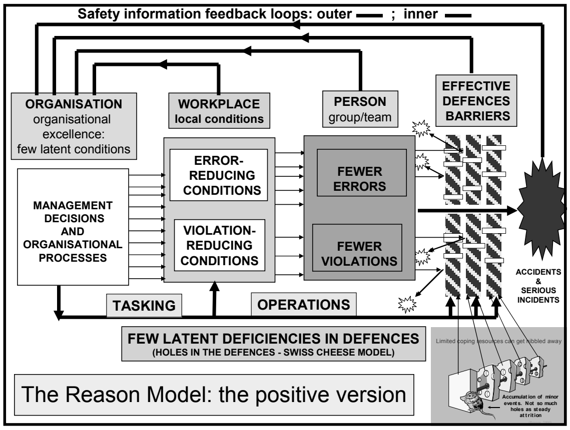
## Reason's model…

- is based on the study of catastrophic failures of complex systems made up of people and technology in many industries
  - Nuclear
  - Aerospace
  - Rail
  - Aviation
  - Petroleum
  - Marine

- The Reason Model now forms the basis of safety programs in several industries
- It is promoted by ICAO
- Most importantly, its practical application has been highly successful for over fifteen years
- It is used by Australian Transport Safety Bureau, beginning in the early 90s with its predecessor, the Bureau of Air Safety Investigation
- It is used by the Australian Defence Force




The Reason Model of Systems Safety




The Reason Model: the positive version

The Systemic Incident Analysis Model (SIAM)

A new approach to safety information

by the

Australian Bureau of Air Safety Investigation
(now the ATSB)

Rob Lee and Joanne De Landre

Safety reporting systems

- What is a safety reporting system?
- What is its purpose?
- These questions are critical, and **MUST** be answered before designing a new system, or evaluating an existing system
- What are your answers to these questions?

- the fundamental purpose of a safety reporting system is to enable us to determine where the overall system is most vulnerable (BASI)
- and, in this way, to determine where to focus our finite human, technological and financial resources, to obtain the most effective safety return for the total system - in our case, the aviation system
- These principles apply to all sociotechnical systems

- Traditional data base concepts are not adequate to support systemic safety analysis
- Progress in systems safety has been hindered by inherent limitations of the data that is typically collected in 'old style' reporting systems

- The Bureau's overall aim was to create a simpler and more effective safety information system to serve its purpose as a leading air safety investigation organisation

## SIAM

- was based upon an established and proven model of systems safety – the Reason Model
- not ‘ad hoc’
- innovative: no precedent
- SIAM is not a software package
  - It is a set of ideas which can be incorporated into any safety reporting system

- Why choose the Reason Model?
  - thoroughly proven in aviation and other high technology industries
  - integral to BASI investigation philosophy
  - supported by the International Civil Aviation Organisation

## SIAM

- was designed to capture **and add value** to information from high volume low detail occurrences - the only data category useful for statistical analysis
- a simpler system:
  - SIAM ‘ready reference sheet’
    - a single page instead of a thick manual

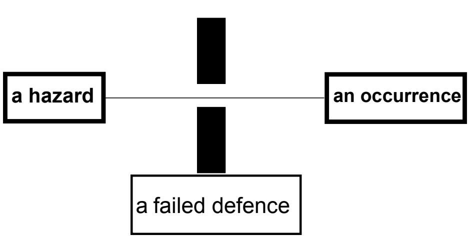
Appendix 1 – SIAM II Reference Sheet

SIAM (Systemic Incident Analysis Model) II

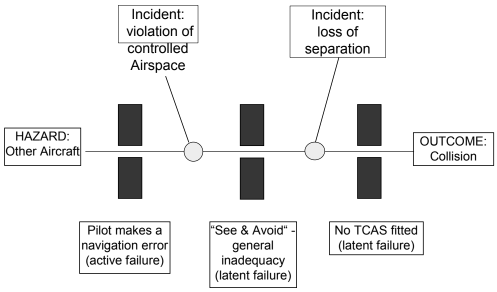
## SIAM - the basic concepts

- HAZARDS - potential for harm in some way
  - Hazards are contained, controlled and managed by :
- DEFENCES – 'hard' (engineered)
  'soft' (procedures, skills)
- OCCURRENCES - happen when defences fail

