NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

5/20/2012

FIRE INVESTIGATION FACTUAL REPORT Report No. 11-061

A. ACCIDENT INFORMATION

Place	:	Dubai, UAE
Date	:	9/3/2010
Vehicle	:	Boeing 747-400F
NTSB No.	:	DCA10RA092
Investigator	:	Bill English

B. GROUP MEMBERS

Joseph Panagiotou	NTSB	Chairman
David Blake	FAA	Member
Al Carlo	Boeing	Member
Douglas Ferguson	Boeing	Member
Ken Hoff	UPS	Member
Mike Thomas	UPS	Member

C. ACCIDENT SUMMARY

On September 3, 2010 at about 8:10 pm local time (1610 UTC), UPS Flight 6, a Boeing 747-400F (N571UP), crashed while attempting an emergency landing at Dubai International Airport (DXB), Dubai, United Arab Emirates (UAE). The flight had departed from Dubai approximately 45-minutes earlier enroot to Cologne, Germany, and returned after the crew declared an emergency and reported smoke and fire. The airplane impacted inside an Emirati army post, approximately 9 miles from Dubai's international airport. The two flight crew members were fatally injured, there were no ground injuries, and the airplane was destroyed by impact and fire. The investigation is being led by the UAE General Civil Aviation Authority (GCAA).

D. DETAILS OF THE INVESTIGATION

Accident Scene Description

The accident aircraft impacted the ground inside the confines of a military base near Dubai, United Arab Emirates. The debris field was approximately 1700 feet long. During the

impact, the aircraft destroyed an unknown number of buildings and trucks. There was an extensive post crash fire which consumed the bulk of the aircraft and cargo (figure 1).

Figure 1: Overall view of the debris field, looking back towards the initial impact location

The debris field was classified into two distinct zones, one where the debris was subjected to a post crash ground fire, and the other where the debris was found outside of the post crash fire zone. The flight, which had departed from the Dubai international airport was fully loaded with cargo on the main deck cargo compartment and the below deck cargo compartments. An account of the cargo container types and their positions on the aircraft can be found in the cargo group's factual report.

The cargo containers and pallets were all destroyed by the impact forces and post crash fire. The few recognizable parts of the containers and pallets were base plates (figure 2) and a few doors (figure 3). All of the pieces identified as being parts of containers and pallets were examined for recognizable in-flight fire damage. Due to the severe post crash fire damage to these components, no particular in-flight fire characteristics were observed. The contents of the cargo containers were spread throughout the debris field, both inside and outside the post crash fire zone. Details about the cargo contents, as declared by the shippers and contained within the cargo manifest, can be found in the cargo group's factual report.

Wreckage Examination

The on-scene wreckage examination focused on items found on the border and outside of the main post crash fire zone. These items were aircraft structure with thermal damage and soot patterns believed to be consistent with damage occurring prior to the aircraft's impact and not artifacts of the post crash fire. The locations from where these items originated on the aircraft are shown in the following two diagrams of the aircraft's

outline (figures 4 & 5). Each of the identified items is numbered on the two diagrams including whether the item was internal aircraft component or external.

