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Cabin Crews in Emergency and Abnormal Situations

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Human Factors
research and technology

The Challenge

Emergency and abnormal situations:

- are often time critical, complex, and/or ambiguous
- are high stress, high workload, and a great deal is at stake
- require exceptionally high levels of coordination inside and outside of the airplane

Emergency and abnormal procedures:

- are generally focused on aircraft systems rather than on the situation as a whole
- are practiced seldom (twice a year or less) and used rarely
- are often highly dependent on fragile cognitive processes
- when needed, are crucial and must be performed correctly

Industry Contacts and Consultants

Manufacturers:	Boeing, Airbus Industries, BAe Systems, Bombardier
Regulatory and Governmental Agencies:	FAA, CAA (UK), JAA, ICAO, Eurocontrol
Unions and Trade Groups:	ALPA, APA, SWAPA, ATA, 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
Taxonomy of the Domain

15 Different Categories of Issues:

- Broad, Over-arching Issues (3)
- Issues Related to Checklists and Procedures (3)
- Issues Related to Humans (5)
- Issues Related to the Aircraft (2)
- Issues Related to Training (1)
- Selected Emergency Equipment and Evacuation Issues (1)

Emergency and Abnormal Situations Project
Taxonomy of the Domain

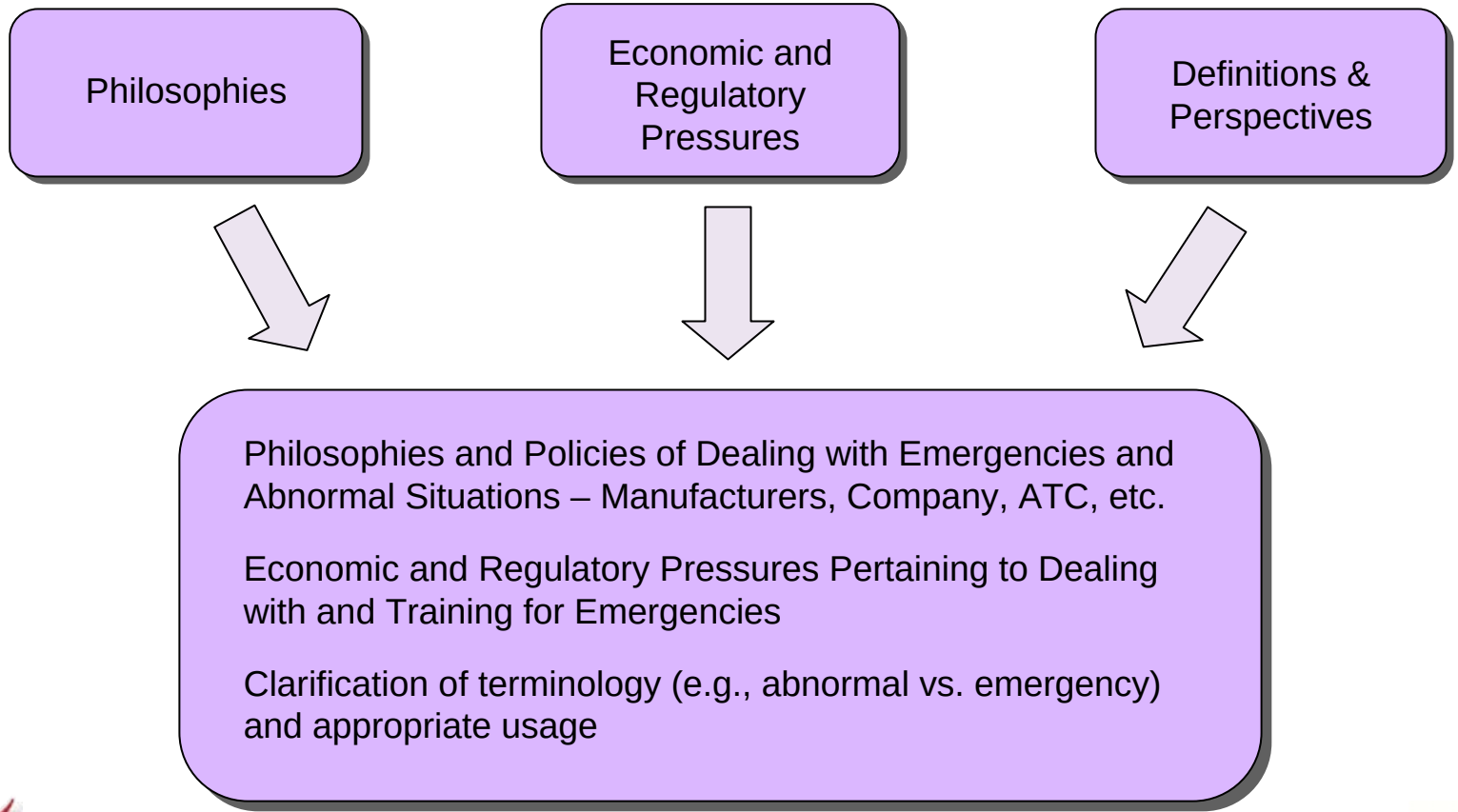
15 Different Categories of Issues:

- **Broad, Over-arching Issues**
- Issues Related to Checklists and Procedures
- Issues Related to Humans
- Issues Related to the Aircraft
- Issues Related to Training
- Selected Emergency Equipment and Evacuation Issues

