EON AI Ventures

THE SITUATION ROOM
For Aerospace MRO

Learn from every accident — before it happens to you.

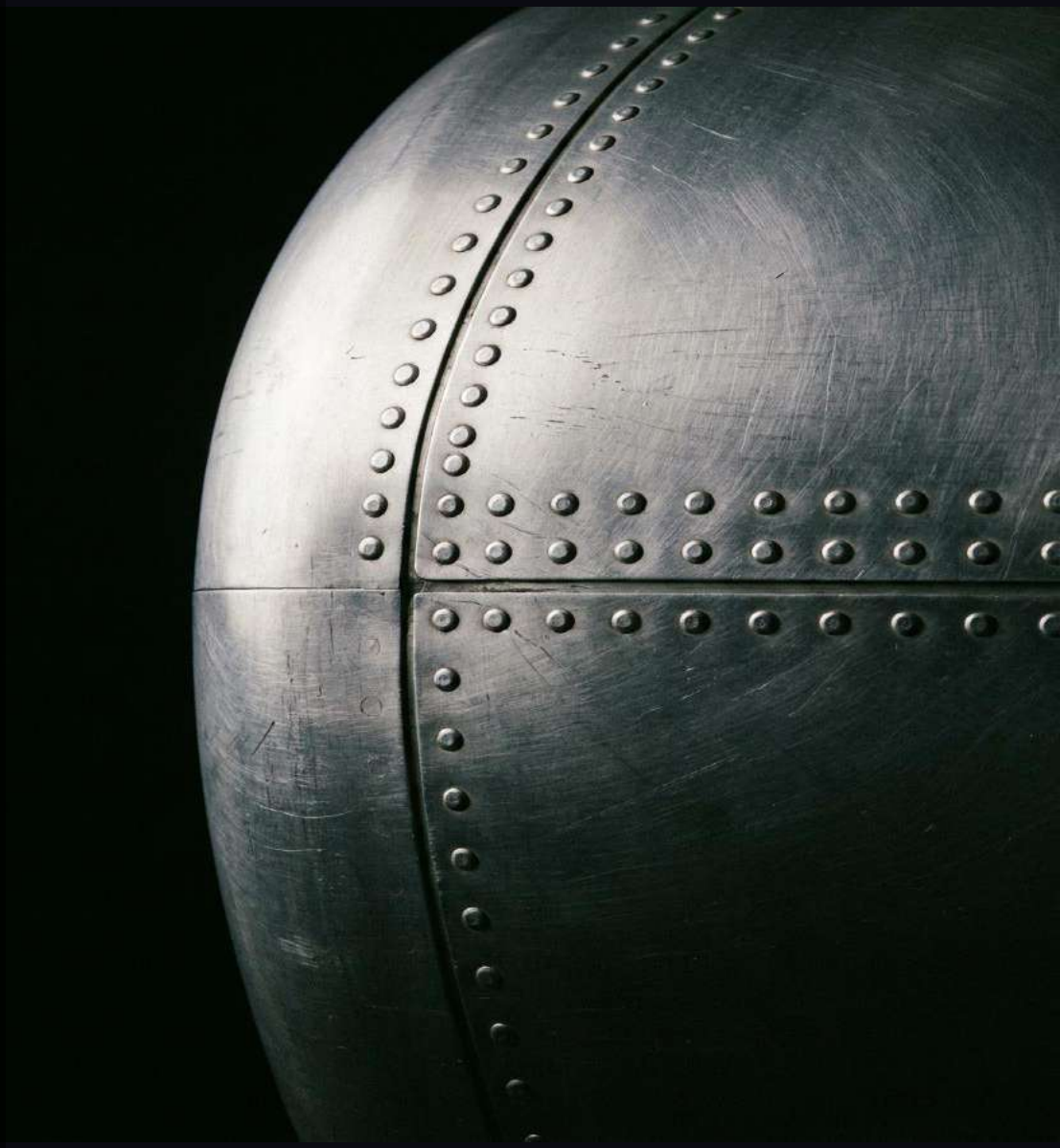
Train on danger, safely.

31 cards · **every fact verified** against the official investigation report · generated from the corpus

WHY

A competence crisis with a delayed fuse

- The workforce is turning over — Airbus and Boeing forecast **600,000+ new aircraft-maintenance technicians** needed in two decades, mostly replacing a retiring generation.
- **The judgment walks out the door** — decades of tacit "why" leave with every engineer who retires.
- **The error is time-displaced** — the mistake and the accident are separated by hours, days, or years. The worker never sees the consequence, so **judgment never builds.**
- **The training is mandated but forgettable** — EASA Part-145 and the FAA require recurrent human-factors training; today it is a slide deck nobody remembers.



Maintenance is a contributing factor in roughly 1 in 8 major accidents.

WHAT

A cinematic catalog of real maintenance accidents

- **Grounded in the official report** — every case sourced to its NTSB, AAIB, JTSB or BEA investigation. 93 cited statistics in the pilot; zero invented.
- **The two-date signature** — each card **shows the error and the accident**, and the gap between them: 27 hours, 7 years, "same shift." That gap is the lesson.
- **The library spine** — component cases link straight into the 50-class Aviation Living Library on ATA iSpec 2200. Alaska 261 opens onto the very jackscrew that failed.
- **The taxonomy the industry speaks** — organized on maintenance shelves, tagged with the twelve Dirty Dozen human factors.

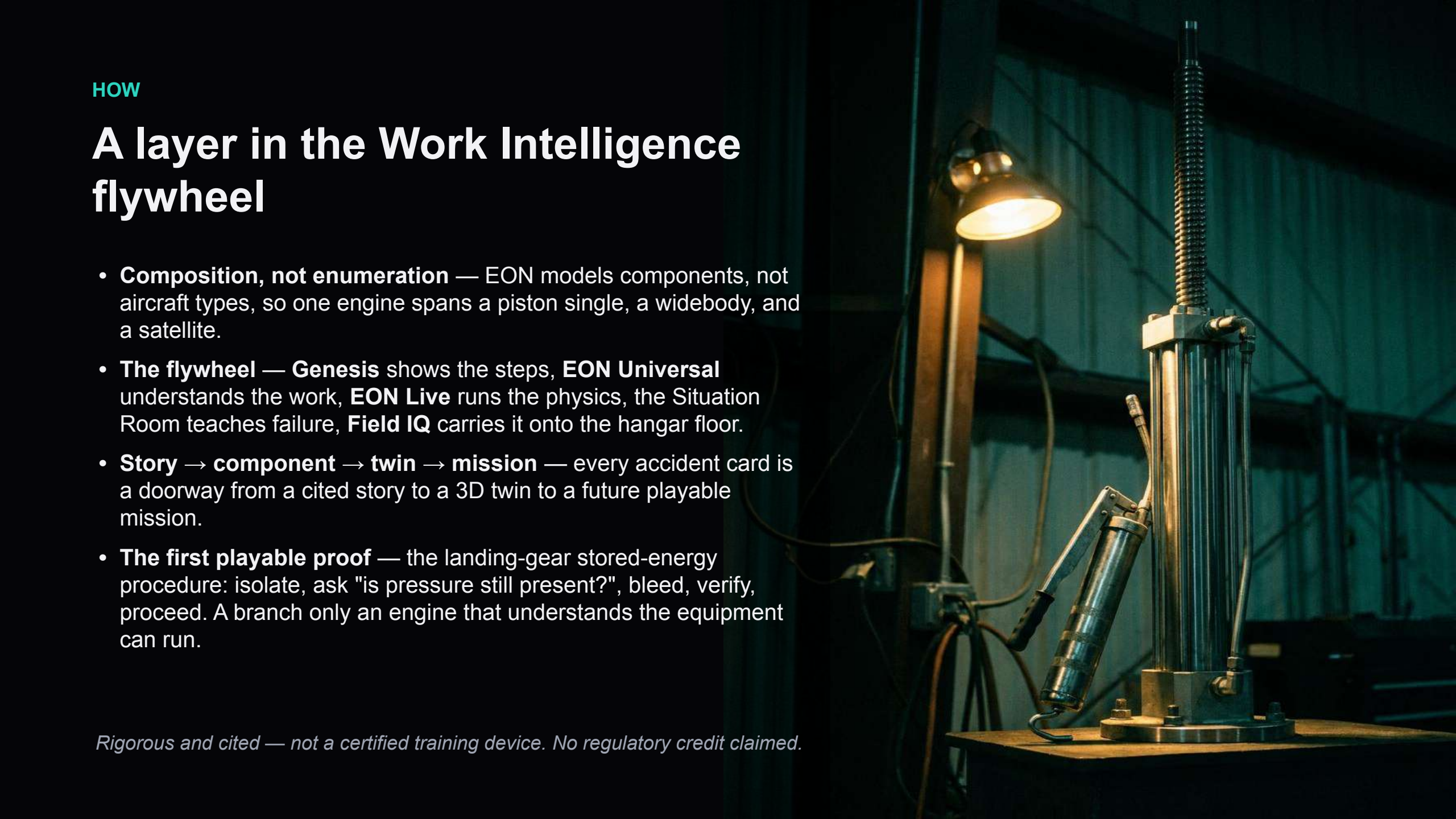
31 real accidents · 2,201 lives in the cited tolls · 31 official reports linked.

HOW

A layer in the Work Intelligence flywheel

- **Composition, not enumeration** — EON models components, not aircraft types, so one engine spans a piston single, a widebody, and a satellite.
- **The flywheel — Genesis** shows the steps, **EON Universal** understands the work, **EON Live** runs the physics, the Situation Room teaches failure, **Field IQ** carries it onto the hangar floor.
- **Story → component → twin → mission** — every accident card is a doorway from a cited story to a 3D twin to a future playable mission.
- **The first playable proof** — the landing-gear stored-energy procedure: isolate, ask "is pressure still present?", bleed, verify, proceed. A branch only an engine that understands the equipment can run.

Rigorous and cited — not a certified training device. No regulatory credit claimed.

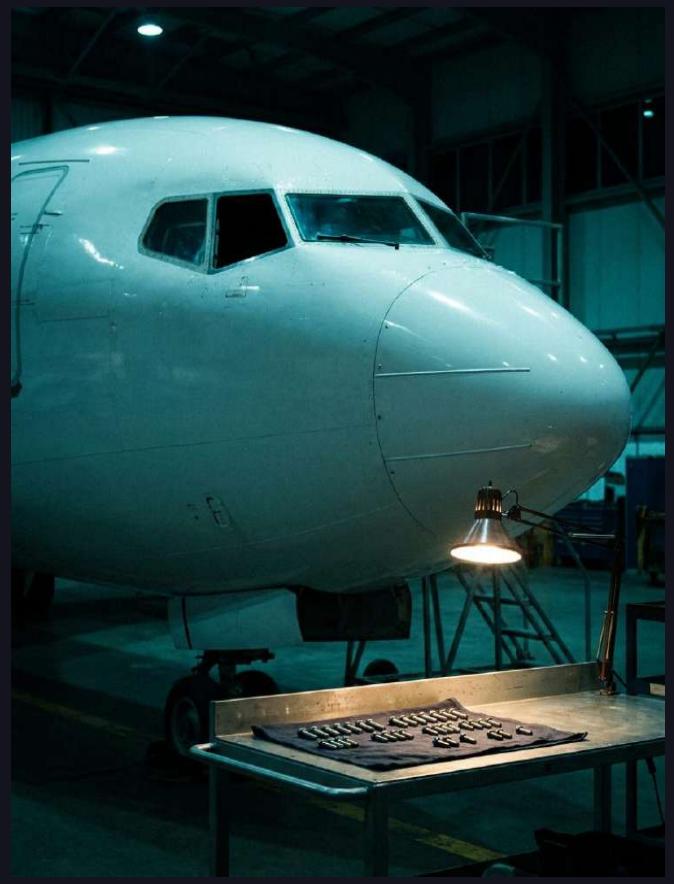


FLAGSHIP DISASTERS

The Wrong Bolts — Windscreen Blowout at 17,300 Feet

CRITICAL | SAVE — EVERYONE LIVED | ✓ OFFICIAL REPORT · AAIB | STRUCTURE: flight-deck windscreen and frame attachment

"The shift manager picked the bolts by eye, in bad light, from an uncontrolled carousel — 84 of 90 were too thin. Twenty-seven hours later the windscreen blew out with the captain half through it. He lived."



✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

WHAT HAPPENED

A BAC One-Eleven's left windscreen was replaced overnight by the Shift Maintenance Manager working alone. He selected the securing bolts by matching them to the old ones by touch and eye at an uncontrolled parts carousel in poor light, instead of looking up the part number. 84 of the 90 bolts he fitted were 0.026 inch too small in diameter, and 6 were 0.1 inch too short. On the next morning's passenger flight, as cabin pressure built, the windscreen blew out of its frame — and the commander was sucked halfway out of the aircraft. Cabin crew held him by the legs until the copilot landed at Southampton. He survived.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Identify the fastener by part number from the Illustrated Parts Catalogue — never by eye-matching the old bolt.
2. Draw stock from the controlled, labeled store; an unlabeled carousel is not a source of aircraft parts.
3. Install and torque to the maintenance manual, with adequate lighting and the right access equipment.
4. Safety-critical work gets an independent (duplicate) inspection before certification — never self-certified.
5. Prove the installation before it carries passengers — the first pressurization must not happen on a revenue flight.