An occurrence happens when a hazard control (defence) fails



## An example from aviation




## SIAM - basic concepts

- air safety occurrences by definition mean that something in the system has gone wrong
- something serious may have **actually** happened - such as an accident
- something more serious **could** have happened if the situation had deteriorated further

## SIAM - basic concepts

- something **appeared** to have happened but did not: - it was a false alarm
- for example: a cargo compartment fire warning to the cockpit crew, but there was no actual fire

## SIAM - basic concepts

- A change in focus from **events** to their **outcomes**
- because it is the **outcome** of an occurrence which is most important to the safety of the system

## SIAM - basic concepts

- Event outcomes:
  - ✈ **REAL**
  - ✈ **POTENTIAL**
  - ✈ **APPARENT**

## SIAM: Types of outcome

- Real outcome
  - – an accident

## Potential Outcome

- a violation of controlled airspace (VCA) is the event - a mid-air collision in controlled airspace is the potential outcome
- A TCAS RA is the event – a mid-air collision is the potential outcome
- a wake turbulence encounter is the event - loss of controlled flight is the potential outcome

## Apparent Outcome

- ✈ a warning light indicates an apparent landing gear problem – but it turns out to be a false alarm
- ✈ A fire warning indicates an apparent engine fire – but it is a false alarm

## SIAM

Defences

- What features of the aviation system failed resulting in this outcome?

## Defences: examples -

- Aircraft features
  - monitoring / warning systems
  - airframe, inc gear / flight control warnings
  - transponders
  - engine and APU
  - avionics system
  - GPWS
  - stall warning
  - ACAS / TCAS

## Defences: examples, cont.-

Aerodrome features

- runway/taxiway layout/conditions
- lighting and marking
- animal and bird control
- security

Maintenance, Repair, Design and Construction

## Defences: examples cont. -

- Navigation
  - navigation equipment
  - charts
  - area familiarisation

## Defences: examples cont.-

- Flight Management
  - Fuel management
  - Aircraft Handling
  - Communication
    - Air to Air communications procedures
    - Air to Ground (not ATS) communications procedures
  - Flight Rule Related
    - other IFR procedures
    - other VFR procedures

## Defences: examples cont.-

- General procedures and standards
  - dispatch and loading procedures
  - acts, regulations, and orders
  - operations manuals and SOP's
  - handover/takeover procedures
  - briefing procedures
  - CRM/teamwork
  - passenger control / management

## Defences: examples cont.-

- ATS Procedures, facilities and standards
  - Co-ordination ("Ground-Ground")
  - Clearances and instructions
    - verbal
    - datalink
    - SID/STAR
    - other published instructions

## Defences: examples cont.-

- ATS procedures, facilities and standards cont...
  - Facilities (hardware and software)
    - TAAATS
      - TAAATS Alerts
      - TAAATS Hardware/Software
    - non-TAAATS ATS Facilities
    - procedures & Standards inc. separation
    - passing / Providing information
    - SARTIME

## Types of defence failures

active failure - a mistake/ error/violation by a person

latent failure - a generally weak, inadequate or missing defence

## Defence failures

- Latent Failures
  - ✈ defences not adequate for the job
    - incorrect instructions
    - non-functioning equipment
    - gaps in supervision
    - poor design
    - unworkable procedures
    - training shortfalls

## Defence failures

- Latent Failures
  - present for many years
  - arise from strategic decisions by management

- Active failures
  - when a good defence was circumvented due to errors or violations
    - pilot using wrong procedure
    - air traffic controller forgetting step in procedure
    - mechanic used wrong tool
    - flight engineer selecting incorrect sequence of fuel tanks
    - pilot overloading aircraft

## Defences

- Usually more than one layer of defences
- If some defences fail - incident
- If all defences fail - accident

Who made the mistake, error, or violation?

- ADSO
- ATS
- Cabin crew
- Dispatch and Ops
- FSO
- Maintenance
- Other
- Tech crew

What is likely to have contributed to the mistake/error/violation?