Emergency and Abnormal Situations Project

Taxonomy of the Domain

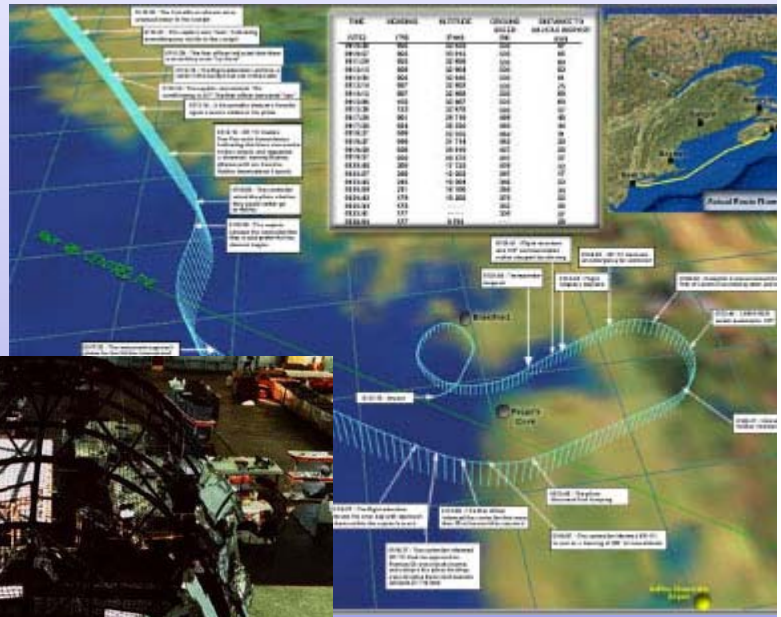
Broad, Over-arching Issues

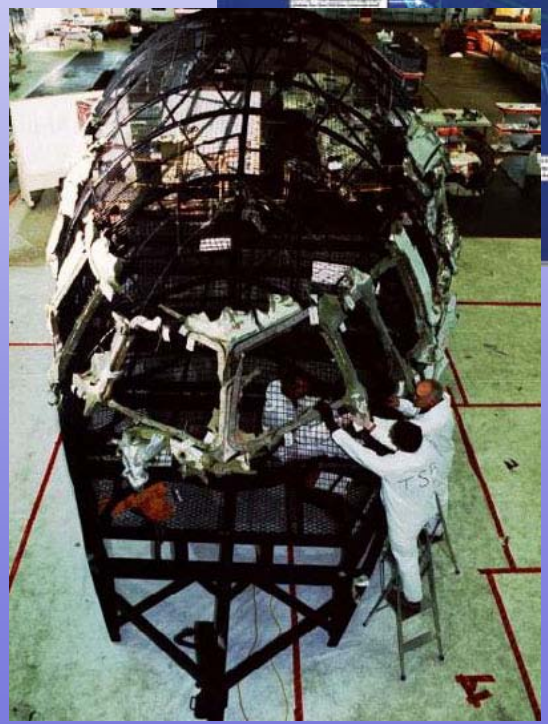


Philosophy of Response to Emergencies

Evident in Checklist Design

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





OCT/25.JAN.96 — EMERGENCY CHECKLIST ALERT AND NON-ALERT — MD-11 — 41.1 Page 9

AIR CONDITIONING SMOKE

ECON P/B ---------- OFF

SMOKE DECREASES

NO

No further action required.

END

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

SMOKE DECREASES

NO

BLEED AIR 1 ---------- OFF
1 - 3 ISOL ---------- ON

DO NOT activate BLEED AIR 1 or PACK 1 for remainder of flight.

END

PACK 1 ---------- ON
PACK 3 ---------- OFF

SMOKE DECREASES

NO

BLEED AIR 3 ---------- OFF
1 - 3 ISOL ---------- ON

DO NOT activate BLEED AIR 3 or PACK 3 for remainder of flight.

END

PACK 3 ---------- ON
PACK 2 ---------- OFF

SMOKE DECREASES

NO

BLEED AIR 2 ---------- OFF
1 - 2 ISOL ---------- ON

DO NOT activate BLEED AIR 2 or PACK 2 for remainder of flight.

