

Boeing 747 study notes

747E -> COMBI B-16403, B-16405, B-16408, B-16409 (Seats: 28+86+162=276)

747W-> All Passenger B-16410, B-16411, B-16412 (Seats: 36+56+280=372)

747Y -> Production Freighter B-16481, B-16482, B-16483

747Y -> SF Group B = B-16401, B-16402, Group A = B-16406, B-16407, B-16462, B-16463

Limitations

- Runway slope $\pm 2\%$.
- Max Tailwind for T/O and LDG 15 kts.
- Max operating altitude 45100'.
- Max T/O and LDG altitude 10000'.
- Max speed in RVSM airspace 0.9 Mach.
- Turbulent air penetration speed 290-310 / .82-.85M.
- Max altimeter difference between Capt and F/O on ground is 35' (SL-5000'). Between Capt or F/O and field are 75'. In-flight is 200' for RVSM operation. Overshoot / Undershoot 150' in RVSM.
- Crosswind for Takeoff / Landing - dry or damp 30 / 30. – wet 25 / 30.
- MTOW 394.6 Alternate (PAX,COMBI 317.5/SF 356.0). MLDW 285.7 / SF 295.7.
- Autopilot minimum engage altitude 250' after takeoff.
- Autopilot must be disengaged before MDA-50' or 100' AGL on single channel ILS approach.
- Use aileron trim with autopilot engaged is prohibited.
- Autothrottle must be disconnected by 50' RA for manual landings.
- Autoland is certified with 3 or 4 engines, up to MLDW, flaps 25 or 30, H/W25, X/W25(RVR<CAT1 15), T/W15, glideslope 2.5-3.25° and 4 Hydraulic systems.
- Engine EGT: 750(ground start or single in-flight start) / 870(40 seconds) / 925(MCT) / 960(T/O or Multi-engine in-flight start).
- Continuous ignition must be ON: Heavy Rain / Severe Turbulence / Volcanic Ash / Icing Condition / Standing Water or Slush on runway.
- Engine oil pressure Min 10 psi. Engine oil temperature Max 160 (175 for 15'), Max oil quantity after engine start 20L.
- Starter Max 5' (30" cool for each 1' period), after 2 consecutive 5' cycles, cool for 10'. No re-engagement above 20% N2. Do not cycle pneumatic valves during engine start.
- Max fuel temperature 54°C (Jet A, A1). Min fuel temperature 3C above fuel freezing temperature.
- Flaps limitation 20.000'. Speed brakes with flaps 20 is not recommended.
- Doors limits : 40 (operating)/65 (opened).
- APU operations, main battery switch must be ON, including 60-second cooldown.
- Windshield wiper < 250 kts.
- Low altimeter setting 29.70 / 1006, level-off within 2000' after transition, use FLCH.

RAM Limitations

- TOW ≤ 300 Tons, x-wind ≥ 15 kts and wet runway, use DERATE no ATM. See RAM 4.4.
- Brake INOP, Full TO and no ATM only.
- Flaps 20 only.

Limitations of DERATED / ASSUMED TEMP. METHOD

Conditions - **DERATED** / **ATM**.

- On Wet Runway - **YES / YES**
- On Slippery/Contaminated Runway - **YES / NO**
- Anti-skid Inop/Any Brake Inop (Using RAM) - **NO / NO**
- Any TR Inop on Wet /Slippery/Contaminated runway - **YES / NO**
- RVR is less than 350 meters - **YES / NO**
- Reported or Anticipated Windshear - **See Note / No**

Note: Use Full TO instead of derated thrust. Use of *derated thrust* ok if **Less than 250 tons** and the selected derated thrust still provide a substantial performance margin.

OPT Limitations

- TOW less than **200** Tons, use 200 Tons.
- TOW \leq **250** Tons, x-wind \geq **15**kts and wet runway, use RAM wet runway V1 correction.
- Brake INOP and wet runway, use RAM for takeoff performance.
- Contaminated or Slippery runway, No ATM by using OPT.