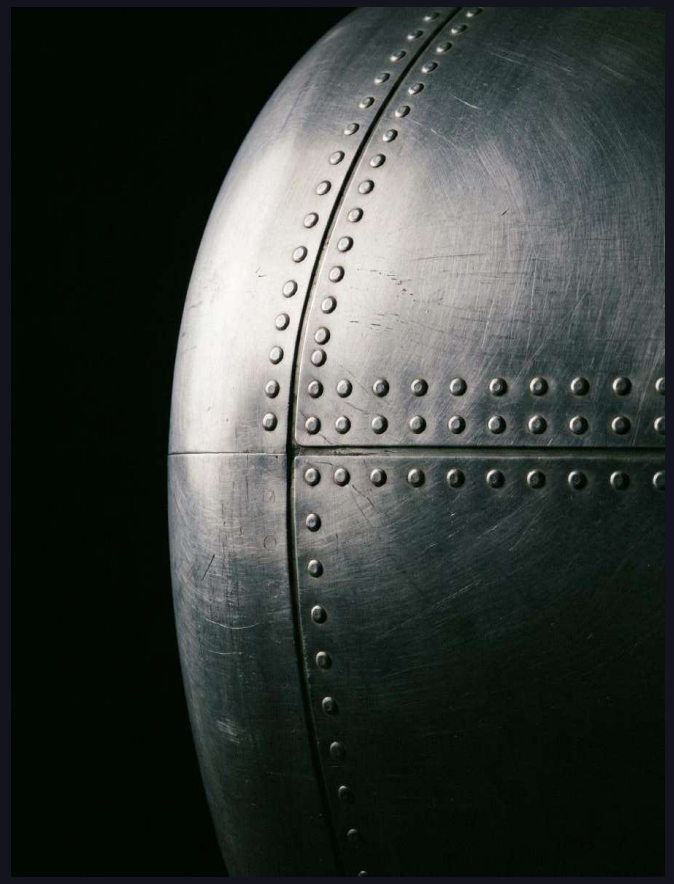
ERROR COMMITTED
night shift, ~0300–0500, 9 June 1990,
THE ACCIDENT
10 June 1990, 0733 hrs, climbing through
IN BETWEEN: 27 HOURS

THE FACTS — CITED ✓ 84 of the 90 securing bolts were 0.026 inch smaller in diameter than specified; the other 6 were 0.1 inch too short. (AAIB AAR 1/92, finding viii) ✓ The windscreen was fitted 27 hours before the accident flight; the aircraft had not flown in between. (AAIB AAR 1/92, finding vii) ✓ The work was done and self-certified by the same Shift Maintenance Manager; no independent check, and the task was not designated a "Vital Point". (AAIB AAR 1/92, causal factor i)

British Airways Flight 5390, BAC One-Eleven Series 528FL, G-BJRT, 10 June 1990, over Didcot, Oxfordshire, diverted to Southampton — AAIB Aircraft Accident Report 1/92. · Dirty Dozen: fatigue, norms, complacency, lack_of_resources · report: AAR 1/92 (EW/C1165)

FLAGSHIP DISASTERS

The Repair That Failed Seven Years Later — JAL 123



✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | HULL LOSS · FATAL · 520 | ✓ OFFICIAL REPORT · JTSB | STRUCTURE: aft pressure bulkhead (fuselage, ATA 53)

"In 1978 a repair crew fitted two splice plates where the drawing demanded one — leaving a single row of rivets to carry the load. Seven years and 12,318 flights of quiet cracking later, 520 people died on Mount Osutaka."

WHAT HAPPENED

After a tailstrike at Osaka on 2 June 1978, the aft pressure bulkhead of a Boeing 747SR was repaired by a repair team dispatched from Boeing. Contrary to the approved repair drawing — one continuous splice plate — the crew used one splice plate narrower than the drawing required plus a filler, so part of the L18 splice that should have been carried by two rows of rivets was carried by one. The joint's strength dropped to about 70% of design, and no written record of the deviation was made. The gap was hidden by fillet sealant: from either side, the wrong repair looked exactly like the right one. Fatigue cracks grew through 12,318 pressurization cycles until, on 12 August 1985, the bulkhead ruptured in climb — destroying all four hydraulic systems and the vertical fin. The crew kept the aircraft airborne for 32 minutes with engine thrust alone.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Execute structural repairs exactly to the approved repair drawing — a substitution is a new repair, not a shortcut.
2. Any deviation requires engineering disposition and written approval before the work continues.
3. Record the as-built configuration; an undocumented repair is invisible to everyone who inspects after you.
4. Inspect the completed repair against the drawing before close-up — including what the sealant will hide.
5. Repaired pressure structure joins the repeat-inspection program for the rest of the airframe's life.

ERROR COMMITTED
the bulkhead repair, 24 June – 1 July 1978,
THE ACCIDENT
12 August 1985, Mount Osutaka, Gunma
IN BETWEEN: 7 YEARS

THE FACTS — CITED ✓ The mis-spliced joint retained about 70% of its designed strength, with one row of rivets carrying a load meant for two. (AAIC report §4.1.3) ✓ 520 of 524 aboard were killed; the 4 survivors were all seated near the tail. (AAIC report §2.13.1) ✓ The repair deviation was visually undetectable after assembly — sealant made the incorrect splice look identical from either side. (AAIC report §4.1.3.5; FAA Lessons Learned, JA8119)

Japan Air Lines Flight 123, Boeing 747SR-100, JA8119, 12 August 1985, Gunma Prefecture, Japan — Aircraft Accident Investigation Commission report, 19 June 1987 (English translation). · Dirty Dozen: lack_of_communication, norms, complacency · report: AAIC report of 19 June 1987 (JA8119)

FLAGSHIP DISASTERS

The Grease Job That Never Took — Alaska 261's Jackscrew

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | HULL LOSS · FATAL · 88 | ✓ OFFICIAL REPORT · NTSB | LIBRARY: FC-30 Horizontal Stabilizer Trim Actuator

"The mechanic budgeted an hour for a lubrication that properly takes more than four. The acme nut quietly wore through 90 percent of its threads — until, off the California coast, the last of them stripped and ▸ *full text in the card*

WHAT HAPPENED

An MD-83's pitch trim rides on a single jackscrew in the tail — a rotating acme screw driving a fixed acme nut — and the design's life assumption was grease. Alaska Airlines had stretched the lubrication interval step by step, from every 700 flight hours in 1985 to a time-controlled 8 months — about 2,550 flight hours — by 1996, and the end-play wear check to every 30 months, about 9,550 flight hours, both with FAA acceptance. The last recorded lubrication, 24 September 1999 at San Francisco, was performed by a mechanic who estimated the whole task at about an hour — properly done it takes more than 4 person-hours — and who could not recall seeing fresh grease come out of the top of the acme nut, the only real confirmation the grease went in. The Board found no effective lubrication on the screw-nut interface, only dried and degraded grease in the nut's grease passage where fresh grease should have been, and concluded that more than just that one servicing had been missed or inadequately performed. On 31 January 2000 the nut's remaining threads sheared in cruise; the jackscrew pulled through the nut, the horizontal stabilizer ran to a position no pilot could hold, and the airplane dove into the sea.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Lubricate the jackscrew exactly per the task card: pump the acme-nut fitting until fresh grease is seen exiting at the top of the nut, and brush-coat the screw threads — seeing the grease come through is the verification, not the feel of the gun.
2. Plan the real duration of the task — access, platform, lighting; properly done it takes more than 4 person-hours. One hour from a lift-truck basket in the rain is not the task.
3. Treat every interval escalation as an engineering decision on that specific task: a fleet-wide C-check extension is not wear-rate data for a flight-critical actuator.
4. Perform end-play checks with the conforming restraining fixture; a shop-made tool that reads low turns a worn nut into a paper-healthy one.
5. When a wear measurement reaches the limit, the component comes off. Rechecking until a passing number appears is not maintenance.

ERROR COMMITTED
24 September 1999, SFO — the last recorded
THE ACCIDENT
31 January 2000, Pacific Ocean off Anacapa
IN BETWEEN: 4 MONTHS

THE FACTS — CITED ✓ The jackscrew lubrication interval grew from every 700 flight hours in 1985 to a time-controlled 8 months — about 2,550 flight hours — by 1996; Douglas' original specification was 300 to 350 flight hours. (NTSB AAR-02/01 §1.6.3.2.1) ✓ The last end-play check, September 1997, first measured 0.040 inch — exactly the replacement limit; ▸ full text in the card

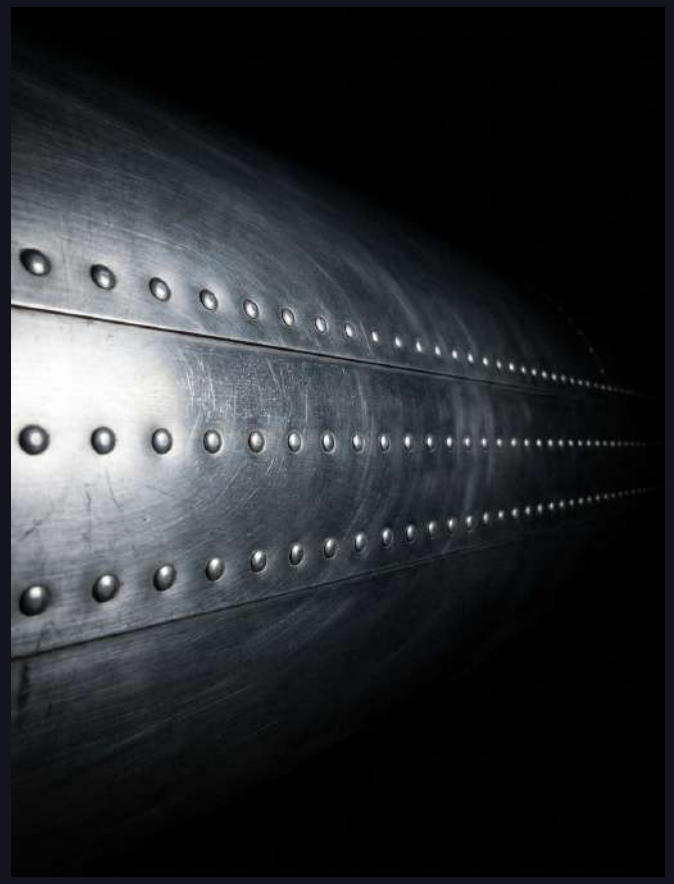
Alaska Airlines Flight 261, McDonnell Douglas MD-83, N963AS, 31 January 2000, Pacific Ocean about 2.7 miles north of Anacapa Island, California — NTSB Aircraft Accident Report NTSB/AAR-02/01, adopted 30 December 2002. · Dirty Dozen: norms, complacency, lack_of_knowledge, lack_of_resources · report: NTSB/AAR-02/01

FLAGSHIP DISASTERS

Eighteen Feet of Sky — the Cracks Behind Aloha 243's Signed-Off Inspection

CRITICAL | FATAL ACCIDENT · 1 | ✓ OFFICIAL REPORT · NTSB | STRUCTURE: fuselage lap joints (S-10L, fuselage section 43)

"The fatigue cracks were already there in November — 0.09 inch and larger, above the size the eddy-current probe reliably finds — and the inspection was signed off anyway. ▸ *full text in the card*



✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
12–14 November 1987 — the AD 87-21-08
THE ACCIDENT
28 April 1988, at 24,000 feet between Hilo
IN BETWEEN: 5 MONTHS

WHAT HAPPENED

An early-production Boeing 737 — line number 152, with cold-bonded fuselage lap joints — had flown 89,680 short interisland hops, the second-most cycles of any 737 in the world. Where the cold bond had failed, the hoop loads meant for the adhesive ran instead through three rows of countersunk rivets in 0.036-inch skin, and fatigue cracks grew from rivet hole to rivet hole. In November 1987, complying with AD 87-21-08, Aloha inspected the S-4 lap joints: cracks were found visually, two sheet-metal repairs were made on 12 November, and the AD was signed off complete on 14 November — but no record existed of the required eddy-current inspection, and cracks well above the detectable size stayed in the joint. The inspections of the S-10, S-14, S-19, S-20 and S-24 lap joints, recommended by Boeing Alert Service Bulletin 737-53A1039 but not mandated by the AD, were never done. On 28 April 1988, as flight 243 leveled at 24,000 feet, the S-10L lap joint failed and about 18 feet of cabin skin and structure — from the entrance door aft, across the crown — separated from the airplane. The No. 1 flight attendant, Clarabelle Lansing, 37 years with the airline, was standing at row 5 and was swept overboard. The crew flew the open-topped 737 down and landed it at Kahului, Maui.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Inspect to the full technical scope, not the minimum legal one — when the alert service bulletin lists six lap-joint lines and the AD mandates one, the other five are still cracking.
2. An NDI result is a record: no written eddy-current report means no inspection. "We always do it" does not survive an accident investigation.
3. Structure heavy checks so structure is actually seen — a D check dissolved into overnight fragments with no interior removal cannot find what hides behind cabin trim for years.
4. Match the inspector to the task: formal NDI training, and scheduling that respects vigilance limits — night work, low find rates and 1,300 rivets per panel are a package that fails silently.
5. Treat cracks found on a high-cycle airframe as an airframe-and-fleet alarm, not a local patch job — chase the finding, not the sign-off.