END

PACK 2 ---------- ON

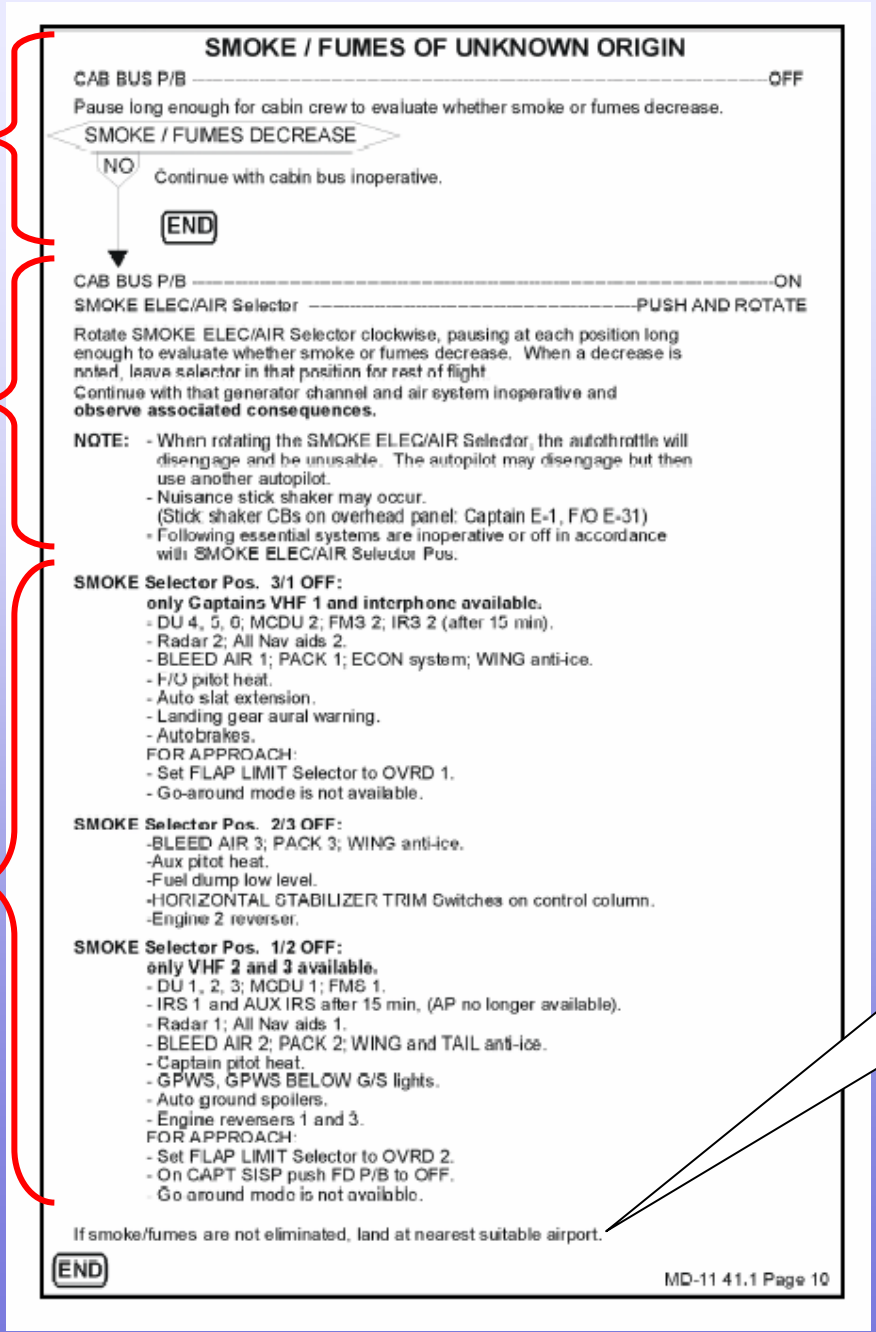
Smoke is not of air conditioning origin.

Refer to EMERGENCY Procedure - SMOKE / FUMES OF UNKNOWN ORIGIN.

END

MD-11 41.1 Page 9

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



SMOKE / FUMES OF UNKNOWN ORIGIN

CAB BUS P/B ——————————————————————————OFF

Pause long enough for cabin crew to evaluate whether smoke or fumes decrease.

SMOKE / FUMES DECREASE

NO — Continue with cabin bus inoperative.

END

CAB BUS P/B ——————————————————————————ON

SMOKE ELEC/AIR Selector ——————————————————PUSH AND ROTATE

Rotate SMOKE ELEC/AIR Selector clockwise, pausing at each position long enough to evaluate whether smoke or fumes decrease. When a decrease is noted, leave selector in that position for rest of flight.

Continue with that generator channel and air system inoperative and **observe associated consequences.**

NOTE:
- When rotating the SMOKE ELEC/AIR Selector, the autothrottle will disengage and be unusable. The autopilot may disengage but then use another autopilot.
- Nuisance stick shaker may occur. (Stick shaker CBs on overhead panel: Captain E-1, F/O E-31)
- Following essential systems are inoperative or off in accordance with SMOKE ELEC/AIR Selector Pos.

SMOKE Selector Pos. 3/1 OFF:
only Captains VHF 1 and interphone available.
- DU 4, 5, 6; MCDU 2; FM3 2; IR3 2 (after 15 min).
- Radar 2; All Nav aids 2.
- BLEED AIR 1; PACK 1; ECON system; WING anti-ice.
- F/O pitot heat.
- Auto slat extension.
- Landing gear aural warning.
- Autobrakes.

FOR APPROACH:
- Set FLAP LIMIT Selector to OVRD 1.
- Go-around mode is not available.

SMOKE Selector Pos. 2/3 OFF:
- BLEED AIR 3; PACK 3; WING anti-ice.
- Aux pitot heat.
- Fuel dump low level.
- HORIZONTAL STABILIZER TRIM Switches on control column.
- Engine 2 reverser.

SMOKE Selector Pos. 1/2 OFF:
only VHF 2 and 3 available.
- DU 1, 2, 3; MCDU 1; FM6 1.
- IRS 1 and AUX IRS after 15 min, (AP no longer available).
- Radar 1; All Nav aids 1.
- BLEED AIR 2; PACK 2; WING and TAIL anti-ice.
- Captain pitot heat.
- GPWS, GPWS BELOW G/S lights.
- Auto ground spoilers.
- Engine reversers 1 and 3.

FOR APPROACH:
- Set FLAP LIMIT Selector to OVRD 2.
- On CAPT SISP push FD P/B to OFF.
- Go-around mode is not available.

If smoke/fumes are not eliminated, land at nearest suitable airport.

END

MD-11 41.1 Page 10

If smoke/fumes are not eliminated, land at nearest suitable airport

ValueJet 592 - In-flight Fire, Florida Everglades, May 11, 1996

ELECTRICAL SMOKE OR FIRE

OXYGEN MASKS AND SMOKE GOGGLES	ON/100%
RADIO RACK Switch	VENTURI
CABIN PRESSURE Control	MANUAL
EMER PWR Switch	ON
GEN Control and APU Bus Switches	OFF

NOTE: Wait a reasonable time to determine whether to follow step A or B below.

