Human Factors in Aviation—The Good, The Bad, and the Ugly: Some Lessons from NASA for Medicine

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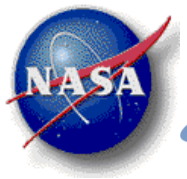
Topics

1. Human Factors in Aviation and Medicine

2. Checklists – Use in Aviation and Medicine

3. Questions and Discussion

What is “Human Factors”?



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

- **1851:14** three cb for aft left lav. toilet flush motor trip
- 00:13 CA resets cb (elapsed time from cb trip)
- 08:31 CA resets cbs again (elapsed time from 1st reset)
- **1902:40** FA reports fire in back washroom to flight crew and that other FAs are fighting it
- 00:30 FO goes to assess (time elapsed from report of fire)
- 01:47 FO "…I can't go back now, it's too heavy, I think we'd better go down"
- 00:09 FA "…You don't have to worry I think its gonna be easing up"
- 00:07 FO "OK it is starting to clear now"
- 00:28 FO goes back to assess a second time
- 00:45 FA "..put a big discharge of CO_2 in the washroom, it seems to be subsiding, all right"
- 00:36 CA calls ATC, reports electrical problem, may be off radios soon, stand by
- 00:23 FA "Getting much better, okay"
- 00:17 FA "CO_2 it was almost half a bottle and it now almost cleared"
- 00:19 FO returns, "I don't like what's happening, I think we better go down, okay?"
- **05:30** (approx.) **elapsed between first report of fire and initiation of emergency descent**

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

- Emergency electrical busses lost power,
- ATC offered landing at Cincinnati-Covington Airport
- CA accepted; heading 060^{o} and 20 miles
- Declared emergency, transponder set to emergency code but it was inoperative due to power loss
- Handoff from one ATC to another
- New ATC unaware of flight's electrical problems identified the wrong target on radar scope
- ATC planned for landing rwy 36; aircraft not positioned well for rwy 36 when identified as correct target; eventually landed rwy 27L

- Though not required by procedure, FO turned off the air conditioning & pressurization packs "because the smoke was getting bad at that point and my reasoning was I have to do something…"
- Toxic fumes and gases built up, a flash fire occurred soon after landing and opening doors for evacuation; 23 passengers died.

Air France 447 ECAM Displays if No Messages Had Been Erased (BEA, 2012, pg. 97).

Air France 447- A330, Blocked Pitot Tube, Atlantic Ocean June 1, 2009

Blocked pitot tube = inaccurate airspeed indication

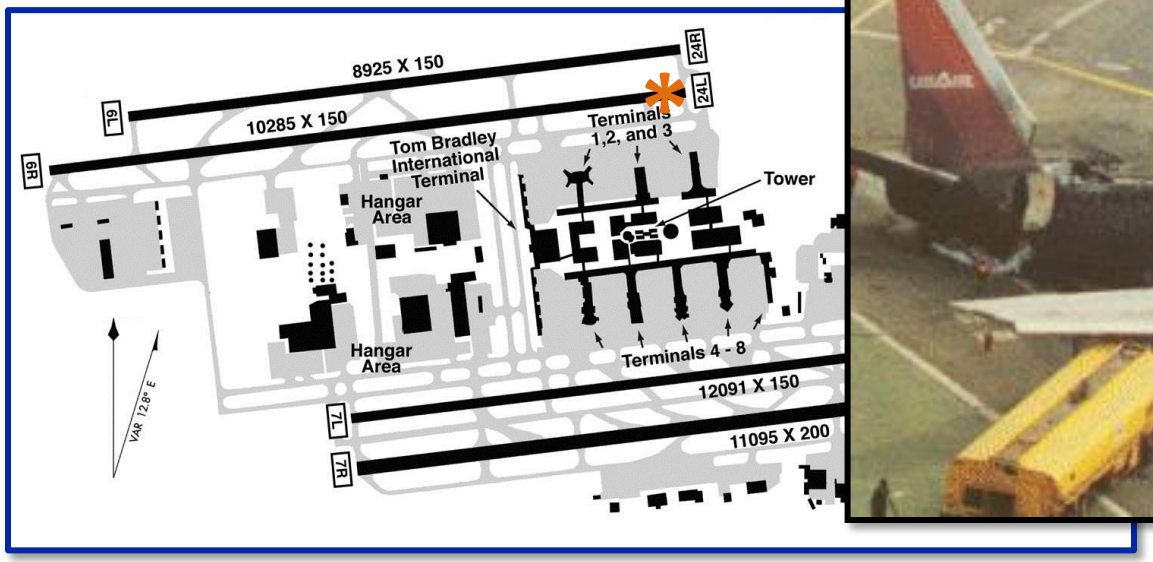
Air SPD.....X Check

Also, the counterintuitive behavior of the stall alerting system contributed to crew's confusion.

Prospective Memory Failure, Distractions, Loss of Situation Awareness

LAX 1991

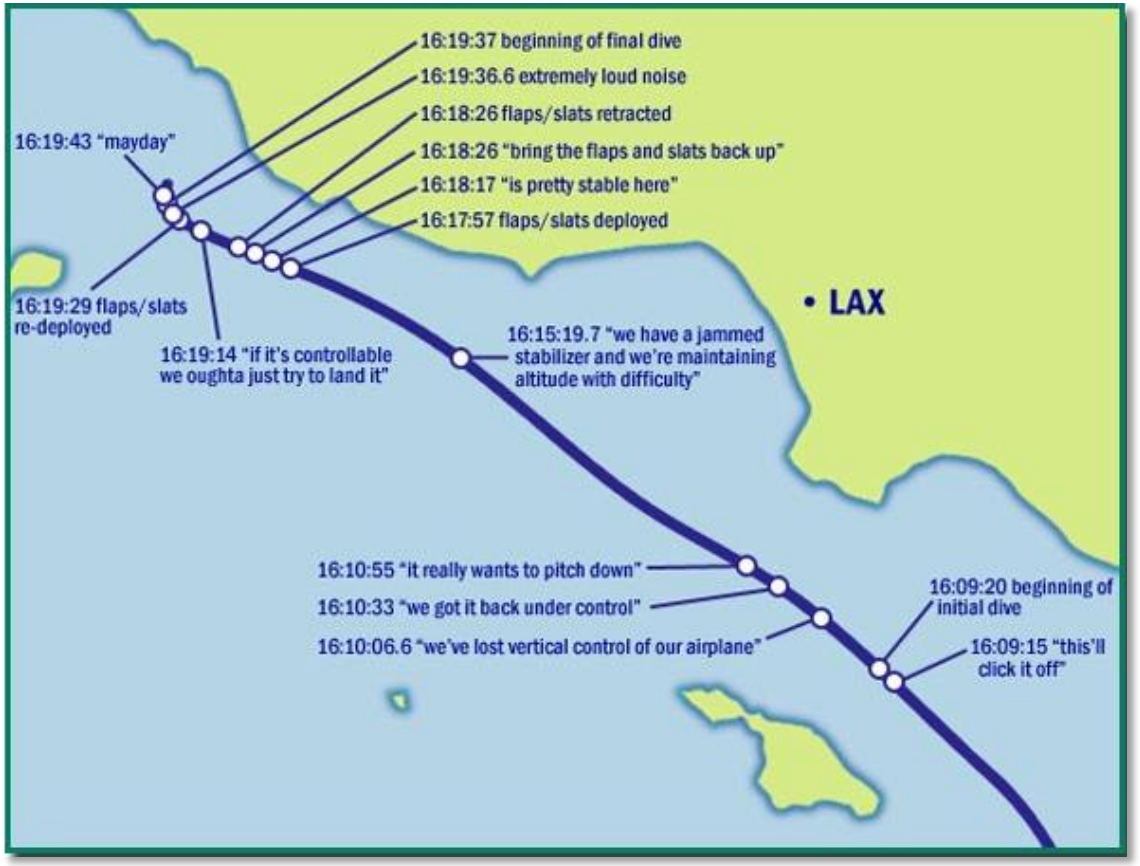
- Tower cleared Skywest 569, a commuter, to taxi into position & hold on rwy 24L
- Delayed takeoff clearance to allow other aircraft to cross on far end of runway
- Controller forgot Skywest 569 had not departed or confused it with another commuter
- Poor visibility: twilight, haze, & glare from lights
- Cleared US Air 1493, a B737, to land on rwy 24L
- Both aircraft destroyed; 34 killed



Alaska 261- MD-83 Jammed Horizontal Stabilizer, Pacific Ocean, January 31, 2000

Dispatch:
uh, if uh you want to land at LA of course for safety reasons we will do that, uh, we'll uh tell you though that if we land in LA, uh, we'll be looking at probably an hour to an hour and a half, we have a major flow program going right now…uh, that's for ATC back in San Francisco.