THE FACTS — CITED ✓ N73711 had accumulated 89,680 flight cycles on 35,496 flight hours — the second-highest cycle count in the worldwide 737 fleet. (NTSB AAR-89/03 §1.6.1) ✓ At the November 1987 AD inspection the five largest fatigue cracks at the S-4R upper rivet row already measured about 0.09 to 0.13 inch — above the 0.08-inch size eddy current reliably detects — and were not found; they grew less than 0.020 inch in the 2,624 cycles remaining before the accident. ▸ full text in the card

Aloha Airlines Flight 243, Boeing 737-297, N73711, 28 April 1988, near Maui, Hawaii, landed at Kahului Airport — NTSB Aircraft Accident Report NTSB/AAR-89/03, 14 June 1989. · Dirty Dozen: fatigue, complacency, pressure, lack_of_knowledge · report: NTSB/AAR-89/03

FLAGSHIP DISASTERS

The 200-Man-Hour Shortcut — Flight 191's Engine Change

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | HULL LOSS · FATAL · 273 | ✓ OFFICIAL REPORT · NTSB | STRUCTURE: engine pylon aft bulkhead

"Taking the engine and pylon off as one piece on a forklift saved about 200 man-hours per airplane. It also cracked a bulkhead flange nobody saw. ▸ *full text in the card*

WHAT HAPPENED

During a C check at Tulsa on 29–30 March 1979, N110AA's No. 1 engine and pylon came off the wing to replace the pylon's spherical bearings per McDonnell Douglas Service Bulletins 54-48 and 54-59 — but not by the McDonnell Douglas sequence. The bulletins assumed the engine comes off the pylon first, then the pylon off the wing; American's engineering change order took engine and pylon down as a single unit cradled on a forklift, cutting the disconnects from 79 to 27 and saving about 200 man-hours per airplane. A McDonnell Douglas field representative reported that Douglas "would not encourage this procedure due to the element of risk" in remating the combined unit to the wing — and the manufacturer had no authority to forbid it. The clearances at the attach points were minimal: the Board found a minor mistake by the forklift operator, or imperceptible fork movement from a hydraulic pressure leak, could bring the aft bulkhead against the wing clevis with fracture-producing force. The work on N110AA spanned a shift change with the assembly hanging mid-procedure, and day-shift mechanics found the aft bulkhead's upper lug in contact with the clevis attach bolts. Out of Tulsa the bulkhead's upper flange carried a 10-inch overload crack, closed up and invisible behind the mated fitting. It held for eight weeks. ▸ full text in the card

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Remove major assemblies in the manufacturer's sequence — engine off the pylon, then pylon off the wing. A combined lift is a new procedure requiring engineering evaluation and manufacturer consultation, not just a man-hours case.
2. Prove the lifting equipment can hold position to the tolerance the fitting demands. A forklift's forks can creep imperceptibly as hydraulic pressure bleeds — precision rigging is part of the procedure, not an accessory.
3. Never leave a heavy assembly partially attached across a shift change or engine-off pause; if the work must stop, the load path must be made safe first.
4. Any contact or forced misalignment during mating is a stop-and-inspect event for the fitting — before close-up hides the evidence.
5. Report structural damage found in maintenance and share it: two identical flange fractures at another carrier were the warning that never arrived.

ERROR COMMITTED
29–30 March 1979, engine-and-pylon change,
THE ACCIDENT
25 May 1979, takeoff from runway 32R,
IN BETWEEN: 56 DAYS

THE FACTS — CITED ✓ The single-unit forklift method cut the engine-change disconnects from 79 to 27 and saved about 200 man-hours per aircraft. (NTSB AAR-79-17 p. 26) ✓ McDonnell Douglas' field representative reported that Douglas "would not encourage this procedure due to the element of risk" in remating — and McDonnell Douglas had no authority to approve or disapprove its customers' maintenance procedures. (NTSB AAR-79-17 pp. ▸ full text in the card

American Airlines Flight 191, McDonnell Douglas DC-10-10, N110AA, 25 May 1979, Chicago-O'Hare International Airport, Illinois — NTSB Aircraft Accident Report NTSB-AAR-79-17, adopted 21 December 1979. · Dirty Dozen: norms, pressure, lack_of_communication, lack_of_awareness · report: NTSB-AAR-79-17

POWERPLANT & APU

The Half-Inch Crack the Inspector Missed — United 232

CRITICAL | HULL LOSS · FATAL · 111 | ✓ OFFICIAL REPORT · NTSB | LIBRARY: PP-01 High-Bypass Turbofan Engine

"At the last overhaul, fluorescent dye actually seeped into the fatigue crack in the fan disk — and the inspector still stamped it serviceable. ▸ *full text in the card*

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

WHAT HAPPENED

The stage 1 fan disk of a DC-10's tail-mounted CF6-6 engine carried a fatigue crack growing from a metallurgical defect — a hard alpha inclusion hidden in the titanium since manufacture. The disk went through six fluorescent penetrant inspections (FPI) in its life, the last during a shop visit that began in February 1988 at United's CF6 Overhaul Shop in San Francisco. By then the crack was almost half an inch long on the surface of the disk bore — long enough that FPI fluid physically entered the crack and left chemical traces later recovered from the fracture face. The inspector did not see the indication; the disk was stamped serviceable and returned to the fleet. On 19 July 1989, 760 flight cycles later, the disk burst in cruise. The uncontained debris severed the lines of all three hydraulic systems that powered the DC-10's flight controls, and the crew flew the airplane for 44 minutes on engine throttles alone before the crash landing at Sioux City.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Prepare the part exactly per the process specification — cleaning, drying, penetrant dwell and developer are each capable of hiding a crack if shortcut.
2. Position and manipulate the part so every inspection surface can actually be viewed — a disk hanging on a cable that is not rotated is not fully inspected.
3. Inspect the full surface systematically under correct lighting; the bore and other high-stress areas of a life-limited disk get deliberate, unhurried attention.
4. Treat every indication as a reject until positively dispositioned — a critical rotating part carries no benefit of the doubt.
5. Build a second layer: independent re-inspection or process redundancy for parts whose uncontained failure exceeds airframe protection.

ERROR COMMITTED
April 1988, the final fluorescent penetrant
THE ACCIDENT
19 July 1989, 1516 CDT, in cruise;
IN BETWEEN: ~16 MONTHS

THE FACTS — CITED ✓ The crack in the disk bore was about 0.498 inch long at the last inspection — a size the Safety Board concluded was detectable by FPI. (NTSB AAR-90-06 §2.4.2 and finding 19) ✓ Compounds from FPI fluid were found inside the fatigue crack: the dye entered the crack at the last inspection, yet the disk was accepted as serviceable. ▸ full text in the card

United Airlines Flight 232, McDonnell Douglas DC-10-10, N1819U, 19 July 1989, Sioux Gateway Airport, Sioux City, Iowa — NTSB Aircraft Accident Report AAR-90-06. · Dirty Dozen: complacency, norms, lack_of_awareness · report: NTSB/AAR-90/06 (PB90-910406)

POWERPLANT & APU

Same Hands, Same Error, Every Engine — Eastern 855

CRITICAL | SAVE — EVERYONE LIVED | ✓ OFFICIAL REPORT · NTSB | PROCEDURAL

"At 1:30 in the morning two mechanics fitted master chip detectors without O-ring seals into all three engines — by feel, in the dark, trusting that someone else had fitted the seals. ▸ *full text in the card*

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

WHAT HAPPENED

During the night before the flight, two Eastern mechanics replaced the master chip detectors on all three RB211 engines of an L-1011. The detectors they had always used came from a cabinet in the foreman's office with the O-ring seals already fitted — but that night the cabinet was empty, so a mechanic drew three from the stockroom, sealed in plastic with serviceable-parts tags. Neither mechanic checked for O-rings: one installed his detectors by feel through the oil-service door, lit by the headlights of his tug. The engines were motored for about 10 seconds each — no leak showed — and the work was signed off. In flight the next morning, oil streamed from all three unsealed detector ports. The No. 2 engine was shut down for low oil pressure; the crew, believing simultaneous oil loss on three engines "almost nil," pressed on until Nos. 3 and 1 flamed out. At 4,000 feet, ditching briefed and the cabin in the brace position, the No. 2 engine restarted — and Flight 855 landed at Miami on that single engine.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Verify the configuration of the part in your hand — O-rings, seals, kits — against the procedure, never against habit or a serviceable tag.
2. Follow the work card as written; installing a sealed component "by feel" without inspecting it defeats the step that matters.
3. After disturbing an oil system, run the leak check to the condition the procedure demands — long enough for a leak to actually show — not to a habitual 10 seconds.
4. Never let the same person repeat one safety-critical task across all engines without an independent check between the error and dispatch.
5. Treat repeat discrepancies on the same task as a system alarm: a recurring error is a procedure or supervision failure, not bad luck.

ERROR COMMITTED
about 0130, 5 May 1983, night shift, Miami —
THE ACCIDENT
5 May 1983, 0915 first low-oil warning;
IN BETWEEN: SAME SHIFT

THE FACTS — CITED ✓ Both required O-ring seals were missing from the master chip detector of every one of the three engines. (NTSB AAR-84-04 §1.12) ✓ Engines Nos. 1 and 3 each leaked about 15 quarts of oil in roughly 33 to 37 minutes of running. (NTSB AAR-84-04 §1.17.2) ✓ After the 1981 corrective procedure and before the accident, eight more incidents of defective or improperly installed master chip detectors occurred at the airline. (NTSB AAR-84-04 §1.17.6)

Eastern Air Lines Flight 855, Lockheed L-1011, N334EA, 5 May 1983, near Miami, Florida — NTSB Aircraft Accident Report AAR-84-04. · Dirty Dozen: norms, complacency, lack_of_awareness · report: NTSB/AAR-84/04 (PB84-910404)

POWERPLANT & APU

The Latches Nobody Checked — Fire Over Heathrow

HIGH | SAVE — EVERYONE LIVED | ✓ OFFICIAL REPORT · AAIB | STRUCTURE: engine fan cowl doors

"Two tired technicians left the fan cowl doors unlatched on both engines — then serviced the wrong aircraft and signed the job off. ▸ *full text in the card*

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
night shift, 23–24 May 2013, Heathrow
THE ACCIDENT
24 May 2013, 0716 hrs UTC, on takeoff from
IN BETWEEN: THE NEXT DAY

WHAT HAPPENED

During overnight checks, two technicians opened the fan cowl doors on both engines of an A319 to inspect the IDG oil levels, found both IDGs low, and lowered the doors onto their hold-open devices — unlatched — intending to return with an oil gun. No warning notice went in the cockpit, no open entry went in the technical log for the low oil. Hours later they drove back, but to the wrong stand: an identical-looking A321. They did not check the registration. Finding that aircraft's cowls latched and its IDG oil full, they rationalized both surprises, latched what they had opened, and signed off G-EUOE's Weekly Check. The real G-EUOE flew the next morning with all eight latches disengaged — a condition neither the tug driver's inspection nor the co-pilot's walk-around caught. At rotation all four fan cowl doors tore off, striking slats, fuselage, landing gear and pylons; on the return approach, fuel leaking from a damaged fuel pipe on the right engine ignited. The crew shut the engine down, landed, and evacuated all 80 occupants by slide.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Follow the AMM opening procedure to the letter — including the cockpit warning notice that tells the next person the cowls are open.
2. An interrupted task gets an open technical log entry the moment it is deferred; an unrecorded open job does not exist for anyone else.
3. On returning to a job, positively identify the aircraft by registration before touching it — never by stand, silhouette or habit.
4. Close-up means latching every latch and verifying each one — and anomalies that "must have been someone else" are stop signs, not reassurance.
5. The walk-around checks fan cowl latches deliberately: crouch to see them — flush doors with latches hanging low are exactly what an unlatched cowl looks like.

THE FACTS — CITED ✓ 34 fan cowl door losses had already occurred on A320-family aircraft before this one; three more since brought the total to 38. (AAIB AAR 1/2015 §1.18.2) ✓ Both the pushback tug driver's inspection and the co-pilot's walk-around missed the unlatched doors on both engines — the report's second causal factor. (AAIB AAR 1/2015 §3b) ✓ Technician A had worked four 12-hour day shifts and eight 12-hour night shifts in the 14 days before the error. (AAIB AAR 1/2015 §1.5.6)

British Airways Flight 762, Airbus A319-131, G-EUOE, 24 May 2013, London Heathrow Airport, returned and landed on Runway 27R — AAIB Aircraft Accident Report 1/2015. · Dirty Dozen: fatigue, complacency, norms, lack_of_awareness · report: AAR 1/2015 (EW/C2013/05/02)

POWERPLANT & APU

The Open Oil System — Caps, Plugs and Covers That Drain Both Engines

HIGH | SERIOUS INCIDENT | ✓ OFFICIAL REPORT · AAIB | PROCEDURAL

"A filler cap, a borescope plug, a chip-detector cover — small closures, huge consequence. When one person leaves them off every engine on the same night, the aircraft takes off with minutes of oil and no ▸ *full text in the card*

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
night of 22/23 February 1995, hangar T2, East
THE ACCIDENT
23 February 1995, 1205 hrs UTC, climbing to
IN BETWEEN: THE NEXT DAY

WHAT HAPPENED

The pattern: engine oil systems are closed by small, undramatic parts — oil filler caps, borescope port plugs, magnetic chip detector covers, rotor drive covers — and when maintenance leaves one unsecured, the engine pumps its oil overboard in flight. When the same person does the same task on every engine in one visit, the error becomes a dual-engine oil loss. The anchor: during a night shift at East Midlands, an undermanned line crew — four on duty instead of the nominal six — meant the shift's Line Engineer performed the 750-hour borescope inspections of both engines of a Boeing 737-400 himself, while also running the shift. The HP rotor drive covers, one per engine, were never refitted, the required ground idle runs were never done, and the job was signed off as complete. Next morning, climbing out for Lanzarote, both oil quantities fell toward zero and both pressures collapsed; the crew declared a Mayday and diverted. Both engines had lost almost all their oil and were shut down on Luton's runway during the landing roll.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Every oil-system closure you disturb — cap, plug, cover, detector — is an open item until it is refitted, torqued and verified; track each one to closure.
2. Where practical, do not let the same person perform the same airworthiness-critical task on all engines in the same visit; split the work or split the shifts.
3. After any oil-system disturbance, run the engine as the manual requires — a ground idle run long enough for a leak to declare itself — before certifying.
4. Certify only what is physically complete: a signature on an inspection with its covers off is the pattern's ignition point.
5. If oil quantity falls on more than one engine in flight, believe the gauges — a shared maintenance visit is a shared failure mode, and "faulty indication" is the trap.

THE FACTS — CITED ✓ Before this incident, HP rotor drive cover refitting had been overlooked on five separate occasions worldwide; even after a lanyard modification, single covers were left off on three more. (AAIB AIR 3/96 §2.9) ✓ The night shift ran with four staff instead of the nominal six, and the only authorised engineer at the station did both engines' borescope inspections himself while also supervising the shift. ▸ full text in the card

Boeing 737-400, G-OBMM, operated by British Midland — titled "British Midlands Airways" on the report cover — 23 February 1995, overhead Daventry, diverted to Luton Airport — AAIB Aircraft Incident Report 3/96. · Dirty Dozen: fatigue, pressure, distraction, norms, lack_of_resources · report: AIR 3/96 (EW/C95/2/3)

LANDING GEAR, WHEELS & HYDRAULICS

Stored Hydraulic Energy in the Gear Bay — The System Was "Off"

CRITICAL | SERIOUS INCIDENT | ✓ OFFICIAL REPORT · AAIB | LIBRARY: HYD-19 Hydraulic Accumulator

"The hydraulics were shut down. The accumulators weren't. One wrong pin bore and 60 tonnes of aircraft came down on its nose."