A If smoke continues:

AC and DC BUS X TIE Switches	OPEN
R & L GEN or APU BUS Switches	ON
F/O FLT INSTRUMENTS	CHECK
EMER PWR Switch	OFF
AC EMERG FEED C/B's (K10 & L11)	PULL

NOTE: If smoke disappears, fault is on AC emergency bus. If smoke continues:

AC EMERG FEED C/B's (K10 & L11)	RESET
DC EMERG FEED C/B (M36) [930, 960 Series A/C (N37)]	PULL

NOTE: If smoke disappears, fault is on DC emergency bus. If smoke continues:

DC EMERG FEED C/B (M36) [930, 960 Series A/C (N37)]	RESET
BATT Switch	OFF

NOTE: If smoke disappears, fault is on battery bus. If smoke continues:

BATT Switch	ON
BATT DIRECT BUS C/B's(Overhead)	PULL

NOTE: If smoke continues:

BATT DIRECT BUS C/B's(Overhead)	RESET
DC TRANSFER BUS FEED C/B(M35) [930, 960 Series A/C (N37)] [A/C #960 (M36)]	PULL

B If smoke stops or decreases, at Captain's discretion:

AC & DC X-TIE Switches	OPEN
LEFT GEN Switch	ON

NOTE: If smoke reappears, fault is on left gen bus, left AC bus, left DC bus, or AC X-tie is shorted:

L GEN Switch	OFF
R GEN Switch	ON
F/O FLT INSTRUMENTS	CHECK
EMGNCY POWER Switch	OFF

NOTE: If smoke reappears, fault is on right gen bus, right AC bus, right DC bus, ground service AC bus, battery charger, or AC X-tie is shorted:

[END]

Philosophy of Response to Emergencies – Checklist Design

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.

Emergency and Abnormal Situations Project
Taxonomy of the Domain

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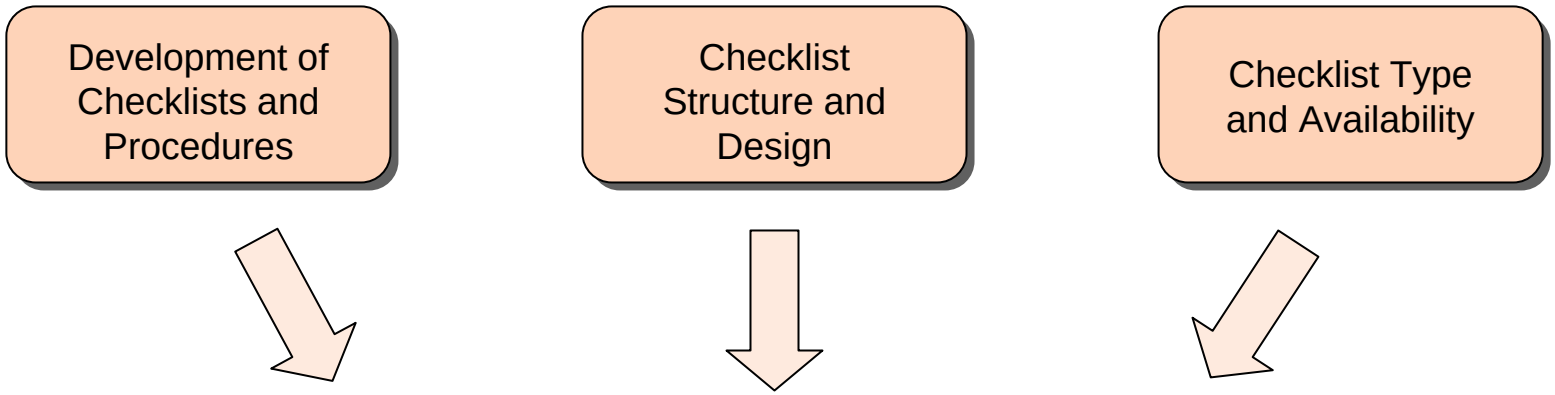
Emergency and Abnormal Situations Project

Taxonomy of the Domain

Checklist and Procedures Issues



Development of Checklists and Procedures – When? By whom? How certified? Are they standardized? Etc.

Checklist Structure and Design – Items, memory items, navigation, locating correct checklist, nomenclature, format, etc.

Checklist Type and Availability – Paper, mechanical, electronic (integrated with aircraft and in electronic flight bags), etc.

Valujet 558 - DC-9 Hard Landing – Nashville, Tenn., Jan. 7, 1996

The crew followed QRH procedures that were incomplete. This caused the aircraft to fall from100 ft agl on final approach. The nosewheel separated from the aircraft.

QUICK REFERENCE HANDBOOK
PILOT MANUAL – DC–9

UNABLE TO RAISE GEAR LEVER

NOSE STEERING WHEEL ..... OPERATE (C)

If steering wheel does NOT turn and centering indices are aligned:

Indicates a malfunction of the anti–retraction mechanism.

If desired, retract landing gear:

GEAR HANDLE RELEASE BUTTON ..... PUSH (PNF)

GEAR LEVER ..... UP (PNF)

If steering wheel turns:

DO NOT RETRACT THE GEAR

Indicates ground shift mechanism is still in the ground mode.

No auto–pressurization, and takeoff warning horn will sound when flaps/slats are retracted.