Figure 2: Cargo container base plate

Figure 3: Cargo container door

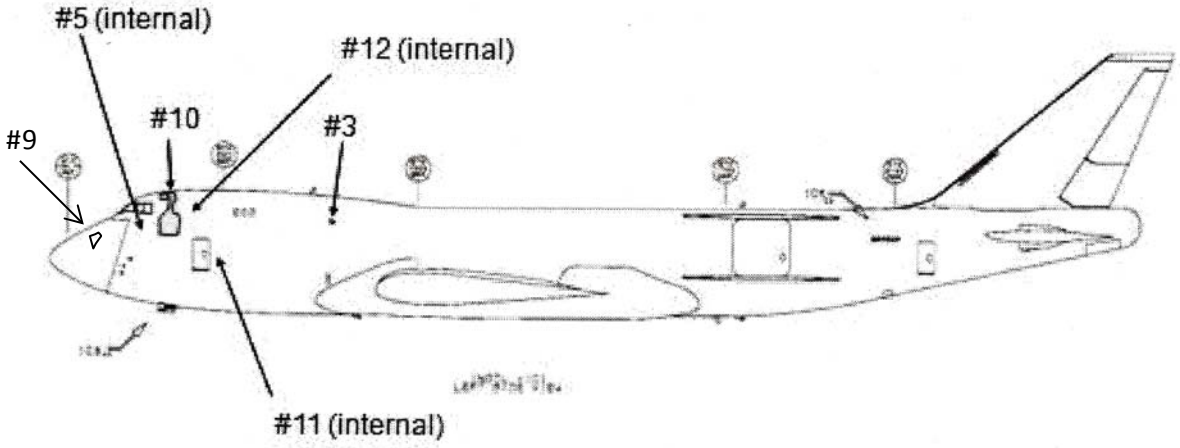

Figure 4: Left hand side outline of accident aircraft depicting locations of identified items

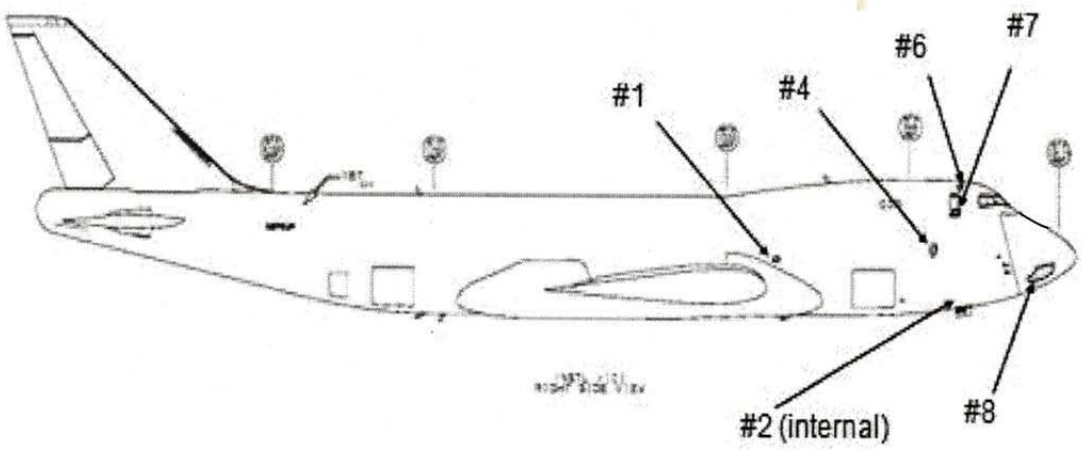

Figure 5: Right hand side of accident aircraft depicting locations of identified items

#1: Fuselage observation window	#7: Hinge casting
#2: Cover from power distribution center	#8: Part of nose door (lower)
#3: Fuselage skin	#9: Part of nose door (upper)
#4: Fuselage skin & structure	#10: Portion of structure and fuselage skin
#5: Structure with pulley attached	#11: Stair to flight deck
#6: Fuselage skin with smoke shutter cutout	#12: Shelf from galley cabinet

Table 1 List of items identified in figures 4 & 5

#1: Fuselage observation window (figure 6)

The piece of the fuselage observation window, or viewport, had sooting around the viewport opening and the viewport seal was charred and reduced to a white powder. An area of the green primer had evidence of thermal degradation of the primer paint. The level of damage sustained by the viewport window and seal in contrast to the level of damage to the surrounding material and primer paint is consistent with the thermal exposure having occurred while the viewport was covered by the bezel leaving only the window portion exposed to the interior of the main deck cargo compartment. This viewport was located on the right side of the aircraft at approximate station number 840, which is also cargo position 6R (figure 7).

