

# UK FLIGHT SAFETY COMMITTEE



## CARGO SUB COMMITTEE REPORT

### CABIN and CARGO COMPARTMENT IMAGE RECORDERS (2CIRs)

#### EXECUTIVE SUMMARY

The installation of Digital Video Image Recorders in the Cabin, Main Deck and all Belly Holds for the reasons given in the this report, would provide valid and vital information to the cockpit previously unavailable. The overall decision making process would be enhanced, providing increased security in both the cabin and the load carrying areas offering a higher degree of affordable safety.

UKFSC Cargo Sub Committee felt that it would be detrimental in both time and safety if current efforts in mounting cockpit cameras would detract from efforts and research afforded in mounting them behind the cockpit door.

Furthermore it is their view, shared by the Airline Pilots Association of America (ALPA), that cockpit cameras, for the use of crash investigation is a wholly reactive use, having little purposeful operational advantage to the living crew in preventing accidents.

#### RECOMMENDATION:

**THE UKFSC CARGO SUB COMMITTEE strongly recommends the eventual mandatory requirement for the fitting of Digital Video Imaging equipment in the Cabin and in all Cargo Carrying Areas for the increased safety of commercial transport.**



## Terms of Reference

The UKFSC Cargo Sub Committee decided to give due thought and consideration to encourage the Industry to introduce a proactive system to complement existing equipment that would enable quality information to reach the cockpit that would prevent an incident from becoming an accident.

It was found to be feasible and deemed desirable to install Digital Video Image Recorders in camera form using existing technology, available now on the market, in both the cabins of passenger and the main decks of cargo aircraft and in the belly holds of both.

This would allow:

- **Fire and Smoke verification** - this would enable smoke verification in both main deck and belly holds in the event of a smoke detector alarm.

Further uses have been discovered during the investigative processes that justify their installation that would prevent the following:

- **Air Piracy** – After 11 September 2001, when terrorists with B757s and B767s attacked the World Trade Centre, the Pentagon and crashed a fourth aircraft at Shanksville Pa. this mode of guerrilla warfare has affected the industry like no other previous threat.
- **Air Rage** - for cabin usage due to a disruptive passenger, and the active gathering of evidence in the case of a situation that gets out of control.
- **Damage Control** - Security and observation of damage control during loading and unloading.
- **Load shift detection** – the use of Movement Sensors to detect Palette movement early in the Takeoff Roll.

General credibility will soon be given to the idea, when Swissair publically announces that they are to fit digital cameras into the avionics, attic, cockpit overhead and the first class galley overhead areas.

## Background

In the world of marine transport, fire has always been the most feared of any emergency suffered at sea. However perhaps because of the speed of aircraft that



enables it to reach safety quickly, it has never been taken as seriously. Engines have fire detection and protection, as do Belly Holds in larger commercial transport but the main deck cargo areas of most freighters are fitted with smoke detectors only. Past history has constantly indicated that the crew can rarely control fire aloft and that the only escape is to land.

Standard current smoke checklists take at least 22 minutes to complete. With descent times of over 25 minutes required from the common transiting altitudes of jet aircraft and 14 minutes being the average time a crew can control an aircraft on fire, the equation for survival creates a paradox

History has shown that fire in the air has deadly consequences, often because crews have not fully appreciated the seriousness of their situation.

Why? The information to the cockpit has been either spurious (false alarm) or inadequate.



## History and Statistics

### **PASSENGER**

To illustrate the necessity for the requirement in fitting such equipment, the documented incidents under the following categories that have occurred in the past can be found in Appendix A

#### **Fire in Flight**

#### **Cargo - Fire and Smoke**

#### **Cargo – Load Shift**

#### **Cargo - Centre of Gravity**

#### **Security – Hijack**

#### **Fire in Flight – Passenger.**

Incidents involving passenger aircraft naturally command much media attention. Some of the best known and still remembered is the following, despite SV 006 being over 20 years ago. In both the Saudia and the Swissair the crew were not able to grasp the severity of the situation. Video information transmitted to the cockpit would have greatly aided the decision making process for the besieged cockpit crew.