Captain:
Well, uh, yu, you eh, huh…boy you put me in a spot here, um…I really didn't want to hear about the flow being the reason you're calling us 'cause I'm concerned about overflying suitable airports. (NTSB, 2002)

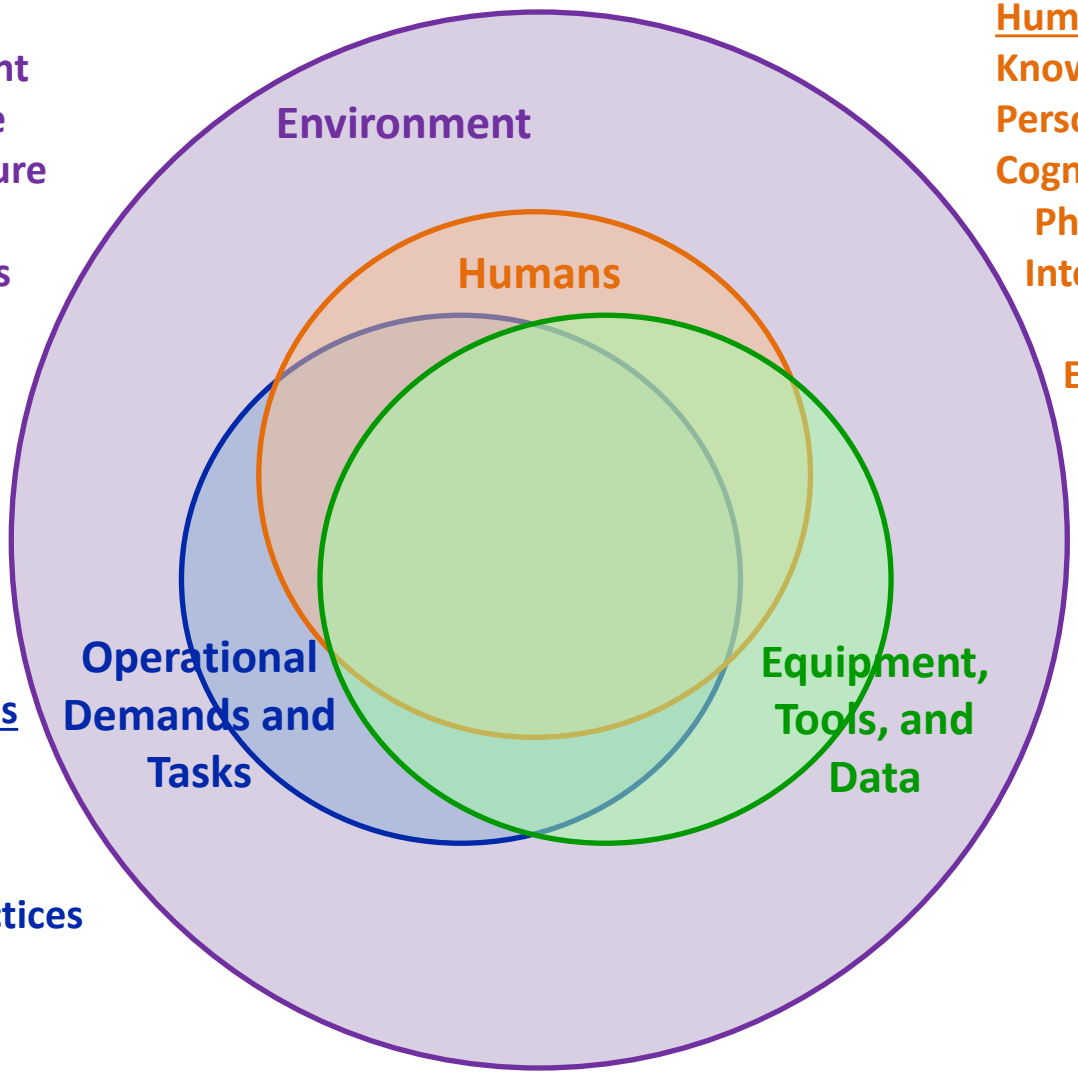


Dispatcher, not knowing seriousness of problem, puts pressure on the Captain to continue to San Francisco.

Model of Human Factors

Environment
Physical Environment
Professional Culture
Organizational Culture and Policies
Economic Influences

Humans
Knowledge, Skills, Abilities
Personalities, Experiences
Cognitive, Motor, and Physiological Functioning
Interpersonal, Team Dynamics
Effects of Stress



Operational Demands and Tasks
Workload
Concurrent Tasks
Procedures and Practices
Dynamic Nature
Pacing
Contextual Factors
Specific Situations Encountered

Equipment ,Tools, and Data
Machines
Materials
Alerting Systems
Technology
Checklists
Performance Data
Medications
Test Results

Aviation and Medicine: Dynamic, Socio-technical, High Consequence Environments

"Anesthesiologists, like surgeons and emergency room physicians, work in a complex, rapidly changing, time-constrained and stressful work environment.

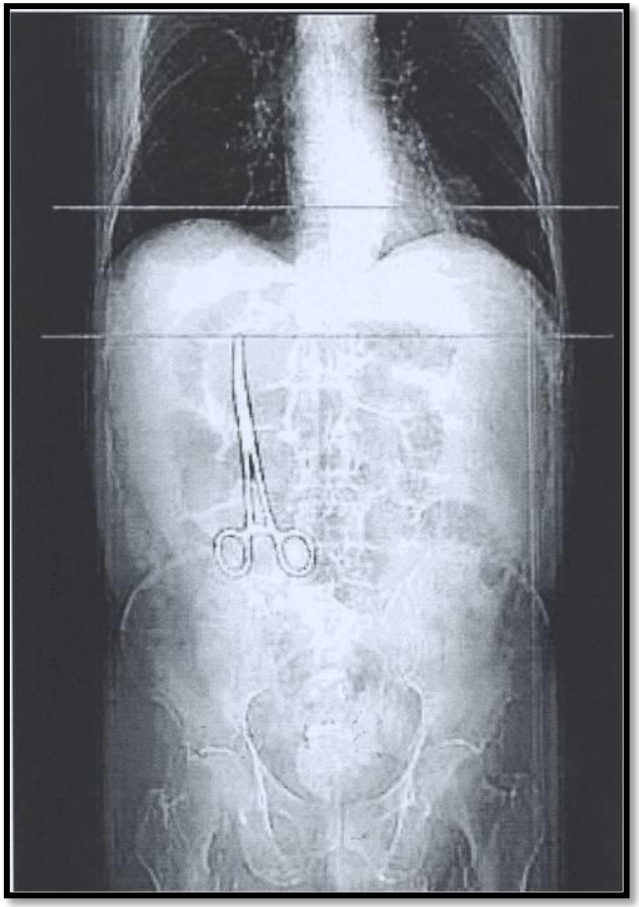
The anesthesia domain is in many ways similar to aircraft cockpits, air traffic control rooms, and combat information centers where effective performance demands expert knowledge, appropriate problem-solving strategies, and fine motor skills."

Human Factors Research in Anesthesia Patient Safety
Techniques to Elucidate Factors Affecting Clinical Task Performance and Decision Making.

Matthew B. Weinger, MD and Jason Slagle, MS
J Am Med Inform Assoc. 2002 Nov-Dec; 9(6 Suppl 1): s58–s63.
doi: 10.1197/jamia.M1229
PMCID: PMC419421

Prospective Memory, Attention, Interruptions, Distractions

http://www.eveningtelegraph.co.uk/news/local/dundee/objects-left-inside-tayside-patients-after-operations-1.688919



From: *Images in Clinical Medicine*. Dembitzer, A. & Lai, E. J. (2003). Retained surgical instrument. *New England Journal of Medicine, 348*(3), 228. Copyright © 2003 Massachusetts Medical Society.

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Alarms

- 86% of the alarms in a pediatric ICU were “false” alarms (i.e., nuisance alarms), and only 8% had genuine clinical significance (Tsien & Fackler, 1997)
- Can be very difficult to know to which patient/monitor the alarm “belongs”
- Alarms deemed to be “false” tend to get ignored.

- Survey of Canadian anesthesiologists: 57% reported that they had deliberately deactivated auditory alarms as a reaction to too many “false” alarms (Kestin, et al., 1988)
- Anesthesiologists responded to <50% of the alarms during most phases of surgery (Seagull & Sanderson, 1988)

Preventable anesthesia mishaps: A study of human factors
Cooper, Newbower, Long, & McPeek

Quality and Safety in Health Care 2002; 11:277-283
Originally published in *Anesthesiology* 1978; 49:399-406

- Conducted a modified critical-incident analysis study
- Retrospective examination of human error and equipment failure in anesthetic practice
- 47 interviews conducted with staff and resident anesthesiologists at one urban teaching institution
- 359 preventable incidents were identified
- Most preventable incidents involved human error (82%)
- Equipment failures: 14% of the preventable incidents
- Equipment design, inadequate experience, and insufficient familiarity with equipment or surgical procedure associated with many categories of human error

Preventable: "Anesthetist clearly failed to follow accepted practice or where a piece of equipment ceased to function normally. When doubt existed about preventability, the incident was excluded."