Figure 6: Fuselage viewport

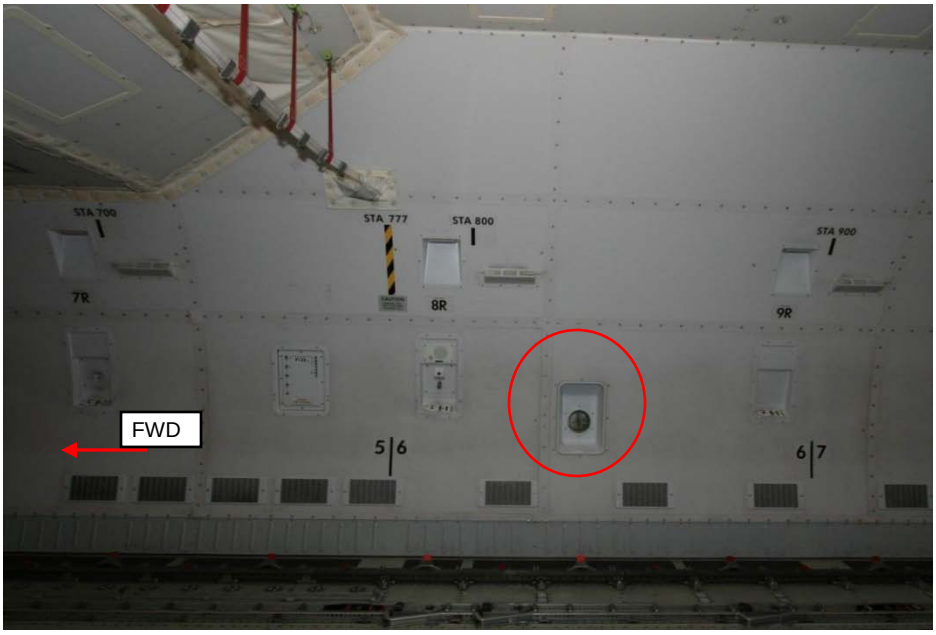

Figure 7: Viewport (with trim bezel) in exemplar aircraft.

#2: Cover from power distribution center (figure 8)

The cover from the power distribution center right was found to have a light sooting on the exterior and interior surfaces. There was no thermal degradation associated with this component which would have been located at approximately body station 420 on the lower lobe.