<u>Period</u>	<u>No. of Incidents</u>		<u>Fatalities</u>
1957-1999	38		1846 (2184)
Examples:			
08.1980 - Saudia	L-1011	Riyadh	301 (301)
06.1983 - Air Canada	DC-9-32	Cincinnati	23 (46)
09.1998 - Swissair	MD-11	Halifax. NS	229 (229)

**Cargo Smoke and Fire - Cargo related**

<u>Period</u>	<u>No. of Incidents</u>	<u>Fatalities</u>
1961 - 1996	37	642 (695)

Examples:

06.1987 -	SAA	B747-244B	Indian Ocean	159(159)
05.1996 -	Valujet	DC-9-32	Florida	110 (110)
09.1996 -	Fedex	DC-10-10F	Stewart.NY.	0 (5)

**Past Smoke and Fire events – Cargo**

statements:

1. 28.11.1987 B 747, South African Airways 159 fatalities  
“It appeared that a fire had started in cargo pallet at position PR”
2. 11.05.1996 DC-9-32, ValuJet 110 fatalities  
‘Smoke generators caught fire – crew incapacitated’

PROBABLE CAUSE: The National Transportation Safety Board determined that the probable causes of the accident, which resulted from a fire in the airplane's class D cargo compartment that was initiated by the actuation of one or more oxygen generators being improperly carried as cargo, were:

- (1) The failure of SabreTech to properly prepare, package, and identify unexpended chemical oxygen generators before presenting them to ValuJet for carriage.
- (2) The failure of ValuJet to properly oversee its contract maintenance program to ensure compliance with maintenance, maintenance training, and hazardous materials requirements and practices; [...]



**Cargo Incident:**

05.09.1996 DC-10-10F, FedEx 0 (5) fatalities  
"An in-flight cargo fire of undetermined origin

ENROUTE MEMPHIS; TN - BOSTON – LOGAN, MA. AT FL .330.

- SMOKE DETECTORS Nrs. 7, 8 and 9 ILLUMINATED:
- EMERGENCY DESCENT INITIATED; EMERGENCY LANDING ON RWY 27 at SWF - 20 minutes later.
- CREW EXITED WITH DIFFICULTY – UNABLE TO OPEN EXIT 1L - DUE TO A/C STILL PRESSURISED.
- 3 CREW AND 2 PAX ESCAPED WITH ROPE BURNS.
- FIREFIGHTERS WERE UNABLE TO CONTROL FIRE. AFTER 4 HOURS:
- TAIL SECTION SEPARATED. A/C BURNT OUT AND TOTAL WRITE OFF

**Hijacking.**

Interestingly since 1952 the Committee could only find sparse statistics on Hijacking in the public domain, as only 16 incidents appear to have been officially documented. However other sources indicate that possibly due to maintaining public confidence, the media seem to either have become weary or plainly have other reporting priorities, because these expert sources indicate that this is still an ongoing problem and maintain that a Hijacking still takes place ONCE per WEEK.

<u>Period</u>	<u>No. of Incidents</u>	<u>Fatalities</u>
1952 - 1996	16? – (1 / Week !!)	597 (978)

Examples:

12.1994 – Air France	A 300-B2	Marseille	7 (170)
11.1996 - Ethiopian	B767-260ER	Comoro	125 (175)

There have been other well-documented incidents involving British Airways, Lufthansa (Mogadishu) and TWA.



**Air Piracy**

Period	No. of Incidents	Fatalities
	5	266

Examples:

	FEDEX	DC.10		0(4 – 3 injured)
11.09.01	AA 11	B 767	WTC. NY	92
11.09.01	UA 175	B767	WTC. NY	65
11.09.01	AA 77	B757	Pentagon Wa.	64
11.09.01	UA 93	B757	Shanksville.Pa	45

On 11 September 2001, terrorists commandeered two B757s and two B767s and crashed two into each of the World Trade Centre Towers, the Pentagon and crashed the fourth at Shanksville Pa. Such a scenario had not been foreseen by any of the security services. It may however surprise many, that this was not the first event of its kind. A disgruntled pilot deadheading on board a Fedex DC-10, on which he was qualified, attacked and seriously injured all three crewmembers and was only thwarted when the Captain, despite his injuries off balanced the attacker by violently manoeuvring the aircraft. The attacker’s goal was to take over the aircraft and fly it into the Fedex headquarters.



**What can be done?**

Special and highly confidential procedures could be introduced with each airline to combat such a threat.

There is little doubt that a covert camera mounted to observe the entrance area of an armoured cockpit door relayed to a multifunction display (MFD) in front of the cockpit crew who would control access through a remote electronic door locking system, would measurably increase the difficulty to cockpit access.

Further measures using aircraft systems and the high environment such as violent manoeuvres, emergency depressurisation, double interlocking cockpit doors, debilitating gas ingestion to name but a few would aid in combating the threat of unwanted cockpit access.

**Disruptive Passengers or Air Rage Incidents.**

A FAA official recently cautioned that ‘ there may be a lot more going on out there in the system than what is reflected in our numbers.’