Bulletin

- Erroneous ILS Receiver Outputs – EIU SELECTOR.
- EICAS NO AUTOLAND after engine start – Call maintenance.
- Triple Flap Control Unit (FCU) Failure – FLAPS CONTROL NNC.
- All 6 Display Units go blank – Cycle EIU L and EIU C CBs.
- Erroneous ATC Message Downlink Anomaly – Use left CDU for downlink.
- Engine Flameout Mitigation – During descent or low power setting in icing condition, PACK HIGH FLOW and NACELLE ANTI-ICE - ON, WING ANTI-ICE (below 22000ft) – ON.
- FMC Direct-To with ABEAM PTS – Check OAT on WIND Page.
- >HYD QTY LOW 4 or >HYD QTY LOW 1 message – Do the NNC.
- Landing Gear Config Warning Anomaly – Verify GND PROX SYS status is not displayed on EICAS before engine start and GND PROX SYS advisory message is not displayed on EICAS after engine start and before takeoff.
- FMC Speed and Altitude Constraint – Use speed intervention.
- 747F – If lower lobe is AFT LOW or HIGH or BOTH LOW, turn AFT CARGO HEAT OFF before descend into humid area.
- 747SF – Turn CARGO TEMP to WARM before descend to humid area.

MEL

- A-> Remark. B-> 3 Days. C-> 10 Days. D-> 120 Days. (Day of Discovery is excluded)
- Category B,C one time extension OK.
- NO AUTOLAND message after engine -> contact maintenance.
- EICAS Cross-Reference List: N/A-> NOT APPLICABLE. None -> No Go, unless message is invalid STATUS message.

QRH

- Engine Severe Damage or Separation -> NNC 8.2 Fire.
- Verbal confirmation required: Thrust lever, Fuel control switch, Fire switch, Generator drive disconnect switch, IRS mode selector.
- Land at nearest airport if: NNC said so, or Smoke or Fire persists, or One main power source remains, or Continues flight is not safe.
- Memory items: CABIN ALTITUDE or Rapid Depressurization, Aborted Engine Start, ENG_ AUTOSTART, ENG_ FAIL or Multiple Engine Flameout or Stall, Engine Limit or Surge or Stall, FIRE ENG_ or Engine Severe Damage or Separation, IAS DISAGREE or Airspeed Unreliable.

Hydraulic

- Sys 4 AUX pump on first to avoid 1 or 2 fluid transfer to 4.
- No autoland with any hydraulic system inop.
- If system 4 failed, rapid extended spoilers will cause nose pitch up due to inboard spoilers inop (powered by sys 4).
- Spoilers powered by hydraulic system $\boxed{3/2/2/3}$ $\boxed{4/4}$ $\boxed{4/4}$ $\boxed{3/2/2/3}$
- Demand pump operates when related EDP output pressure low or related fuel control switch is CUTOFF. Demand pumps 1 & 4 also operate when flaps in transit or flaps out of UP in flight.

AutoFlight

- Multi channel engaged - LOC and G/S capture, below 1500'RA.
- Go-around disarmed and cannot be engaged when descends below 5 feet RA plus 2 seconds.
- Push TOGA switch, A/T provide 2,000 ft climb rate. Second push provides full go-around thrust.
- A/T change to HOLD mode at 65 knots.
- Autoland :
 - Europe – Check Jeppesen Airport Briefing for CAT II/III runways.
 - USA – Use applicable CAT II/III approach charts.
 - 1500' multi A/P engaged, ROLLOUT and FLARE armed, autoland status display LAND 2 or LAND 3, AC and DC buses 1, 2 and 3 are isolated from synchro bus (AC bus 4 still connected) BTB1,2,3 open, Electrical SYNOPTIC INHIBITED for Autoland..
 - 500' first alignment initiates a sideslip to reduce crab angle to 5 degrees.
 - 200' second alignment, CAUTION lights and beeper inhibited except AUTOPILOT, AUTOTHROTTLE DISC, NO AUTOLAND, SPEEDBRAKES EXT.
 - 50' FLARE engaged.
 - 25' IDLE.
 - 5' ROLLOUT engaged and wings are leveled. Reverse thrust will disengage A/T.

