

# Emergency and Abnormal Checklists – A User's Perspective

Captain Bill Jones

Air Line Pilots Association,  
International

Emergency and  
Abnormal  
Situations in  
Aviation  
Symposium

June 2003

Fedex 87 – Subic Bay

October 17, 1999



Alaska 261  
January 31, 2000



**88 FATALITIES**

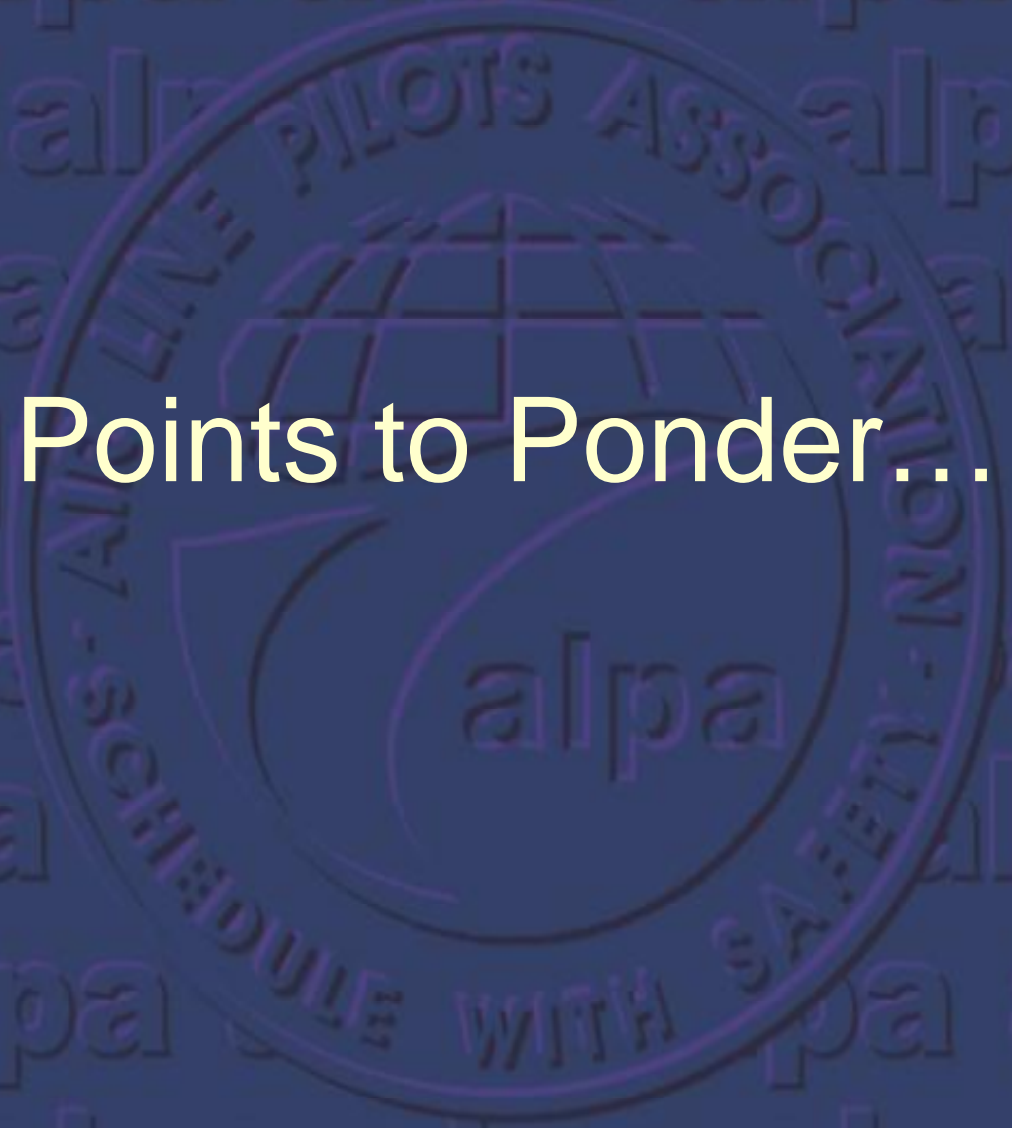


Air Transat 236 – Azores  
August 24, 2001

291 passengers and 13 crew members



# Points to Ponder...



How do I know which  
emergency or abnormal  
situation I am in?