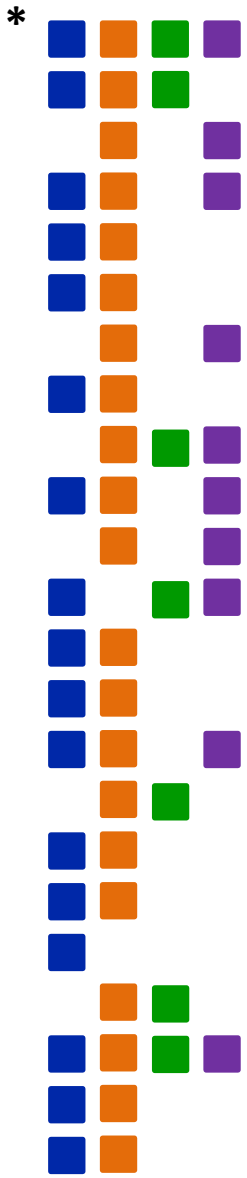
Preventable anesthesia mishaps: A study of human factors
Cooper, Newbower, Long, & McPeek (1978/2002)

Table 2 The most frequent incidents*

Breathing circuit disconnection	27
Inadvertent gas flow change†	22
Syringe swap	19
Gas supply problem	15
Intravenous apparatus disconnection	11
Laryngoscope malfunction	11
Premature extubation	10
Breathing circuit connection error†	9
Hypovolemia	9
Tracheal airway device position changes	7

*This list includes both human error and equipment failures. Note that these somewhat arbitrary categories encompass only 39% of the total database, with the remainder representing a larger variety.
†See text for special nature of anesthesia machines involved.

Summary of Some Associated Factors Cited



77	Inadequate total experience
45	Inadequate familiarity with equipment/device
27	Poor communication with team, lab, etc.
26	Haste
26	Inattention/carelessness
24	Fatigue
24	Excessive dependency on other personnel
22	Failure to perform a normal check
22	Training or experience – other factors
18	Supervisor not present enough
18	Environment or colleagues – other factors
17	Visual field restricted
16	Mental or physical – other factors
14	Inadequate familiarity with surgical procedure
13	Distraction
12	Poor labelling of controls, drugs, etc.
12	Supervision – other factors
12	Emergency/demanding/difficult case
10	Situation precluded normal precautions
10	Inadequate familiarity with anesthetic technique
9	Teaching activity under way
8	Apprehension
5	Boredom

Operational demands, tasks
Humans
Equipment, tools, data
Environment

* Guesses by Burian

From: Cooper, Newbower, Long, & McPeek (1978/2002)

Brief Tangent

"Human Error"

- By itself, is not a very useful construct
- Generally simplistic – very few incidents or accidents are the result of only "human error"
- The label does not help us understand the underlying causes of most incidents and accidents, and therefore
- Does not help us develop appropriate and effective mitigations
- When "human error" is identified, that should be the beginning of the investigation, not the end

Human Factors Knowledge Domains

Domain	Issues
Cognitive Psychology	Attention, cognitive processing, working and prospective memory, situation awareness
Sensation, Perception, and Physiological Psychology	Alarm, tool/equipment, and display design; effects of stress, temperature, noise, fatigue
Clinical, Personality, and Social Psychology	Interpersonal behavior and team dynamics, effects of organization culture, effects of stress
Industrial/Organizational Psychology	Workload, task prioritization, concurrent task management
Ergonomics	Size, weight, maneuverability of equipment and tools, workspace layout and dimensions
Automation/Computer Engineering	Design, functionality, and usability of technology and automation
Education	Training, skill retention, text comprehensibility

Operational Domain Expert + Human

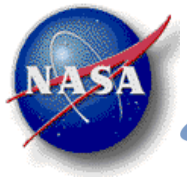
≠ Human Factors Expert

Navigation Display – Magenta “Stands Out”


GS 355
TAS 360
5
6
7
8
9
SHERO
074°
25NM
TXK
TXK
GGG
80
PRX
SLB
UIM
40
SHERO
TYR
FZT
MJF
URH
BYP
354/21
TRISS

Right…….

Checklists in Aviation and Medicine



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Checklists in Aviation and Medicine

- Types - Purposes
- Modality of Presentation
- Methods of Accomplishment

- Types - Purposes
- Modality of Presentation
- Methods of Accomplishment

Aviation - Normal Checklists

BOEING

NORMAL CHECKLIST

PREFLIGHT	
Oxygen	TESTED, 100%
Instrument Xfer & Display Switches	NORMAL, AUTO
Window Heat	ON
Pressurization Mode Selector	AUTO
Flight Instruments	SET
Parking Brake	SET
Engine Start Levers	CUTOFF

BEFORE START	
Flight Deck Door	CLOSED & LOCKED
Fuel	___ KGS/LBS, PUMPS ON
Passenger Signs	ON
Windows	LOCKED
MCP	SET
Takeoff Speeds	SET
CDU Preflight	COMPLETED
Rudder & Aileron Trim	FREE & ZERO
Taxi & Takeoff Briefing	COMPLETED
Anti Collision Lights	ON

BEFORE TAXI	
Generators	ON
Probe Heat	ON
Anti-Ice	____
Isolation Valves	AUTO
Engine Start Switches	CONTINUOUS
Recall	CHECKED
Autobrake	RTO
Engine Start Levers	IDLE DETENT
Flight Controls	CHECKED
Ground Equipment	CLEAR

BEFORE TAKEOFF	
Flaps	___, GREEN LIGHT
Stabilizer Trim	___ UNITS

AFTER TAKEOFF	
Engine Bleeds	ON
Packs	AUTO
Landing Gear	UP & OFF
Flaps	UP, NO LIGHTS

DESCENT	
Pressurization	LANDING ALT____
Recall	CHECKED
Autobrake	____
Landing Data	VREF___ MINIMUMS___
Approach Briefing	COMPLETED

APPROACH	
Altimeters	___ SET

LANDING	
Engine Start Switches	CONTINUOUS
Speed Brake	ARMED
Landing Gear	DOWN
Flaps	___, GREEN LIGHT

SHUTDOWN	
Fuel Pumps	OFF
Probe Heat	OFF
Hydraulic Panel	SET
Flaps	UP
Parking Brake	____
Engine Start Levers	CUTOFF
Weather Radar	OFF

SECURING AIRCRAFT	
IRS's	OFF
Emergent Exit Lights	OFF
Window Heat	OFF
Packs	OFF

737-800NG

LIMITATIONS	
T.O. Weight	kgs 70,533
Landing Weight	kgs 65,317
Taxi Weight	kgs 70,761
Zero Fuel Weight	kgs 61,688
Landing Gear ext/ret	kts 270/235

©Roberto Morocutti - NOT FOR REAL FLIGHT USE

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Aviation - Emergency and Abnormal (Non-normal) Checklists

ENG DUAL FAILURE

1. **If no fuel remaining:**
   - a. THR LEVERS ..... Confirm ..... IDLE
   - b. EMER ELEC PWR (if EMER GEN not on-line) ..... MAN ON
   - c. FAC 1 ..... OFF then ON

   [Resetting FAC 1 enables the recovery of characteristic speeds displayed on the PFD, and enables rudder trim recovery, even if no indication is available. Once hydraulic power is lost, the right aileron is lost, and is in the up float position. Rudder trim may be used to compensate for this up floating aileron.]

   - d. Optimum speed .....

   or

   - e. Landing Strategy .....

   [Determine most appropriate place for fo

   - f. ATC (VHF1, HF1, ATC1) .....
     - (1) If unable to contact ATC on ass
       - (a) ATC Code .....
       - (b) Distress Message .....

       [Use one of the follow 2182 KHz or 8364 KH

   - g. Oxygen Masks (above 10,000') V
   - h. Go to step 2.

If fuel remaining:

- a. ENG MODE Selector .....
- b. THR LEVERS ..... Co
- c. Airspeed ..... Optimum rel

(1) **If A319 or A320:**

[For airspeed indicat attitude for optimum nose down. Add 1° 110,000 lbs.

or

CFM: At 300 kts, th nautical miles per 100

IAE: At 280 kts, the air miles per 1000 feet (no wind)]

If A321:

[For airspeed indication failure (volcanic ash) the pitch attitude for optimum relight speed is 4.5° nose down.Add 1° nose up for each 22,000 lbs. above 132,000 lbs.

At 300 kts, the aircraft can fly approximately 2.0 nautical miles per 1000 feet (no wind)]

- d. Landing Strategy ..... Determine

[Determine most appropriate place for forced landing/ditching.]