Emergency equipment

- Emergency lighting powered by its own battery lasts 15 minutes. Charge maintained by DC bus4.
- Emergency light control ARMED position - Lights on if DC powers lost.
- Oxygen bottle - Low flow 155 minutes. High flow 77 minutes.

Landing gear

- Tiller 70° , Rudder pedal 7° . Body gear 13° .
- Nose gear and body gear retract/extend by hydraulic 1, wing gear by hydraulic 4.
- Body gear steering activated with Nose wheel steering angle greater than 20 degrees and ground speed decreases through 15 kts. Centered and locked if GS increased through 20 kts or NWS less than 20 degrees.
- Autobrake (Landing) activate when - All 4 thrust levers IDLE and Main gear on ground, and Wheels spin up.
- Deceleration rate - 1=4 ft/s², 2=5 ft/s²..., Max= 11 ft/s².
- RTO with autobrakes armed, activated when ground speed > 85 kts and all thrust levers IDLE.
- Normal brake powered by hydraulic 4, alternate brake powered by 1 or 2. If loss hydraulic 4, 1 and 2, BRAKE SOURCE light illuminates.

Fuel system

- Ballast Fuel minimum=4,600kg
- Fuel tank capacities: 1+4=26,576. 2+3=76,263. CWT=52,167. Reserves=8,036. Stab=10,030. Total=173,072.
- Minimum ramp fuel 20 tons.
- CWT pumps ON if CWT > 7.7 tons.
- Fuel temperature displayed on EICAS is from main tank 1 (coldest fuel in cruise). Advisory message is displayed if below -37°C and temperature turns amber.
- Unjettisonable fuel - CWT 900kg. - MT 1 / 2 / 3 / 4 3,200kg.
- Reserve tank valves automatically opened when main tank 2 or 3 reaches 18,200kg.
- Fuel imbalance - between MT 2/3 > 2,700kg. - between MT 1/4 > 1,300kg. gone if < 450kg.
- Fuel temperature on EICAS is replaced with fuel-to-remain during jettison.
- FMC Alert Message: FUEL DISAGREE -> Totalizer and Calculated Δ > 4 Tons.
- FUEL DISAGREE: PROG 2 - Fuel Totalizer and Calculated values disagree by 4080 Kg or more.

Flight controls

- Outboard ailerons locked out with flaps up and airspeed above 235 kts.
- Spoiler lever in ARM position, all spoilers will be extended when airplane is on ground (main gear) and throttles 1 and 3 are in idle.
- Spoiler lever in DN position, all spoilers will be extended if reverser 2 or 4 idle & throttle 1+3 idle.
- Advance 1 or 3 throttle will retract ground spoilers.
- Alternate flaps extension position 25.
- Flap Load Relief: Flaps 25 or 30 and primary mode only.
- Shearout -> Inboard & Outboard Elevators. Rudder system.
- Override -> Control Wheels, control ailerons on corresponding wing.
- Spoilers

1 / 2 / 3 / 4	5 / 6	7 / 8	9 / 10 / 11 / 12
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In-flight Speedbrake= 3, 4, 5, 6, 7, 8, 9, 10. Roll Control= All except 6, 7. EICAS display= 4, 12.