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## HYD B ELEC PUMP OVHT

**Message:** HYD B ELEC PUMP OVHT

**Condition:** The blue electric pump has overheated.

1. Place the BLUE ELEC PUMP pb switch to OFF.
2. See Approach Procedures.

### STATUS

CAT III approach not authorized.

APPROACH PROCEDURES	INOP SYS
<ol style="list-style-type: none"><li>1. Increase the landing distance by 1.1 due to a partial loss of ground spoilers.</li><li>2. The slats will operate slower than normal.</li><li>3. End.</li></ol>	BLUE HYD SPLR 3

\*\*\*\*\*

## HYDRAULIC PUMP LOW PRESSURE

Condition: A hydraulic pump **LOW PRESSURE** light illuminated indicates output pressure of the related pump is low.

### HYDRAULIC PUMP SWITCH ..... OFF

[Intermittent illumination of the hydraulic pump **LOW PRESSURE** light may be the result of single electric pump operation and a high demand on the hydraulic system.]

## HYDRAULIC PUMP OVERHEAT

Condition: A hydraulic pump **OVERHEAT** light illuminated indicates a fluid or motor **overheat** in the related electric motor-driven pump.

### ELECTRIC HYDRAULIC PUMP SWITCH ..... OFF

[Intermittent illumination of the hydraulic pump **LOW PRESSURE** light may be the result of single electric pump operation and a high demand on the hydraulic system.]



0 Unannounced Checklists ..... 0

1 Airplane General  
Emergency Equipment, Doors, Windows .....

2 Air Systems .....

3 Anti-Ice/Deice

157 Separate Checklists

5 Communications .....

6 Electrical .....

7 Engines, APU .....

8 Fire Protection .....

20 Checklist are considered

Unannounced

11 Flight Management, Navigation .....

12 Fuel .....

13 Hydraulics .....

14 Landing Gear .....

15 Warning Systems .....

Alpa alpa alpa alpa alpa  
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The background features a large, faint, circular seal of the Federal Aviation Administration (FAA). The seal contains a globe with latitude and longitude lines. The text "FEDERAL AVIATION ADMINISTRATION" is written around the top inner edge of the seal, and "DEPARTMENT OF TRANSPORTATION" is written around the bottom inner edge. The word "ALPA" is prominently displayed in the center of the seal.

Annunciated v. Unannunciated

# First Indication



Condition: **The fuel IMBAL indicator indicates main fuel tank quantities differ by more than 1000 lbs.**

**FUEL** .....**BALANCE**

## **INFLIGHT ENGINE FUEL LEAK**

Condition: **An inflight engine fuel leak is suspected or confirmed by one or more of the following:**

- visual observation of fuel spray from strut/engine
- excessive engine fuel flow or fuel imbalance indication

total fuel quantity decreasing at an abnormal rate

- **IMBAL** indication
- **USING KSV FUEL** message
- **INSUFFICIENT FUEL** message

**CENTER FUEL PUMP SWITCHES** ..... **OFF**

[Fuel CONFIG indication may be displayed with fuel in center tank.]

**CROSSFEED SELECTOR** ..... **CLOSE**

**IMBAL**

Condition: The fuel IMBAL indicator indicates main fuel tank quantities differ by more than 1000 lbs.

If a leak is suspected:

Accomplish the ENGINE FUEL LEAK checklist.

If a fuel imbalance has occurred without indications of a fuel leak:

FUEL.....BALANCE

**LOW**

Condition: The fuel LOW indicator indicates fuel quantity in the related main tank is less than 2000 lbs.

**MAIN TANK FUEL PUMP SWITCHES .....ALL ON**

**CROSSFEED SELECTOR ..... OPEN**

[Ensures remaining fuel available to both engines.]

Apply thrust changes slowly and smoothly. If a climb is required, maintain the minimum pitch attitude required for safe flight.

[Minimizes the possibility of uncovering the fuel pumps.]

## ENGINE FUEL LEAK

**Condition:** An in-flight engine fuel leak is suspected or confirmed.

One or more of the following may be evidence of a fuel leak

- visual observation of fuel spray from strut or engine
- excessive fuel flow
- total fuel quantity decreasing at an abnormal rate
- fuel IMBAL indication
- USING RSV FUEL message
- INSUFFICIENT FUEL message
- CHECK FMC FUEL QUANTITY message.

**CENTER FUEL PUMP SWITCHES** ..... OFF

[Fuel CONFIG may be displayed with fuel in the center tank.]