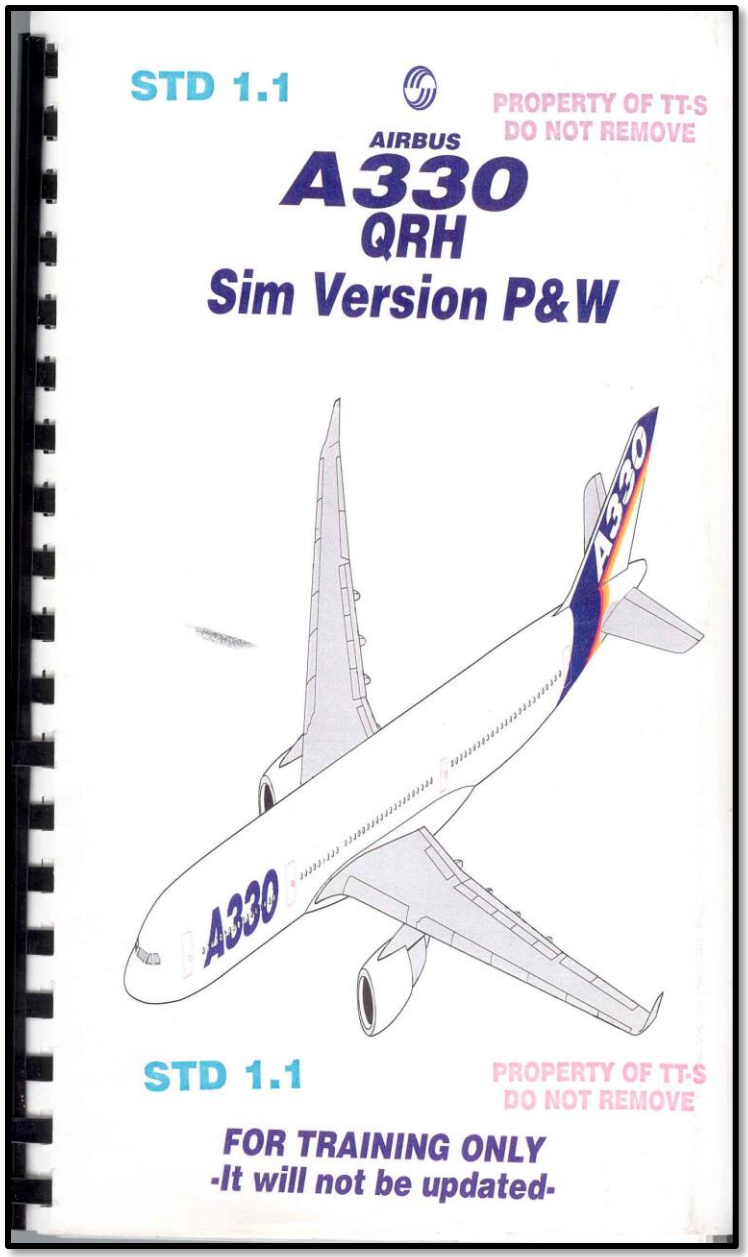
- e. EMER ELEC PWR (if EMER GEN not on-line) ..... MAN ON
- f. ATC (VHF1, HF1, ATC1) ..... Notify
  - (1) If unable to contact ATC on assigned frequency:
    - (a) ATC Code A7700
    - (b) Distress Message ..... Transmit

    [Use one of the following frequencies: VHF 121.5 MHz, HF 2182 KHz or 8364 KHz]

Cont'd

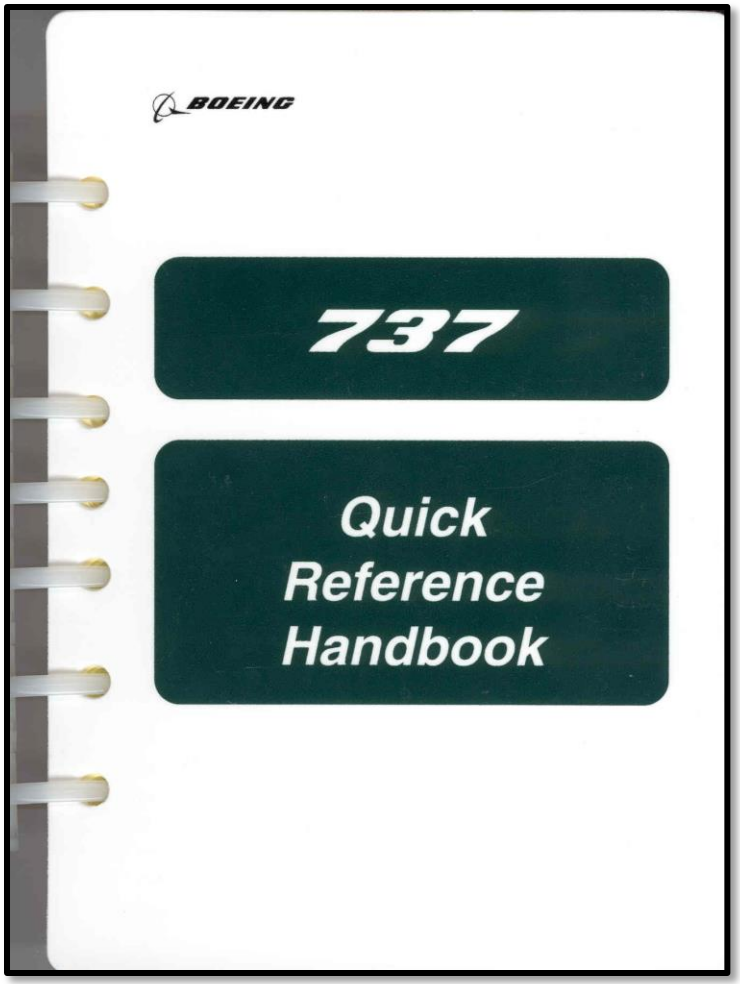
Aviation
Emergency and Abnormal (Non-normal) Checklists

Approx. 6 ½ inches

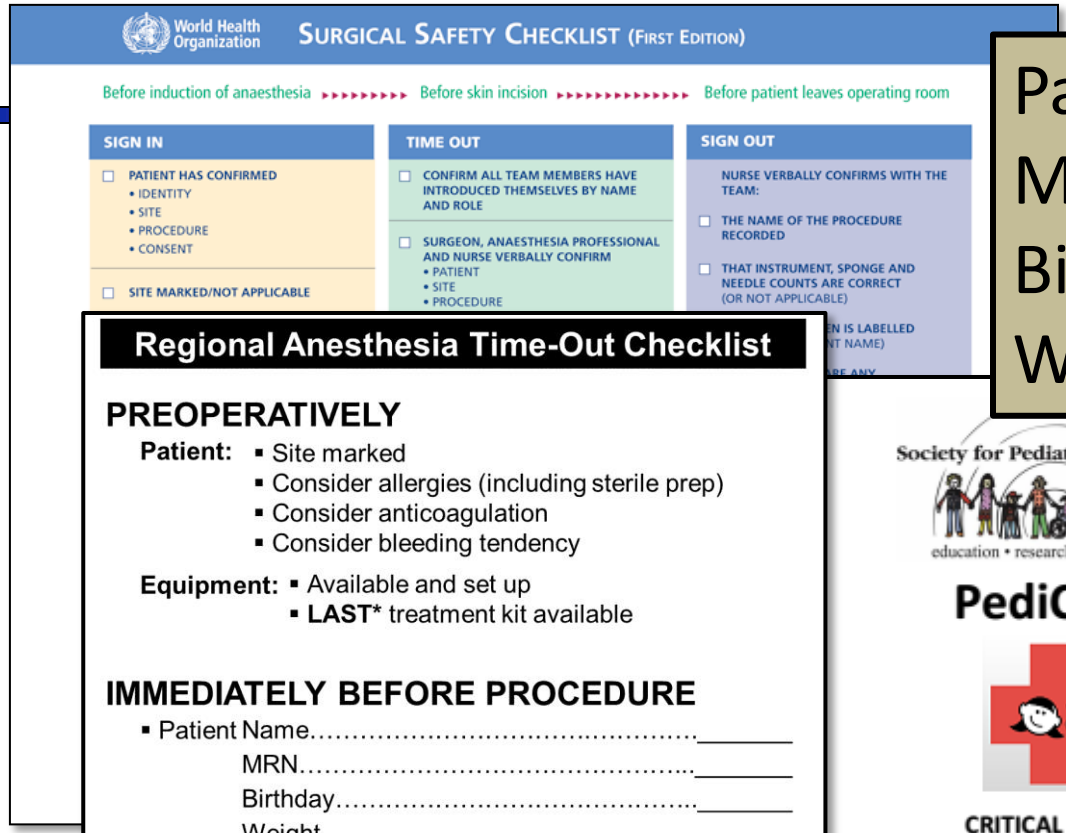


Approximately 11 inches

Approx. 6 ½ inches



Approximately 9 inches



Medicine

Patient: April Showers
MRN: 07582
Birthday: 1 Apr 2011
Weight: 15.2 kg

Regional Anesthesia Time-Out Checklist

PREOPERATIVELY

Patient:
- Site marked
- Consider allergies (including sterile prep)
- Consider anticoagulation
- Consider bleeding tendency

Equipment:
- Available and set up
- **LAST*** treatment kit available

IMMEDIATELY BEFORE PROCEDURE

- Patient Name……_____
  MRN……_____
  Birthday……_____
  Weight……_____
- Surgery type……_____
- Block type(s)……_____
- Laterality……_____
- Dose and timing of other local anesthetics……_____
  (By surgeon, by anesthesia, in ED, on floor, topical, or IV)
- Maximum allowable local anesthetic for block……_____

NOTE: **LAST** can occur with appropriate doses.
Carefully titrate for individualized patient conditions.