Fire Protection

- COMBI: Fire Fighter = CM3 / L4 or L2, Assistant Fire Fighter = L4 / R4. MDCC equipment check OK by L4 from L5 interphone. Final pre-flight check by Fire fighter from R5 interphone.
- Engines – Dual loop Fire + Dual loop Overheat Detection (Warning if BOTH loops detect), Extinguisher (2 bottles each wing).
- APU – Dual loop Fire Detection. (Auto shut down if either loop detect). Extinguisher (1 bottle).
- Lower Cargo – PAX & COMBI 2-Dual loop, Freighter 4-Dual loop Fire Detection (Smoke detection), Extinguisher (Lower Cargo 4 bottles, COMBI main deck cargo 10 bottles).
- Main Deck – COMBI 4-Dual loop, Freighter – 16-Dual loop (BOTH loop detect)
- Wheel wells - Fire Detection.
- Lavatory – Smoke Detection, Automatic Extinguisher in waste bin.
- Crew rest – Smoke Detection.
- Fire warning lights and bell inhibited from V1 to 400' or 25 sec after V1.
- Overheat caution lights and beeper inhibited above 80 kts until 400' or 20 seconds after rotation. If RTO, inhibit lasts until speed below 75 kts.

Electrical

- Ground Handling Bus powered by APU GEN1 or EXT1, powers Lower cargo handling equipment, fueling system, AUX HYD Pumps 1 & 4.
- Freighter – Main Deck Cargo Handling Bus powered by EXT2 or APU2, powers main deck cargo handling equipment, lighting, nose and side cargo doors.
- Brake Power Transfer - Powered by one EXT PWR with SSB closed and then second EXT PWR selected ON. - Powered by one APU generator with SSB closed then second APU generator selected ON. - Either the L/H or R/H tie bus.

EICAS Inhibits

- From V1 to 400' RA or 25 seconds after V1- Engine fire bell and Master warning lights. -Cabin altitude/Overspeed siren and Master warning lights.
- From 80 knots to 400' RA or 20 seconds after rotation, or below 75 knots - Beeper and Master caution lights.

Warning

- Takeoff Configuration Warning, on ground and engine 2 or 3 thrust in takeoff range. - Body gear steering not centered. - Flaps not in takeoff position. - Spoiler lever not in DOWN. - Stabilizer not in takeoff range. - Parking brake set.
- Landing Config Warning, in-flight and any landing gear not locked down and ANY throttle at idle (Less than 800' RA) or landing flaps selected.

Call system

- SELCAL chime inhibited when airspeed greater than 80 knots and below 800'.

- To access priority line- Dial code 33 or Push CAB switch on ACP twice within 3 seconds.
- CVR records last 30 minutes. Push ERASE button more than 2 seconds erase tape on ground with parking brake set and AC power available.

APU

- Is not certified for in-flight start.
- Can be operated to 20,000ft.
- Can provide pneumatic to 15,000ft.
- No electrical power in-flight.
- Requires APU and main batteries.
- Main tank 2 (aft pump) supplies fuel.
- DC fuel pump backup (no AC or aft Inop)
- If DC and No2 aft pump inop, any other main tank pumps supply via xfeed.
- Two 90kva generators.

Pressurization

- Two outflow valves, each valve has two motors (AC for AUTO mode, DC for MAN mode). Both valves closed if cabin altitude > 11000' in AUTO mode.
- EICAS CAB ALT readout in amber above 8500'. And in red at or above 10000', turn amber when descend below 9500'. EICAS CABIN ALTITUDE message blank below 9500.
- Passenger oxygen activate automatically at CAB ALT 14000'.