**CROSSFEED SELECTOR** ..... CLOSED

Identify an engine fuel leak by observing one main fuel tank quantity decreasing faster than the other.

An increase in fuel imbalance of approximately 500 lbs or more in 30 minutes should be considered an engine fuel leak.

Conditions permitting, visually check for an engine fuel leak.

If both main tank quantities decrease at the same rate:

- 
- How do I know which checklist(s) to run?

0 Unannounced Checklists ..... 0

1 Airplane General  
Emergency Equipment, Doors, Windows .....

2 Air Systems .....

3 Anti-Ice/Deice

157 Separate Checklists

5 Communications .....

6 Electrical .....

7 Engines, APU .....

8 Fire Protection .....

20 Checklist are considered

Unannounced

11 Flight Management, Navigation .....

12 Fuel .....

13 Hydraulics .....

14 Landing Gear .....

15 Warning Systems .....



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VOLCANIC ASH .....	NNC.0.30
WINDOW DAMAGE .....	NNC.0.32

How many are actually trained?

# How do I respond to the ambiguities in the checklists?

Checklist Design Issues

# Opportunities for Failure Institutionalized in Checklists

- Inability to map from items in the checklist to those in cockpit
- Inconsistency of placing embedded normal checklists within abnormal procedures
- Dead End Checklists
- Reference to other checklists without listing location

# Opportunities for Failure Institutionalized in Checklists (con't)

- Failure to reference other appropriate checklists
- Checklist with no items
- Checklists not up to date with current regulations
- Font Size
- Similarly named but very different checklists
- Same cues/multiple choice checklists

# Aircraft QRH Smoke and Fire Procedures

Same cues/multiple choice checklists

Varig 820

123 Dead

July 1973



Saudia 163  
301 Dead  
August 1980



Air Canada 797

23 Dead

June 1983





South African 295  
159 Dead  
November 1987



Valujet 592

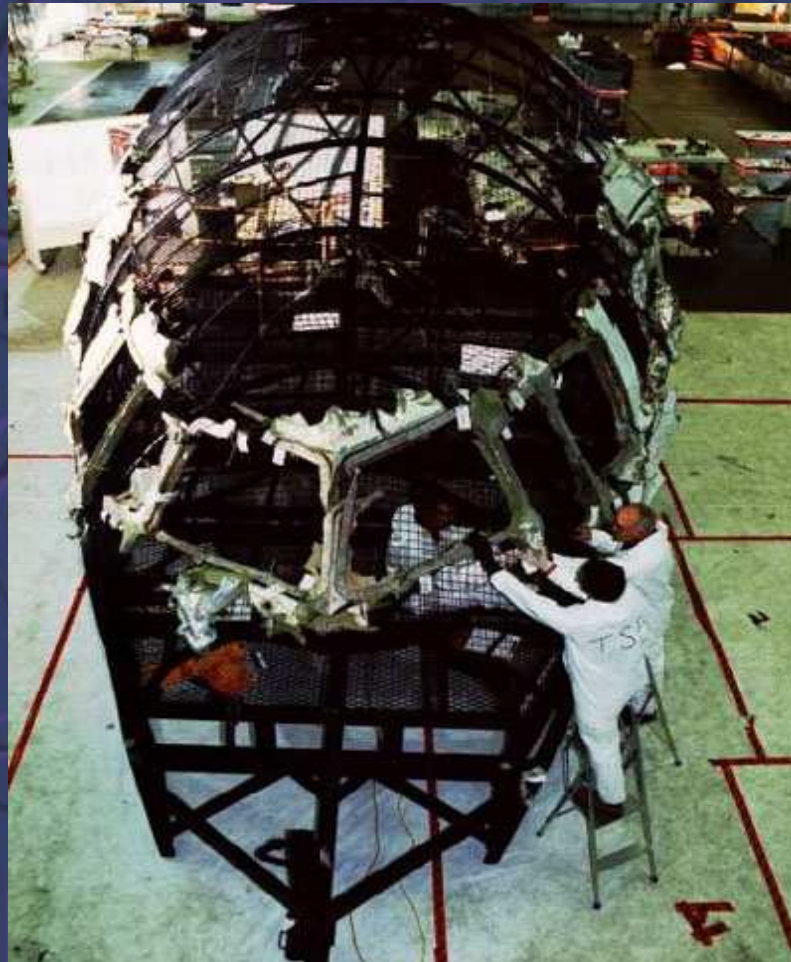
110 Dead

May 1996



(Courtesy WSYN)