From FAA reports for the last five years:-

<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>
185	320	282	310	266

ALPA believes the number of incidents worldwide could be closer to 10,000 per year.

UA (United Airlines) in 2000 experienced 737 incidents. In comparison with the figures from the FAA, it would seem great many incidents are going unreported, being largely at the discretion of the crewmember involved.

By UA are five categories reported:

1. Bomb Threats
2. Unauthorised Smoking
3. Criminal Acts (Interfering with the crew, damage to a/c and theft)
4. FAR violations (intoxication passenger, not complying with crew instructions, unauthorised use of electronic equipment).
5. Assault on crew (verbal or physical)

In the UK, alone at LHR (Heathrow) some 280 unruly passenger incidents were reported in the year 2000. Over 50% of these were alcohol related.



With overcrowding, aircraft congestion and slot problems all promising to be on the increase, the likelihood of an increase of disgruntled passengers must surely increase, and with it the incidents of Air Rage.

The recent incident in January 2001 on the BA flight LHR to NBO when a passenger stormed in to the cockpit and took over control of the aircraft, causing violent manoeuvres almost crashing the aircraft, merely illustrates the point how dangerous an out of control passenger can be.

The following points can be made:

- Airline passengers expect safety and security during their flight
- Flight Attendants are legally entitled to be protected from Assault
- The action of various individuals over the past year threatens this situation
- Over the past three years international airlines have witnessed a 400% increase in Air Rage incidents
- It is only a matter of time before one of these causes a major air accident After the events in New York on 11 September 2001, there is now a public call and demand for such measures and precautions. BA jet forced to land in Tenerife after a drunk passenger attempted to force his way onto the flight deck
- Flight diverted to Milan after a father and son on an Air 2000 flight fought with passengers
- A British businessman who threatened to kill the pilot of a BA airliner and head-butt a fellow passenger was fined nearly £6,700 in May.

### **Security problems**

The daily life of a cabin crew can be difficult, tiring and sometimes dangerous.



For example:

1. ' She asked me to sit down but I didn't like the way she said it. She was aggressive so I did her."
2. "I was screaming for my colleague to help. He continued to bash the bottle across my back. I thought he was going to kill me. I was just trying to do my job."
3. "He told an air stewardess he would chop her hands off and banged on the flight deck door as the pilot brought the plane in to land."

There are increasingly more and more incidents being reported and calls for Critical Stress Incident handling (CISM) are on the rise. One major airline in Europe is fielding four such debriefings each month. 50% being passenger source related.

### **Other Perspectives.**

#### **CARGO.**

Within the Cargo community there are daily incidents involving:-

- Onloading and offloading damage to aircraft.
- Wrongly calculated loadsheets
- Resultant Forward and Aft Centre of Gravity (C of G) problems for the pilots. When gravely wrong, this is then manifested by too early rotation (C of G too AFT) or too late (C of G too FWD), thereby sometimes experiencing VR at VR + 10 or VR + 15 Knots before actual rotation is achieved (hopefully). There is no current system available today that gives the pilots any early warning of such conditions. Cockpit crew detection is only experienced very late (aft) or too late (fwd) during the takeoff roll and rejecting techniques for these two situations are seldom trained.
- Tailtipping during loading.



All these incidents are seemingly part of the perception in the Cargo community in the cost of doing business (C of D B).

However Digital Video cameras together with the associated system, able to store 16 hours of data, could be used for evidential gathering in insurance reclamation in the case of loading damage.

Movement sensors could be used for Palette or load shift during takeoff and during cruise.

Live animal transport could be monitored. E.g. Horse Charters.

Smoke or Fire verification in the Belly Holds and on the Main Deck after a cockpit crew receives a Smoke detector warning could be carried out from the cockpit using either EICAS or a multi function display (MFD). Present smoke warnings are often inaccurate and sometimes spurious due to sweating animals and certain pungent fruit exuding strong fumes in an enclosed space.

Dangerous cargo could be monitored during flight.

**Load Shift**

<u>Period</u>	<u>Incidents</u>	<u>Fatalities</u>
1961-1997	14 (cfmd!!)	72 (77)

**Cargo Centre of Gravity**

<u>Period</u>	<u>Incidents</u>	<u>Fatalities</u>
1962-1997	26	198 (567)

Lack of true statistics (few Cargo companies keep them although this is changing) due to: -

- Cargo origin - no real media interest
- A/C trim envelope redundancy protects almost all incidents
- LCAG – 4 incidents in last 3 months – ongoing.(C of D B?). Palette Locks.