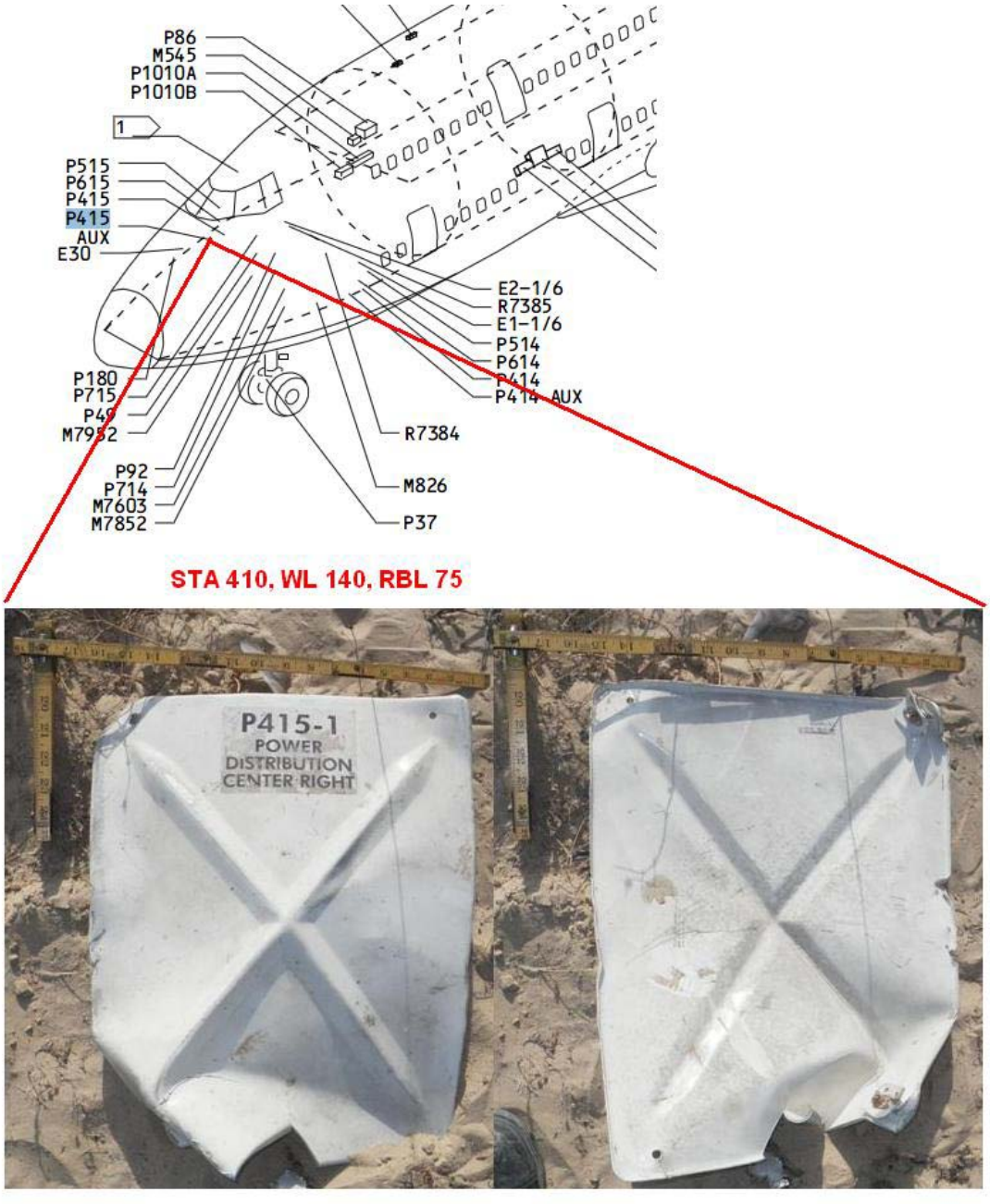

Figure 8: Cover from power distribution center

#3 Fuselage skin (figure 9)

The fuselage skin piece was a heavy gauge (~.125") skin piece from fuselage. On the interior surface there is sooted corrosion inhibiting compound (CIC) around a protected surface which became exposed after the aircraft breakup (left photo in figure 9). On the exterior surface of this part is a portion of lettering identified as belonging to the letter "V" (right photo in figure 9) from the text "Worldwide Services" displayed along the upper lobe on the left side of the aircraft (figure 10).

Figure 9: Fuselage skin piece

Figure 10: Text on exemplar aircraft exterior

#4 Fuselage skin and structure (figure 11)

The fuselage skin and structure piece originated from the right hand side of the aircraft's fuselage skin between station 460 and 488 and somewhere between stringer 17 and 24. This item was found to have soot trapped within impact induced folds.

Figure 11: Fuselage skin and structure piece

#5 Structure with pulley (figure 12)

The portion of structure with pulley was found to have heavy sooting on one side while being relatively devoid of soot on the other. This item would have been at a location described by, LBL 40, WL 302, station 287 25sv0012.

Figure 12: Structure piece with pulley (showing both sides)

#6: Fuselage skin with smoke shutter cutout (figure 13)

The portion of fuselage skin contained the cutout for the flight deck's smoke evacuation shutter. The actual smoke shutter had separated from this portion of the fuselage. A very thick soot trail almost resembling tar extended from the cutout location aft to the end of the recovered portion of fuselage. A photo of an exemplar smoke shutter and cutout is shown in figure 14.

Figure 13: Fuselage skin piece with smoke shutter cutout (interior on the left, exterior on the right)