Swissair 111  
229 Dead  
September 1998



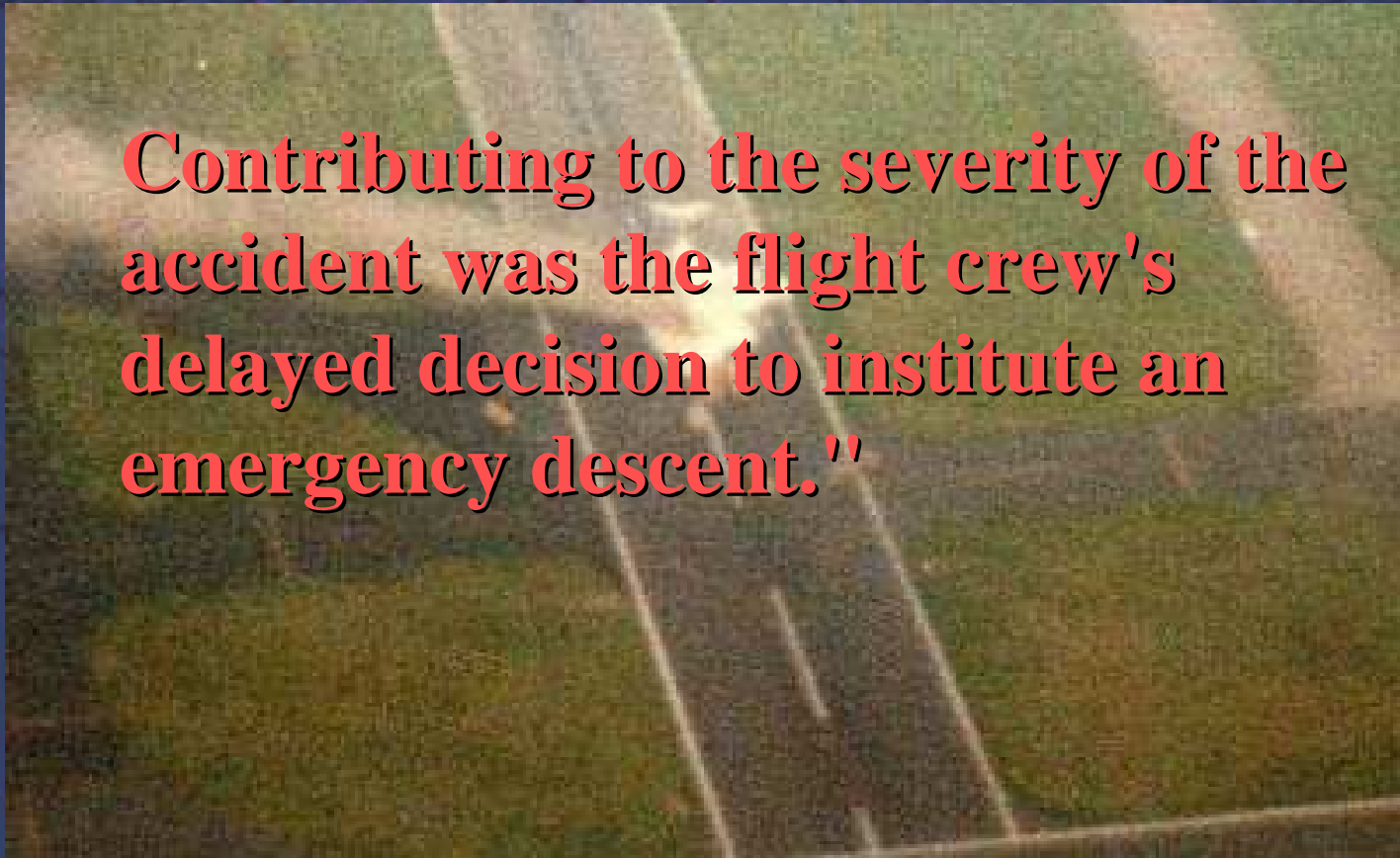
Air Canada 797

23 Dead

June 1983



"A fire of undetermined origin, an underestimate of fire severity, and conflicting fire progress information provided to the captain.  
(NTSB/AAR-84/09)



**Contributing to the severity of the accident was the flight crew's delayed decision to institute an emergency descent."**

There are some situations which always require landing at the nearest suitable airport. These situations include, but are not limited to, conditions where:

- the non-normal checklist contains the words “Plan to land at the nearest suitable airport”
- cabin smoke or fire which persists
- one main AC power source remaining (such as engine or APU)

It should be stressed that for persistent smoke or a fire that cannot be positively confirmed to be completely extinguished, the earliest possible descent, landing, and passenger evacuation should be accomplished.