The ground control relay electrical circuits can be placed in the flight mode by pulling the Ground Control Relay circuit breakers (H20 and J20).

Do not exceed VLE (300 kts/M.70).

Approach and landing:

If landing gear was not retracted prior to landing, ground spoilers must be operated manually.

AIRPLANE ..... DEPRESSURIZE (PNF)

ANTI–SKID SWITCH (before 30 kts) ..... OFF (PNF)

GROUND CONTROL RELAY C/Bs (if pulled)
(H20 and J20) ..... RESET (C or FO)

The missing information was included in the AOM expanded checklists but was never transferred to the QRH checklists.

Approach and landing:

If landing gear was not retracted prior to landing, ground spoilers must be operated manually.

AIRPLANE ..... DEPRESSURIZE (PNF)
– Ensure airplane is depressurized prior to landing.

ANTI–SKID SWITCH (before 30 kts) ..... OFF (PNF)
– During landing rollout and prior to 30 kts, momentarily release brakes and place Anti–skid switch to OFF.

GROUND CONTROL RELAY C/Bs (if pulled)
(H20 and J20) ..... RESET (C or FO)
– Reset Ground Control Relay circuit breakers during taxi and verify that circuits are in the ground mode.

AIR PACK FAULT

If pack not supplied:

If in single pack operation:

REMAINING PACK ..... ON

PACK (Affected) ..... OFF

If pack overheat:

If in single pack operation:

REMAINING PACK ..... ON

PACK (Affected) ..... OFF

PACK MODE SEL (Affected) ..... MAN/COLD

When turb temp below limit:

PACK (Affected) ..... ON

PACK (Affected) ..... MAN CTL

If both packs inoperative:

MAX ALTITUDE ..... 10,000 FT/MEA

WHEN ΔP BELOW 1 PSI:

RAM AIR ..... ON

PROC: AIR PACK FAULT

If Pack Fault due to low bleed air supply, a bleed leak does not exist, and if WING ANTI-ICE not required:

BLEED VALVE (Affected sided) ..... OFF

AIR X FEED ..... MAN/IN LINE

PACK (Affected) ..... ON

If above FL370:

ECON FLOW ..... ON

END OF PROCEDURE

If Pack Fault due to low bleed air supply, a bleed leak does not exist, and if WING ANTI-ICE not required:

~~**If Pack Fault due to low bleed ... pply, then a bleed leak does not exist, a ... NG ANTI-ICE is not required:**~~

If Pack Fault due to low bleed air supply, and if a bleed leak does not exist, and if WING ANTI-ICE is not required:

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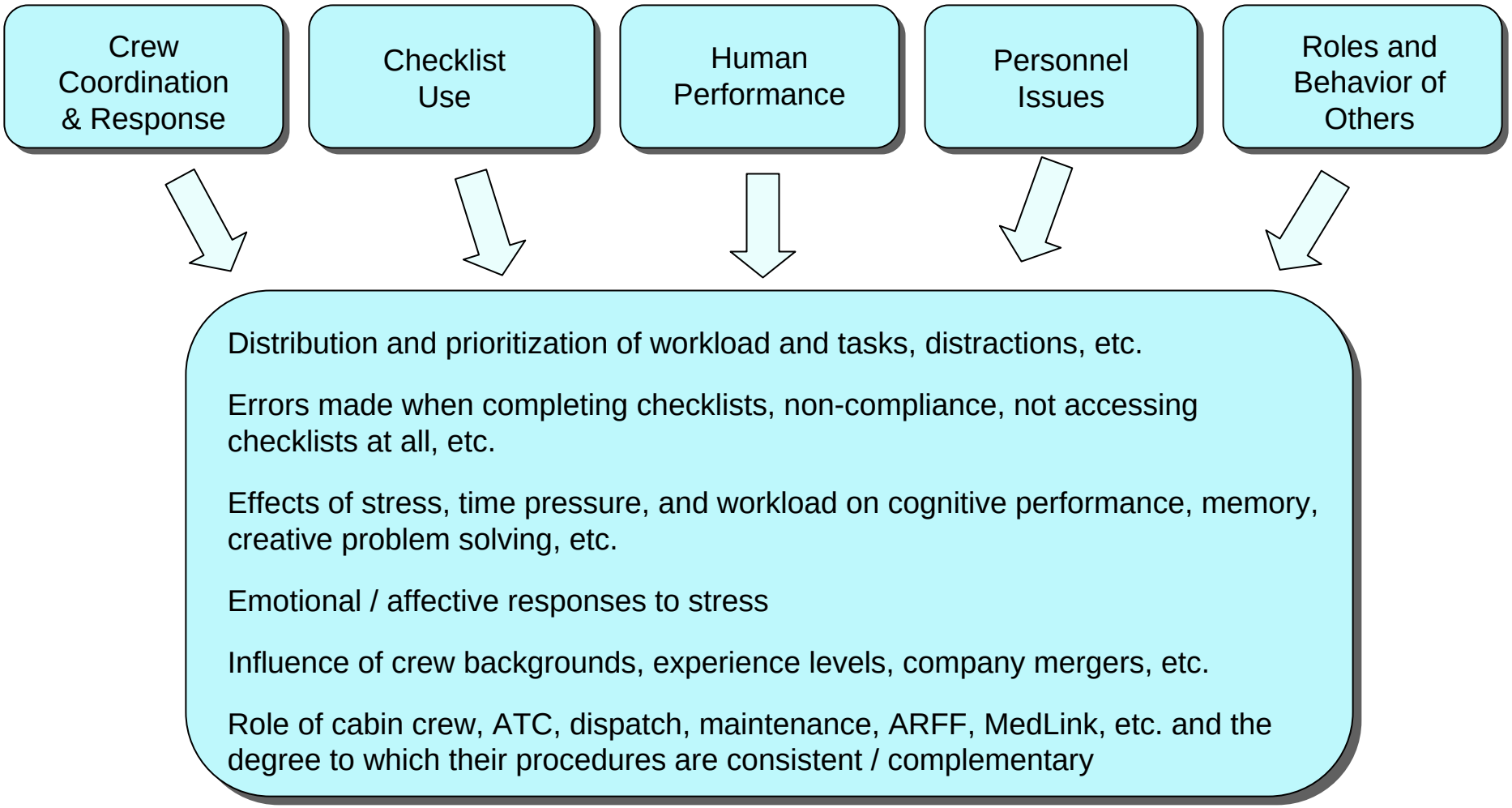
Issues Related to Humans