- Attitude / Motivation
- Distracting events / interruptions
- English language ability
- Environment (eg Noise, visibility)
- Equipment design / availability
- Fatigue / drowsiness
- High workload / concentration
- Interpersonal problems (at work)
- Low workload / boredom
- Medical / physiological factors
- Non work issues / preoccupation

Recovery measures

Detection - how was the problem revealed?

- GPWS
- ACAS/TCAS
- ATS noticed the problem
- Aircrew noticed the problem
- TAAATS
- A third party noticed the problem

What, if anything, limited the consequences in this occurrence?

- Equipment
  - fire extinguishing systems
  - other emergency equipment

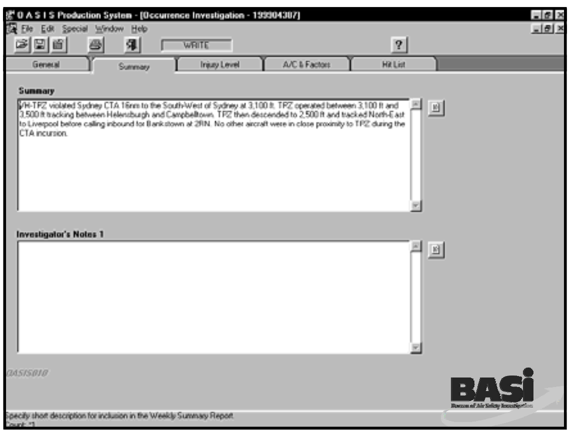
What, if anything, limited the consequences in this occurrence?

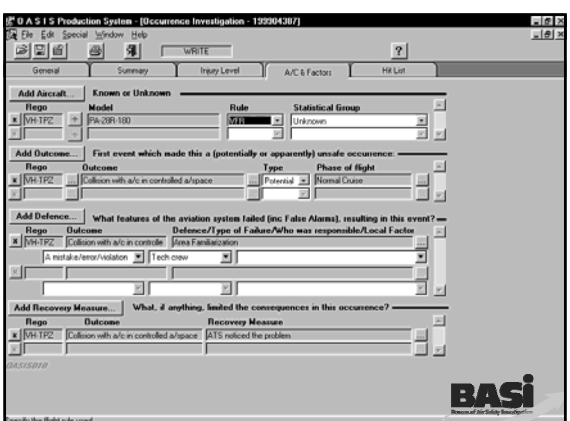
- Procedures
  - aircraft diversion or return
  - ATS radar/navigation assistance
  - evasive manoeuvre
  - rejected takeoff
  - go around/missed approach
  - emergency services/RFFS

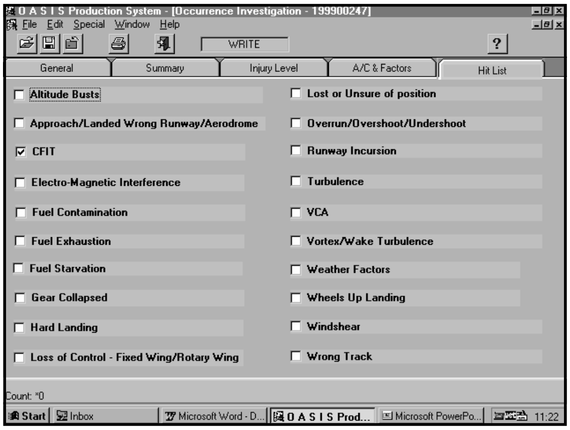
What, if anything, limited the consequences in this occurrence?