Swissair 111  
229 Dead  
September 1998





There was no integrated in-flight firefighting plan in place for the accident aircraft, nor was such a plan required by regulation. Therefore, the aircraft crew did not have procedures or training directing them to aggressively attempt to locate and eliminate the source of the smoke, and to expedite their preparations for a possible emergency landing. In the absence of such a firefighting plan, they concentrated on preparing the aircraft for the diversion and landing.



Transportation  
Safety Board  
of Canada

Bureau de la sécurité  
des transports  
du Canada

Canada

“Neither the Swissair nor Boeing Smoke/Fumes of Unknown Origin Checklist emphasized the need to immediately start preparations for a landing by including this consideration at the beginning of the checklist. Including this item at the end of the checklist de-emphasizes the importance of anticipating that any unknown smoke condition in an aircraft can worsen rapidly.”



Transportation  
Safety Board  
of Canada

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des transports  
du Canada

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**FLIGHT AND CABIN CREW**

# RESPONSE

to

# in-flight smoke

**SAFETY**

**JOHN MORTON**  
PRINCIPAL ENGINEER  
SYSTEMS ENGINEERING  
BOEING COMMERCIAL AIRPLANES GROUP

**ROGER NICHOLSON**  
ASSOCIATE TECHNICAL FELLOW  
SERVICE ENGINEERING  
BOEING COMMERCIAL AIRPLANES GROUP

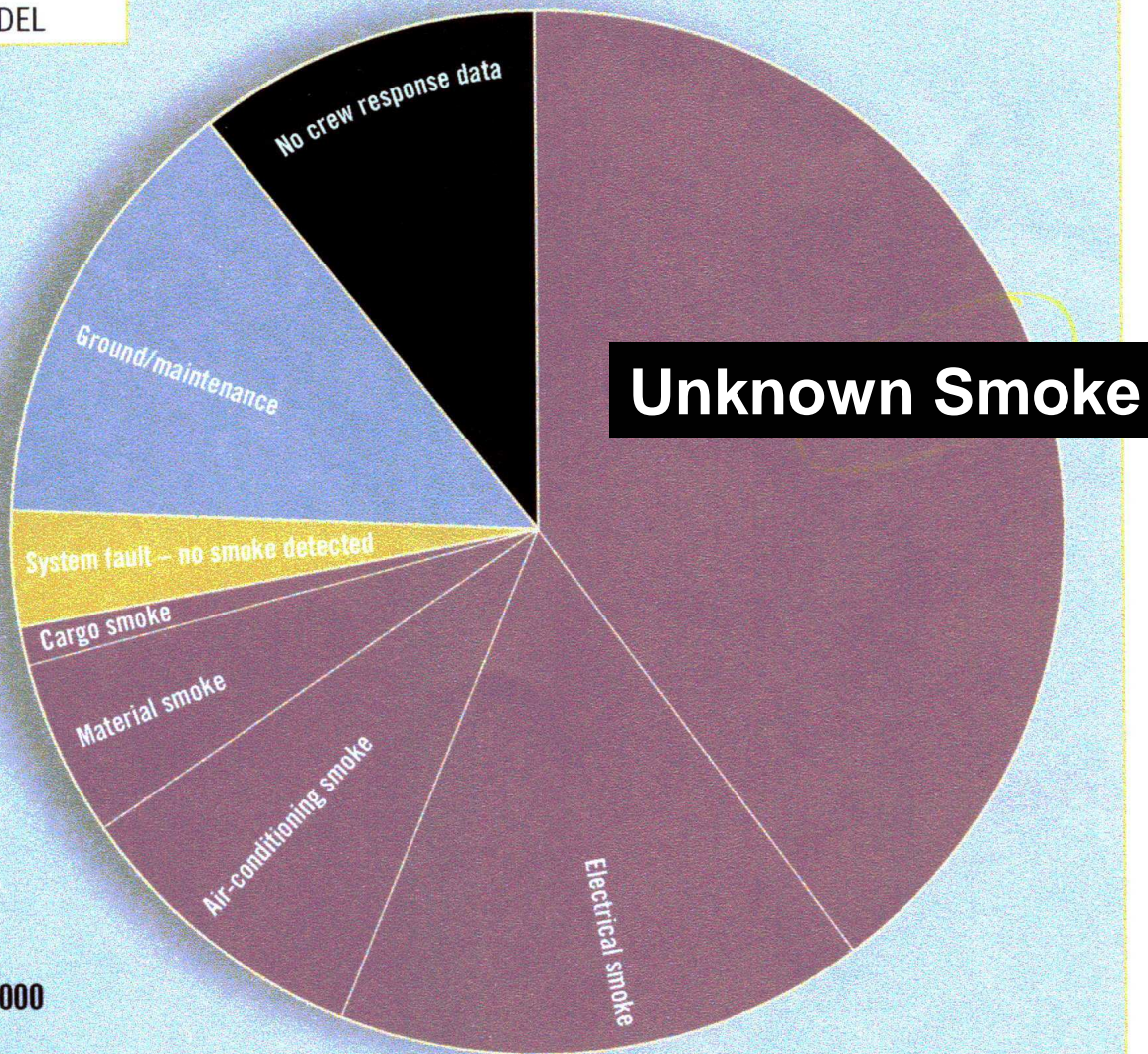
**BILL ROBERSON**  
DIRECTOR  
EXECUTIVE FLIGHT OPERATIONS  
BOEING COMMERCIAL AIRPLANES GROUP