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

WHAT HAPPENED

A landing gear and its hydraulics store energy long after shutdown — charged accumulators, pressurized struts, and the sheer weight of the aircraft held by locks and pins. At Heathrow in 2021, an engineer troubleshooting nose-gear-door faults on a Boeing 787 pressurized the hydraulics and selected the gear lever with the downlock pins believed fitted — but the nose-gear pin had been inserted into the wrong bore of the downlock link. The nose gear retracted and the aircraft's nose struck the ground, injuring two people. The same energy hides everywhere in the gear bay: in 1999 a ground engineer at Manchester took a spray of pressurized hydraulic fluid to the skin and eyes when a DHC-8 nose gear collapsed during a fluid-transfer operation.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Isolate and tag hydraulic power to the system you are working — all sources, not just the pumps.
2. Ask the conditional question — is stored pressure still present? Accumulators and struts hold energy after shutdown.
3. Bleed stored pressure down and re-check; repeat until the gauge reads zero.
4. Verify zero energy at the gauge, and fit the correct pins in the correct bores — physically confirm engagement, never assume from paperwork.
5. Only then proceed. Anything abnormal — stop and escalate.

ERROR COMMITTED
during ground troubleshooting, 18 June 2021,
THE ACCIDENT
the same session — nose gear retracted on
IN BETWEEN: SAME DAY

THE FACTS — CITED ✓ Heathrow, 18 June 2021: the 787's nose-gear downlock pin had been inserted in the apex-pin bore instead of the downlock-pin hole; when hydraulics were pressurized and gear selected up, the nose gear retracted and the nose struck the ground — two minor injuries. (AAIB Bulletin 12/2022, AAIB-27411) ✓ Manchester, 12 August 1999: hydraulic fluid released as a spray from the nose-gear area during a fluid-transfer operation; ▸ full text in the card

Boeing 787-8, G-ZBJB, London Heathrow, 18 June 2021 — AAIB Bulletin 12/2022 (AAIB-27411); and DHC-8-311, G-BRYP, Manchester, 12 August 1999 — AAIB Bulletin 2/2000. · Dirty Dozen: lack_of_awareness, distraction, lack_of_knowledge · report: Bulletin 12/2022 (AAIB-27411)

LANDING GEAR, WHEELS & HYDRAULICS

"Forget It" — The Under-Inflated Tires of Flight 2120

CRITICAL | HULL LOSS · FATAL · 261 | ✓ OFFICIAL REPORT · PCA (Saudi Arabia), with Canadian participation

"The low tire pressures were measured four days before — then the record was altered in black ink and never checked again. ▸ *full text in the card*

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
morning of 11 July 1991, Jeddah ramp —
THE ACCIDENT
11 July 1991, takeoff from Jeddah runway 34L;
IN BETWEEN: SAME DAY

WHAT HAPPENED

A DC-8-61 on Hajj charter flew for four days on main-gear tires its own maintenance team knew were low. During an A-check tire pressure check on 7 July, the avionics specialist measured tires #2 and #4 below the prescribed pressures and told the lead mechanic; a mechanic later altered the only record of those readings, and no tire was gauge-checked again. A tire change planned at Accra on 10 July was abandoned after the project manager faxed "Do not let maint change wheels in Acc" to get the aircraft back on schedule. On the morning of 11 July at Jeddah, with passengers boarding, the lead mechanic asked for nitrogen; the contract facility's bottles were empty, the only other source meant delay, and the project manager — responsible for the schedule, not qualified to judge airworthiness — directed the aircraft to depart unserviced. During taxi and takeoff the #1 tire, carrying the load its under-inflated axle mate #2 could not, over-deflected and overheated. It failed early in the takeoff roll; #2 failed almost immediately after; a piece of wheel rim embedded in the left flap, and the gear was retracted with burning tire remnants into the wheel well. The fire took pressurization, hydraulics and finally the cabin floor and control systems. The aircraft crashed 2,875 metres short of the runway on the attempted return.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Check tire pressures with a calibrated gauge at the intervals the maintenance manual requires — Douglas specified 180 psi for the DC-8-61 — and record the actual reading.
2. A tire below the maintenance manual minimum is a maintenance action, not a judgment call: the manual required a tire found below 146 psi to be replaced, together with its mate on the same axle.
3. Service with nitrogen from a verified source; if nitrogen is not available, the aircraft waits — availability of a cart is not an airworthiness variable.
4. Never alter a recorded reading. The check sheet is an aircraft maintenance record; the true numbers are the only protection the next crew has.
5. Release to service is made only by a person qualified and authorized to make it — a schedule owner's "Forget it" carries no airworthiness weight, and countermanding it is the qualified person's duty.

THE FACTS — CITED ✓ Tires #2 and #4 were below the minimum pressure for flight dispatch; maintenance personnel knew and did not rectify them. (Saudi PCA final report, findings 3.2.5–3.2.6) ✓ The only record of the low pressures — measured on 7 July, four days before the accident — was altered by the mechanic, and there was no evidence of any gauge check after 7 July. (Saudi PCA final report, findings 3.2.7–3.2.8; ▸ full text in the card

Nigeria Airways Flight 2120, operated by Nationair Canada, McDonnell Douglas DC-8-61, C-GMXQ, 11 July 1991, King Abdulaziz International Airport, Jeddah, Saudi Arabia — final report released by the Presidency of Civil Aviation, Kingdom of Saudi Arabia, reproduced as Report No. 4 in ICAO Circular 290-AN/168. · Dirty Dozen: pressure, lack_of_knowledge, lack_of_assertiveness, lack_of_resources, norms · report: PCA final report, C-GMXQ, via ICAO Circular 290-AN/168 (ICAO Ref 0272/91)

LANDING GEAR, WHEELS & HYDRAULICS

Remove Before Flight — The Gear Pins That Stayed In

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
about 0745 local, 21 June 2021, Sydney — tow
THE ACCIDENT
21 June 2021, initial climb out of Sydney —
IN BETWEEN: SAME DAY

HIGH | SERIOUS INCIDENT | ✓ OFFICIAL REPORT · ATSB | LIBRARY: LG-23 Main Landing Gear Shock Strut

"Five pins hold a 787 rigid on the ground. After the tow, a crew that had never towed a 787 stowed three of them by feel, up a ladder too short to see the stowage rack — and the two still in the main gear rode ▸ full text in the card

WHAT HAPPENED

This is a pattern card: landing-gear ground-lock and downlock pins left installed — or fitted in the wrong hole — before flight or during maintenance. The anchor: a Qantas Boeing 787-9, VH-ZNH, was towed to the terminal at Sydney on the morning of 21 June 2021. The tow supervisor and a wing walker — neither of whom had towed a 787 before — removed three of the five downlock pins and stowed them in the electrical equipment centre, a 787 stowage location other Qantas types don't have; the available ladder was too short to see into the rack, so the pins went in by feel. Two pins, one in each main landing gear, stayed in. The engineer signed the technical log for removal and stowage after a second by-feel check of the same rack; the relief pilot's external inspection did not pick up the streamers. On gear-up selection in the initial climb the nose gear retracted and both main gears stayed locked down. The crew put the gear back down and returned to Sydney. The same device in the wrong hole is just as effective: a British Airways 787-8's nose gear collapsed on stand at Heathrow in June 2021 when the downlock pin was inserted into the adjacent apex-pin bore — that event carries its own card.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Know the pin count and pin stowage for the type before touching it — the 787 carries five gear pins, and stows them in the electrical equipment centre, not the flight deck.
2. Pin removal after towing is a counted task: pins removed, pins in hand, pins in their stowage receptacles — seen, not felt. Get access equipment that lets you see the rack.
3. Sign the technical log for removal and stowage only on a positive count of stowed pins — a by-feel check of a rack you cannot see into is not a count.
4. On the external inspection, check each gear leg at the pin hole itself. Do not scan for streamers: they fade, foul and hide, and expectation bias hides them further.
5. At handover between tow crew, engineering and flight crew, state the pin status explicitly — quantity removed, quantity stowed, by whom.

THE FACTS — CITED ✓ Two of the five downlock pins — one in each main landing gear — were not removed after towing, and were not identified during the subsequent external inspections before departure. (ATSB AO-2021-026, What the ATSB found) ✓ The tow crew members who handled the pins had not towed a 787 before, and the ladder used was too short to see into the pin stowage — the pins were stowed and later "verified" by feel. ▸ full text in the card

Qantas Airways Boeing 787-9, VH-ZNH, 21 June 2021, near Sydney Airport, New South Wales — ATSB Transport Safety Report AO-2021-026, final, released 16 November 2021. · Dirty Dozen: lack_of_knowledge, lack_of_communication, lack_of_awareness, complacency · report: AO-2021-026 (final, 16 November 2021)

FLIGHT CONTROLS & RIGGING

Half the Down Elevator Gone — Air Midwest 5481

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | HULL LOSS · FATAL · 21 | ✓ OFFICIAL REPORT · NTSB | STRUCTURE: elevator control cable rigging

"On the night shift a mechanic doing the rigging for the first time — supervised by an inspector training two people at once — skipped steps and left the airplane with half its nose-down travel. ▸ *full text in the card*

WHAT HAPPENED

Between the night of January 6 and the morning of January 7, 2003, a Beech 1900D went through a detail six maintenance check at Air Midwest's Huntington station, run by contract mechanics. The airplane came into the check with full elevator travel. During the check a mechanic examined and incorrectly adjusted the elevator control system — his first time on that inspection, with no previous on-the-job training for it — while the quality assurance inspector supervising him was giving OJT to two mechanics at once. With the inspector's sanction, several steps of the complete elevator control system rigging procedure were bypassed, including the steps that would have revealed what the adjustment had done: the cable-tension turnbuckles in the tail had been set so that downward elevator travel was restricted to 7 degrees airplane nose down — about half of what the manufacturer specifies. The airplane flew nine flights with nobody noticing. On the morning of January 8, loaded so far tail-heavy that its center of gravity sat well aft of the certified limit, Flight 5481 pitched up on takeoff from Charlotte. With only half the nose-down authority available, the crew could not get the nose back down: the airplane reached 54 degrees nose-up, stalled, and crashed moments after liftoff.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Rig the elevator control system by the complete maintenance manual procedure — every step, in order. A rigging procedure is a single instrument; there are no optional steps.
2. Set and verify cable tensions at the turnbuckles per the manual, then measure control surface travel against the specified range in both directions — for the 1900D, down travel of 14 degrees, plus 1 and minus 0.
3. Any step skipped or altered requires documented engineering authorization — a floor-level agreement between a mechanic and an inspector is not one.
4. A mechanic's first performance of a task is done under dedicated OJT supervision; the supervisor watches the task, not two tasks at once.
5. Before release, an inspector independently verifies rig-pin engagement, tension and full-and-free travel — the check is of the airplane, not of the paperwork.

ERROR COMMITTED
night of 6–7 January 2003, detail six check,
THE ACCIDENT
8 January 2003, 0847:28 EST, seconds after
IN BETWEEN: 2 DAYS

THE FACTS — CITED ✓ The incorrect rigging during the detail six check restricted elevator travel to 7 degrees airplane nose down — about one-half of the downward travel specified by the manufacturer. (NTSB AAR-04/01, finding 5) ✓ The accident airplane's actual center of gravity was 45.5 plus-or-minus 2 percent MAC; the Beech 1900D certified aft limit is 40 percent MAC. ▸ full text in the card

Air Midwest Flight 5481, doing business as US Airways Express, Raytheon (Beechcraft) 1900D, N233YV, 8 January 2003, Charlotte-Douglas International Airport, North Carolina — NTSB Aircraft Accident Report AAR-04/01. · Dirty Dozen: lack_of_knowledge, norms, complacency, lack_of_resources · report: NTSB/AAR-04/01 (PB2004-910401)

FLIGHT CONTROLS & RIGGING

The Bolt Nobody Secured — Emery 17

CRITICAL | HULL LOSS · FATAL · 3 | ✓ OFFICIAL REPORT · NTSB | STRUCTURE: elevator control tab pushrod attachment

"One bolt held the right elevator control tab to its pushrod. Its nut was never installed — or went on without its cotter pin — and no inspection ever caught it. ▸ *full text in the card*

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

WHAT HAPPENED

The crank fitting of a DC-8's right elevator control tab attaches to its pushrod through a single 5/16-inch drilled-shank bolt, secured by a castellated nut and a cotter pin. On the freighter that took off from Sacramento Mather as Emery 17, that bolt was gone before liftoff: the NTSB determined it separated not by failure — a properly installed attachment there withstands 7,300 pounds of shear — but because it was never properly secured: the castellated nut was either never installed or was installed without its cotter pin. The last documented maintenance to disturb that attachment was the airplane's D inspection at Tennessee Technical Services in Smyrna, completed 17 November 1999, when the overhauled elevator assembly was installed and rigged; the Safety Board could not determine the exact moment the securing was missed, and no inspection between then and the accident caught it. With the pushrod disconnected, aerodynamic loads drove the free tab and the right elevator with it: the airplane pitched up on rotation and would not stop. The crew, commanding full nose-down elevator, kept it flying for about two minutes before the left wingtip struck a support column and the airplane came down in an automobile salvage yard. ▸ full text in the card

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Assemble flight-control attach fittings with the complete specified hardware set — drilled-shank bolt, washer, castellated nut and cotter pin — from the illustrated parts catalog, not from what came off.
2. Torque the castellated nut, align the castellation with the bolt's cotter-pin hole, and install the cotter pin with legs correctly bent — the pin is the only thing keeping vibration from backing the nut off.
3. Disconnection and reconnection of any flight-control linkage is a required inspection item: an independent qualified inspector verifies the securing before close-up.
4. During rigging, treat any attachment you may have disturbed as disturbed — if the aft rod-end hardware might have come off to adjust the pushrod, its securing gets re-verified, not assumed.
5. If the manual or work card is silent on securing hardware, stop and get it corrected — a missing cotter pin in the paperwork must not become a missing cotter pin on the airplane.