- chance?
- unlikely to have escalated anyway
  - little or no other traffic
  - non-critical item
  - low workload
  - low speed or ample height / time

Examples of the SIAM data entry screens:






## Interpretation and analysis of safety information

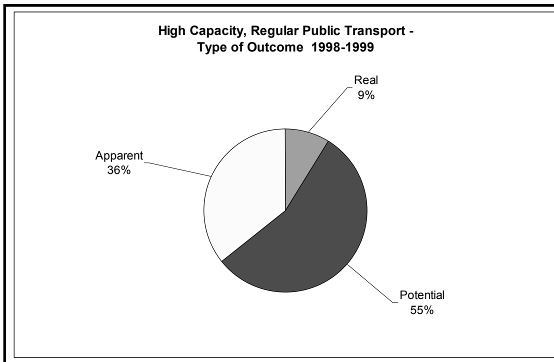
SIAM - Preliminary analysis of high capacity regular public transport incidents from July 1998 to June 1999

A total number of 2,239 incidents

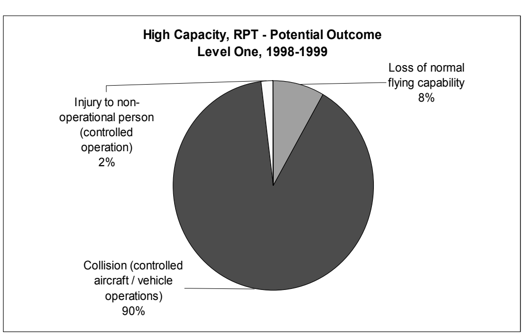
## SIAM - defence failure levels

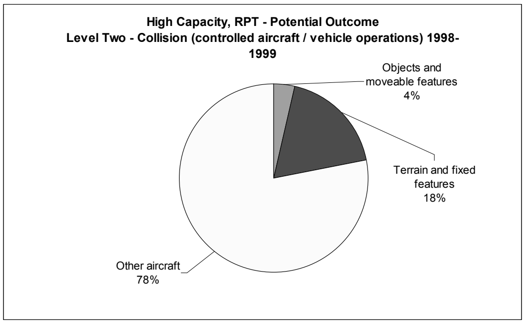
- Level One SIAM Failures are broad descriptions of defences
- Level Two SIAM Failures identify the components of each Level One category
- Level Three SIAM Failures identify in more detail the elements of the defence that failed

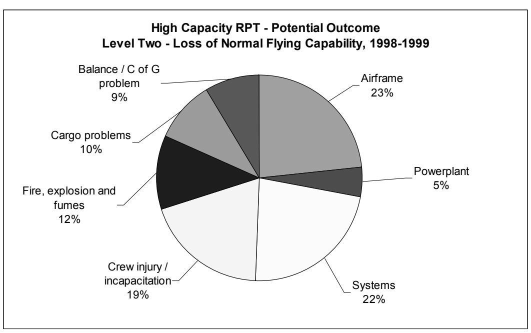
Type of outcome

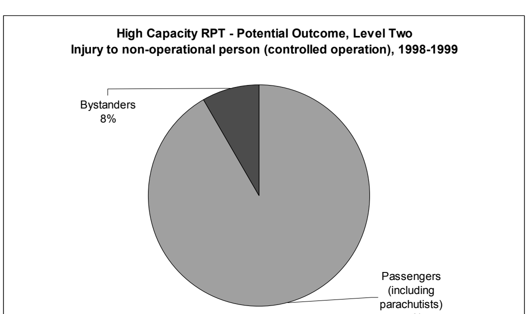



**NOTE : Of the 2,239 incidents studied, 202 (9%) involved 'real' outcomes, 1237 (55%) involved 'potential' outcomes and 800 (36%) involved 'apparent' outcomes.**



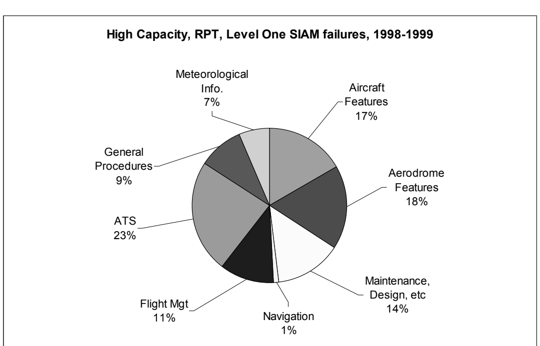

High Capacity, RPT - Potential Outcome
Level Two - Collision (controlled aircraft / vehicle operations) 1998-1999
Objects and moveable features 4%
Terrain and fixed features 18%
Other aircraft 78%