3

### FLIGHT CREW PERCEPTION OF SMOKE SOURCE FOR A REPRESENTATIVE AIRPLANE MODEL

FIGURE

■ Smoke events with flight crew on board, 72%



Smoke events, November 1992 to June 2000

### 737NG Operations Manual

It should be stressed that for persistent smoke or a fire that cannot be positively confirmed to be completely extinguished, the earliest possible descent, landing, and passenger evacuation should be accomplished.

- 0 Unannounced Checklists .....
- 1 Airplane General,  
Emergency Equipment, Doors, Windows .....
- 2 Air Systems .....
- 3 Anti-Ice, Rain .....
- 4 Automatic Flight .....
- 5 Communications .....
- 6 Electrical .....
- 7 Engines, APU .....
- 8 Fire Protection .....
- 9 Flight Controls .....
- 10 Flight Instruments, Displays .....
- 11 Flight Management, Navigation .....
- 12 Fuel .....
- 13 Hydraulics .....
- 14 Landing Gear .....
- 15 Warning Systems .....

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**Non-Normal Checklists**      **Chapter NNC**  
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**DITCHING** ..... **NNC.0.4**

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**INFLIGHT ENGINE FUEL LEAK** ..... **NNC.0.11**

**INFLIGHT ENGINE START** ..... **NNC.0.12**

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**UNCOMMANDED YAW OR ROLL** ..... **NNC.0.29**

**VOLCANIC ASH** ..... **NNC.0.30**

**WINDOW DAMAGE** ..... **NNC.0.32**



## AIR CONDITIONING SMOKE/FUMES

Condition: A concentration of air conditioning smoke/fumes is identified.

OXYGEN MASKS ..... ON, 100%  
CREW COMMUNICATIONS ..... ESTABLISH

RECIRCULATION FAN SWITCHES ..... OFF

[Eliminates possible source of smoke/fumes.]

If smoke/fumes stop:

Continue flight with the recirculation fan switches OFF.

If smoke/fumes continue:

ISOLATION VALVE SWITCH ..... CLOSE

R PACK SWITCH ..... OFF

If smoke/fumes stop:

Continue flight with the R PACK switch OFF and ISOLATION VALVE switch CLOSE.

If smoke/fumes continue:

R PACK SWITCH ..... AUTO

L PACK SWITCH ..... OFF

If smoke/fumes stop:

Continue flight with the L PACK switch OFF and ISOLATION VALVE switch CLOSE.

If smoke/fumes continue:

L PACK SWITCH ..... AUTO

Plan to land at nearest suitable airport.

Accomplish the SMOKE/FUMES REMOVAL checklist, if required.

**ELECTRICAL SMOKE/FUMES/FIRE**

Condition: **Electrical smoke/fumes/fire is identified.**

- OXYGEN MASKS . . . . . ON, 100%**
- CREW COMMUNICATIONS . . . . . ESTABLISH**
- RECIRCULATION FAN SWITCHES . . . . . OFF**

[Removes fan as a possible source of smoke/fumes. Stops recirculation of smoke/fumes and increases fresh air flow.]

