Challenges in Emergency and Abnormal Checklist Design

Barbara Burian, Ph.D.
San Jose State University Foundation
at the NASA Ames Research Center

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Emergency and Abnormal Situations Project
Industry Contacts and Consultants

| Manufacturers: | Boeing, Bombardier, Airbus Industries, BAe Systems, |
| Regulatory and Governmental Agencies: | FAA, CAA (UK), JAA, ICAO, Eurocontrol, NavCanada |
| Unions and Trade Groups: | ALPA, APA, SWAPA, ATA, IATA, AFA, ADF |
| Accident Investigation Bodies: | NTSB, TSB of Canada, ISASI |
| Airlines: | Airborne Express, Air Canada, Alaska, Aloha, American, Atlantic Southeast, Cathay Pacific, Continental, Delta, Fed Ex, Frontier, Hawaiian, Horizon, JetBlue, Southwest, United, UPS, US Airways, TWA (prior to merger) |
Emergency and Abnormal Situations Project

15 Different Categories of Issues – some are related to:

- Training
- Human Performance under Stress
- Automation and Automated Aircraft Systems
- Emergency Equipment and Evacuation Issues
- Checklists and Procedures
Challenges in Emergency and Abnormal Checklist Design

Smoke, Fire, and Fumes
Checklists and Procedures
Smoke, Fire, and Fumes Checklists and Procedures

What Drives (or Should Drive*) the Design and Content?

• Differences in aircraft and equipment design
• Understanding of how different types of fires are ignited, fed, and spread
• Type of operations – extended range, passenger vs. cargo
• Assumptions about efficacy of crew response and expectations about amount of time available
• Human factors considerations, Understanding of human performance while under stress *
• History of the air carrier, History within the industry
• Philosophies, company policies, and economic considerations
• Regulations, Advisory Circulars, etc.
Smoke, Fire, and Fumes Checklists and Procedures

A Few of the Many Issues

Ambiguity of cues / level of certainty about situation
Conflicting warnings / cues
Smoke / Fumes of an unknown origin
Determining / Accessing the proper checklist
Length of time to complete procedures
Initiate descent / diversion and when
What type of descent profile
Checklist wording – how compulsory
Reduced visibility – font size, layout
What memory items

Timing of source identification vs. smoke removal vs. descent initiation vs. fighting fire
High false smoke alarm rate
EROPS – nearest airport is far away
Ditching while on fire
How much troubleshooting
Fire in inaccessible places
Powering down electrical buses
Circuit breaker resetting
If / when to declare an emergency with ATC
Communicating / coordinating with Cabin crew
Smoke, Fire, and Fumes Checklists and Procedures

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Smoke, Fire, and Fumes Checklists and Procedures

Methods for Accessing the Correct Checklist:

• Gateway Checklist
• Several Separate Checklists
• One Integrated Checklist
Accessing the Correct Checklist: Gateway Checklist

1. Oxygen Mask & Smoke Goggles (As Required)

2. Crew & Courier Communications
   Establish Check Mike switches set to MASK, place cockpit speaker ON, place MIC SEL switch to FLT INT, and establish crew communication.

3. Cockpit Door & Smoke Screen
   Close the cockpit door & smoke screen to exclude heavy concentrations of smoke. Leave door closed unless opening it is dictated by a greater emergency, and then at Captain’s discretion.

4. If Descent is required
5. If Descent is NOT Required

   PROCEED TO STEP 6

   PROCEED TO STEP 14

   - WARNING

   Should structural damage be suspected, limit airspeed. Gear and / or Speed Brakes may be used depending on type of damage.

6. Autopilot
7. Throttles
8. Speed Brake
9. Airspeed

   MACH .82 TO .85 (320 TO 350 KIAS)

   - NOTE

   If structural damage is known or suspected, use appropriate turbulence penetration speed.

10. ATC
11. Transponder (If no contact with ATC)
12. Tank Pumps
13. Altimeter

14. Type Of Smoke Or Fire

   DETERMINE & PROCEED TO APPROPRIATE PROCEDURE, THIS CHAPTER

   A. ELECTRICAL FIRE & SMOKE
      Can best be determined by small or visible smoke from electrical components (e.g., circuit breaker, radio)

   B. AIRCONDITIONING-SMOKE
      Can best be recognized by smoke emanating from overhead air conditioning outlets.

   C. CABIN CARGO SMOKE
      Can best be recognized by checking smoke detectors on the Second Officers panel, or by observing smoke or fire in the main deck cargo area.

(End of Procedure)
Accessing the Correct Checklist: Several Separate Checklists
# Accessing the Correct Checklist: One Integrated Checklist

**SMOKE, CABIN/COCKPIT**

- Oxygen masks and regulators: On, 100%
- Crew and flight attendant communications: Establish
- Cabin fans switch: Off
- Blower switch: Override
- Extract switch: Override
- Galley/galley and cabin switch: Off
- Descent: Initiate
- Cabin signs: On

**CONTINUED FROM ORC**

If dense smoke at any time, accomplish reverse side.