ATA 406
B727 Rapid Decompression – Indianapolis, Indiana
May 12, 1996

PACK REINSTATEMENT FOLLOWING AUTO PACK TRIP

ELECTRONIC PRESSURIZATION

After 1000 Feet AFL:

Both Pack Switches ..... OFF
Pack Reset Button ..... PUSH
Auto Pack Trip Switch ..... CUT OUT

If in AUTO mode:

One Pack Switch ..... ON

Do not reinstate second pack unless flaps are retracted.

When ready to reinstate second pack:
Second Pack Switch ..... ON

If in STANDBY mode:

– Cabin ALT Selector ..... SET 2000 FEET ABOVE *AIRPLANE'S* ALTITUDE
– Cabin Rate Switch ..... FULL INCREASE
– One Pack Switch ..... ON
After initial pressure surge and as rate of climb returns to zero:
Cabin ALT Selector ..... SET CRUISE CABIN PRESSURE ALTITUDE
– Cabin Rate Knob ..... SET AT INDEX OR AS REQUIRED
Adjust as required to maintain desired rate of change.

If in MANUAL mode:

– Outflow Valve ..... 1/4 to 1/2 OPEN
– One Pack Switch ..... ON
– Outflow Valve ..... ADJUST TO MAINTAIN DESIRED RATE OF CLIMB

tate second pack:
Switch ..... CLOSE
..... ON
abilizes:
Switch ..... NORMAL

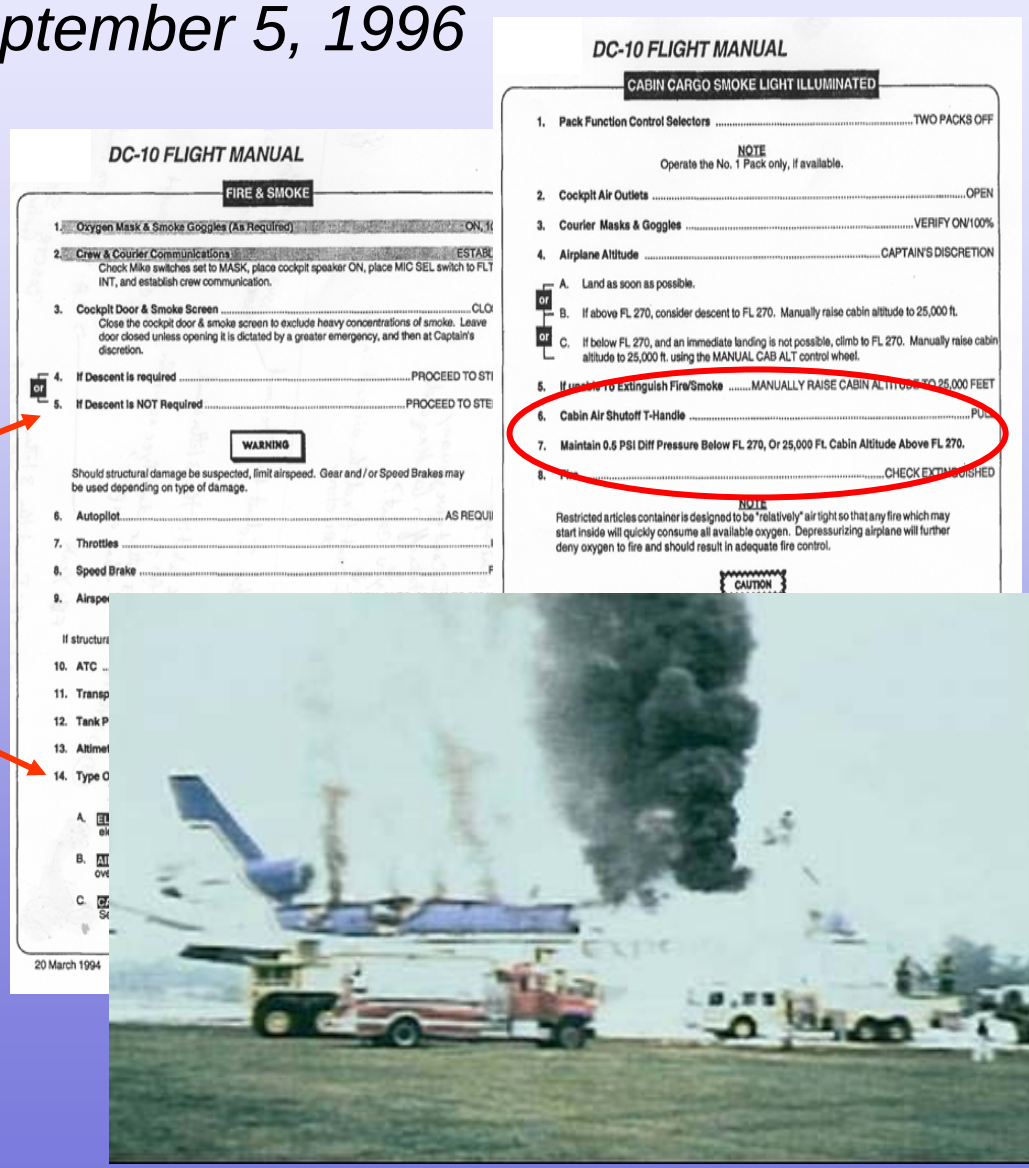
Without referring to a checklist to reinstate a pack that had automatically tripped off, the flight engineer opened the outflow valve by mistake (instead of closing it) and caused the aircraft to rapidly decompress.