**If smoke/fumes/fire source is known:**

- ELECTRICAL POWER (affected equipment) . . . . . REMOVE**
- If practical, remove power from affected equipment by switch or circuit breaker in flight deck or cabin.**

Continued on next page

**SMOKE/FUMES REMOVAL**

Condition: Smoke/fumes removal is required.

- OXYGEN MASKS** ..... ON, 100%
- CREW COMMUNICATIONS** ..... ESTABLISH
- CABIN DOOR** ..... CLOSE

[Prevents smoke/fumes contamination of/from other compartments.]

If pack(s) are on and smoke/fumes source is confirmed to be in the flight deck or main cabin:

- L AND R PACK SWITCHES** ..... HIGH
- RECIRC FAN SWITCHES** ..... OFF
- LAND ALT** ..... 10,000 FEET

[Increases the ventilation rate.]

- ENGINE No. 1 and No. 2 BLEED AIR SWITCHES** ..... VERIFY ON
- ENGINE THRUST** ..... MAXIMUM PRACTICAL N1 (Minimum 45%)

[Provides maximum cabin ventilation.]

- FLIGHT DECK AIR CONDITIONING AND GASPER OUTLETS** ..... OPEN

**CAUTION:** Do not open any flight deck window. Keep the cabin door closed.

If smoke/fumes are uncontrollable:

- AIRPLANE ALTITUDE** ..... LOWEST SAFE ALTITUDE, (GRID MORA) or 10,000 FT, WHICHEVER IS HIGHER

At 14,000 feet or below:

- PRESSURIZATION MODE SELECTOR** ..... MAN

Continued on next page



2.26.1

**A-320**

**EMERGENCY/ABNORMAL PROCEDURES**

Apr 28, 1992

**Fire/Smoke Protection**

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2.26.1

**A-320**  
**EMERGENCY/ABNORMAL PROCEDURES**

Apr 28, 1992

**Fire/Smoke Protection**

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SMOKE LAV + CRG DET FAULT	2.26.
SMOKE LAVATORY DET FAULT	2.26.1
SMOKE LAVATORY SMOKE	2.26.1

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**Non-Normal Checklists** Chapter NNC  
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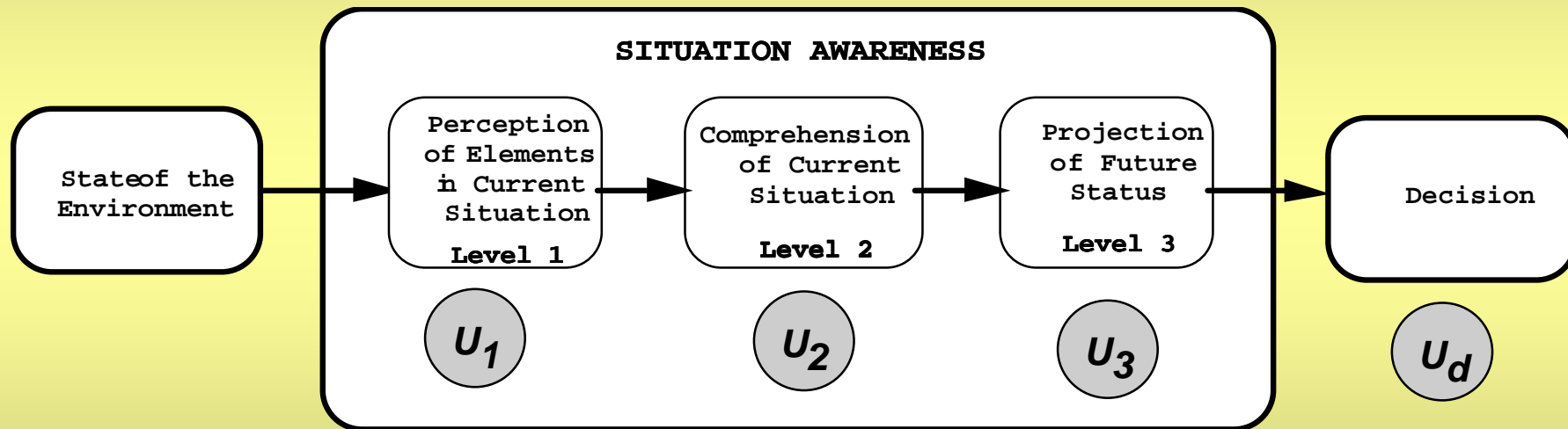
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# Research Challenges