**REFERENCE ACTION:**

If electrical, cabin, or galley equipment smoke/fire is suspected:

- Emergency exit light switch: On
- If commercial switch installed:
  - Commercial switch: Off
- If commercial switch is not installed:
  - Bus tie switch: Off
  - Generator 2 switch: Off
  - If smoke persists or just before landing gear extension:
    - Generator 2 switch: On
    - Bus tie switch: Auto

If air conditioning smoke is suspected:

- APU bleed switch: Off
- Blower switch: Auto
- Extract switch: Auto
- Pack 1 switch: Off
- If smoke does not decrease:
  - Pack 1 switch: On
  - Pack 2 switch: Off
  - Cargo heat aft isolation valve switch: Off
  - If smoke persists:
    - Pack 2 switch: Override
    - Extract switch: Override

If avionics smoke is suspected:


**DENSE SMOKE**

**EMERGENCY DESCENT**

- FCU altitude (safe altitude/10,000 feet): Set
- FCU expedite switch: Push
- Target speed: Confirm, .80M/340KIAS
- Thrust: Confirm, idle
- Speed brakes: Extend
- ATC: Advise

**SMOKE REMOVAL**

- Pack flow selector: High
- Landing elevation selector: Safe altitude/10,000 feet
- When at safe altitude/10,000 feet:
  - Pack switches 1 + 2: Off
  - Cabin pressure mode selector: Manual
  - Manual vertical speed control switch: Full up
  - When differential pressure is less than 1 PSI:
    - Ram air switch: On
    - If cockpit smoke requires a cockpit window to be opened:
      - Maximum speed: .200 KIAS
      - Headsets: On
      - Cockpit window: Open

**EMERGENCY ELECTRICAL CONFIGURATION (If Required)**

- Emergency electrical generator 1 line switch: Off
- Emergency electrical power switch: Manual on

**When emergency generator available:**

- APU generator switch: Off
- Generator 2 switch: Off
- Before landing gear extension:
  - Generator 2 switch: On
  - Emergency electrical generator 1 line switch: On

Courtesy of Captain Richard Gilbert, UAL
What Drives (or Should Drive) the Design and Content?

Determining / Accessing the Proper Checklist

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Smoke, Fire, and Fumes Checklists and Procedures

Emergency Descent and Diversion Guidance:

Where in the Checklist

and

How Stated?
Swissair 111 - In-flight Fire
Nova Scotia, Canada
September 2, 1998

EMERGENCY CHECKLIST
ALERT AND NON-ALERT

MD-11
41.1
Page 9

AIR CONDITIONING SMOKE

ECON P/B
SMOKE DECREASES
NO
No further action required.
END

AIR SYSTEM P/B
ECON P/B
PACK 1
OFF
ON
ON

SMOKE DECREASES
NO
BLEED AIR 1
1 - 3 ISOL
DO NOT activate BLEED AIR 1 or PACK 1 for remainder of flight.
END

PACK 1
PACK 3
OFF
ON

SMOKE DECREASES
NO
BLEED AIR 3
1 - 3 ISOL
DO NOT activate BLEED AIR 3 or PACK 3 for remainder of flight.
END

PACK 3
PACK 2
OFF
ON

SMOKE DECREASES
NO
BLEED AIR 2
1 - 2 ISOL
DO NOT activate BLEED AIR 2 or PACK 2 for remainder of flight.
END

PACK 2
OFF
ON

Smoke is not of air conditioning origin.
Refer to EMERGENCY Procedure - SMOKE / FUMES OF UNKNOWN ORIGIN.
END
If smoke/fumes are not eliminated, land at nearest suitable airport.
(7) Prepare to land immediately at nearest suitable airport.
AIR COND SMOKE

If electrical smoke from the avionic compartment is suspected, refer to the AVIONICS SMOKE abnormal procedure.

- CREW OXY MASK ...................................... ON/100 %
  Use the emergency knob when necessary
- CAB FANS .................................................. OFF
- APU BLEED .................................................. OFF
- PACK 1 ...................................................... OFF

● if smoke persists:
  - PACK 1 ...................................................... ON
  - PACK 2 ...................................................... OFF
  - SMOKE/TOXIC FUMES REMOVAL PROC
  (see 1.06A, if necessary) .......................... APPLY

NOTE: If cargo ventilation system is installed, it is recommended that the cargo ventilation be closed to prevent a cargo smoke warning from being triggered by smoke coming from the cabin.

LDG ELV .................... 10,000 FT/MEA

DESCENT (FL 100 OR MEA) .... INITIATE

A320

EMERGENCY PROCEDURES

SMOKE/TOXIC FUMES REMOVAL

Use the smoke removal procedure in case of dense smoke or toxic fumes (smell) or if smoke generation cannot be stopped.