The captain, flight engineer, and a flight attendant, who had been on the flight deck, each lost consciousness during the event.

FedEx 1406, DC-10 In-flight Fire – Newburgh, New York September 5, 1996

In a rapidly deteriorating situation under high stress and workload, some checklist steps were missed which resulted in the aircraft being partially pressurized after making an emergency landing.

The crew and two passengers barely escaped the burning aircraft.



Air Canada 797 - DC-9 In-flight Fire, Covington,Kentucky June 2,1983

Initial actions taken by cabin crew to assess and deal with fire were inadequate

Captain was told the smoke was lessening – 5 ½ minute delay in starting emergency decent

After poor handoff, ATC identified the wrong radar target as the emergency flight

First officer turned the airconditioning and pressurization packs off

Toxic fumes and gases built up, a flash fire occurred soon after landing and 23 passengers died.

Emergency and Abnormal Situations Project

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Emergency and Abnormal Situations Project

Taxonomy of the Domain

Issues Related to the Aircraft

Critical Aircraft Systems

Automation Issues

Systems within flight protection envelopes, automated systems, etc.

Warnings, warning systems, and “warning overload”

What kinds of automation should be used and under what circumstances and when should automation not be used?

Issues in reverting to manual flying, degradation in hand flying skills, etc.

SAS 751 - MD-81 Dual Engine Failure – Gottrora, Sweden – December 27, 1991

On takeoff, ice was ingested into the engines which damaged the fan stages and caused the engines to surge – all power was lost 77 seconds later.

During the event engine power was increased automatically by the Automatic Thrust Restoration (ATR) feature, which increased the intensity of the surging and contributed to the failure of the engines.

Neither the crew nor the company knew that the ATR feature existed on the airplane.

Birgenair ALW 301 - B757 Loss of Control – Puerto Plata, Dominican Republic – February 2, 1996

Erroneous information was sent to the captain's airspeed indicator and center autopilot by the left air data computer because a pitot tube was blocked.

The crew members were tremendously confused by contradictory warnings (overspeed and stall warnings) and conflicting airspeed indications on the three displays.

The center autopilot and autothrottles contributed to their problems. The crew did not attempt to fly the aircraft manually and tried to use automation in a way that did not help them.

The aircraft crashed into the ocean. All onboard perished.

Emergency and Abnormal Situations Project

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Emergency and Abnormal Situations Project

Taxonomy of the Domain

Issues Related to Training

Training

Relevant training technologies and approaches

Initial vs. recurrent training in dealing with these situations

Skill acquisition and retention of procedures that are unpracticed or seldom practiced

Training for "textbook" vs. "nonstandard" situations

Training for handling single vs. multiple problems

Joint training of flight and cabin crews

British Midlands, Loss of Engine Kegworth, Leicestershire, England January 8, 1989

The flight crew mistakenly thought they had problems was with their right engine and shut it down.

Cabin crew and passengers could see flames coming from the left engine but this information was not given to the flight crew

48 passengers died as a result of the crash landing

Joint emergency training for flight and cabin crews was recommended by the Air Accidents Investigation Branch of the Ministry of Transport (UK)

Emergency and Abnormal Situations Project

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Emergency and Abnormal Situations Project

Taxonomy of the Domain

Selected Equipment and Evacuation Issues

Equipment and Evacuation Issues

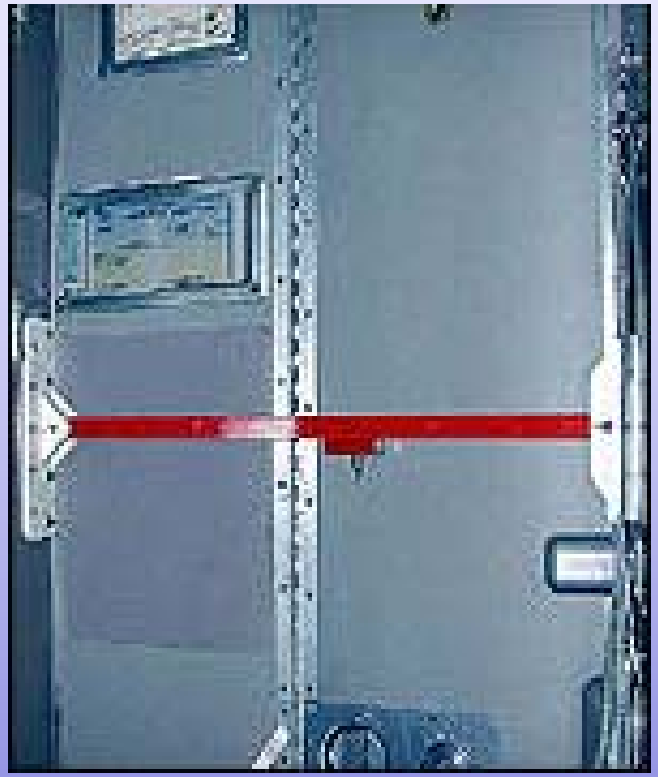
Equipment that is problematic to use in an emergency (e.g., smoke goggles that do not fit over eyeglasses)