High Capacity RPT - Potential Outcome
Level Two - Loss of Normal Flying Capability, 1998-1999
Balance / C of G problem 9%
Airframe 23%
Cargo problems 10%
Powerplant 5%
Fire, explosion and fumes 12%
Crew injury / incapacitation 19%
Systems 22%


High Capacity RPT - Potential Outcome, Level Two
Injury to non-operational person (controlled operation), 1998-1999
Bystanders 8%
Passengers (including parachutists) 92%

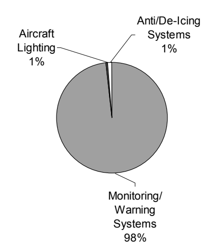
SIAM: Level One defence failures
(the total system)

What features, or 'defences', of the aviation system failed, resulting in this occurrence?



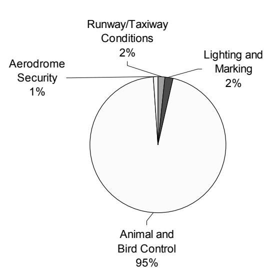
SIAM Level Two defence failures

High Capacity, RPT, Level Two SIAM failures - Aircraft Features, 1998-1999

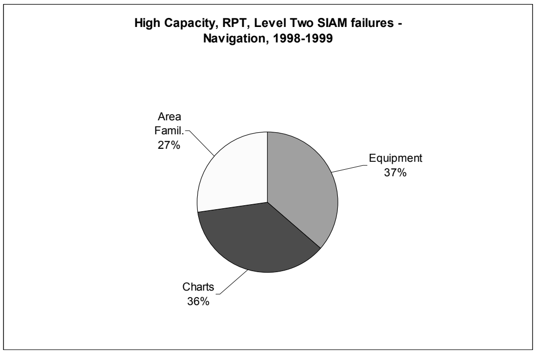



**NOTE : Failure of Aircraft Features was identified in 380 (17%) of the 2,239 incidents studied.**

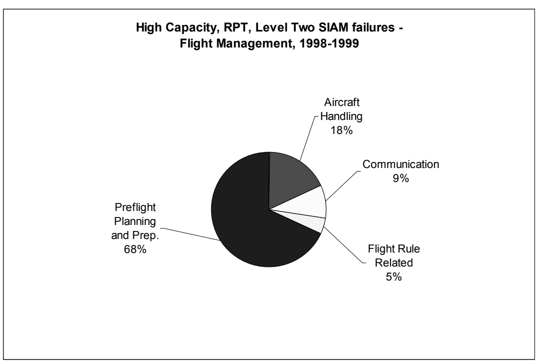
High Capacity, RPT, Level Two SIAM Failures - Aerodrome Features, 1998-1999



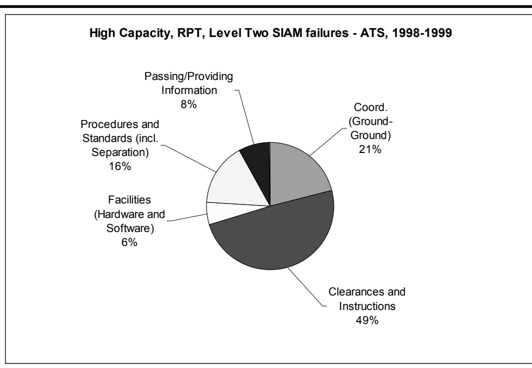

**NOTE : Failure of Aerodrome Features was identified in 403 (18%) of the 2,239 incidents studied.**




**NOTE : Navigation problems were identified in 22 (1%) of the 2,239 incidents studied.**

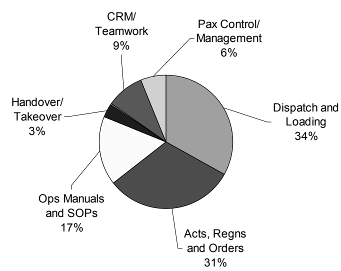



**NOTE : Flight Management Defence Failures were identified in 246 (11%) of the 2,239 incidents studied.**




**NOTE : ATS Defence Failures were identified in 514 (23%) of the 2,239 incidents studied.**

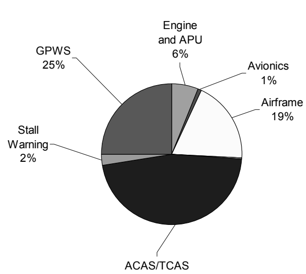
**High Capacity, RPT, Level Two SIAM failures - General Procedures and Standards, 1998-1999**