ERROR COMMITTED
last documented disturbance of the attachment
THE ACCIDENT
16 February 2000, about 1951 PST, two minutes
IN BETWEEN: 3 MONTHS

THE FACTS — CITED ✓ Probable cause: loss of pitch control resulting from the disconnection of the right elevator control tab, caused by the failure to properly secure and inspect the attachment bolt. (NTSB AAR-03/02 §3.2) ✓ A properly installed attachment bolt there has a rated shear strength of 7,300 pounds; the Board concluded the bolt did not fail but separated because the castellated nut was either never installed or installed without a cotter pin. ▸ full text in the card

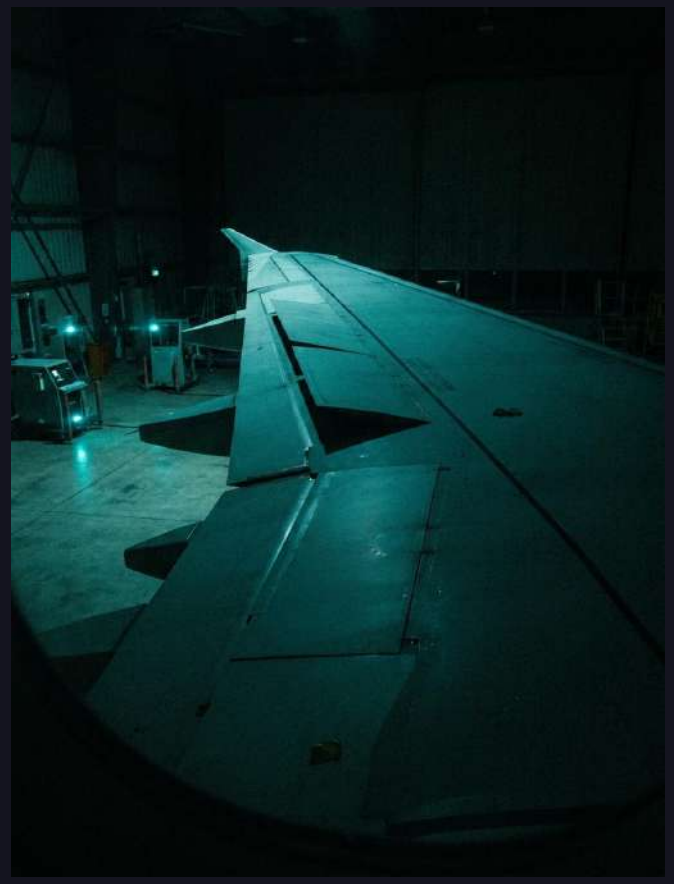
Emery Worldwide Airlines Flight 17, McDonnell Douglas DC-8-71F, N8079U, 16 February 2000, Rancho Cordova, California — NTSB Aircraft Accident Report AAR-03/02, adopted 5 August 2003. · Dirty Dozen: complacency, lack_of_awareness, norms · report: NTSB/AAR-03/02 (PB2003-910402)

FLIGHT CONTROLS & RIGGING

The Spoilers Left in Maintenance Mode — G-KMAM

HIGH | SAVE — EVERYONE LIVED | ✓ OFFICIAL REPORT · AAIB | LIBRARY: FC-28 Flight Control Actuator

"The flap change ran long, the collars and flags never went on, and nobody re-instated the spoilers or function-checked them. On the first flight afterward the A320 rolled right on its own at liftoff — and kept trying for 37 minutes."



✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

WHAT HAPPENED

To change a damaged right-hand outer flap, engineers put the A320's spoilers into maintenance mode and moved them — using an incomplete procedure. The collars and flags that lock and placard a spoiler actuator in maintenance mode were never fitted, so nothing visible marked the spoilers as unsafe, and the purpose of the collars was not fully understood by engineers more familiar with other types. Across the shift handovers of a job that overran its 0700 return-to-service estimate — amended at least twice, with the team under pressure — the spoilers' status never got briefed. After flap fitment, the re-instatement and functional check of the spoilers were not carried out. The airplane was handed to the crew at about 1500. During the flight-control check, spoilers 2 to 5 on the right wing failed to answer right-roll demands on the ECAM — neither pilot noticed, and the operator had given its pilots no specified procedure for the check. On rotation at 1530 the aircraft rolled right undemanded; the co-pilot needed full left sidestick, handed control to the commander at about 300 feet, and past 1,700 feet the ECAM finally declared F/CTL ALTN LAW and F/CTL SPLR FAULT. The crew flew a 37-minute circuit and landed back at Gatwick.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Put a flight-control system into maintenance mode only by the complete maintenance manual procedure — on the A320 spoiler actuator that includes fitting the collars and flags that physically lock and visibly placard the deactivated state.
2. Deviation from the maintenance manual requires design-authority consultation and approval — an engineer who cannot achieve full compliance is not empowered to certify the work.
3. Carry the deactivation status across every shift handover, explicitly: which systems are in maintenance mode, what remains to re-instate.
4. After the job, re-instate the system by the book and perform the full functional check — surfaces answering the correct command, in the correct direction, on indication and on the wing.
5. Stage-sheet the task so re-instatements, inspections and function checks each carry an authorised signature before the Certificate of Release to Service.

ERROR COMMITTED
the night before and the day of the incident
THE ACCIDENT
26 August 1993, 1531 hrs UTC, on takeoff from
IN BETWEEN: THE NEXT DAY

THE FACTS — CITED ✓ During the flap removal the spoilers were placed in maintenance mode and moved using an incomplete procedure — specifically, the collars and flags were not fitted. (AAIB AAR 2/95, causal factor i) ✓ The re-instatement and functional check of the spoilers after flap fitment were not carried out; during the independent flight-control check, the failure of spoilers 2 to 5 on the right wing to respond went unnoticed by the pilots. ▸ full text in the card

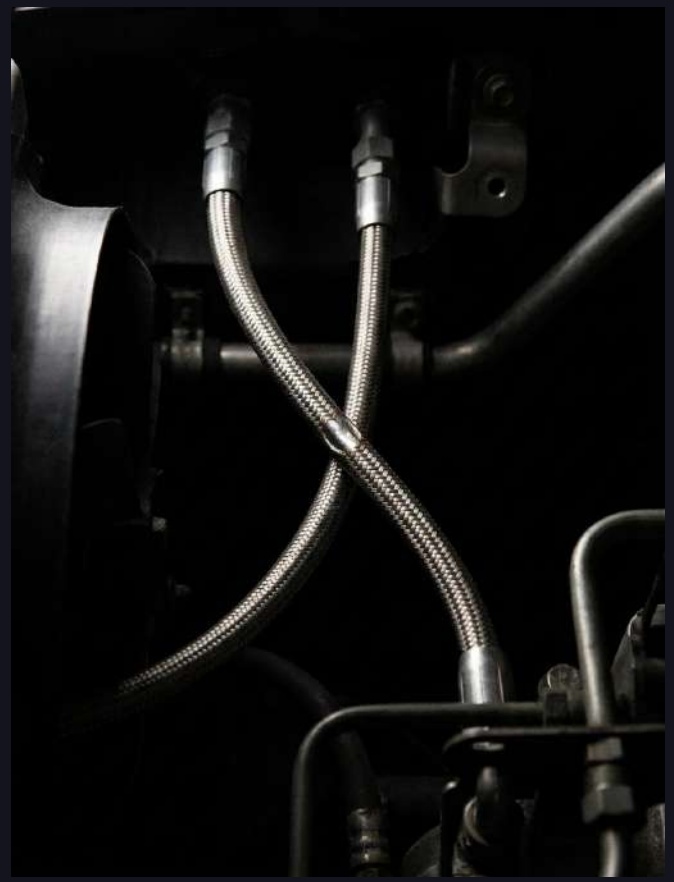
Excalibur Airways Airbus A320-212, G-KMAM, 26 August 1993, London Gatwick Airport — AAIB Aircraft Accident Report 2/95 (EW/C93/8/3), published 24 January 1995. · Dirty Dozen: pressure, lack_of_knowledge, lack_of_communication, norms · report: AAR 2/95 (EW/C93/8/3)

FUEL, PNEUMATICS & ICE

The Engine That Didn't Match — Fuel Exhaustion Over the Atlantic

CRITICAL | SAVE — EVERYONE LIVED | ✓ OFFICIAL REPORT · GPIAA | STRUCTURE: engine fuel and hydraulic line clearance

"The loaned engine was one modification behind the aircraft, and when the hydraulic pump wouldn't fit, the fix was to swap a single tube on verbal advice. ▸ *full text in the card*



✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
engine change, midnight 17–18 August 2001
THE ACCIDENT
24 August 2001 — both engines flamed out over
IN BETWEEN: 6 DAYS

WHAT HAPPENED

Metal chips in the oil forced Air Transat to replace the right engine of its A330 with a loaned Rolls-Royce Trent 772B. Mid-task, the crew discovered the rear hydraulic pump from the removed engine would not fit — the loaned engine was in a pre-SB (Service Bulletin RB.211-29-C625) configuration, the aircraft's old engine post-SB. The lead technician could not access the SB text from the available computer terminals and accepted advice from maintenance engineering to carry over only the fuel tube from the removed engine. The aircraft was released with a post-mod hydraulic pump, a post-mod fuel tube and a pre-mod hydraulic line — a mismatch that put the two tubes in hard contact. 67.5 flight hours later, over the mid-Atlantic at night, the chafed fuel tube ruptured and fuel poured overboard at up to 13 tonnes per hour. Both engines flamed out from fuel exhaustion. Captain Robert Piché and First Officer Dirk DeJager glided the A330 roughly 19 minutes and 65 nautical miles to a dead-stick landing at Lajes. All 306 aboard survived.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Before an engine change, compare the modification/SB status of the replacement engine against the aircraft and the components being carried over — configuration check first, not mid-task.
2. When a part will not fit, stop the task: an unexpected interference is a configuration alarm, not an installation obstacle.
3. Resolve mixed-mod questions from the Service Bulletin and IPC text in hand — never from verbal advice or memory of "what the fleet has".
4. Never mix pre-mod and post-mod components in one assembly unless the SB explicitly permits the combination.
5. Verify required clearances against the documentation, record the as-built configuration, and put an independent inspection on the finished assembly.

THE FACTS — CITED ✓ The aircraft was released with a post-SB C664 hydraulic pump, a post-SB C625 fuel tube P/N FK30383 and a pre-SB C625 hydraulic line P/N LJ51006; the fuel tube ruptured after 67.5 flight hours. (GPIAA Final Investigation Report 22/ACCID/2001, §1.1.3) ✓ DFDR analysis put the fuel leak rate through the cracked tube at a maximum of about 13.0 metric tons per hour. ▸ full text in the card

Air Transat Flight 236, Airbus A330-243, C-GITS, 24 August 2001, diverted and landed engine-out at Lajes, Terceira Island, Azores — GPIAA Final Investigation Report 22/ACCID/2001. · Dirty Dozen: pressure, lack_of_resources, norms, lack_of_communication · report: Final Investigation Report 22/ACCID/2001

FUEL, PNEUMATICS & ICE

The Wrong Fuel — Misfueling and Fuel Contamination in General Aviation

HIGH | FATAL ACCIDENT · 4 | ✓ OFFICIAL REPORT · NTSB | PROCEDURAL

"The nozzles are shaped so jet fuel physically cannot enter a piston airplane — until somebody modifies one. An air-ambulance Cessna got 40 gallons of Jet A through a workaround nozzle; four people had one climb-out left."

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
anchor case — 40 gallons of Jet A dispensed

THE ACCIDENT
27 August 2014, 19:03 local — both engines

IN BETWEEN: SAME DAY

WHAT HAPPENED

PATTERN CARD. Piston aircraft engines detonate and quit on jet fuel, and the industry's physical guard — a fat "duck's bill" Jet A nozzle that cannot enter a small avgas filler port — keeps being defeated on the ramp: FBOs modify jet-fuel nozzles with smaller round spouts to service turbine helicopters, and turbine-conversion STCs leave avgas-sized filler ports on airplanes that now need Jet A (NTSB Safety Alert SA-050). In the anchor case, an air-ambulance Cessna 421C at Las Cruces was fueled with 20 gallons of Jet A per wing from a truck whose nozzle had been permanently modified to a round spout — past filler labels reading "AVGAS ONLY", with the pilot standing there helping replace the fuel caps. Both engines detonated and lost power on initial climb; the pilot, two medical crewmembers and one patient died. Water and sediment contamination belong to the same family: the wrong or dirty fluid delivered during servicing, invisible once the caps go back on.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Confirm the aircraft registration, required fuel grade and which tanks to fill with the placards and the pilot before dispensing — never fuel from assumption or aircraft resemblance.
2. Match nozzle to port and respect the mismatch: a jet-fuel nozzle that slips into an avgas filler is the alarm itself. Never operate modified or reduced jet nozzles on avgas-capable ramps.
3. Know your STC traps: a converted airframe can look identical to its piston sibling — check the data plate and placards, not the silhouette.
4. Write the truth on the ticket and read it back: the fuel receipt names the fuel that actually went in, and pilots have signed receipts saying "Jet A" without noticing.
5. Treat post-fueling checks honestly — sump and smell, but remember a mixture can pass a visual check; the paperwork and the dispensing truck are the real trail.