If a scent similar to orange peel is smell in the cockpit, suspect a toxic leak of rain repellent fluid (if installed).

- CREW OXY MASKS ...................................... ON/100 %
  Check that the oxygen diluter is at 100 %.
  Use the emergency knob when necessary.
- SEAT BELTS/NO SMOKING ............................. ON
- CAB FANS .................................................. OFF
- PACK 1 + 2 (if fuel vapors) .......................... OFF
- PACK FLOW (if no fuel vapors) ....................... HI

Do not shut down air cond. packs and do not reduce ventilation in an attempt to smoother the fire. Do not deploy pax oxygen masks if fire is suspected in the cabin.

- LDG ELEV ............................................ 10 000 FT/MEA
- DESCENT (FL 100 OR MEA) ......................... INITIATE
  PAX oxygen as required by regulation.
- ATC ...................................................... NOTIFY

● When ΔP 1 PSI or below:
  - RAM AIR .................................................. ON

● if cockpit window opening required:
  - MAX SPD .................................................. 200 KT
  - HEADSETS .................................................. ON
  - COCKPIT WINDOW ..................................... OPEN

CAUTION __________
Due to increased noise level pay particular attention to visual warnings
If smoke or fumes are persistent:

Plan to land at the nearest suitable airport.
**Smoke, Fire, and Fumes Checklists and Procedures**

**Emergency Descent and Diversion Guidance**

**Summary: Air Conditioning Smoke**

*(A Somewhat Unfair Comparison)*

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>Number of Checklists*</th>
<th>Location</th>
<th>Wording</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD-11</td>
<td>2</td>
<td>Last item, 2nd checklist</td>
<td>If smoke/fumes not eliminated, land at nearest suitable airport</td>
</tr>
<tr>
<td>CRJ-900</td>
<td>1</td>
<td>Middle of checklist (step 7)</td>
<td>Prepare to land immediately at nearest suitable airport.</td>
</tr>
<tr>
<td>A320</td>
<td>2</td>
<td>Nowhere</td>
<td>N/A</td>
</tr>
<tr>
<td>B767-400</td>
<td>1</td>
<td>Next to the last item</td>
<td>If smoke or fumes are persistent: Plan to land at the nearest suitable airport.</td>
</tr>
</tbody>
</table>

* to get to descent / diversion guidance
## Emergency Descent and Diversion Guidance

### Summary: Electrical Smoke / Fire

<table>
<thead>
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<th>Number of Checklists*</th>
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<th>Wording</th>
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</thead>
<tbody>
<tr>
<td>CRJ-900</td>
<td>1</td>
<td>First third of checklist (step 6)</td>
<td>Prepare to land immediately at nearest suitable airport.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A320</td>
<td>-</td>
<td>There is no electrical smoke or fire checklist</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Avionics Smoke has items for electrical smoke – 1st item</td>
<td>LAND ASAP</td>
</tr>
<tr>
<td>B767-400</td>
<td>1</td>
<td>Last item on the checklist</td>
<td>If smoke or fumes or fire persists or source is unknown: Plan to land at the nearest suitable airport.</td>
</tr>
</tbody>
</table>

* to get to descent / diversion guidance
Smoke, Fire, and Fumes Checklists and Procedures

Emergency Descent and Diversion

In a study of 15 in-flight fires that occurred between January 1967 and September 1998, the TSB of Canada determined that the average amount of time between the detection of an on-board fire and when the aircraft ditched, conducted a forced landing, or crashed was 17 minutes.
Smoke, Fire, and Fumes Checklists and Procedures

False Cargo Smoke Alarms, 1974 -1999

Verified Smoke Events Versus Smoke Alarms

Cost of Diversions: fuel, passenger ill-will, operational considerations, aircraft and crew scheduling, possible evacuation injuries, etc.
What Drives (or Should Drive) the Design and Content?

Descent and Diversion Guidance – Location and Wording

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• Regulations, Advisory Circulars, etc. (AC 120-80: “…flight crew members should begin planning for an emergency landing as soon as possible after the first indication of fire” pg 6.)
EAS Project Team

Immanuel Barshi, Ph.D.**
Sean Belcher, M.A.**
Ben Berman, A.B.**
Barbara Burian, Ph.D.*
Key Dismukes, Ph.D.**
Richard Fariello, B.S.**

Colleen Geven, A.A.**
Richard Geven, M.A.**
Jon Holbrook, Ph.D.
Jessica Lang Nowinski, Ph.D.
Sharon Pickering, M.S.

* Certificated Pilot
** ATP Certificate
Barbara Burian, Ph.D.
bburian@mail.arc.nasa.gov

Emergency and Abnormal Situations Project
http://human-factors.arc.nasa.gov/eas