For treatment of suspected LAST – Flip card

* Local Anesthetic Systemic Toxicity

Society for Pediatric Anesthesia
education • research • patient safety

PediCrisis

CRITICAL EVENTS CARDS

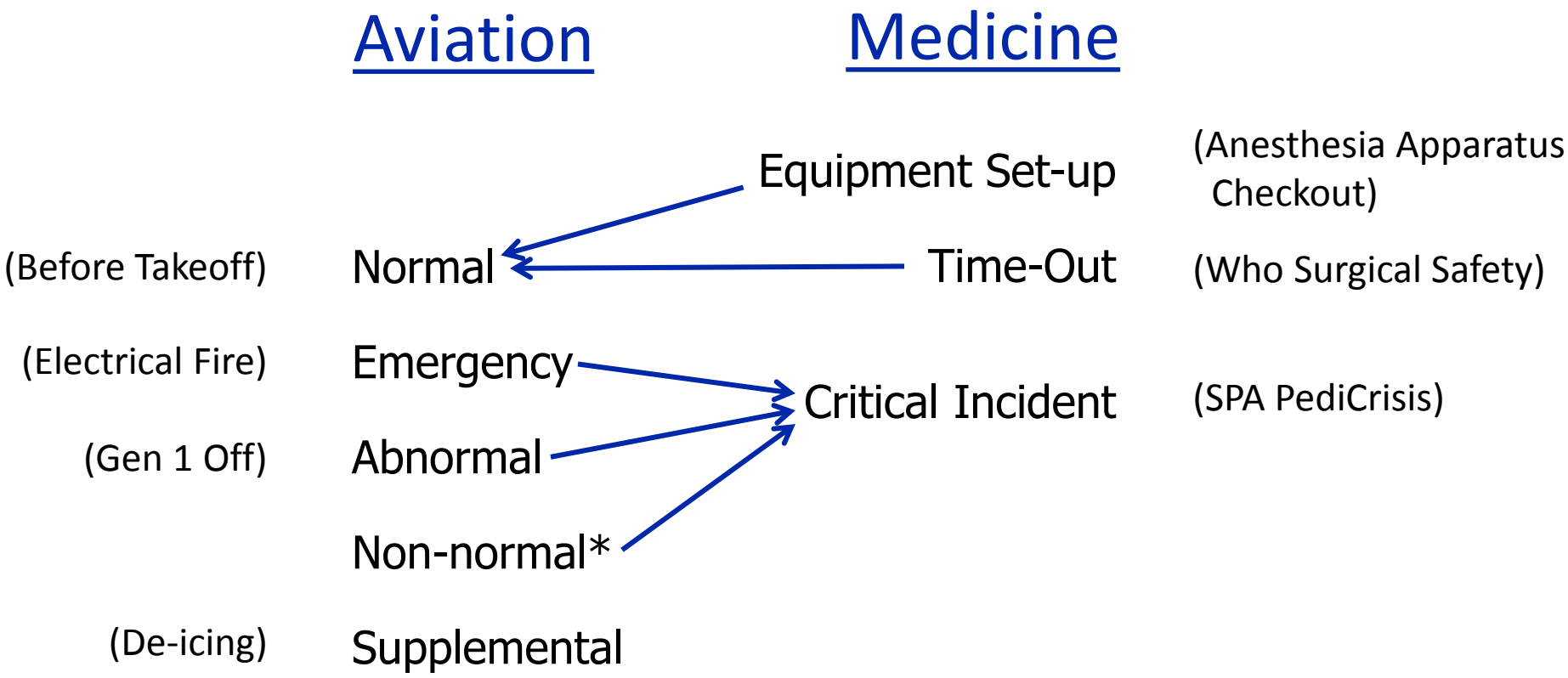
Call for help!

Code Team _____
PICU _____
Fire _____
Overhead STAT _____

Revision November 19, 2014

Air Embolism	2
Anaphylaxis	3
Bradycardia	4
Cardiac Arrest	5-7
Difficult Airway	8
Fire: Airway / OR	9-10
Hyperkalemia	11
Hypertension	12
Hypotension	13
Hypoxia	14-15
Local Anesthetic Toxicity	16
Loss of Evoked Potentials	17
Malignant Hyperthermia	18
Myocardial Ischemia	19
Pulmonary Hypertension	20
Tachycardia	21
Transfusion & Reactions	22-23
Trauma	23-25

Types of Checklists



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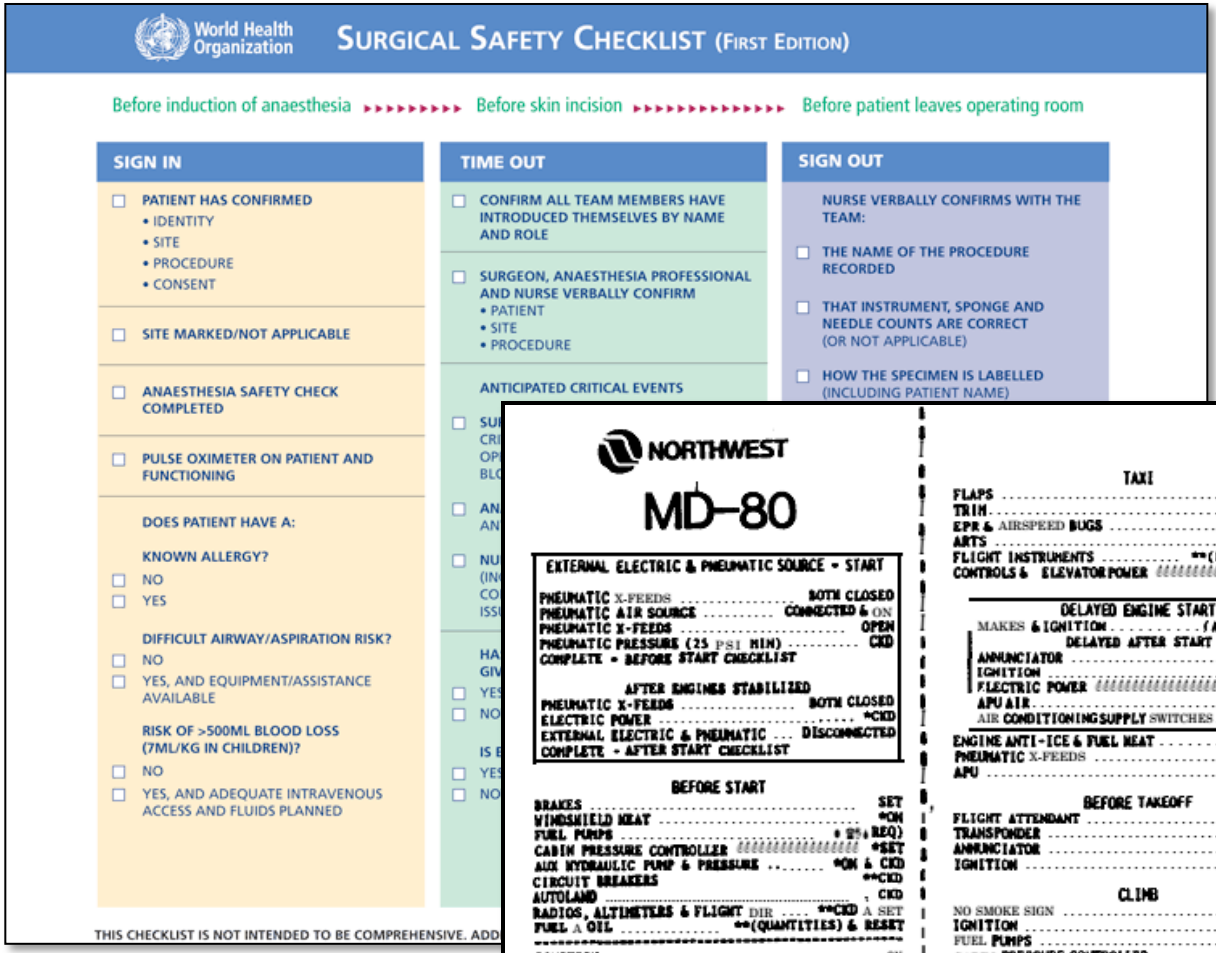
* Different definitions within the industry