- LH - B 737 QC – ROM. 6 Tonnes falsely loaded Fwd C of GFEDEX & LCAG – TAILTIPPING dangers (B 747F & DC-8 F)

### Load Shift

This is a constant source of concern for specialist freighter pilots.

For instance.-

An Emery DC-8- 71 F in February 2000 took off from Sacramento Mather Airport at 19:45 hours. The crew reported handling problems and at 19:49 crashed into an Auto junkyard, with the loss of all three crewmembers.

Load shift on takeoff was suspected.

Being a cargo aircraft, the Press attention was naturally short lived. From the examples above even the well-known airlines suffer from these dangers, especially with the outsourcing of services, the associated ground personnel have neither the identity nor the motivation with the Company they are contracted to.

### What can we do?

Some of the following statements may help to concentrate the required thought process:

Passenger orientation.

- Flight Attendants and Passengers cannot be expected to testify against violent thugs. Pilots are not trained as Security men nor Policemen and should not be expected to react as such. No cockpit crewmember should be expected to jeopardise neither himself nor herself nor the operation by leaving their position for verification purposes. ICAO Rules clearly state that drunken passengers are a danger to the flight. Local Police attitudes vary from country to country.
- Stories told by witnesses vary.
- Ejected passengers have threatened to take legal action against the airline.

Cargo orientation



- Cockpit crews require more accurate and immediate information in the cockpit to aid in their decision making process
- No cockpit crewmember should be expected to jeopardise neither himself nor herself nor the operation by leaving their position for verification purposes.
- Load Shift on takeoff should be manifested to the crew immediately on occurrence
- Rejected takeoff awareness due to C of G problems should be heightened and trained.



## Solutions

### Digital Video Cameras

The use of Closed Circuit Television can be utilised to help in all these problems:

#### Why?

- Closed Circuit TV monitoring is now widely accepted
  - Used every day in city centres, shopping malls, and airports
  
  - An acceptable way of controlling crime
  - TV pictures used in court need little back up from witnesses
  - Overt CCTV Systems form a potent deterrent to the would-be thug
- Cargo Operations have areas that could use CCTV to very good effect

#### The Advantages.

- Comprehensive Security
- High Reliability
- Low Maintenance
- Simple, User Friendly Interface
- Password Protected
- Courtroom Proven Recordings
- Overt and/or Covert Camera installation



## Cabin – Passenger

Digital external and internal cameras are available on the market today, and are being fitted to some Boeing Business Jets (BBJ). Corporate customers for the BBJ, presently being outfitted by Lufthansa Technik (LHT) in Hamburg, have ordered two sets of external cameras for security use.

Internal cameras with optical or digital recording mediums could be used for the recording and storage of Air Rage activity gathering evidence for use in later prosecutions. The possible retrieval of costs from the perpetrator(s) would partially recover the cost of purchase and installation.

It would be highly desirable if digital video recording information from covert positioned cameras could be transmitted by satellite to the Security forces to aid them in intelligence gathering.

This technology is available now as part of the external and internal security observation requirement, mostly being ordered by State and VIP Corporate aircraft, at the moment.

This security watch does not have to be on site, with the information being downlinked through PTSN and ISDN telecommunication means and thereby through secure Intranet communication links.

Summary –Passenger fit.

- Up to ten (10) closed circuit TV cameras, dependent on aircraft size.
- Full coverage throughout the passenger cabin Configuration can be customised to aircraft operator's requirements
- State of the Art Digital Video Recorder:

Digital cameras in the cabin can be triggered from:

Flight Attendant Panic Button

Seat Belt Indication

Any other available signal

There is also psychological support in the presence of Cabin cameras in that the passenger may well feel behoven to behave when overt cameras are visible. The Flight Attendant may also feel more secure in the knowledge that there is some form of extra help on board and that they are not totally alone.



## Cargo – Main Deck

The same video technology and system can offer silent and constant observation and verification at the time of a smoke alarm. This would negate the need to lose a crewmember from the cockpit for the incalculable risk of a visible inspection. The fact of allowing part of the operating crew to leave the cockpit at a time of a possible emergency, when crews are under pressure and high workload, to visually verify the alarm, makes no sense. This could result in losing the inspecting crewmember to total incapacitation due to oxygen starvation while fire fighting or due to smoke inhalation.

Cameras or video cameras could be fitted in the main Deck of Cargo aircraft, which would be connected to the lighting system, or even without lighting should infrared cameras be used.