Inadequate training in the use of emergency equipment

Negative transfer (interference) of equipment usage across different aircraft types

Confusion or problems regarding the initiation of evacuations

Airtran 356 - 717-200 – Flushing, New York – March 26, 2003
NTSB Preliminary Report



While on final approach the forward flight attendant noticed a burning smell and discovered that the handset to call the cockpit was not working.

After landing she pounded on the cockpit door and yelled to get the flight crew's attention.

The flight crew never heard the flight attendant pounding or yelling.

Emergency and Abnormal Situations Project

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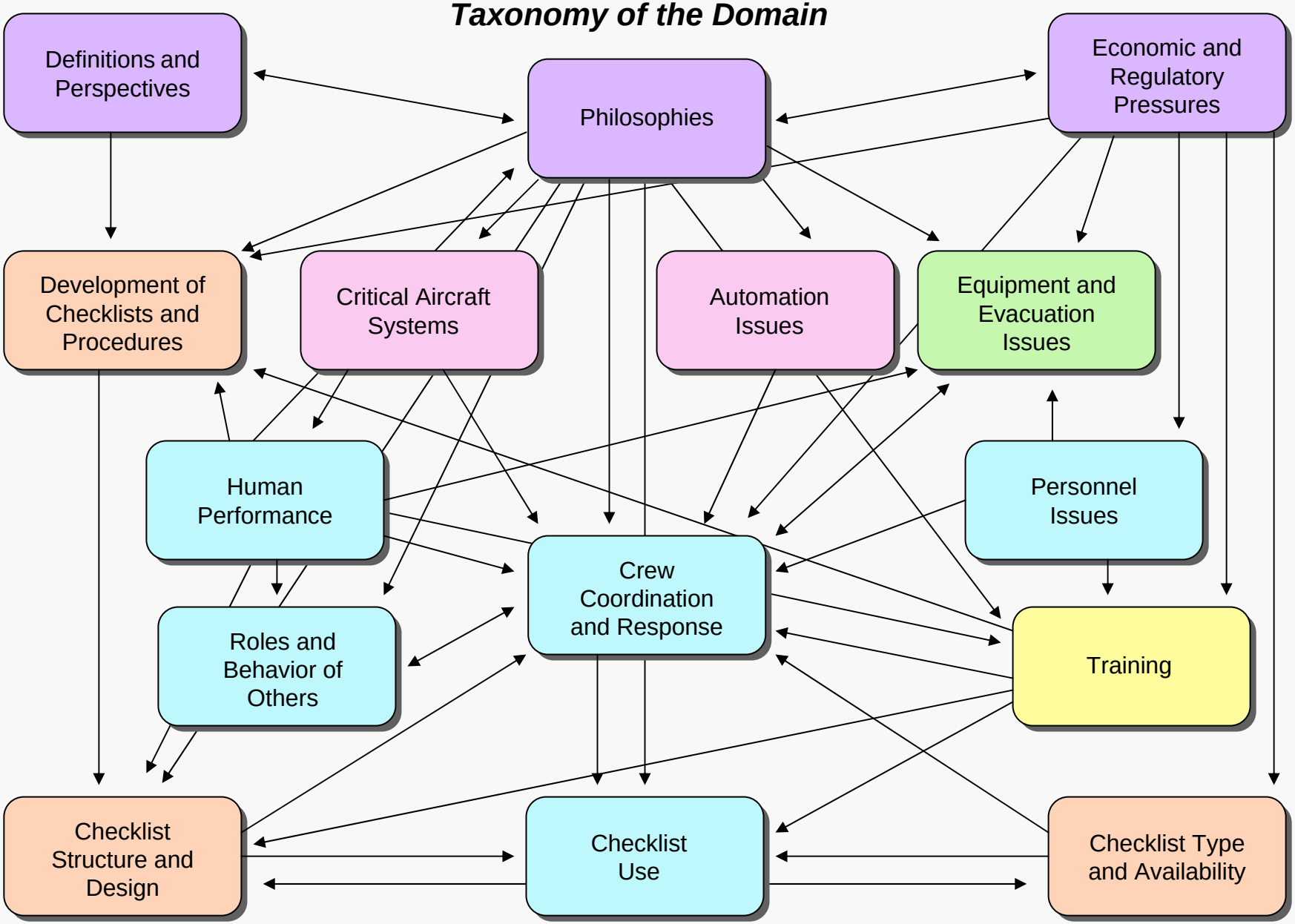

Overall Goal of the EAS Project

Develop guidance for procedure development and certification, training, crew coordination, and situation management based on knowledge of the operational environment, human performance limitations, and cognitive vulnerabilities in real-world situations.

Products and Deliverables

Intermediate Products:

Reports, Articles, Papers, Presentations

End Products:

Field Guides for

- Training Entities and Instructors
- Operators
- Manufacturers
- Regulatory Agencies (Certification, POIs)

EAS Project Team

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