Normal/Time-out Checklists	Emergency/Abnormal /Critical Event Checklists
Memory aid	Memory aid
Provides structure and standardization of crew/team interactions	Provides structure and standardization of crew/team interactions
Primary and most effective method to catch human errors and ID equipment failures	Items requiring confirmation from two or more people can help catch human errors
Ensure aircraft is properly configured for a particular phase of flight/Ensure essential actions accomplished prior to phase of medical procedure	Ensure essential steps for non-normal situation response are carried out and in the correct sequence
Check that essential steps have been accomplished (true check-list)	Guide the response to an emergency or abnormal situation (procedure)
Do then Verify (Check)	Read and Do
Single list of items completed sequentially	Complex navigation within checklist and among other checklists and materials may be required
Which checklist to be performed is never in doubt	Which checklist to be performed may be unclear; items for exact situation may not exist
NOT to be performed from memory	Some initial time-critical checklist items may be required to be performed from memory
Might be interrupted during accomplishment	Almost certainly will be interrupted during accomplishment

- Types - Purposes
- **Modality of Presentation**
- Methods of Accomplishment

Paper



World Health Organization

SURGICAL SAFETY CHECKLIST (FIRST EDITION)

Before induction of anaesthesia ▸▸▸▸▸▸▸▸▸ Before skin incision ▸▸▸▸▸▸▸▸▸▸▸▸▸ Before patient leaves operating room

SIGN IN

- ☐ PATIENT HAS CONFIRMED
  - IDENTITY
  - SITE
  - PROCEDURE
  - CONSENT
- ☐ SITE MARKED/NOT APPLICABLE
- ☐ ANAESTHESIA SAFETY CHECK COMPLETED
- ☐ PULSE OXIMETER ON PATIENT AND FUNCTIONING
- DOES PATIENT HAVE A:

  KNOWN ALLERGY?
  - ☐ NO
  - ☐ YES

  DIFFICULT AIRWAY/ASPIRATION RISK?
  - ☐ NO
  - ☐ YES, AND EQUIPMENT/ASSISTANCE AVAILABLE

  RISK OF >500ML BLOOD LOSS (7ML/KG IN CHILDREN)?
  - ☐ NO
  - ☐ YES, AND ADEQUATE INTRAVENOUS ACCESS AND FLUIDS PLANNED

TIME OUT

- ☐ CONFIRM ALL TEAM MEMBERS HAVE INTRODUCED THEMSELVES BY NAME AND ROLE
- ☐ SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE VERBALLY CONFIRM
  - PATIENT
  - SITE
  - PROCEDURE
- ANTICIPATED CRITICAL EVENTS

SIGN OUT

NURSE VERBALLY CONFIRMS WITH THE TEAM:

- ☐ THE NAME OF THE PROCEDURE RECORDED
- ☐ THAT INSTRUMENT, SPONGE AND NEEDLE COUNTS ARE CORRECT (OR NOT APPLICABLE)
- ☐ HOW THE SPECIMEN IS LABELLED (INCLUDING PATIENT NAME)

THIS CHECKLIST IS NOT INTENDED TO BE COMPREHENSIVE. ADD

NORTHWEST

MD-80

EXTERNAL ELECTRIC & PNEUMATIC SOURCE - START

PNEUMATIC X-FEEDS	BOTH CLOSED
PNEUMATIC AIR SOURCE	CONNECTED & ON
PNEUMATIC X-FEEDS	OPEN
PNEUMATIC PRESSURE (25 PSI MIN)	CKD
COMPLETE - BEFORE START CHECKLIST	

AFTER ENGINES STABILIZED

PNEUMATIC X-FEEDS	BOTH CLOSED
ELECTRIC POWER	*CKD
EXTERNAL ELECTRIC & PNEUMATIC	DISCONNECTED
COMPLETE - AFTER START CHECKLIST	

BEFORE START

BRAKES	SET
WINDSHIELD HEAT	*ON
FUEL PUMPS	* (AS REQ)
CABIN PRESSURE CONTROLLER	*SET
AUX HYDRAULIC PUMP & PRESSURE	*ON & CKD
CIRCUIT BREAKERS	**CKD
AUTOLAND	CKD
RADIOS, ALTIMETERS & FLIGHT DIR	**CKD & SET
FUEL & OIL	**(QUANTITIES) & RESET
IGNITION	ON
SEAT BELT SIGN	ON
BEACON	ON

AFTER START

ANNUNCIATOR	CKD
IGNITION	*OFF
ELECTRIC POWER	*CKD
APU AIR	*(AS REQ)
AIR CONDITIONING SUPPLY SWITCHES	* AUTO
PNEUMATIC X-FEED	*ONE CLOSED
TRANSFER PUMP & HYDRAULIC SYSTEMS	*ON & CKD

TAXI

FLAPS	**(SETTING)
TRIM	**(SETTING)
EPR & AIRSPEED BUGS	**(SETTINGS)
ARTS	(AS REQ)
FLIGHT INSTRUMENTS	**(HDG) & SLAVING
CONTROLS & ELEVATOR POWER	* CKD-TOP, CKD-BOTTOM

DELAYED ENGINE START

MAKES & IGNITION ... (AS REQ) & ON

DELAYED AFTER START

ANNUNCIATOR	CKD
IGNITION	*OFF
ELECTRIC POWER	*
APU AIR	*OFF
AIR CONDITIONING SUPPLY SWITCHES	* AUTO

ENGINE ANTI-ICE & FUEL HEAT	(AS REQ)
PNEUMATIC X-FEEDS	*CLOSED
APU	* (AS REQ)

BEFORE TAKEOFF

FLIGHT ATTENDANT	* NOTIFIED
TRANSPONDER	*ON
ANNUNCIATOR	CKD
IGNITION	ON

CLIMB

NO SMOKE SIGN	*(AS REQ)
IGNITION	*(AS REQ)
FUEL PUMPS	* + REQ)
CABIN PRESSURE CONTROLLER	*CKD
SYNC	*ON
HYDRAULIC PUMPS	*OFF & LOW
FLAP TAKEOFF SELECTOR	*STOWED

IN-RANGE

ALTIMETERS	**(SETTING) & X-CKD
EPR	*(GA)
AIRSPEED BUG	**(SETTING)
SEAT BELT SIGN	*ON
CABIN PRESSURE CONTROLLER	* CKD
HYDRAULIC PUMPS	*ON & NIW

BEFORE LANDING

No SMOKE SIGN	*ON
IGNITION	*ON
FUEL SYSTEM	*SET FOR LANDING
SYNC	*OFF
GEAR	*THREE GREEN
SPOILERS	*
AUTO BRAKES	(AS REQ)
FLAPS	* (SETTING)*

AFTER LANDING

SPOILERS	*DOWN
FLAPS	*(AS REQ)
ICE PROTECTION	*OFF
IGNITION	*OFF
APU	* (AS REQ)
PNEUMATIC X-FEED	*ONE OPEN
RADAR & TRANSPONDER	*OFF & STANDBY
APU AIR & ELECTRIC POWER	*(AS REQ) & CKD

PARKING

AIR CONDITIONING SUPPLY SWITCHES	*OFF & AUTO
PNEUMATIC X-FEEDS	*OPEN
FUEL CONTROLS	OFF
SEAT BELT SIGN	OFF
BEACON	*OFF
CHOCKS & BRAKES	(AS REQ)
AUX & TRANSFER PUMPS	*OFF
FUEL PUMPS	*(AS REQ)
WINDSHIELD HEAT	*(AS REQ)
LOGBOOK W Y	(AS REQ)

TERMINATING

EMERGENCY LIGHTS	*OFF
PITOT HEAT	*OFF
AIR CONDITIONING PANEL	*(AS REQ)
RADIOS & GALLEY POWER	*OFF

SECURING AIRPLANE AT NON NWA STATIONS

APU	*OFF
OUTFLOW CONTROL	* + REQ)
BATTERY SWITCH	*OFF

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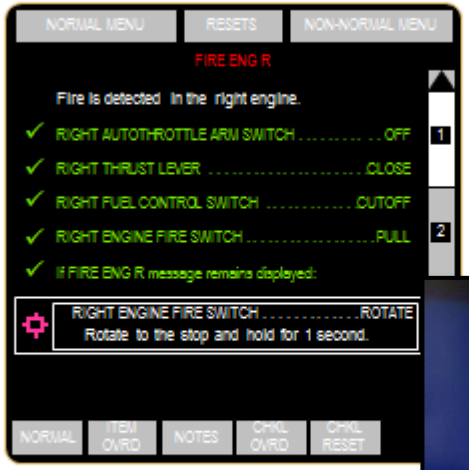
Other Modalities of Presentation

Wearable

Audible

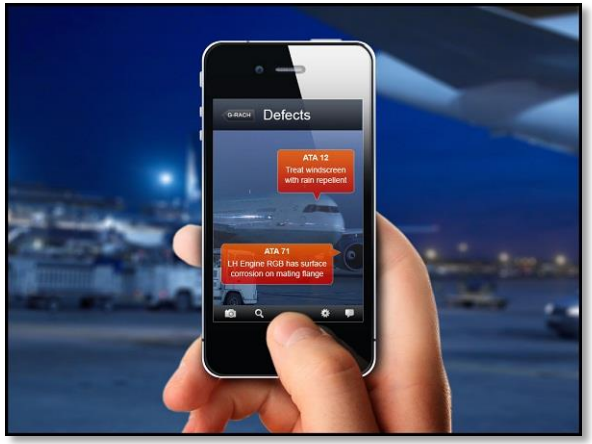
"Merge left,
Merge left, now
NOW, NOW!!!"