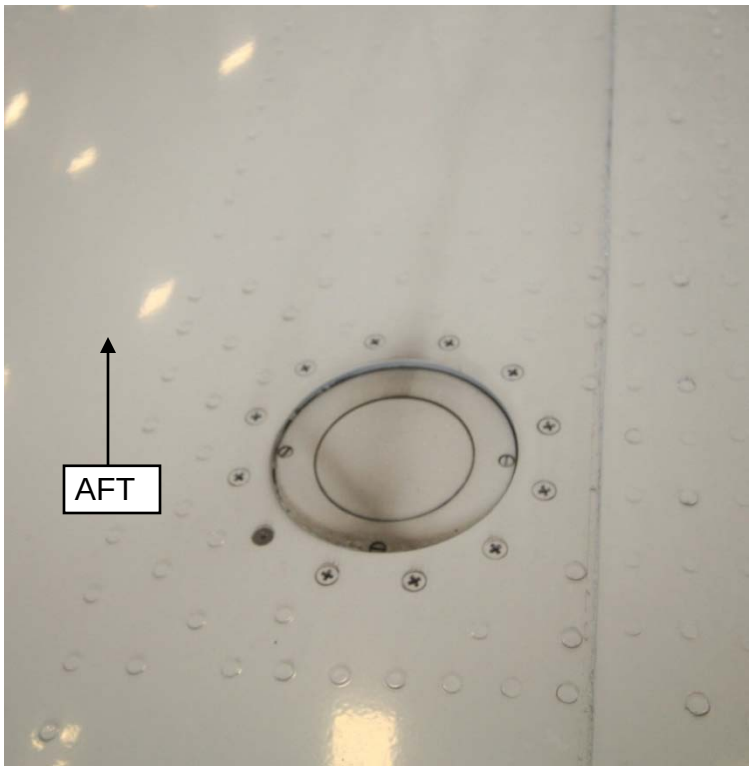

Figure 14: Smoke shutter fuselage cutout from exemplar aircraft

#7 Hinge casting (figure 15)

The hinge casting (PN:65b14006-3) piece was found with soot on one side and clean on the other. This item belonged to the escape slide mechanism on the right side of the upper lobe just aft of the flight deck (figure 5).

Figure 15: Hinge casting piece

#8 Portion of nose door (lower)

This portion of the nose door (figure 16) was from the lower part of nose door on the right hand side near station 180. This item exhibited localized charring of the primer and some burnt insulation in the area shown circled in figure 16.

Figure 16: Portion of nose door (lower right hand side)

#9 Portion of nose door (upper)

This portion of nose door (figure 17) was from the upper portion of the door on the left hand side approximately between stations 160 to 200. This piece exhibited some localized discoloration of primer shown circled in figure 17.

Figure 17: Portion of nose door (upper)

#10 Portion of structure and fuselage skin (figure 18)

This portion of structure and fuselage skin originated from the left hand side, upper section 41, Station 360 – 420. There was heavy fire damage in the form of charred insulation and primer paint between stations 360 and 380 stopping at the level of the upper deck floor (figure 18). The fire-damaged area contained TCAS coax cables and an air vent hose.