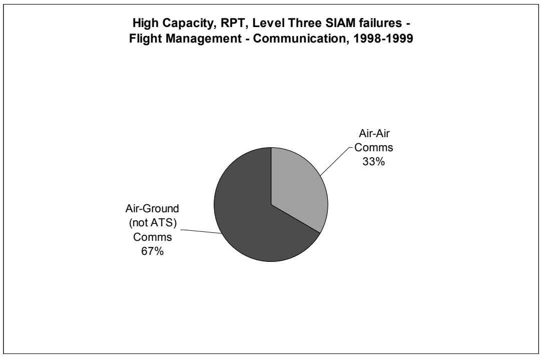

**NOTE : General Procedures and Standards Defence Failures were identified in 201 (9%) of the 2,239 incidents studied.**

SIAM Level Three defence failures

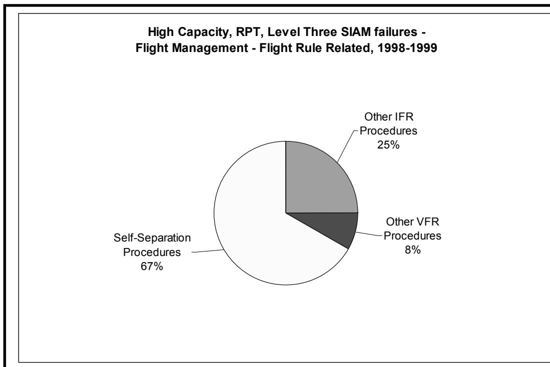
**High Capacity, RPT, Level Three SIAM failures - Aircraft Features - Monitoring/Warning Systems, 1998-1999**



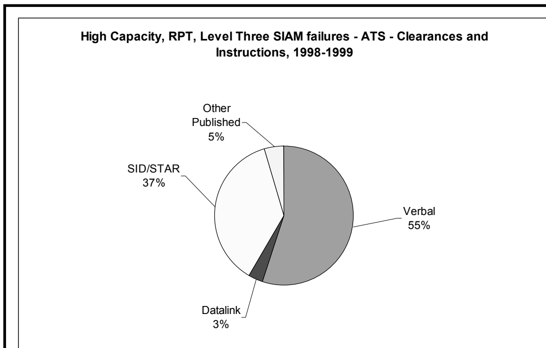

**NOTE : Aircraft Features (Level 1) Defence Failures were identified in 380 (17%) of the 2,239 incidents studied. Monitoring / Warning Systems (Level 2) Defence Failures were identified in 373 (98%) of the 380 Level Two Defence Failures.**




**NOTE : Flight Management (Level One) Defence Failures were identified in 246 (11%) of the 2,239 incidents studied. Communications (Level Two) Defence Failures were identified in 22 (9%) of the Level Two Defence Failures.**

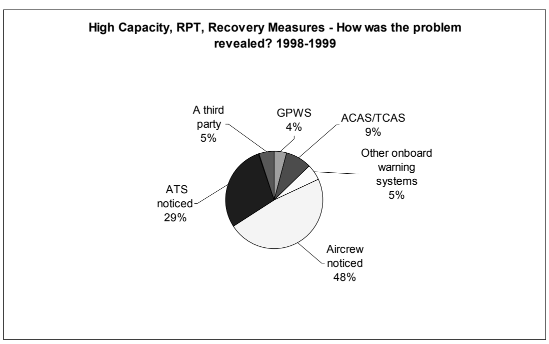



**NOTE : Flight Management (Level One) Defence Failures were identified in 246 (11%) of the 2,239 incidents studied. Flight Rule Related (Level Two) Defence Failures were identified in 12 (5%) of the Level Two Defence Failures.**