Graphic



Electronic

Text



Augmented Reality

Holographic


URE WARNING
CO-PILOT CHECKLIST
1. DON'T TOUCH ANYTHING
2. KEEP YOUR MOUTH SHUT

- Types - Purpose
- Modality of Presentation
- Methods of Accomplishment

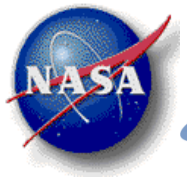
Methods of Checklist Accomplishment

Number of People	Audible?	Item Format		Accomplishment	
		Sentence Form/List	Challenge-Response	Do then Verify	Read and Do
one	silent or audible	yes	yes (reader does both)	yes	yes
two or more	audible	yes	yes	yes	yes

Item Format

Sentence Form/List: Proceed to nearest airport for landing.
Avoid rapid rudder deflection.
If the high oil pressure light remains illuminated:
Surgical site marked.
Instrument, sponge, and needle counts are correct.

Challenge-Response: Throttles……confirm……Idle
FAC 1……OFF then ON
Surgery type……_____
Block type(s)……_____



Human Systems
Integration Division

Checklists……

Why Do We Need Them?

Spanair Flight 5022 - August 20, 2008 - Madrid, Spain

Flaps not set for Takeoff – aircraft could not climb.

Possible Source Memory Confusion

- Set Takeoff (TO) flaps
- Taxied to runway
- Had to return to parking (probe - high temperature)
- Retracted flaps
- Got help from maintenance for probe problem
- Taxied back to runway; rushing
- *Recalled having originally set TO flaps before first taxi?*
- Tried to takeoff without TO flaps set

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

Without referring to the 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.

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

When ready to reinstate second pack:
Cargo Heat Outflow Switch ..... CLOSE
Second Pack Switch ..... ON
When rate of climb stabilizes:
Cargo Heat Outflow Switch ..... NORMAL

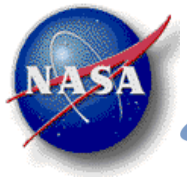
The captain, flight engineer, and a flight attendant, who had been on the flight deck, each lost consciousness during the event.

Checklist Myths

- Using a checklist is a sign of inexpertness or lack of knowledge.
- Competent and conscientious professionals will not make the kinds of errors that checklists are designed to catch.
- Performing a checklist completely from memory is the sign of a true expert.
- Experts should be able to run checklists as quickly as possible.

Barriers for Implementing Checklists

- Believing checklist myths
- Not understanding underlying philosophy/purpose of checklists and how to use them effectively
  - Should be a deliberate exercise – not just pro forma
  - Should give eyes time to fixate on what is being checked
- Checklist use runs counter to organizational/professional culture(s)
- Method of checklist accomplishment runs counter to established professional hierarchies



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14 Checklist Design and Content Factors
(Paper, Integrated Electronic, EFB)

Physical Properties, Interface, & Integration	**- size, weight, materials, integration w/displays & alerts**
Typography, Symbology, Color, Graphics, and Display Characteristics	**- font, font size, boldface, intuitive symbology, flashing text, font and paper/display background colors**
Layout, Format, & Display	**- look, arrangement, philosophy of response/use**
Organization, Access, & Prioritization	**- finding correct checklist, prime real estate pgs.**
Purpose	**- fix, troubleshoot, stabilize/safe, disable/isolate**
Objective (of checklist item)	**- direct action, inform, assess, make decision**
Length and Workload	**- physical length, timing length, workload**
Nomenclature, Abbreviations & Numerical Information	**- terms, labels, abbreviations, numerical information**
Language, Grammar, & Wording	**- English?, verb tense, reading difficulty, clarity, orientation/perspective, directiveness**
Level of Detail	**- amount of information provided**
Comprehensive & Correct	**- all necessary steps included, appropriate for situation**
Engineering Coherence	**- order of steps/timing makes "sense" to aircraft**
Logical Coherence	**- order of actions makes sense to the pilot and make "sense" operationally**
Progression & Jumping	**- movement within & between checklists/manuals**

USAirways 1549 - A320 Dual Engine Failure during Climbout, Weehawken, NJ (Hudson River) January 15, 2009

If Ditching is anticipated:

ENG DUAL FAILURE

1. ▶ **If no fuel remaining:**
   - a. THR LEVERS ..... Confirm ..... IDLE
   - b. EMER ELEC PWR (if EMER GEN not on-line) ..... MAN ON
   - c. FAC 1 ..... OFF then ON

   [Resetting FAC 1 enables the recovery of characteristic speeds displayed on the PFD, and enables rudder trim recovery, even if no indication is available. Once hydraulic power is lost, the right aileron is lost, and is in the up float position. Rudder trim may be used to compensate for this up floating aileron.]

   - d. Optimum speed ..... Green Dot

   or

   - e. Landing Strategy ..... Determine

   [Determine most appropriate place for forced landing/ditching.]

   - f. ATC (VHF1, HF1, ATC1) ..... Notify
     - (1) If unable to contact ATC on assigned frequency:
       - (a) ATC Code A7700
       - (b) Distress Message ..... Transmit

       [Use one of the following frequencies: VHF 121.5 MHz, HF 2182 KHz or 8364 KHz]

   - g. Oxygen Masks (above 10,000') ..... Verify ..... ON
   - h. Go to step 2.

2. ▶ **If fuel remaining:**
   - a. ENG MODE Selector ..... IGN
   - b. THR LEVERS ..... Confirm ..... IDLE
   - c. Airspeed ..... Optimum relight speed 300 kts(CFM)/280 kts(IAE)
     - (1) ▶ **If A319 or A320:**

       [For airspeed indication failure (volcanic ash) the pitch attitude for optimum relight speed is 4.5°(CFM)/ 2.5°(IAE) nose down. Add 1° nose up for each 22,000 lbs. above 110,000 lbs.

       or

       CFM: At 300 kts, the aircraft can fly approximately 2.0 nautical miles per 1000 feet (no wind)

       IAE: At 280 kts, the aircraft can fly approximately 2.2 nautical miles per 1000 feet (no wind)]

       ▶ **If A321:**

       [For airspeed indication failure (volcanic ash) the pitch attitude for optimum relight speed is 4.5° nose down.Add 1° nose up for each 22,000 lbs. above 132,000 lbs.

       At 300 kts, the aircraft can fly approximately 2.0 nautical miles per 1000 feet (no wind)]

   - d. Landing Strategy ..... Determine

   [Determine most appropriate place for forced landing/ditching.]

   - e. EMER ELEC PWR (if EMER GEN not on-line) ..... MAN ON
   - f. ATC (VHF1, HF1, ATC1) ..... Notify
     - (1) If unable to contact ATC on assigned frequency:
       - (a) ATC Code A7700
       - (b) Distress Message ..... Transmit

       [Use one of the following frequencies: VHF 121.5 MHz, HF 2182 KHz or 8364 KHz]

Cont'd

- g. FAC 1 ..... OFF then ON

[Resetting FAC 1 enables recovery of characteristic speeds displayed on the PFD and permits recovery of rudder trim even if no indication is available.]

If no relight after 30 seconds:

- h. ENG MASTER 1 and 2 ..... Confirm ..... OFF

Wait 30 seconds:

- i. ENG MASTER 1 and 2 ..... ON

Note: Unassisted start attempts can be repeated until successful or until APU Bleed is available.

If unsuccessful:

- j. CREW OXYGEN MASKS (Above 10,000') Verify ..... ON

When below FL250:

- k. APU ..... START
- l. WING ANTI ICE ..... OFF

When below FL200:

- m. APU BLEED ..... ON

Note: If APU Bleed is available, APU Bleed assisted starts may be accomplished at Green Dot Speed.

- n. ENG MASTER 1 and 2 ..... Confirm ..... OFF

Wait 30 seconds:

- o. ENG MASTER 1 and 2 (one at a time) ..... ON

2. ▶ **If engine restart is successful:**
   - a. Proceed to nearest suitable airport for landing.
   - b. Engine Dual Failure Checklist complete and

   or

   - ☛ Clear non-applicable ECAM actions and review SYS Status page(s).
   - ☛ Establish and communicate a plan.

   ▶ **If engine restart is considered impossible:**
   - a. Airspeed ..... Optimum speed Green Dot

   [Green dot is displayed on Captain's PFD. It represents best L/D. At Green dot speed the aircraft can fly up to approximately 2.5 nautical miles per 1000 feet with no wind. Average rate of descent is 1600 feet per minute.]