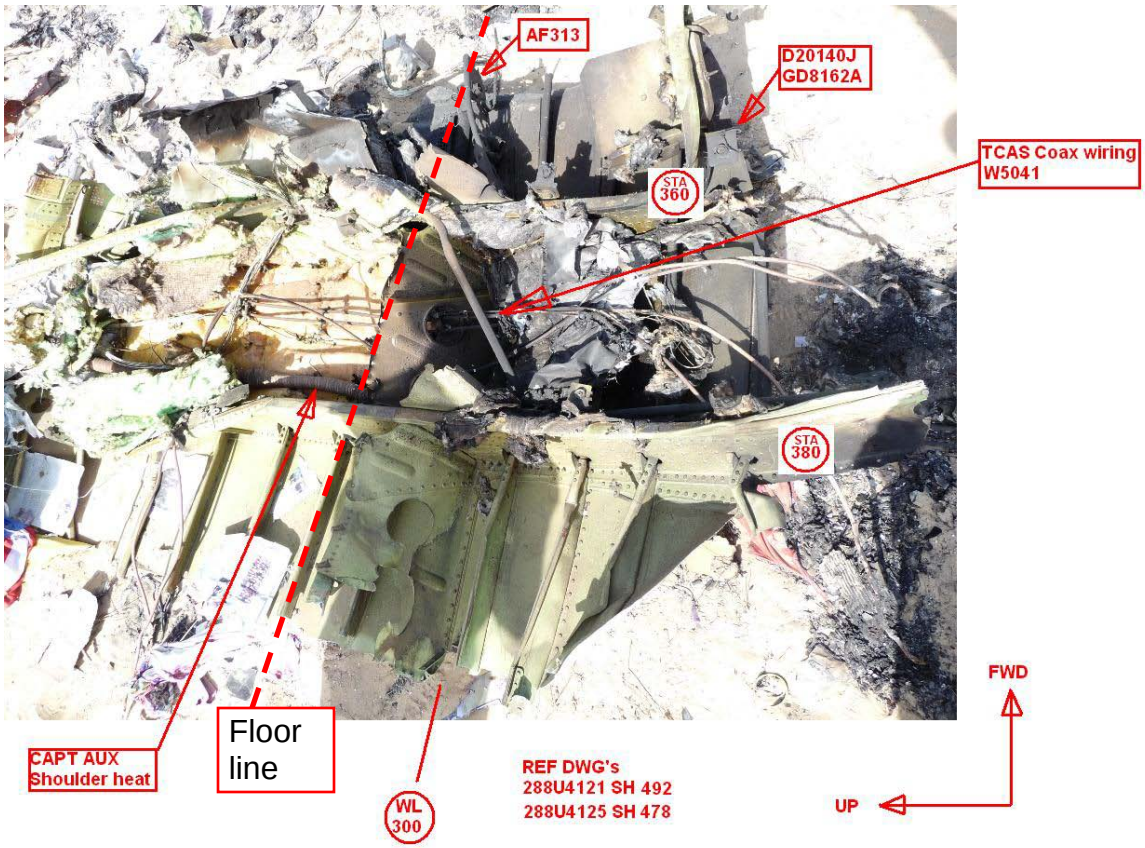

Figure 18: Portion of structure and fuselage skin

#11 Stairs to the flight deck (figure 19)

The stairs to the flight deck extend from the floor of the main cargo deck up to the upper deck. The stairs have sooting at the top portion of the stairs which then tapers off towards the bottom. This soot graduation is consistent with a stratified smoke layer existing within the main cargo deck. The demarcation of sooting on the stairs suggests a smoke layer extending to the height shown by the dotted line in figure 20.

Figure 19: Stairs to the flight deck

Figure 20: Exemplar interior showing stairs to the flight deck and a dotted line showing the level of the smoke layer

#12 Shelf from galley cabinet (figure 21)

The shelf originated from the cabinet behind flight deck bulkhead (figure 22). The shelf has heavy soot stains around outlines of items that had been sitting on the shelf during flight (figure 21).

Figure 21: Shelf from galley cabinet

Figure 22: Galley shelf behind flight deck bulkhead in exemplar aircraft

Main Deck Cargo Compartment Fire Protection Systems

Smoke Detection

The main cargo smoke detection system is a draw-through air sampling system. A venturi ejector using bleed air creates a vacuum which pulls the sample air through the system. Multiple pick-up points are provided throughout the main deck cargo compartment. The main cargo compartment is divided into sixteen smoke zones No. 1 - 16. Zones 1 through 7 are connected to the FWD venturi ejector and zones 8 through 16 are connected to the AFT venturi ejector. The smoke sampling ports in each smoke zone are connected to two detectors connected in dual loop "AND" logic configuration. These dual detectors are installed in main deck cargo compartment. There are six sampling ports located in smoke zones 1, 2, 3, 4, 5, 7, 11, 12, 13, 14, 15, and 16. There are five sampling ports located in smoke zones 6, 8, and 9. Smoke zone 10 has five sampling ports if there is no Satcom, but it has six sampling ports if Satcom is installed. Zones 1 though 8 have individual sampling ports to sample the air. Zones 10 and 13 through 16 have orifices located in piccolo tubes attached to the interior of the ceiling panels. Zones 9, 11 and 12 use a combination of individual sampling ports and piccolo tubes for air sampling.

The detection systems use dc power from 28-volt dc bus No. 2 and No. 4. The system circuit breaker is located on P7 and P6 overhead circuit breaker panel respectively.

The smoke detection systems give the flight crew visual and/or aural indications of abnormal conditions in the main deck compartment and lower cargo compartments.

The generated signal will create master fire warning light, fire bell, warning, and advisory EICAS (engine indicating and crew alerting system) messages. The fire warning bell sound comes from 2 multi-purpose speakers in flight deck. The master fire warning light indicators are located above captain and first officer's main instrument panels.