THE FACTS — CITED ✓ 4 of 4 aboard killed; both engines showed evidence of detonation after roughly 40 gallons of Jet A went into tanks placarded "AVGAS ONLY". (NTSB CEN14FA462) ✓ The FBO's Jet A truck nozzle had been permanently modified to a small round spout for helicopter fueling — which is what let it into the avgas filler port. ▸ full text in the card

Pattern card — anchor: air-ambulance Cessna 421C, N51RX, operated for Elite Medical Air Transport, 27 August 2014, Las Cruces, New Mexico — NTSB accident CEN14FA462; pattern basis NTSB Safety Alert SA-050. · Dirty Dozen: complacency, lack_of_knowledge, norms, lack_of_communication · report: CEN14FA462; Safety Alert SA-050

FUEL, PNEUMATICS & ICE

The Ice Nobody Touched — Double Engine Failure at Gottröra

CRITICAL | SAVE — EVERYONE LIVED | ✓ OFFICIAL REPORT · SHK | PROCEDURAL

"The mechanic felt the wing before de-icing and found only slush — so after de-icing, he didn't feel it again. Seventy-six seconds after liftoff both engines were destroying themselves on the clear ice the ▸ *full text in the card*

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

WHAT HAPPENED

An SAS MD-81 landed at Stockholm/Arlanda at 2209 the night before with about 2,550 kg of fuel in each wing tank, cold-soaked to between −53 and −62°C at cruise. Overnight, in air hovering around +1°C, that cold fuel froze moisture on the wing skins into clear ice — a night technician noticed ice forming on the upper wing surfaces at about 0200. In the morning the handover mechanic climbed a ladder, put a knee on the left wing and felt the forward part by hand: no ice, only slush. The aircraft was then de-iced with 850 litres of hot Type I fluid — but after de-icing, nobody checked the upper wing surfaces for clear ice again, because none had been found before. The wings were not clean. On rotation the clear ice broke loose and was ingested by both tail-mounted engines. The right engine began surging 25 seconds into the flight and lost thrust 51 seconds later; the left engine failed two seconds after that. The crew put the aircraft down in a field at Gottröra four minutes after takeoff. The fuselage broke into three pieces. All 129 aboard survived.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Treat a cold-soaked wing — long high-altitude sector, large fuel quantity remaining in the wing tanks — as a clear-ice case regardless of above-freezing air temperature.
2. Check for clear ice by physical touch on the upper wing surface at the tank areas; clear ice cannot be reliably seen, only felt.
3. De-ice, then verify: repeat the hands-on check after de-icing and before dispatch — a pre-de-icing check proves nothing about the finished wing.
4. Use the wing ice indicators: tufts that do not move under fluid spray are frozen down — that is a finding, not a curiosity.
5. Report to the flight crew in facts, not reassurance — "de-icing finished" is not "wings verified free of ice".

ERROR COMMITTED
morning of 27 December 1991, Arlanda —
THE ACCIDENT
27 December 1991 — takeoff 0847, both engines
IN BETWEEN: SAME SHIFT

THE FACTS — CITED ✓ About 2,550 kg of fuel cold-soaked between −53 and −62°C sat in each wing tank overnight — roughly 60% of tank volume, enough to chill the upper wing skin into clear-ice conditions. (SHK Report C 1993:57, §1.1 and §2.4) ✓ 850 litres of Type I fluid at about 85°C were sprayed on — and the mechanic made no clear-ice check after de-icing, because he had found none before. ▸ full text in the card

Scandinavian Airlines System Flight SK 751, McDonnell Douglas MD-81 (DC-9-81), OY-KHO, 27 December 1991, forced landing at Gottröra, Sweden — Swedish Board of Accident Investigation Report C 1993:57. · Dirty Dozen: norms, complacency, lack_of_knowledge · report: Report C 1993:57

ELECTRICAL, AVIONICS & AIR DATA

The Tape That Stayed On — Blind Instruments Over the Pacific

CRITICAL | HULL LOSS · FATAL · 70 | ✓ OFFICIAL REPORT · DGAT Peru (Accident Investigation Board) | STRUCTURE: fuselage static ports

"Masking tape went over the static ports so the polish wouldn't clog them. It passed the quality check, the line handover and the walk-around — and at one in the morning a 757's instruments started lying to ▸ *full text in the card*

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
polishing of the lower fuselage during
THE ACCIDENT
2 October 1996 — takeoff 00:42 local, impact
IN BETWEEN: THE NEXT DAY

WHAT HAPPENED

Before a night departure to Santiago, Aeroperú's Boeing 757 was in maintenance in Lima: two turbine blades changed, a hydraulic pump repaired — and the lower forward fuselage scheduled for polishing. Standard practice for polishing is to cover the flush static ports with adhesive tape so polish cannot clog them. The tape was masking tape — low-contrast, unflagged — and when the polishing crew finished, they did not remove it. The taped ports then survived every layer built to catch them: the quality-control check at work completion, the handover to the duty supervisor, to the line chief (the principal supervisor was off sick; his replacement assigned a line mechanic who did not carry out the pre-flight visual inspection correctly), and the crew's own walk-around in the dark. From rotation, the sealed static system fed the air data computers garbage: altitude and airspeed indications went erratic over a black ocean at night. The crew declared an emergency three minutes after takeoff and fought contradictory instruments and cascading warnings for 29 minutes before the aircraft struck the sea 48 nautical miles from the airport. All 70 aboard died.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Log every temporary covering — tape, plugs, probe covers — applied for washing, polishing or painting as a tracked item, exactly like a tool issued to the job.
2. Use conspicuous, flagged, high-contrast coverings on pitot-static openings; plain masking tape on a flush port is camouflage.
3. Make removal a work step with its own sign-off, verified at task close-out — "work finished" must be impossible to certify with coverings in place.
4. Quality control inspects static ports and probes specifically before release to the line after any surface work near them.
5. Treat pitot-static openings as named items on line handover and the pre-flight walk-around — checked with a flashlight at night, not silhouette-glanced.

THE FACTS — CITED ✓ A recovered section of the left-hand fuselage showed the three static ports still covered by masking tape — named by the investigation as the principal evidence for the probable cause. (DGAT Peru AIB report, damage analysis) ✓ Takeoff 05:42 UTC, emergency declared at 05:45, impact at 06:11:30 UTC — a 29-minute fight against instruments that could not tell the truth. ▸ full text in the card

Aeroperú Flight 603, Boeing 757-23A, N52AW, 2 October 1996, off the coast of Lima, Peru — Accident Investigation Board, Directorate General of Air Transport, Peru; NTSB assisted. · Dirty Dozen: complacency, lack_of_awareness, norms, distraction · report: Final report, accident of Boeing 757-200 N52AW, 2 October 1996 (English translation)

ELECTRICAL, AVIONICS & AIR DATA

Twenty Days Without Covers — The Blocked Pitot of Puerto Plata

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | HULL LOSS · FATAL · 189 | ✓ OFFICIAL REPORT · JIAA (DGAC Dominican Republic) | LIBRARY: AV-49 Pitot Probe

"The 757 sat on a Caribbean ramp for twenty days with its pitot tubes open to the sky, then flew. The captain's airspeed indicator was dead at the 80-knot call — and he kept going. Five minutes later, 189 people were in the Atlantic."

WHAT HAPPENED

A Boeing 757 chartered from Birgenair sat at Puerto Plata for what investigators believed was twenty days without flying. During that period an engine inspection required a ground run — and investigators believe the engine and pitot covers were not installed before or after the test. The aircraft was then returned to service without the pitot-static verification recommended by the manufacturer's maintenance procedures for a lengthy time on the ground. On the night takeoff, the captain's airspeed indicator was dead at the first officer's "80 knots" call; the captain elected to continue. In the climb, the blocked left pitot line made his indicator read ever-higher airspeed, triggering an overspeed warning while the aircraft was actually approaching a stall — two alarms telling opposite lies. The crew's confusion ended with the aircraft stalled and rolling into the Atlantic about five minutes after brake release. The wreckage — and the pitot tube — were never recovered; the report states the exact reason for the obstruction was never determined, and that the probable source was mud and/or debris from a small insect introduced into the pitot tube while the aircraft was on the ground.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Install pitot and probe covers whenever the aircraft is parked beyond the manufacturer's short-stay limit — storage procedures start on day one, not when someone remembers.
2. Ground runs do not suspend storage protection: covers come off for the run and go back on afterwards, as logged steps.
3. Return-to-service after prolonged parking requires the manufacturer's pitot-static system verification — it exists precisely to catch what settled in the tubes.
4. Record cover installation and removal in the aircraft's paperwork so a missing cover is a visible discrepancy, not a silent nothing.
5. Brief crews that any airspeed anomaly at the low-speed calls after ground storage is a reject-and-inspect item — the pitot-static system is guilty until proven clean.

ERROR COMMITTED
start of the roughly 20-day parked period at
THE ACCIDENT
6 February 1996 — takeoff 03:42 UTC, impact
IN BETWEEN: 20 DAYS

THE FACTS — CITED ✓ The aircraft was believed not to have flown for twenty days, and investigators believe the engine and pitot covers were not installed before or after the engine ground test run in that period. (JIAA final report, §2.3) ✓ It was returned to service without the manufacturer's recommended pitot-static verification — a check the report says may have discovered and corrected the blockage before flight. ▸ full text in the card

Birgenair Flight ALW-301, chartered by Alas Nacionales, Boeing 757-225, TC-GEN, 6 February 1996, off Puerto Plata, Dominican Republic — Junta Investigadora de Accidentes Aéreos, DGAC Dominican Republic, final report; NTSB participated; English translation distributed by ALPA/ICAO, hosted by the FAA. · Dirty Dozen: complacency, norms, lack_of_awareness · report: Final Aviation Accident Report, Birgenair Flight ALW-301, 6 February 1996

ELECTRICAL, AVIONICS & AIR DATA

Crossed Wires — When the Connectors Fit and the System Lies

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

HIGH | SERIOUS INCIDENT | ✓ OFFICIAL REPORT · NTSB | PROCEDURAL

"Two identical connectors, four days, one landing. A 737 left its brake modification with the wheel-speed wiring swapped — so the anti-skid protected the wrong wheels, the tires burned flat, and the airplane ▸ *full text in the card*

WHAT HAPPENED

PATTERN CARD. Electrical wiring errors during maintenance — crossed connections, wrong pins, unclamped harnesses left to chafe — share one ugly property: the wrong connection usually mates perfectly. In the anchor case, an American Airlines 737-800 completed a scheduled steel-to-carbon brake modification; the electrical connectors for the number 1 and number 2 left-gear wheel speed transducers were swapped, and two right-gear flexible hydraulic hoses were reversed at the flow limiters. Nothing looked wrong, everything fit, and there was no functional check able to catch either swap. Four days later, landing at DFW, the anti-skid system worked exactly backwards: skidding wheels got full brake pressure, rolling wheels got the release. The outboard tires wore flat and failed, stopping distance stretched past the runway end, and the aircraft came to rest in the paved overrun area. All 104 aboard evacuated uninjured. The NTSB noted it has investigated several incidents and accidents from cross-wired wheel speed transducers — all of them maintenance human error.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Label harnesses and connectors before disconnection — identical connectors on adjacent lines are a cross-connection waiting for a shift change.
2. Reconnect from the wiring diagram and the drawing, never from reach, routing memory or "it only fits one way" — it usually fits both ways.
3. Clamp and route per the drawing; an unclamped harness that merely touches structure today is a chafed short circuit later.
4. After any wiring disturbance on a safety system, run a functional/operational check that is actually capable of detecting a cross-connection — a continuity beep proves the wire, not the system.
5. Put an independent inspection on reconnected flight-safety wiring before release; the installer's eye is the one eye guaranteed to see what was intended, not what is.

ERROR COMMITTED
anchor case — brake system modification
THE ACCIDENT
10 February 2024, 19:42 local — runway
IN BETWEEN: 4 DAYS

THE FACTS — CITED ✓ Connectors for the number 1 and number 2 wheel speed transducers were swapped and two hydraulic hoses reversed — so skidding wheels received the brake pressure meant for rolling wheels, and vice versa. (NTSB DCA24LA095) ✓ Contributing to the diminished braking was the lack of a functional check able to verify hoses and transducer wiring after the modification — the check added afterwards can detect both swaps. ▸ full text in the card

Pattern card — anchor: American Airlines Flight 1632, Boeing 737-823, N991AN, 10 February 2024, runway excursion at Dallas-Fort Worth International Airport — NTSB incident DCA24LA095; pattern basis UK CAA recurring-error canon via CAP 716. · Dirty Dozen: lack_of_awareness, norms, complacency · report: DCA24LA095

PRESSURIZATION, CABIN & OXYGEN

The Switch Left in MANUAL — Ghost Flight Over the Aegean

CRITICAL | HULL LOSS · FATAL · 121 | ✓ OFFICIAL REPORT · AAIASB | LIBRARY: AC-41 Cabin Pressurization Outflow Valve

"An overnight pressure test ended with the pressurization selector still in MANUAL. Three checklists ran past it without seeing it. Two hours later a fighter pilot flew alongside a silent 737 full of people who would never wake up."

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
overnight cabin pressurization leak check,
THE ACCIDENT
14 August 2005, departed Larnaca 06:07,
IN BETWEEN: SAME SHIFT

WHAT HAPPENED

After a night flight into Larnaca, the cabin crew wrote up the aft service door — "seal around door freezes & hard bangs are heard during flt." A ground engineer inspected the door and ran a cabin pressurization leak check, pressurizing the aircraft on the ground with the pressurization mode selector set to MAN (manual). The Board concluded the selector then remained in MAN — the leak test was the last known time it was manipulated — and was not returned to AUTO. The aircraft was released at 03:15 and departed for Athens at 06:07. In AUTO the outflow valve closes and the cabin pressurizes itself; in MAN it does only what a human commands, and no one commanded anything. The crew missed the selector position on the Preflight procedure, the Before Start checklist and the After Takeoff checklist. As the 737 climbed, the cabin climbed with it; the warnings that followed were misread, the pilots lost consciousness, and the aircraft flew on autopilot until fuel exhaustion, crashing near Grammatiko. All 121 aboard died.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Before a ground pressurization test, record the as-found configuration of every control you will move — the selector, the outflow valve, the toggle.
2. Perform the leak check to the AMM task, by its task number.
3. After the test, restore every control to its flight configuration — for the 737 pressurization panel, selector back to AUTO — and have it verified.
4. Document the work against the specific AMM task reference, not as a one-line summary; the next crew inherits only what the log tells them.
5. Treat any control moved for maintenance as a threat until a second person or a checklist has positively confirmed its restoration.