   - b. Early in approach:
     - (1) Cabin Secure ..... Order
     - (2) CABIN SIGNS ..... ON
     - (3) GALY & CAB (GALLEY) ..... OFF
     - (4) COMMERCIAL pb (if installed) ..... OFF
     - (5) Use rudder with care.

       [Avoid large or rapid rudder deflection, as only blue hydraulic power is available from the RAT.]

     - (6) For landing ..... Use FLAPS 3

       [Only slats will extend and operating time is noticeably increased, as only blue hydraulic power is available from the RAT.]

Cont'd

Below 15000':

- c. RAM AIR ..... ON
- d. BARO ..... Set

Below 10000':

- e. CREW OXYGEN MASKS ..... OFF
- f. OXYGEN CREW SUPPLY ..... OFF
- g. V_{APP} ..... Determine

Note: A319/320 V_{REF} + 25/150 kts minimum

A321 V_{REF} + 30/160 kts minimum

3. ▶ **If Forced Landing is anticipated:**

Prior to 3000' AGL:

- a. FLAPS ..... Configure for Landing

Note: Final Descent slope when configured (CONF 3 and Gear Down) will be approximately 800-900 feet per minute with no wind.

When in CONF 3 and at V_{APP}:

- b. GRAVITY GEAR EXTEN ..... PULL & TURN

Note: Disregard "USE MAN PITCH TRIM" on the PFD. The stabilizer is frozen due to insufficient hydraulic power.

When L/G downlocked:

or

- c. L/G Lever ..... DOWN
- d. GND SPOILER ..... ARM
- e. Max Brake Press ..... 1000 psi

[Brakes on Accumulator only]

At 500'AGL:

- f. Brace Signal ..... Command

At touchdown:

- g. ENG MASTER 1 and 2 ..... OFF
- h. APU MASTER SW ..... OFF
- i. ENG DUAL FAILURE Checklist complete, and
- ☛ If required, go to "Evacuation" Checklist, on page i.

▶ **If Ditching is anticipated:**

Prior to 3000' AGL:

- a. FLAPS ..... Configure for Landing
- b. L/G Lever ..... Check Up

At 2000' AGL:

- c. Ditching pb ..... ON

Note: In case of strong crosswind, ditch facing into the wind. In the absence of strong crosswind, ditch parallel to the swell. Touchdown with approximately 11 degrees of pitch and minimum vertical speed.

At 500'AGL:

- d. Brace Signal ..... Command

At touchdown:

- e. ENG MASTER 1 and 2 ..... OFF
- f. APU MASTER SW ..... OFF
- g. ENG DUAL FAILURE Checklist complete, and
- ☛ If required, go to "Evacuation" Checklist, on page i.

Progression and Jumping

Start

[redacted] | ABNORM 1-2 | Sep 09/02

1. **SINGLE ENGINE PROCEDURES**

In-Flight Engine Shutdown

Accomplish an engine shutdown only when flight conditions permit:

(1) Affected thrust lever ..... CONFIRM AND IDLE
(2) Affected thrust lever ..... CONFIRM AND SHUT OFF
(3) Affected HYDRAULIC pump ..... ON
- If left engine shut down .... HYDRAULIC 1 ON
- If right engine shut down ... HYDRAULIC 2 ON

(4) Affected FUEL, BOOST PUMP ..... CONFIRM AND OFF
(5) WING A / I CROSS BLEED ..... SELECT NON-AFFECTED SIDE
(6) LH or RH COWL ANTI-ICE ..... AFFECTED SIDE OFF

▼

QUICK REFERENCE HANDBOOK CSP C-022 | POWER PLANT MALFUNCTIONS

[redacted] | ABNORM 1-3 | Sep 09/02

Enroute terrain clearance is a consideration:

Yes

(7) Operating engine thrust lever ..... SET TO CLIMB
(8) Airspeed ..... MAINTAIN ENROUTE CLIMB SPEED
(9) Allow the airplane to climb or descend to the single engine level-off altitude.

(10) APU (if available) (37,000 feet and below) ..... START

NOTE
Do not attempt to relight an engine that is suspected to be damaged (engine fire, rotor burst, reverser deployed, etc...).

Engine damage is suspected/intentional shutdown:

Yes

(11) Land at the nearest suitable airport.
(12) Single Engine Approach and Landing Procedure ..... ACCOMPLISH (Refer to ABNORM 1-9)

- END -

No

(11) Engine Relight procedure .. ACCOMPLISH, as required
- Starter-Assisted Cross Bleed Relight Procedure (Refer to ABNORM 1-3)
- Starter-Assisted APU Bleed Relight Procedure (Refer to ABNORM 1-5)
- Windmilling Relight (Refer to ABNORM 1-7)

Relight engine using starter-assisted start whenever possible.

---------- END ----------

No

(7) Proceed to step (10)

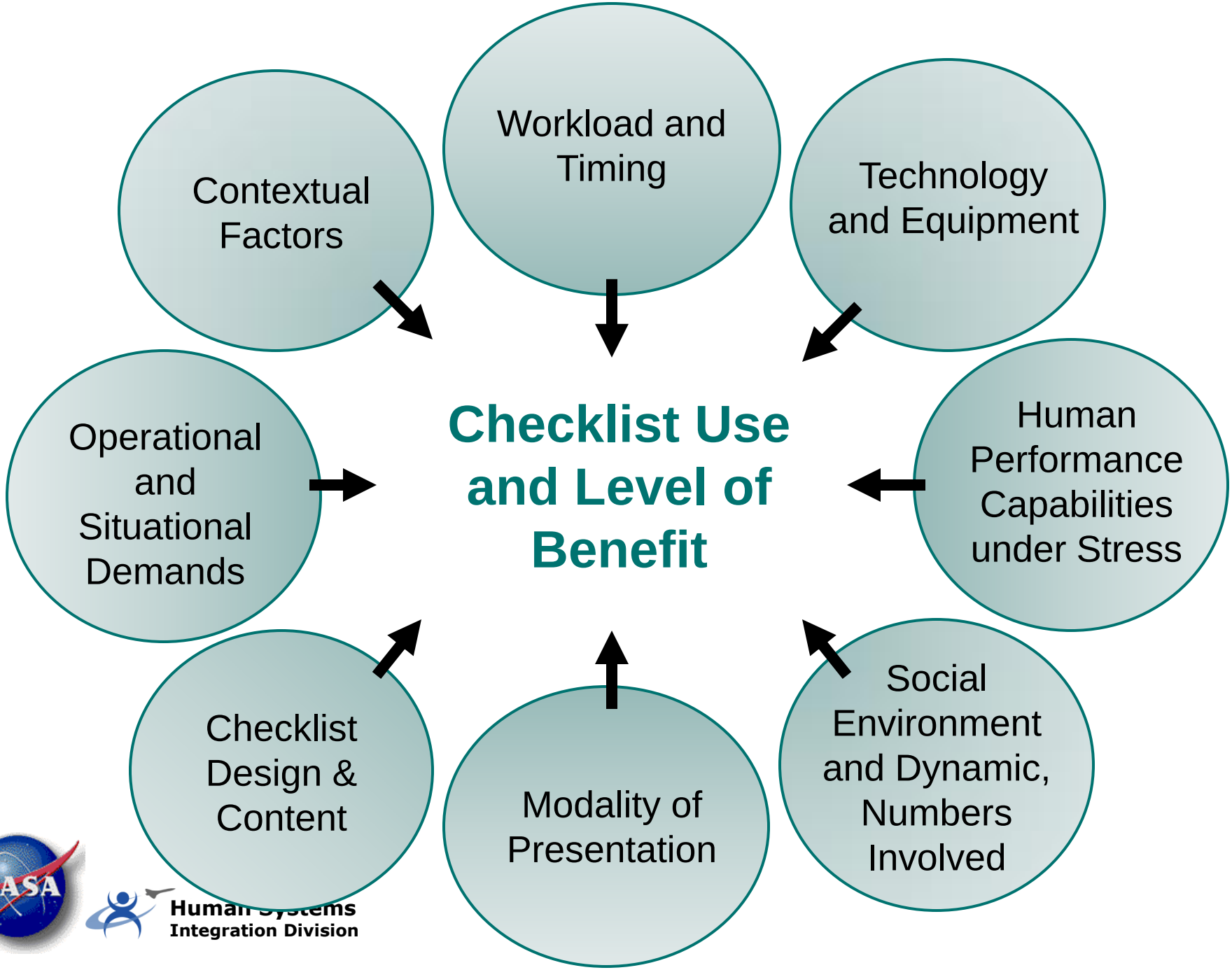
ENGINE RELIGHT PROCEDURE

Starter-Assisted Cross Bleed Relight

(1) Altitude ..... 21,000 FEET AND BELOW
(2) L and R FUEL, BOOST PUMP ..... CONFIRM ON
(3) BLEED SOURCE ..... OPERATIVE ENGINE
(4) ISOL ..... OPEN

▼

QUICK REFERENCE HANDBOOK CSP C-022 | POWER PLANT MALFUNCTIONS



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← NOT Me!

Thanks!

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