Supplementary Procedure

- **DISPATCH WITH NON-STANDARD FUEL DISTRIBUTION** Condition: Fuel in the center wing tank, and wing tanks are less than full. On the DCS loadsheet, the maximum ZFW will be reduced by the amount of fuel in the center wing tank. A manual trim sheet is required to correctly determine the LITOW and MACTOW. If the ACARS or the computer load sheet specify the remark "APPLY NONSTANDARD FUELING" then a manual trim sheet is not required.
- **DISPATCH WITH UNUSABLE FUEL IN CWT** Condition: When the fuel remaining in the center wing tank is less than 1400kg with MEL item 28-15-2B or 28-15-1B (B-16401~402), which is considered "Unusable Fuel". Preflight - On the DCS loadsheet, unusable fuel will be included in the ZFW. In the FMS-CDU PERF INIT page:
 - on ZFW line, enter load sheet ZFW *minus* unusable fuel weight.
 - on RESERVES line, enter not less than CFP ALTN fuel plus FINAL RES fuel *plus* unusable fuel.
 - do not enter the unusable fuel amount in CWT into BALLAST line in the FMS-CDU PERF INIT page.
- **FUEL BALLAST** Combi: A minimum of 4,600 kg ballast fuel will be carried. Preflight - On the DCS loadsheet, ballast fuel will be included in the ZFW. In the FMS-CDU PERF INIT page: on ZFW line, enter load sheet ZFW *minus* ballast fuel weight. on RESERVES line, enter not less than CFP ALTN fuel plus FINAL RES fuel *plus* BALLAST fuel. on BALLAST line, enter ballast fuel weight. Cancel FUEL BALLAST QTY message. Ballast fuel should not be burned or jettisoned.
- **AIR SYSTEM FUEL PENALTY** apply if: Freighter/Special Freighter- LOWER LOBE CARGO COND

- AIR FLOW RATE selector operated. or Pax/Combi- RECIRC FAN switches operated.
- **HANDLING STRONG SMELLING CARGO IN LOWER LOBE CARGO COMPARTMENT:** Recirculation Fan switches Both OFF, Observe fuel penalty. Aft Cargo Heat switch - OFF
 - **GROUND CONDITIONED AIR USE:** Before connecting ground conditioned air- PACK control selectors OFF. Passenger/Combi: RECIRC FAN switches OFF. After disconnecting ground air conditioning cart- PACK control selectors NORM. Pax/Combi- RECIRC FAN switches ON.
 - **PUSH BACK WITHOUT APU AND EXTERNAL POWER:** In cases of APU inop and EXT power unavailable during push back, starting engine(s) at the gate before push back may be required. Start engine(s) with normal procedure or by the MEL then do the following procedure before push back. After engine(s) start: Position HYD DEMAND pump selectors 1 and 4 to AUTO.
 - **ENGINE GROUND PNEUMATIC START:** Start one engine at a time. Prior to engine start- Pack control selectors OFF, minimum duct pressure 30 psi. Accomplish normal engine start.
 - **ENGINE CROSSBLEED START:** Crossbleed start is not permitted during pushback. The aircraft must be parked and the tug disconnected before initiating a crossbleed start. If the thrust increase required for a crossbleed start is above the normal idle range, a clearance is required from both air traffic control and the ground engineer. Start one engine at a time. SP 7.1.
 - **APU INOPERATIVE – GENERATORS FAIL TO PARALLEL AFTER ENGINE START:** If possible, start two engines at the gate prior to disconnecting ground electrical power. If only one engine can be started at the gate, select #1 or #4 engine as the first engine to be started, putting #1 or #4 IDG on the synchronous bus. If either of the above is not possible, and/or remaining three IDGs fail to synchronize after all engines started: SP 6.1.
 - **ENGINE MANUAL START:** A manual engine start has to be performed when autostart is not possible or not desirable.
 - **ENGINE START VALVE MANUAL OPERATION:**
 - **APU-TO-PACK TAKEOFF:** After engine start- L and R ISLN valve switches OFF, Leave APU running to supply air to pack 2. Before takeoff- PACKS 1 and 3 control selectors OFF. After takeoff- After engine thrust is reduced to climb, one Pack Control selector to NORM. When cabin pressurization stabilizes, position remaining Pack Control selector to NORM. L and R ISLN valve switches ON, APU selector OFF.
 - **PACK OFF TAKEOFF:** Before takeoff- PACK Control selectors OFF. After takeoff: After engine thrust is reduced to climb and prior to reaching 3,000 feet AGL, position one Pack Control selector to NORM. When cabin pressurization stabilizes, position remaining Pack Control selectors to NORM
 - **LANDING AIRPORT ELEVATION BETWEEN 8,000 FEET AND 10,000 FEET:** SP 2.6
 - **HIGH CABIN TEMPERATURE DURING CRUISE:** SP 2.3.