A small monitor with multiscreen function fitted in the cockpit, would be switched on after a Smoke Detector alarm has activated, allowing the cockpit crew to verify the alarm visually as either spurious or real. The crew would not need to be separated from his or her proper oxygen equipment nor leave his or her seats, removing the necessity of someone entering a dangerous area. Emergency procedures would be enacted with the full crew complement.

In the belly cargo areas a cheaper monochrome low light video camera would be used. These similarly would be connected to the same monitor in the cockpit or paged into the EICAS on suitably equipped aircraft.

By expediently acting upon information received, a serious incident would be controlled, preventing the situation escalating into a certain accident.

This would enable a **proactive** use of information allowing an incident to be acted upon with expediency rather than waste vital time in the verification process.

Internal cameras could be used in evidential gathering during loading for observation and load damage control and insurance reclamation.



**Cargo summary:**

- Silent observation and verification at the time of a smoke alarm
- Negate the risk of a crewmember having to do a visual inspection and losing them to perhaps incapacitation or even death.
- 100% crew available for the emergency handling of the procedures and the actual aircraft.
- Damage control during on and off loading. Stored evidence for subsequent reclamation.
  
- Belly Holds afforded the same security.

**Load Shift.**

Detection through the use of Video Motion Detection using programmed Activity Dwell Time.

The Dwell time could be adjusted as desired. Movement during takeoff would require interval somewhat faster than that required for intruder movement when the same technology is used for external aircraft security.

Detection through Video Motion Detection.

- 6 Cam system - e.g. # 4 detects.
- Update sequence:- 1, 4, 2, 4, 3, 4, 5, 4, 6, 4
- Programmed through Activity Dwell Time  
(adapted from external security system)

Prevents:

- High Speed Rejected Takeoffs for excess aft C of G.
  - i. detection at initial throttle application.
  - ii. possible incorporation with T/O Configuration Warning system?
- Main gear tyre replacement due to thermal plug activation after a rejected T/O would be avoided. A B747 has sixteen tyres, an expensive proposition.
  
- Subsequent technical delays would be avoided.

The cost savings in rejecting a takeoff in the low speed regime (below 80 knots) and thereby saving the total replacement of main gear tyres due to thermal plug



protection, not to mention the very known and proven dangers associated with high speed aborted takeoffs, are only too obvious.

### **Video Data Retrieval.**

Not only can this digital data be stored, erased when not required but equally transmitted using all modern telecommunications, both ground line as well as satellite.

A further advantage is that with the data being multiplexed, digitally compressed and recorded onto an integral hard disk, together with referenced entries as to time, date, title and duration of incident, renders tampering impossible. The British Legal System has accepted this type of digital video information as submissible in a court of law.

Recordings can be:

- Reviewed from a laptop PC on board the aircraft
- Removed on hard drive for later review
- Available to Security Staff:
- Inspected at the airport
- Transmitted to the Company offices and reviewed.

Further advantages with digital recordings:

- They are robust

They do not degenerate with: -

- Viewing
- Copying
- Re-recording

And is

- Tamper proof = Courtroom approved
- Widely used in high security applications  
Low maintenance  
No tapes to change  
or heads to clean

### **The Cost**

**2CIRs**



NARROW BODIED AIRCRAFT	5 Cam	c. \$ 60,000
WIDE BODIED AIRCRAFT	10 Cam	c. \$ 75,000
Complete aircraft	Wide Body	c. \$ 130,000
Colour Video Camera - Cabin and Main deck		c. \$ 12,000
Monochrome Camera - Belly Holds		c. \$ 7,000

**Is this technology available and is anyone doing it now?**

- US Military KC 135 Tankers for the Fuel Boom operators.
- US Military – Airborne Laser Program
- For external security use – State and VIP Corporate Operators – BBJ

Swissair, having extensively researched this medium has decided to fit digital cameras in inaccessible areas for fire and smoke detection in 19 MD-11s. These areas include the roof above the first class galley and passenger area, the attic and the avionics compartment. Once completed Swissair has plans to incorporate the camera upgrades on all its fleet of 57 Airbus Industrie aircraft as soon as the work on MD-11s is finished.

**Is anyone else interested?**

- FEDEX
- UPS is presently researching the feasibility also incorporating its truck fleet

**WHY?**

A PROACTIVE system that provides information that is lacking today.  
Safeguards the cockpit crew from likely incapacitation during inspections.  
Aids in preventing an Incident from becoming an Accident.  
Reassures Cabin crews that they are not alone.  
Overt Cabin cameras could serve as a deterrent to bad on board behaviour.



## Executive Summary

See on page 1 of 18

## Recommendations

See on page 1 of 18

End of report.

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