THE FACTS — CITED ✓ The Board concluded the pressurization mode selector remained in MAN after the overnight Pressure Leak Test — the last known time the selector had been manipulated — and it stayed in MAN until impact almost three hours after takeoff. (AAIASB Final Report, analysis) ✓ The MAN position went unrecognized through three crew checks: the Preflight procedure, the Before Start checklist and the After Takeoff checklist — the accident's first direct cause. ▸ full text in the card

Helios Airways Flight HCY522, Boeing 737-31S, 5B-DBY, 14 August 2005, Grammatiko, Hellas — Hellenic AAIASB Aircraft Accident Report, November 2006. · Dirty Dozen: lack_of_communication, complacency, lack_of_awareness · report: AAIASB Aircraft Accident Report, HCY522 5B-DBY, November 2006

PRESSURIZATION, CABIN & OXYGEN

Boxes Marked "Empty" — Fire in the Hold Over the Everglades

CRITICAL | HULL LOSS · FATAL · 110 | ✓ OFFICIAL REPORT · NTSB | PROCEDURAL

"The removed oxygen generators needed plastic safety caps that cost pennies. They got green tags, bubble wrap, and a shipping ticket that said "Empty." Ten minutes after takeoff the cargo hold was a furnace."

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

WHAT HAPPENED

ValuJet's heavy-maintenance contractor SabreTech was replacing expired and near-expired chemical oxygen generators on MD-80s. From about mid-March 1996 crews removed roughly 144 generators; the work cards were signed off on 30 April and 5 May. An unexpended chemical oxygen generator is a live pyrotechnic device: pull the lanyard and it burns at hundreds of degrees making oxygen. The required plastic safety caps were never installed — mechanics signed the cards anyway — and the generators were tagged with the wrong parts tags, boxed with bubble wrap, and staged as if they were ordinary stock. Days before the accident the boxes were prepared for return to ValuJet as company material: five boxes described on the shipping ticket as "Oxy Cannisters - Empty," with no hazardous-materials markings. Loaded into the forward class D cargo compartment of Flight 592 — a hold with no fire detection and no suppression — one or more generators actuated, ignited the packaging around them, and the DC-9 crashed into the Everglades ten minutes after takeoff.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Treat removed energetic or hazardous components as live until rendered safe — an unexpended oxygen generator is a hazmat item, not a spare part.
2. Install the safety caps (or expend the generator) before it leaves the aircraft's side; never sign a step that was not done.
3. Tag honestly: the tag's condition status must match physical reality, and "empty" is a measurement, not a hope.
4. Package and label per the hazmat regulations, with trained shipping personnel — maintenance's paperwork is the only truth the ramp will ever see.
5. Anyone in the chain — mechanic, stores, shipping, ramp — who cannot verify what is in the box has the duty to stop it.

ERROR COMMITTED
generator removal and packaging,
THE ACCIDENT
11 May 1996, in-flight fire and impact in the
IN BETWEEN: 6 DAYS

THE FACTS — CITED ✓ About mid-March 1996, SabreTech crews began replacing the expired and near-expired generators; the tasks were signed off as completed on 30 April for N803VV and 5 May for N802VV. (NTSB AAR-97/06 §1.1.2.3) ✓ The five boxes delivered to the ValuJet ramp had no hazardous-materials markings, and the shipping ticket described them as "Oxy Cannisters - Empty". ▸ full text in the card

ValuJet Airlines Flight 592, DC-9-32, N904VJ, 11 May 1996, Everglades near Miami, Florida — NTSB Aircraft Accident Report AAR-97/06. · Dirty Dozen: pressure, norms, lack_of_knowledge, lack_of_communication · report: NTSB/AAR-97/06 (PB97-910406)

STRUCTURES & FATIGUE

The Doubler That Was Too Small — 22 Years to Breakup

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | HULL LOSS · FATAL · 225 | ✓ OFFICIAL REPORT · ASC | STRUCTURE: fuselage skin doubler repair

"In May 1980 a tailstrike repair skipped the SRM: the scratched skin stayed, and the doubler stopped short of the damage. The crack grew in the shadow of the patch for 22 years, then took the whole airplane apart at 35,000 feet."

WHAT HAPPENED

On 7 February 1980 the 747 (then B-1866) scraped its tail landing at Hong Kong Kai Tak, abrading the belly skin of Section 46. It was ferried home unpressurized and temporarily patched. The permanent repair, done 23–26 May 1980, was supposed to follow the Boeing Structural Repair Manual: remove (trim) the damaged skin, or cover it with a doubler extending far enough beyond the damage to restore full structural strength. Neither happened — the scratched skin stayed in place, and the repair doubler did not extend sufficiently beyond the entire damaged area. The repair looked finished; strength-wise it was a bandage over a wound that kept opening. Fatigue cracks grew from the tailstrike scratches beneath the doubler through 22 years of pressurization cycles — invisible to every inspection because the doubler itself hid them. On 25 May 2002, twenty-two years almost to the day, the aft lower fuselage let go as Flight 611 approached cruise altitude; the aircraft broke apart in flight over the Taiwan Strait.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Map the full extent of tailstrike damage before repairing — every scratch is a crack initiator.
2. Execute the SRM repair exactly: trim damaged skin where required, or size the doubler to extend beyond the entire damaged area with the specified fastener rows.
3. Any deviation from the SRM requires the manufacturer's engineering disposition in writing before close-up.
4. Record the as-built repair — dimensions, coverage, fasteners — so future inspectors know what is under the doubler.
5. Put repaired pressure structure on a repeat-inspection program sized to the repair, for the life of the airframe.

ERROR COMMITTED
permanent tailstrike repair, 23–26 May 1980,
THE ACCIDENT
25 May 2002, in-flight breakup approaching
IN BETWEEN: 22 YEARS

THE FACTS — CITED ✓ The permanent repair of May 23–26, 1980 was not accomplished per the Boeing SRM: the damaged skin in Section 46 was not removed, and the repair doubler did not extend sufficiently beyond the entire damaged area to restore structural strength. (ASC-AOR-05-02-001 Vol I, Findings 2 and 3) ✓ A 15.1-inch through-thickness main fatigue crack and multiple site damage were found under the repair doubler; ▸ full text in the card

China Airlines Flight CI611, Boeing 747-209B, B-18255, 25 May 2002, Taiwan Strait near Penghu — Aviation Safety Council Aviation Occurrence Report ASC-AOR-05-02-001. · Dirty Dozen: norms, lack_of_knowledge, complacency · report: ASC-AOR-05-02-001, Volume I (published 25 February 2005)

STRUCTURES & FATIGUE

The Wing That Kept Leaking — Sealant Over a Broken Spar

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | HULL LOSS · FATAL · 20 | ✓ OFFICIAL REPORT · NTSB | STRUCTURE: wing spar and skin

"The right wing told them six times in two months — fuel weeping from the wing root, day after day. Each time, maintenance answered with fresh sealant. On December 19 the wing answered back, and separated in flight off Miami Beach."

WHAT HAPPENED

The 58-year-old Grumman Turbo Mallard seaplane had been telling its operator about the right wing for months. In July 2005, three flight-log entries recorded fuel leaking at the right wing root; in September 2005, the company's own CASS meeting minutes recorded a fuel leak in the right wing dry bay three days running. The repair method, each time: remove and replace the fuel-tank sealant. The fuel was not the problem — it was the messenger, escaping through fatigue cracks in the wing structure. The wreckage showed the truth the paperwork never held: a long chordwise skin crack just outboard of right wing station 34 had at some point received a major repair — one external and three internal doublers — that appeared nowhere in the company's maintenance records, and fatigue had also broken through the rear Z-stringer and the rear spar lower cap. On 19 December 2005, seconds after takeoff from the Port of Miami, the right wing separated and the aircraft crashed into the ship channel. All 20 aboard died.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Treat a recurring leak in a structural area as a structural investigation, not a sealant job — find why the fuel has a path.
2. Trend the discrepancies: the same defect, same location, multiple times, is a CASS red flag that mandates root-cause analysis.
3. Inspect beneath: skin cracks near highly loaded joints demand NDT of the spar, stringers and skin, not a surface fix.
4. Document every structural repair as a major repair with engineering approval — an off-the-books doubler blinds the entire future of the airframe.
5. When an aging airframe's inspections keep finding the same distress, escalate to the manufacturer or engineering authority for a structural integrity assessment.

ERROR COMMITTED
the maintenance program's failure window;
THE ACCIDENT
19 December 2005, right wing separation in
IN BETWEEN: 4 MONTHS

THE FACTS — CITED ✓ Probable cause: in-flight failure and separation of the right wing resulting from the failure of the Chalk's Ocean Airways maintenance program to identify and properly repair fatigue cracks in the right wing, and the failure of the FAA to detect and correct deficiencies in that program. (NTSB AAR-07/04 §3.2) ✓ July 2005: three flight-log entries for fuel leaks at the right wing root; ▸ full text in the card

Flying Boat, Inc. d/b/a Chalk's Ocean Airways Flight 101, Grumman Turbo Mallard G-73T, N2969, 19 December 2005, Port of Miami, Florida — NTSB Aircraft Accident Report AAR-07/04. · Dirty Dozen: norms, complacency, lack_of_resources · report: NTSB/AAR-07/04 (PB2007-910405)

STRUCTURES & FATIGUE

Half the Strength — Substandard Parts in the Tail

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | HULL LOSS · FATAL · 55 | ✓ OFFICIAL REPORT · AIBN | STRUCTURE: vertical stabilizer attachment fittings

"The fin-attachment sleeves fitted in 1986 had barely half the specified strength, and the 1989 inspection that should have pulled them was signed off without ever removing them. Over the Skagerrak, the tail shook itself to pieces."

WHAT HAPPENED

During a 1986 maintenance visit, all four pins and sleeves connecting the Convair 580's vertical fin to the fuselage were replaced. The investigation later found that all four sleeves and both front pins did not conform to the specified hardness — their actual hardness corresponded to a tensile strength of little more than 50 percent of the specified value. Their dimensions and material composition looked right; their strength was not. The soft parts wore fast, opening abnormal clearances in the fin attachments. The inspection designed to catch exactly this — a structural inspection requiring the pins and sleeves to be removed, the fittings checked, and new pins and sleeves installed — came due in July/August 1989: the shop instead checked the attachments ultrasonically without removing the pins and sleeves, and signed and stamped the work as completed. The same 1986 visit had also reinstalled the APU on a front support of inferior design and unknown origin, which failed and fed vibration into the tail. On 8 September 1989, the loose-jointed fin let the tail surfaces develop aeroelastic flutter; the primary control surfaces disintegrated and the aircraft fell into the sea with all 55 aboard.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Source structural fasteners and fittings only with full traceability to approved manufacture — certificates matched to the batch, not to the box.
2. Verify incoming critical parts against specification — hardness and dimensions — before they go anywhere near the airframe.
3. Perform structural inspections exactly as written: if the task says remove the pins and sleeves, ultrasound through them is not the task.
4. Never certify an inspection step that was substituted or abbreviated without engineering approval of the alternative.
5. Treat growing clearances, wear and recurring vibration in empennage attachments as flutter precursors demanding immediate grounding-level attention.

ERROR COMMITTED
KFC maintenance visit, 1986 — the report
THE ACCIDENT
8 September 1989, loss of control and breakup
IN BETWEEN: 4 YEARS

THE FACTS — CITED ✓ All four vertical-fin attachment pins and sleeves were replaced during the 1986 maintenance; all four sleeves plus the two front pins did not conform to the specified hardness — a tensile strength of little more than 50 percent of the specified value. ▸ full text in the card

Partnair Flight 394, Convair 340/580, LN-PAA, 8 September 1989, Skagerrak north of Hirtshals, Denmark — Aircraft Accident Investigation Board Norway report HAV 02/93, February 1993. · Dirty Dozen: norms, complacency, lack_of_resources · report: HAV 02/93 (English extract of the Norwegian report of 12 February 1993)

TOOLS, FOD & SIGN-OFF

The Screws That Vanished at Shift Change

CRITICAL | HULL LOSS · FATAL · 14 | ✓ OFFICIAL REPORT · NTSB | STRUCTURE: horizontal stabilizer leading edge attachment

"The second-shift inspector pulled the screws from the tops of both leading edges to help the job along. Nobody wrote it down. ▸ *full text in the card*

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
night shift, 10–11 September 1991, Houston
THE ACCIDENT
11 September 1991, about 1003 CDT, in-flight
IN BETWEEN: THE NEXT DAY

WHAT HAPPENED

On 10 September 1991 — the night before the accident — Maintenance Control scheduled both horizontal stabilizer deice boots on the EMB-120 for replacement. Second-shift mechanics started on the right side, removing most of the bottom screws of the right leading edge. To help, the second-shift inspector climbed on top of the T-tail and removed the attaching screws from the top of the right leading edge — then walked across and removed the top screws from the LEFT leading edge as well, roughly 47 screws per side. None of this partial disassembly of the left side was documented on the work cards or passed across the shift-change turnover. The third shift completed and closed up the right side — the only side they knew about — and the aircraft was released to service. The left leading edge was held on by its bottom row of screws alone. Climbing through 11,500 feet the next morning, the left horizontal stabilizer leading edge separated, the airplane pitched violently nose-down and broke up over a cornfield near Eagle Lake. All 14 aboard died.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Document every disassembly step on the work card the moment it happens — especially work started opportunistically on the other side of the aircraft.
2. An inspector who turns wrenches becomes a mechanic: the work he does must be recorded and inspected like anyone else's.
3. Shift turnover is a formal, written handover of aircraft configuration — incomplete work, panels open, fasteners out — not a hallway conversation.
4. Before release, verify the aircraft physically matches the paperwork: walk both sides, touch what was opened.
5. Flight-critical attachments get an independent inspection against the full work scope, not just the tasks someone remembered to write.