Fire Suppression

The freighter main deck has fire suppression procedures which conform to FAA class "E" compartment requirements and the established Boeing fire suppression procedures. Following smoke detection, air inflow shut-off is accomplished. The airplane descends or ascends to 20,000 to 25,000 feet altitude. The guarded fire suppression "DEPRESS/DISCH" switch initiates a depressurization of the entire airplane at a rate of approximately 9,000 ft/min to a final cabin pressure of 20,000 to 25,000 feet.

The cabin is depressurized to a slightly higher pressure than ambient to ensure the negative pressure relief valves are shut during the steady state fire suppression mode. The ambient oxygen content, pressure and temperature conditions are reduced at 25,000 feet altitude as compared to lower altitude conditions. When the main deck arming switch is selected, two packs automatically shut down. The remaining pack reconfigures to reduced flow, supplying air to the upper deck for ventilation and flight deck instrument cooling only. All valves providing airflow to or within the main deck and lower lobe cargo compartments are commanded closed. Electronic equipment E/E cooling configures to closed loop.

Lower Lobe Cargo Compartment Fire Protection Systems

Smoke Detection

The forward lower cargo compartment has eight smoke detectors, and the aft compartment has eight smoke detectors. Each smoke detector has a beacon lamp which supplies a smoke (fire) indication to flight crew when smoke is present in the air. The flight crew will be notified of fire and fault condition by master fire light, fire bell, warning, and status EICAS messages.

Fire Suppression

The lower cargo compartment fire extinguishing system is designed to fill the fwd or aft cargo compartment with a fire extinguishing agent when smoke is detected. The system is electrically controlled by switches on the P5 pilot's overhead panel.

Flight Deck Smoke Evacuation Shutter

The smoke shutter attaches to the fuselage structure above the flight compartment door. The pilots use a tee handle to open and close the smoke shutter in case of smoke in the cockpit. The tee handle is between the P7 Overhead Circuit Breaker Panels. The tee handle attaches to a cable which attaches to the smoke shutter. The shutter assembly is installed on the aft control cabin ceiling. Access to the mounting screws is on top of the airplane. The smoke shutter must remove the smoke from the flight compartment during the pressurization of the airplane.

Cargo Identified In The Debris

The cargo identified on scene included clothing, machined parts and subassemblies, flashlights, gun parts, costume jewelry, cases for electronic equipment, usb flash drives, un-populated circuit boards, espresso makers, automotive entertainment and navigation systems, bike frames, pellets for injection molding, wrist watch components, rubber bracelets, cell phones, MP3 and MP4 players, mannequin heads, wigs, shoes. No items posing a flammable fuel load or capable of acting as an ignition source were visually identified except for batteries and battery containing devices.

The following photographs are of batteries and battery containing devices found in the debris (figures 23 – 41).

Figure 23: Lithium-ion battery pack.

Figure 24: Fire damaged remains of battery pack with a fractured cell

Figure 25: Additional battery pack remains

Figure 26: D-Cell size lithium primary batteries. Photo shows fire damaged and undamaged batteries

Figure 27: Lithium primary button sized flat cell batteries (watch style) with small circuit board

Figure 28: 36-cell lithium-ion battery pack with thermal damage.

Figure 29: 36-cell lithium-ion battery pack with multiple vented cells

Figure 30: Lithium-ion, mobile phone type battery

Figure 31: Lithium-ion, mobile phone type battery

Figure 32: Intact and fire damaged Panasonic batteries (2-pack Li-ION set)