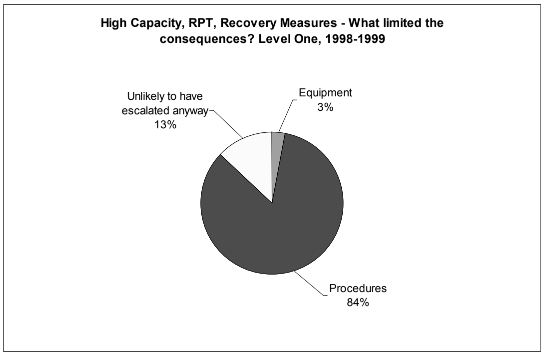



**NOTE : Air Traffic Services (Level One) Defence Failures were identified in 514 (23%) of the 2,239 incidents studied. Clearances and Instructions (Level Two) Defence Failures were identified in 252 (49%) of the Level Two Defence Failures.**

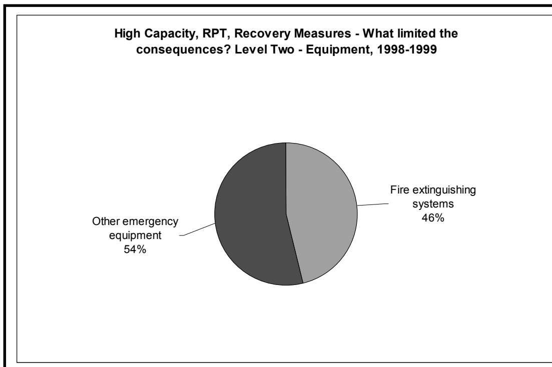
Recovery Measures: How was the problem revealed ?




Recovery Measures (Level One): What limited the consequences ?

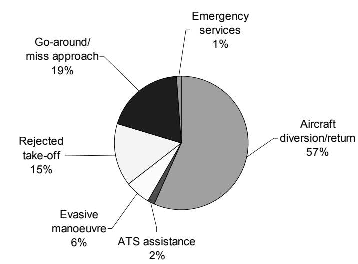



Recovery Measures (Level Two): What limited the consequences ?



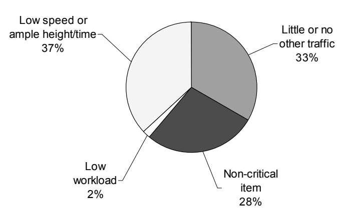

**NOTE : Equipment was identified as the Recovery Measure that Limited the Consequences in 67 (3%) of the 2,239 incidents studied.**

**High Capacity, RPT, Recovery Measures - What limited the consequences? Level Two - Procedures, 1998-1999**




**NOTE : Procedures were identified as the Recovery Measure that Limited the Consequences in1880 (84%) of the 2,239 incidents studied.**

**High Capacity, RPT, Recovery Measures - What limited the consequences? Level Two - "Unlikely to have escalated anyway", 1998-1999**




**NOTE : “Unlikely to have escalated anyway” was identified as the Recovery Measure that Limited the Consequences in 291 (13%) of the 2,239 incidents studied.**

## Conclusion

- SIAM development and evaluation was successfully completed over 18 months
- a new way of maximising the safety value of occurrence information
- a far more powerful tool for accident prevention and systems safety enhancement
- directly compatible with risk management systems

## Conclusion

- SIAM concepts can be incorporated into any incident reporting system
- identifies weaknesses in the system which need further investigation
- Note: SIAM does not provide a solution; it simply indicates where to look for latent conditions
- ATSB data base is presently being reviewed to see how it can be improved still further

## Some final points…

- The successful implementation of a safety reporting program depends upon:
  - senior management commitment
  - a willingness to report safety issues without fear of retribution – a 'just and fair' organisational culture
  - education and training of all personnel in the use of the system

- Feedback to reporters on the results of their reports
- Regular dissemination throughout the organisation of the results of analyses of the data.
  - this constant feedback to people is essential to positively reinforce their reporting attitudes and behaviour

- These lessons learned in aviation, and other high technology industries, can be readily applied to healthcare safety information systems
- With great practical benefits to the overall safety of the healthcare system

Thank you

*Lee and Burdekin Pty Ltd*