THE FACTS — CITED ✓ None of the 47 screws that would have attached the upper surface of the left leading edge was found in the wreckage, and there was no evidence they were installed when the leading edge separated. (NTSB AAR-92/04 §1.12) ✓ The second-shift inspector removed the top attaching screws from the right leading edge, then walked across the T-tail and removed the top screws from the left side as well; the bottom screws stayed in. ▸ full text in the card

Britt Airways d/b/a Continental Express Flight 2574, Embraer EMB-120RT, N33701, 11 September 1991, Eagle Lake, Texas — NTSB Aircraft Accident Report AAR-92/04. · Dirty Dozen: lack_of_communication, norms, complacency · report: NTSB/AAR-92/04 (PB92-910405), adopted 21 July 1992

TOOLS, FOD & SIGN-OFF

The Wear Strip From Someone Else's Airplane

CRITICAL | HULL LOSS · FATAL · 113 | ✓ OFFICIAL REPORT · BEA | STRUCTURE: nonconforming wear strip on another aircraft

"A DC-10 mechanic in Houston made a wear strip his own way — wrong material, wrong holes, wrong mastic. Sixteen days later it fell onto runway 26R at Paris, five minutes ahead of a Concorde at takeoff power."

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

ERROR COMMITTED
wear strip replaced on the Continental
THE ACCIDENT
25 July 2000, takeoff from runway 26R, Paris
IN BETWEEN: 16 DAYS

WHAT HAPPENED

On 9 July 2000 at Houston, a Continental Airlines technician replaced the lower left wear strip on the fan reverser cowl of a DC-10's number 3 engine. The replacement was improvised: the cowl support ended up drilled with thirty-seven holes where the installation requires only twelve, the part was made of titanium alloy with a mastic not normally used for the operation, and the adjacent strip was left too long — the BEA found the strip had neither been manufactured nor installed in accordance with the manufacturer's procedures. Sixteen days later that DC-10 took off from Paris Charles de Gaulle, five minutes ahead of Air France Concorde F-BTSC, and the strip fell onto runway 26R. At takeoff power, shortly before rotation, the Concorde's front right tire on the left gear ran over the 435-millimeter metal strip and burst; heavy tire debris struck the wing and ruptured fuel tank 5; the leak ignited into a massive fire under the left wing. Unable to climb or accelerate, the Concorde crashed onto a hotel at Gonesse less than two minutes later. 109 aboard and 4 people on the ground died.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Fabricate replacement parts only from approved data — material, dimensions and finish per the manufacturer's specification, never by copying the worn part "close enough".
2. Install per the documented procedure: hole patterns, fastening and sealants are part of the design, not preferences.
3. If the approved part or data is not available, ground the discrepancy through engineering — an improvised part is an unapproved part.
4. Inspect the installation against the drawing before closing the cowl, and treat anything protruding or misfitted on cowlings as a FOD hazard to every aircraft behind you.
5. Remember the runway is shared: what falls off your aircraft becomes the next crew's emergency.

THE FACTS — CITED ✓ The strip installed at Houston on 9 July 2000 had neither been manufactured nor installed in accordance with the procedures as defined by the manufacturer. (BEA final report f-sc000725a, findings) ✓ The wear strip found on the runway was 435 mm long, 29 to 34 mm wide and about 1.4 mm thick, made of TA6V titanium alloy; the cowl support had been drilled with thirty-seven holes where the installation requires only twelve. ▸ full text in the card

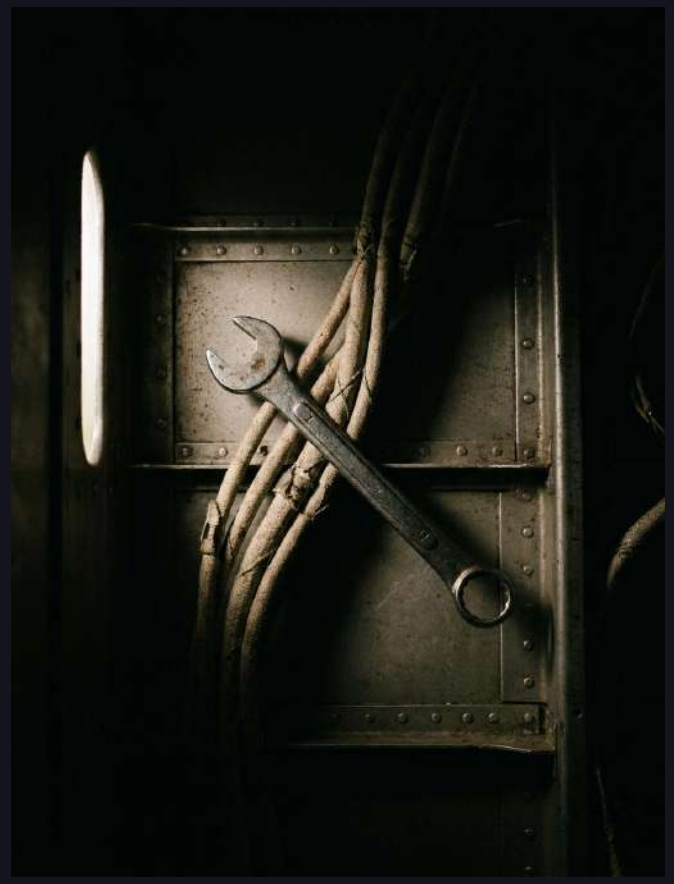
Air France Flight 4590, Aerospatiale/BAC Concorde, F-BTSC, 25 July 2000, Gonesse, France; initiating object from Continental Airlines DC-10-30 N13067 — BEA final report f-sc000725a, January 2002. · Dirty Dozen: norms, lack_of_knowledge, complacency · report: BEA final report f-sc000725a (English translation)

TOOLS, FOD & SIGN-OFF

The Tool You Didn't Count Back In

HIGH | FATAL ACCIDENT · 2 | ✓ OFFICIAL REPORT · AAIB | PROCEDURAL

"A screwdriver nobody missed rode along in the tail for weeks of flying — until an aerobatic maneuver dropped it into the elevator quadrant at the exact moment two brothers needed to pull out of a dive."



✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

WHAT HAPPENED

PATTERN CARD — tools and foreign objects left in aircraft after maintenance. The anchor: a Yak-52 completed a stall turn during aerobatics and entered a vertical dive it never recovered from. In the wreckage the AAIB found a short-handled flat-bladed screwdriver jammed in the elevator control run: the elevator could not move beyond neutral in the nose-up direction. The aircraft had been through a 50-hour inspection and annual check in September 2002 and register-conversion work at the same maintenance organisation in November 2002. A trainee mechanic there came forward: he had lost a short-handled flat-bladed screwdriver matching the one found. His personal tools lived in toolboxes at the back of the hangar that were never locked; tools were borrowed, sometimes without the owner's knowledge. Nobody logged a lost tool; nobody swept the aft fuselage before the aircraft went flying. The tool waited in the tail through multiple flights — including a full aerobatics sortie — until gravity and maneuvering delivered it into the elevator quadrant. Both occupants, brothers, were killed.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Control tools: shadowed, inventoried kits checked out and checked in per task — personal tools included, and toolboxes secured.
2. Count the tools before you close the panel; the count is part of the task, not an option after it.
3. A lost tool is a reportable event that halts release: the aircraft does not fly until the tool is found or the affected zones are searched and cleared.
4. Loose-article checks of control runs and closed-out bays are inspection items after any work in those zones.
5. Culture: coming forward about a lost tool must be celebrated, not punished — the trainee's honesty is what closed this investigation.

ERROR COMMITTED
November 2002 — the trainee mechanic who lost
THE ACCIDENT
5 January 2003 at 1125 hrs, near Towcester,
IN BETWEEN: 2 MONTHS

THE FACTS — CITED ✓ A short-handled flat-bladed screwdriver was found jammed in the elevator control run; the elevator could not be moved beyond neutral in the nose-up direction. (AAIB Bulletin 10/2003, EW/C2003/01/01) ✓ A trainee mechanic at the maintenance organisation declared he had lost a screwdriver matching the item found; his toolbox was kept unlocked at the hangar, and he had worked on the aircraft in November 2002. ▸ full text in the card

Yak-52, G-YAKW, private flight, 5 January 2003, near Towcester, Northamptonshire — AAIB Bulletin 10/2003, ref EW/C2003/01/01 (pattern anchor; the pattern spans all aircraft classes). · Dirty Dozen: complacency, distraction, norms, lack_of_awareness · report: AAIB Bulletin 10/2003 (EW/C2003/01/01)

TOOLS, FOD & SIGN-OFF

The Second Pair of Eyes That Never Looked

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | SERIOUS INCIDENT | ✓ OFFICIAL REPORT · AAIB | PROCEDURAL

"The rule says safety-critical work gets an independent check. BA 5390's windscreen was fitted and self-certified by one man; Flight 2574's inspector was doing the mechanics' work himself. ▸ *full text in the card*

WHAT HAPPENED

PATTERN CARD — required inspection items and duplicate inspections signed without a true second check. Anchor one: British Airways 5390, where a BAC One-Eleven windscreen was replaced overnight by a Shift Maintenance Manager working alone who then certified his own work; the windscreen was not designated a "Vital Point," so no independent check was required — and the wrong bolts flew the next morning, blowing the windscreen out at 17,300 feet with the captain half through the frame. Anchor two: Continental Express 2574, where the quality-assurance layer collapsed from the other side — the inspector became a second mechanic, removing leading-edge screws himself, and the release process signed an aircraft whose true configuration no inspector had independently verified. Fourteen died. The independent check is aviation maintenance's last technical barrier: two failures, one year apart, showed the two ways it dies — never required, or absorbed into the work it was supposed to check.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Classify safety-critical tasks — flight controls, structural attachments, pressure boundaries — as required inspection items demanding an independent check.
2. The independent inspector must not have performed, assisted, or supervised the work being inspected.
3. Inspect the work, not the story: physically verify fastener count, torque, rigging — against the full documented work scope.
4. Never let production pressure convert inspectors into extra mechanics; the moment they touch the task, independence is void and a new inspector is required.
5. Sign-off discipline: your stamp certifies what you personally verified, nothing more — a signature is a load-bearing structure.

ERROR COMMITTED
anchor: night shift of 8–9 June 1990,
THE ACCIDENT
anchor: 10 June 1990 — windscreen blowout at
IN BETWEEN: THE NEXT DAY

THE FACTS — CITED ✓ BA 5390: the windscreen was fitted and self-certified by the same Shift Maintenance Manager; the task was not designated a "Vital Point," so no independent check was required — AAIB causal factor. (AAIB AAR 1/92) ✓ Continental Express 2574: probable cause was the failure of maintenance and inspection personnel to adhere to proper maintenance and quality assurance procedures. ▸ full text in the card

Pattern anchors — British Airways Flight 5390, BAC One-Eleven, G-BJRT, 10 June 1990 (AAIB AAR 1/92) and Continental Express Flight 2574, EMB-120RT, N33701, 11 September 1991 (NTSB AAR-92/04). · Dirty Dozen: complacency, norms, fatigue, lack_of_communication · report: AAIB AAR 1/92 (EW/C1165) and NTSB/AAR-92/04

SATELLITE AIT & CLEAN ROOM

The 24 Bolts Someone Else Borrowed

✓ QA-passed poster (Gemini dual-lens) — Dan taste gate pending

CRITICAL | SERIOUS INCIDENT | ✓ OFFICIAL REPORT · NASA | PROCEDURAL

"The paperwork said the turn-over cart was configured. The RTE believed the paperwork. At 13 degrees of tilt, a $223-million weather satellite slid off the cart and hit the cleanroom floor — because another ▸ *full text in the card*

WHAT HAPPENED

At Lockheed Martin Space Systems in Sunnyvale, the NOAA N-Prime weather satellite was being rotated from vertical to horizontal on its Turn-Over Cart so the MHS instrument could be shimmed. While the cart had been sitting in a common staging area, another project — needing to install its own adapter — had removed the 24 bolts securing the TIROS adapter plate to the cart, and never communicated it to the NOAA team. No tag or indication marked the incomplete configuration. On the Saturday morning of the operation, the Responsible Test Engineer did not "assure" the cart's configuration through the physical and visual verification the procedures required — he assured it from paperwork of a prior operation. The government Quality Assurance Representative was notified at home but was absent for the operation's start, and a Mandatory Inspection Point was inappropriately waived. The spacecraft was lifted, secured to the unbolted plate, and rotated: at about 13 degrees of tilt it slipped off the cart and fell to the cleanroom floor, sustaining heavy damage. No one was injured.

THE CORRECT PROCEDURE THE ERROR VIOLATED

1. Treat shared ground support equipment as unknown configuration until physically verified — someone else's project may have changed it since you last saw it.
2. Configuration verification means eyes and hands on the hardware: count the bolts; paperwork from a prior operation proves only the past.
3. Any de-configuration of staged equipment gets tagged on the hardware and communicated to every project that uses it.
4. Mandatory Inspection Points are mandatory: waiving one requires the same rigor as the inspection itself.
5. If schedule pace is compressing verification steps, stop — a lifted spacecraft is a one-chance operation.

ERROR COMMITTED
the 24 adapter-plate bolts were removed
THE ACCIDENT
Saturday 6 September 2003; the spacecraft
IN BETWEEN: SAME DAY

THE FACTS — CITED ✓ The satellite fell because the TIROS adapter plate was not bolted to the turn-over cart with the required 24 bolts; another project had removed them while the cart sat in a common staging area, without communicating it to the NOAA team, and no tag marked the incomplete configuration. ▸ full text in the card

NOAA N-Prime (TIROS) spacecraft, Lockheed Martin Space Systems Company, Sunnyvale, California, 6 September 2003 — NASA NOAA N-PRIME Mishap Investigation Final Report, 13 September 2004. · Dirty Dozen: lack_of_communication, complacency, norms, pressure · report: NOAA N-PRIME Mishap Investigation Final Report, 13 September 2004