Figure 33: Mobile phones and batteries

Figure 34: Personal electronic device with battery inside

Figure 35: Lithium-ion battery pack

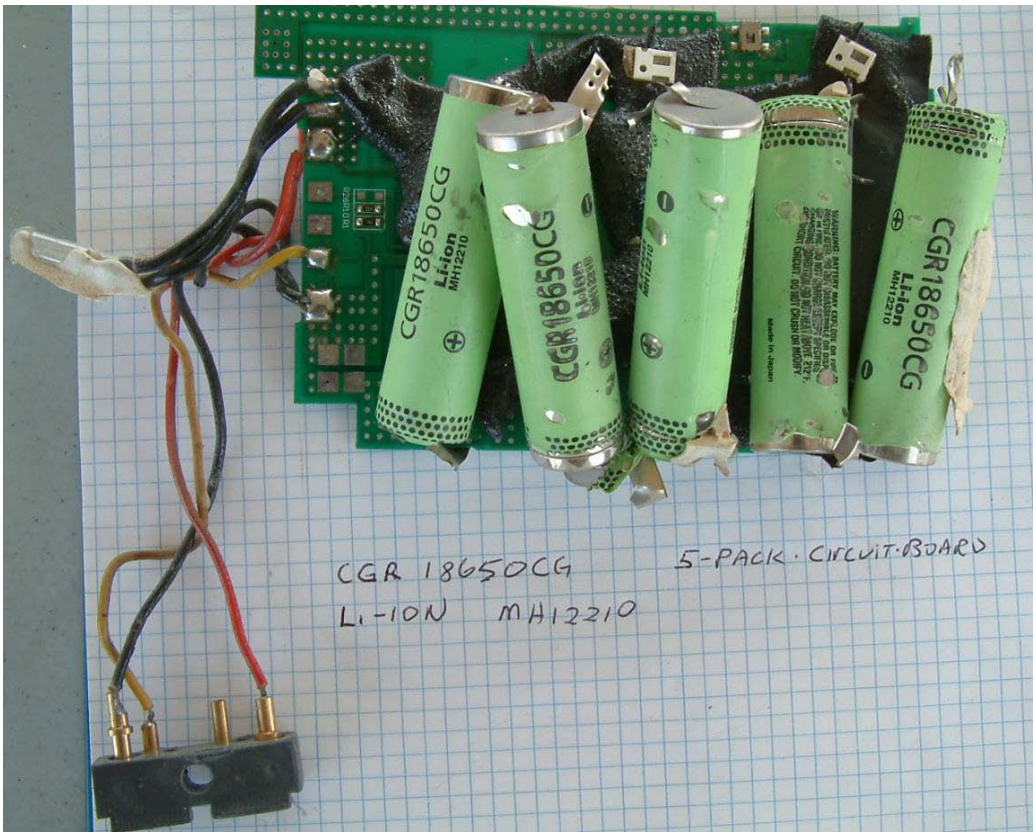

Figure 36: Lithium-ion battery pack

Figure 37: Lithium-ion battery pack

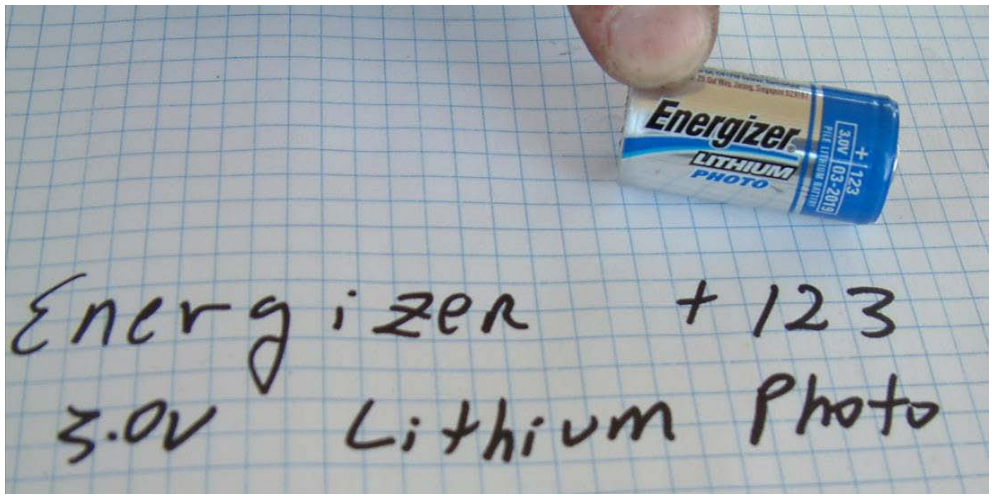

Figure 38: Lithium primary (CR123 type) battery

Figure 39: Electronic cigarettes containing lithium primary batteries

Figure 40: Lithium-ion polymer type battery pack

Figure 41: Lithium-ion polymer type battery pack with thermal damage

Joseph Panagiotou
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