# First Step: Establish Situation Awareness Requirements



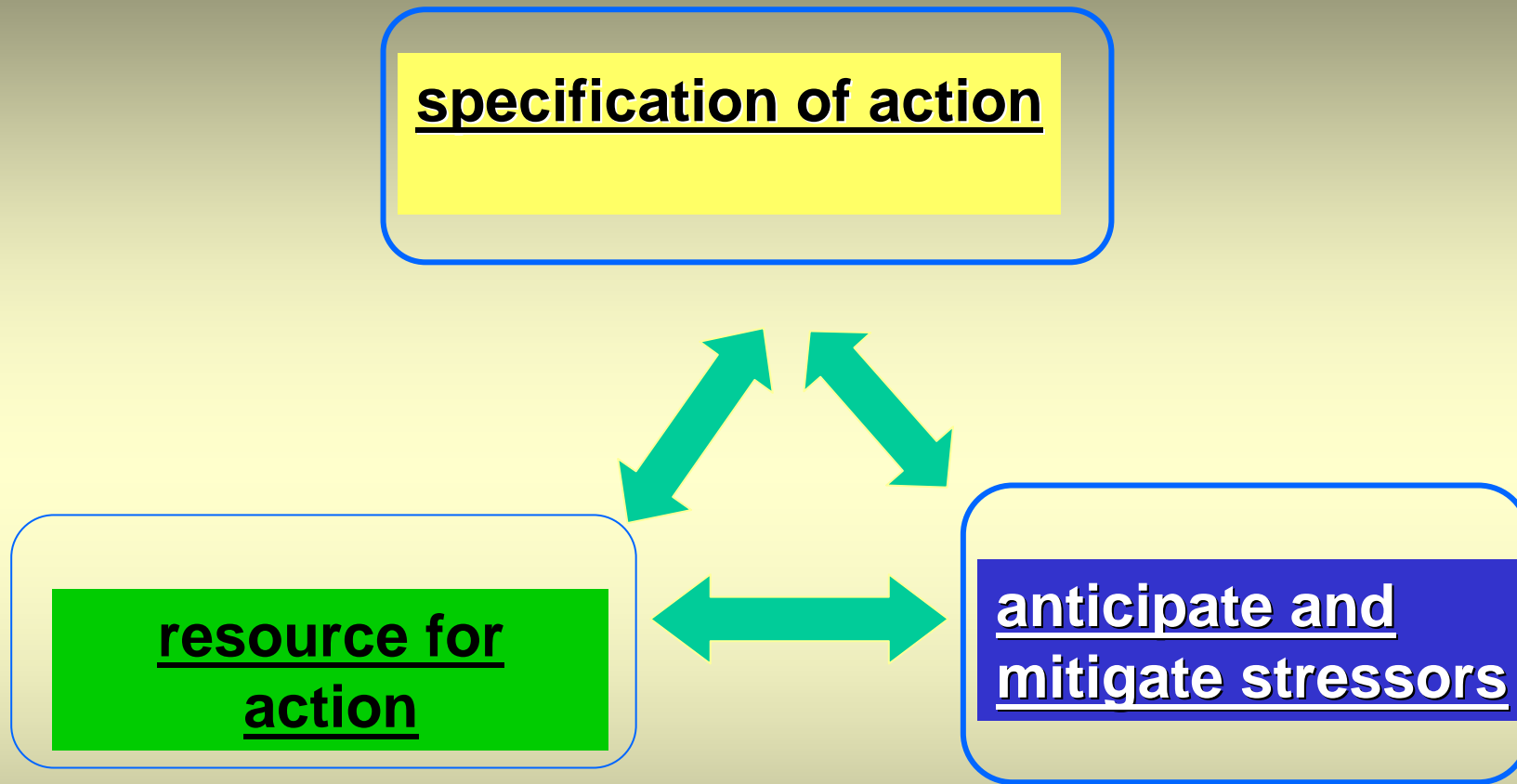
# Three Design Criteria for E&AS Checklists

- Checklists that are specification of action
  - Specificity
  - Sequential
- Checklists that are resource for action
  - Expertise
  - generalities
- Checklists that anticipate and mitigate stressors
  - Environmental
  - Physiological
  - Psychological

Adapted from Woods, 2003



## Interrelationship of Design Criteria



Thank you very  
much for your  
attention.



Good luck  
with  
your endeavors.